THIRD WAVE LOCAL AUTHORITIES – TARGETED FEASIBILITY STUDY TO DELIVER NITROGEN DIOXIDE CONCENTRATION COMPLIANCE IN THE SHORTEST POSSIBLE TIME

Local authorities covered	Broxbourne Borough Council

Part 1: Understanding the problem

This section should set out background on the information about the road links projected to have exceedances in the PCM national model, in combination with source apportionment data, to provide a description of the severity of the NO2 exceedance and its possible sources and causes. It should set out the scale of the problem and the case for change. Maps and local data should be included. ***Each road link should be addressed in turn.***

Introduction

The Pollution Climate Mapping (PCM) national model has identified that Broxbourne Borough Council (the Council) have one road link (Census ID 78365) projected to have an exceedance of the annual mean EU Limit Value of 40µg/m^3 for nitrogen dioxide (NO_2). The road link under consideration is a section of the A10, from its junction with B198 to the slip road leading towards the A1170/B156 roundabout. This road link is managed by Hertfordshire County Council's Highways Team.

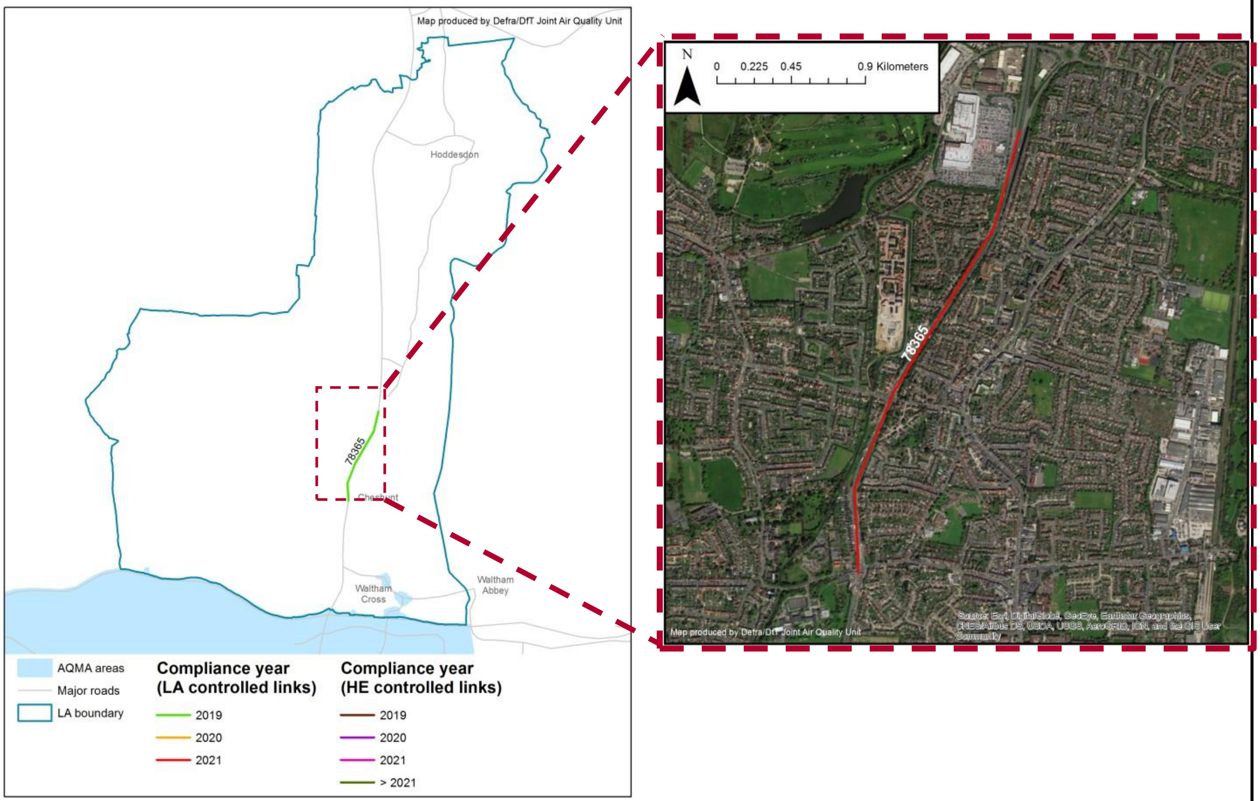
In line with the Ministerial Direction, this Targeted Feasibility Study (TFS) sets out the Council's work undertaken to:

- Characterise the air quality issue along the A10 PCM exceedance stretch, as identified in the national modelling; and
- Identify measures which could reduce the concentration of NO_2 along the A10 PCM exceedance stretch as quickly as possible, with the principal objective of bringing forward compliance with the statutory annual mean EU Limit Value.

This TFS report has been prepared by the Council with consultancy support provided by Bureau Veritas UK Ltd.

Figure 1 details the location of the A10 PCM exceedance stretch.

Figure 1 - Predicted A10 PCM Exceedance Location in Broxbourne

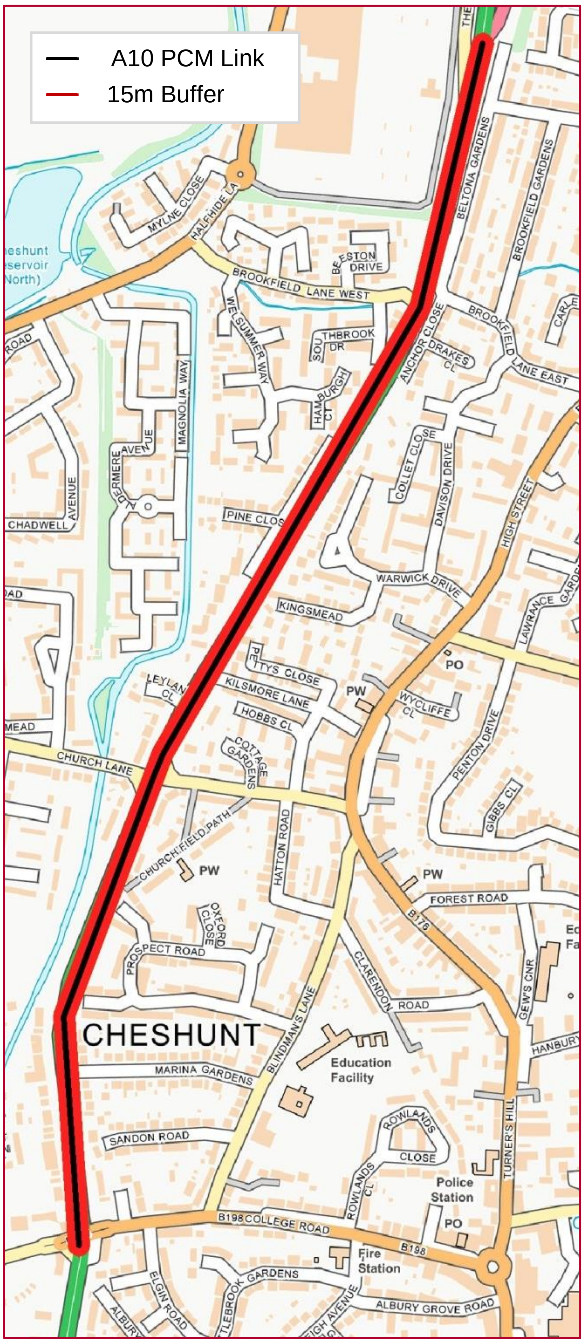


Public Access and Exposure

The Council have undertaken spatial analysis using a 15m buffer around the A10 PCM exceedance stretch. The analysis confirmed that there is relevant public access and associated exposure that meets the provided criteria (Figure 2).

There are approximately 80 residential properties situated within 15m of the PCM exceedance stretch and a pavement that runs parallel to the majority of the road link. Therefore, there is a potential for public access and exposure to pollutant concentrations associated with road traffic emissions arising from the A10.

Figure 2 - Spatial Analysis with 15m buffer around the A10 PCM Exceedance Stretch



PCM Findings

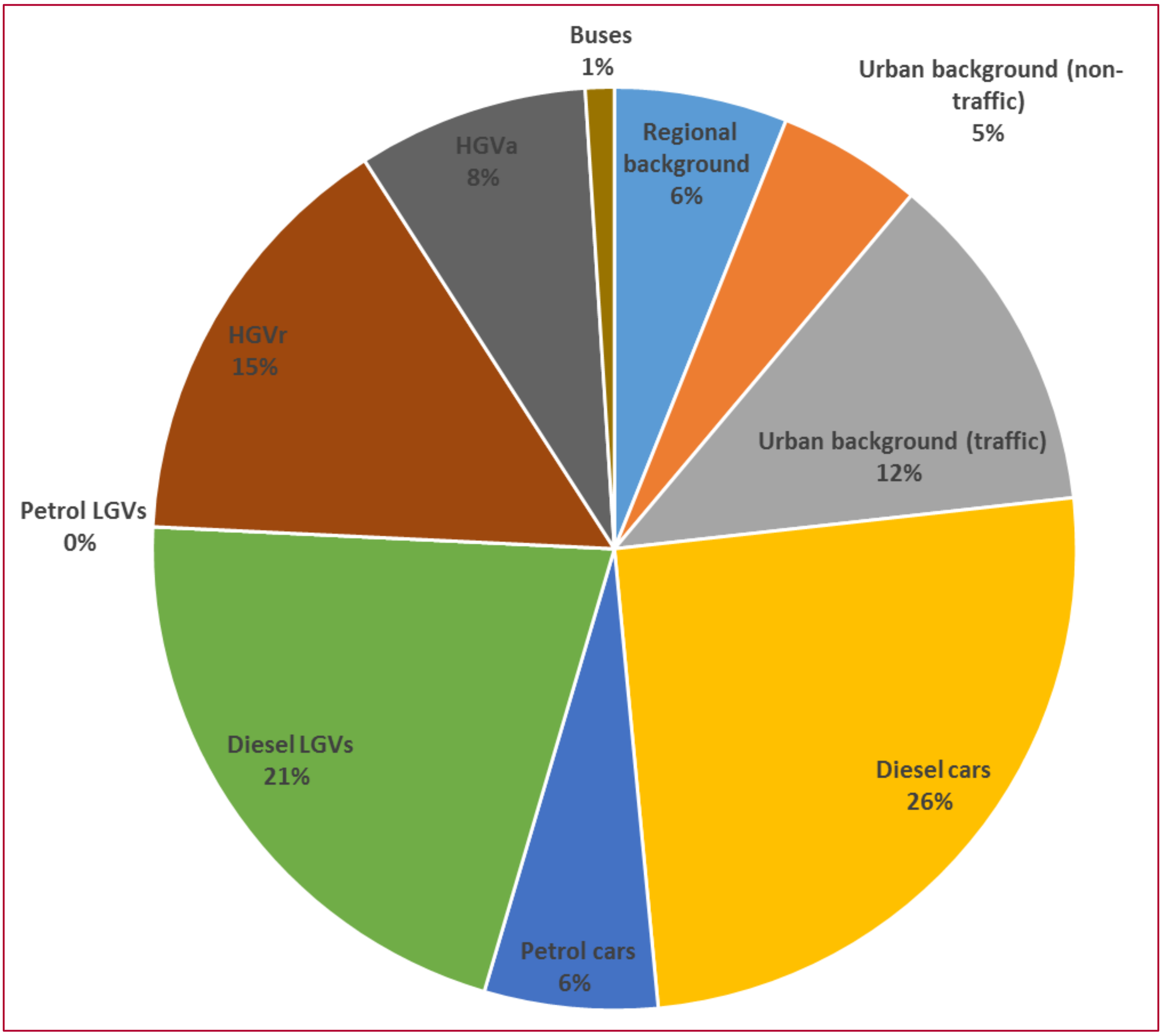
The results from the PCM model show that the Census ID 78365 road link is predicted to have the following annual mean NO_2 concentrations, with compliance with the annual mean NO_2 EU Limit Value of 40µg/m^3 achieved in 2019.

- $44\mu g/m^3$ in 2017;
- $41\mu g/m^3$ in 2018;
- $39\mu g/m^3$ in 2019;
- $37\mu g/m^3$ in 2020; and
- $35\mu g/m^3$ in 2021.

In line with PCM predictions, compliance could therefore be brought forwards if annual mean NO_2 concentrations are reduced by at least $1\mu g/m^3$ in 2018. A $4\mu g/m^3$ reduction in annual mean NO_2 concentrations would have been required to achieve compliance in 2017.

The PCM data shows that in 2015 (the most recent national modelling base year), the source contributors to total NO_X concentration on this road link were as illustrated in Figure 3. It is worth noting that over time, the relative contribution to total NO_x concentrations from difference sources will change in line with changes to the local fleet composition and traffic flow parameters.

Figure 3 - PCM based Total NO_x Concentration Source Apportionment (2015)



The PCM based NO_x source apportionment would suggest that in 2015, 23% of the total NO_x concentration are attributable to regional and urban background sources (including traffic), whilst the remaining 77% is associated with local road traffic sources. Of this 77%, diesel cars have been identified to be the principal source, contributing 26% of the total NO_x. Petrol cars comparatively contribute significantly less at only 6%. Diesel LGVs contribute 21%, whilst rigid and articulated HGVs contribute towards 23% of the total. Buses are predicted to contribute only 1% of the total NO_x concentration.

The PCM model utilises traffic data from the Department of Transport (DfT) traffic counts database, which are in turn used to calculate the corresponding vehicle emissions for input on each modelled road link. For PCM Census ID 78365, the traffic data from corresponding DfT count point (ID 78365 - E 535490, N 203000) has been applied. The DfT traffic data for the year 2014 was based upon a manual count, whereby trained enumerators count traffic by vehicle type over a 12 hour period. This raw data is then combined with information from a network of Automatic Traffic Counts (ATCs) to calculate a series of Annual Average Daily Flows (AADF) with associated fleet composition. The 2015 traffic data was estimated based on the 2014 AADF.Figure ***4*** shows the traffic composition at DfT count point ID 78365 for the 2015 year, for which a total AADF of 44,034 was recorded with a Heavy Duty Vehicle (HDV) proportion of 5.5%, whilst the general AADF trend at this location since the year 2000 is provided in

Figure ***5***.

Figure 4 - Fleet Composition on the A10 PCM Exceedance Stretch, as defined on DfT count point ID 78365 (2015)

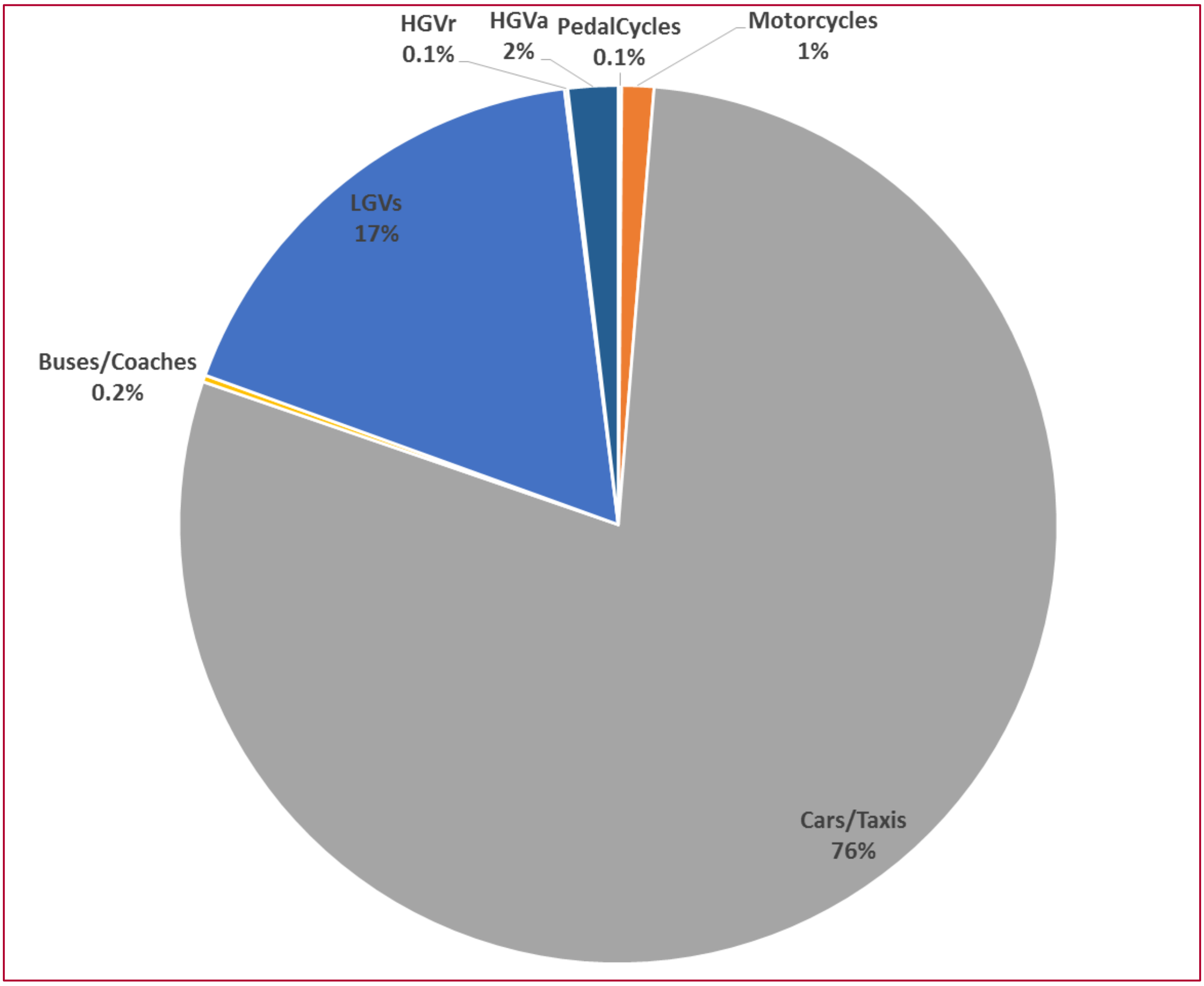
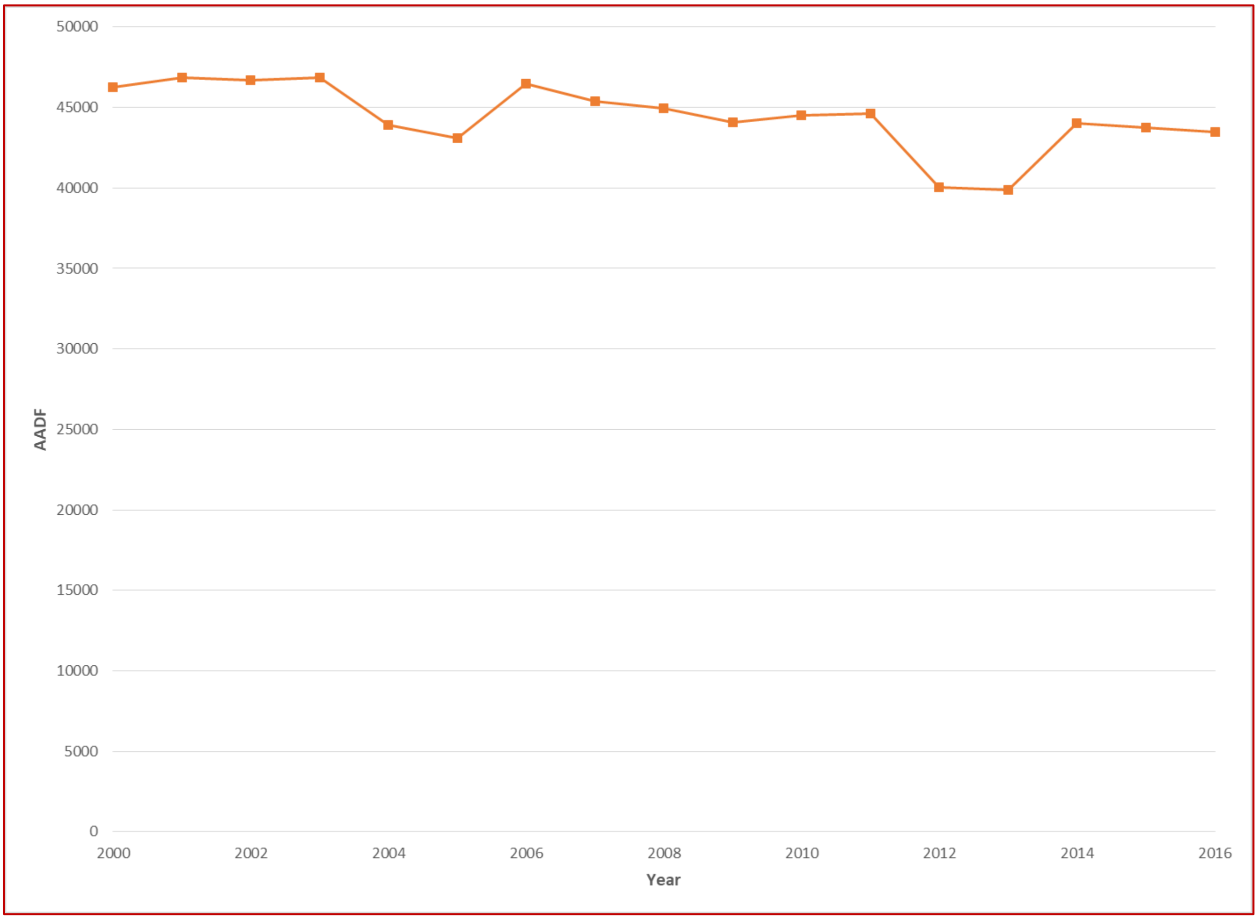


Figure 5 - AADF Trend on the A10 PCM Exceedance Stretch, as defined at DfT Count Point ID 78365



Local Information

The A10 PCM exceedance stretch has been previously highlighted through the Local Air Quality Management (LAQM) regime to be at risk of exceeding the annual mean NO_2 UK Air Quality Strategy (AQS) objective. As such, an Air Quality Management Area (AQMA 6, Great Cambridge Road (A10) & College Road) was declared in May 2017 encompassing dozens of residential properties and a school along the A10 and College Road, from the Theobalds Lane junction up to the Brookfield Centre (B156 Flyover and B156/A10 Slip Road). Monitoring surveys have therefore been undertaken in the vicinity of the study area to quantify the extent of the potential for exceedance.

In addition to collating various pre-existing local datasets, a local dispersion modelling exercise has been undertaken in ADMS-Roads, outputs from which provide an improved insight into the risk to compliance with the annual mean NO_2 objective along the A1231 PCM exceedance stretch, including updated source apportionment results to be used to better direct possible measures.

The model was verified using 2017 monitoring data collected at diffusion tubes BB09, BB27, BB28 and BB35. A local growth factor has been applied to the 2016 DfT traffic data, from count point ID 78365, to estimate 2017 traffic flows within the PCM exceedance stretch (2017 DfT traffic counts were not published at the time of undertaking the study). The latest version of the Emissions Factors Toolkit (EFT version 8.0.1.a) and associated LAQM tools have been used within the modelling exercise. Further information with regards to the model inputs can be found in Annex 1.

The following section therefore details the available pre-existing local information, and the findings of local monitoring surveys and local dispersion modelling undertaken by the Council, to inform the extent of any further intervention required to achieve compliance along the A10 PCM exceedance stretch.

Local Context

The A10 is a major road in England which runs from London Bridge in the London Borough of Southwark to the Norfolk port town of King's Lynn. Within the Broxbourne Borough Council area, the A10 is classified as a dual carriageway and runs through the centre of the borough from north to south. It has been highlighted as one of Hertfordshire's most heavily trafficked routes, offering a key road link to London, London Airports, the M25, Cambridge and Dover. The PCM exceedance stretch is prone to traffic congestion due several junctions with local roads situated along this stretch of the A10.

A Tesco Extra and Marks & Spencer is located at the northern edge of the PCM exceedance stretch, however the main land use along the majority of the A10 PCM exceedance stretch is residential, with many dwellings situated directly adjacent to the road. The M25 is located approximately 2km from the southern edge of the identified section of road and therefore a high proportion of the traffic flows will be associated with commuter traffic to and from London.

Local Air Quality Monitoring

Two local Council monitoring sites (BB09 and BB28) meet the siting requirements of the Ambient Air Quality Directive (AAQD). The Council air quality monitoring data for these two sites, and several others within the study area, provide a useful insight into the air quality along the A10 PCM exceedance stretch, and so are presented and discussed within this section.

The Council do not operate any continuous monitoring sites. The nearest roadside Automatic Urban and Rural Network (AURN site) (Haringey Roadside Station) is located 11km south on High Road, adjacent to the A10. The AURN is the UK air quality monitoring compliance network, which reports compliance against the Ambient Air Quality Directive (2008/50/EC). According to the DfT traffic count for this road link, the AADF in 2016 was estimated to be 15,501 (ID 73479 - E 533900, N 191210). This is significantly less than what was estimated along the A10 PCM exceedance stretch and therefore this AURN site is not considered to be representative of the air quality experienced along the A10 PCM Exceedance stretch.

The Council monitor NO_2 using a network of passive monitoring sites across the Borough, encompassing 39 passive diffusion tube sites in 2017. The closest of these sites are BB09, BB28 and BB40, which are all located on the A10 within the PCM exceedance stretch. Annual mean NO_2 concentrations for 2015, 2016 and 2017 are detailed in Table 1 for these three locations.

Table 1 - Diffusion Tube Annual Mean NO_2 Concentrations

Site ID	X	Y	NO_2 Annual Mean Concentration (µg/m^3)		
			2015	2016	2017
BB09	535310	202374	**48.5**	**54.3**	**50.7**
BB28	535448	202959	**67.3**	**73.3**	**71.2**
BB40**[1]	535314	202244	-	-	**40.1***

All concentrations have been bias adjusted.
*Annualised, concentration based on only 3 months of data.
** BB40 was rejected by JAQU as the monitoring site is located within 25m of a major junction, but is nevertheless provided for reference.
Bold denotes exceedance of the annual mean AQS objective for NO_2.

Exceedances of the annual mean AQS objective for NO_2 have been reported at all three diffusion tube sites within the A10 PCM exceedance stretch. The highest annual mean NO_2 concentration recorded by the Council in 2017 was at monitoring site BB28, with a concentration of 71.2µg/m^3 recorded. By way of comparison, BB29 and BB34 are situated just north and south of the A10 PCM exceedance stretch respectively. Concentrations reported in 2017 for these two locations were below the annual mean AQS objective for NO_2, with 37.3µg/m^3 reported at BB29 and 37.7µg/m^3 at BB34. This suggests that the geographical extent of the exceedance stretch as predicted by the PCM national model can be considered to be fairly accurate.

With regards to exposure, BB41 and BB42 are located at residential properties on roads that run parallel to the A10, approximately 20m from the edge of the A10. 2017 annual mean NO_2 concentrations at BB41 and BB42 were reported as 39.2µg/m^3 and 38.5µg/m^3 respectively, suggesting that it is not only properties situated directly on the A10 that are exposed to elevated NO_2 concentrations derived from heavy traffic on this road link, but also those located along Beltona Gardens, Pettys Close, Warwick Drive and Anchor Close.

The Council are therefore not surprised that this area has been identified by the PCM national model as an exceedance stretch as it supports the findings from their own LAQM monitoring undertaken in the study area.

Local Traffic Flows

The DfT derived AADF figures for 2016 on the A10 have been compared to the 2016 Annual Average Weekday Flow (AAWD) figures sourced from the Hertfordshire Highways

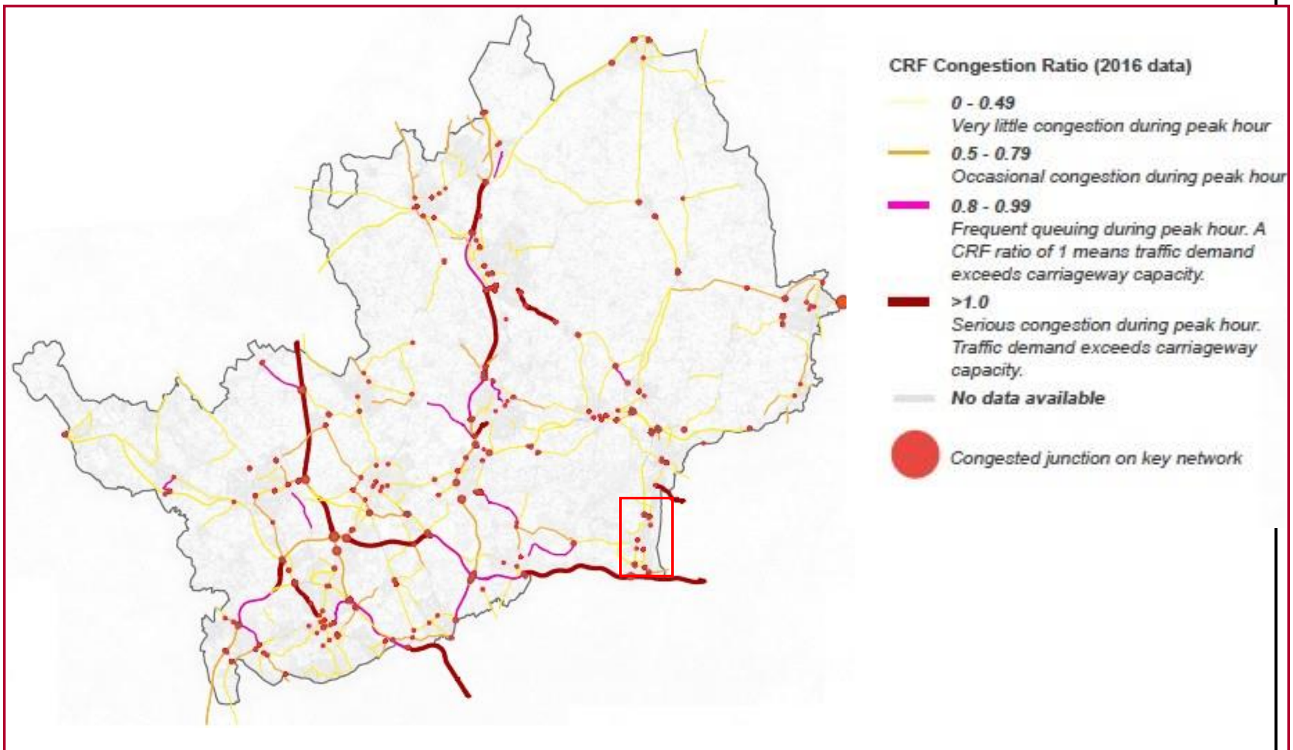
[1] Note this monitoring site does not meet the AQD siting requirements

Information website[2]. AAWD flows are derived from observations between 06:00 and 22:00 on each weekday. Hertfordshire County Council generally quotes the AAWD for a road. Despite the slight difference in units of measurement, a general comparison can be made between the DfT AADF and Highways AAWD figures. The DfT count point is situated within the A10 PCM exceedance stretch (ID 78365 - E 535490, N 203000) and the Highways count point is situated on the A10 just south of the B198 junction (E 35266, N 201935).

In 2016 the DfT estimated an AADF of 43,494, with a HDV AADF of 2,276 (equivalent to a HDV proportion of 5.2%). The Highways AAWD flow was counted as 45,601, which is 2,107 greater than the DfT count. The AAWD is expected to be slightly higher than the AADF as the weekend traffic will likely be less and therefore bring down the AADF slightly. The DfT traffic flow information applied in the PCM is therefore considered to be comparable to other local surveyed traffic flows for the A10 PCM exceedance stretch.

Figure 6 replicates the findings presented in Figure 3.1.1 of the Hertfordshire Traffic and Transport Data Report (2017), which details the peak hour congestion routes in Hertfordshire. The red box shows the area where the A10 PCM exceedance stretch is located. It can be seen that there are congested junctions along this route, with the A10 PCM exceedance stretch considered to have "occasional congestion during peak hour".

Figure 6 - Hertfordshire Congestion Corridors



[2] http://webmaps.hertfordshire.gov.uk/highwayspub/index.htm?layers=[5:15,18]

Local Dispersion Modelling

A local dispersion modelling study was undertaken to assess annual mean NO_2 concentrations across the A10 PCM exceedance stretch, with 2017 taken to be the baseline year. The ADMS-Roads model (version 4.1.1) and the EFT version 8.0.1.a were used for the purposes of the study, with traffic data used as input to the model derived from a combination of available sources, including:

- 2016 DfT traffic count data (AADF and fleet composition); and
- 2015 traffic data included in the Detailed Assessment of Air Quality for Broxbourne Borough Council, submitted by Air Quality Consultants in 2016 to inform the declaration of the AQMAs in Broxbourne.

Where required, traffic data inputs were factored to the baseline year of 2017 using a factor calculated using local trends from Hertfordshire County Council Highways data (2007 to 2016). A factor of 0.9917 was applied to 2015 flows, whilst a factor of 0.9634 was applied to adjust 2016 flows to the baseline year of 2017.

Annual mean NO_2 concentrations were predicted for the 2017 baseline scenario at receptors plotted 4m from the kerb and at least 25m from major junctions along the A10 PCM exceedance stretch (38 receptors to facilitate direct comparison against the PCM model predictions – referred to as 'Discrete receptors'). All receptors were included at a height of 2m.

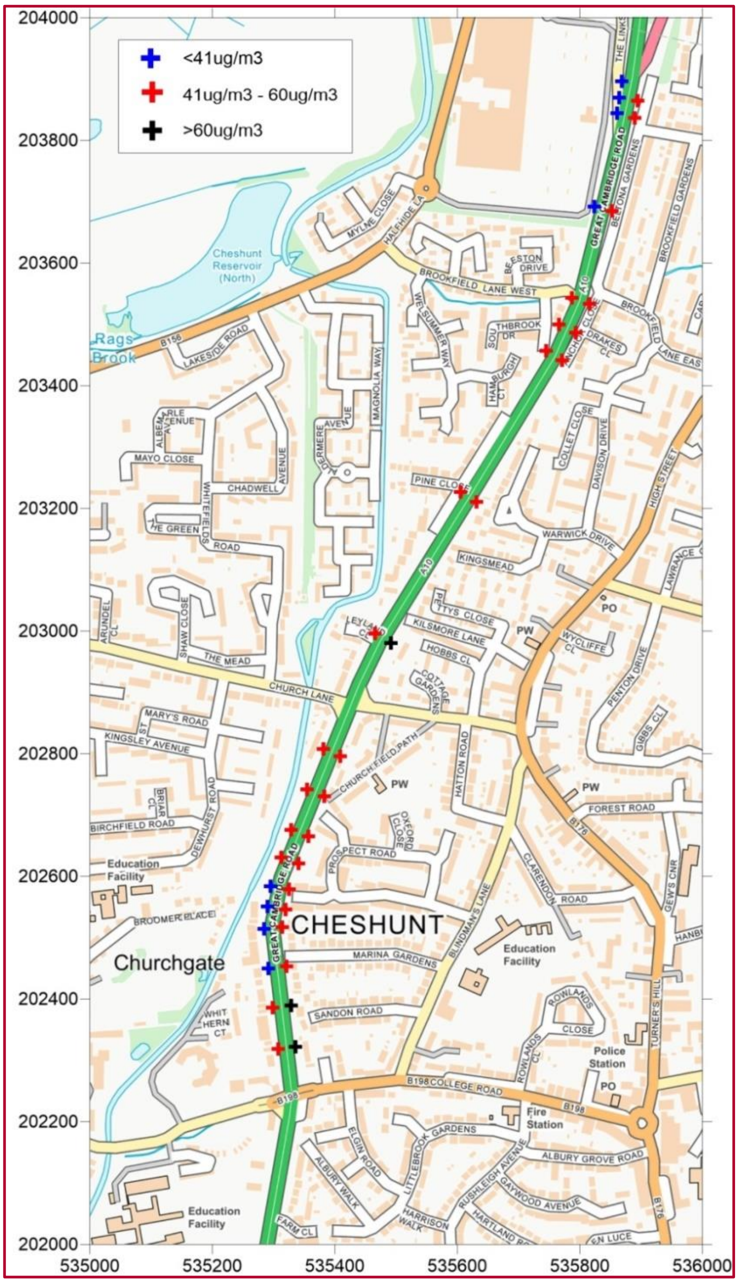
Details of the model inputs and model verification process can be found in Annex 1, whilst Annex 2 provides the model predicted annual mean NO2 concentration results.

Local Dispersion Modelling Results – Discrete Receptors

Out of the 38 discrete receptors modelled, 29 predicted annual mean NO_2 concentrations above the EU limit value of 40µg/m^3 for the 2017 baseline year. Of these 29 receptors, 3 predicted NO_2 concentrations above 60µg/m^3. The maximum annual mean NO_2 concentration at a discrete receptor along the A10 PCM exceedance stretch was predicted to be 77.0µg/m^3 at discrete receptor 25. This is significantly higher than the EU limit value of 40µg/m^3, suggesting compliance along Census ID 78365 is unlikely to be achieved by 2019, as predicted by the PCM national model.

Figure 8 below details the locations of the discrete receptors that are predicted in 2017 to be exceeding the annual mean EU limit value for NO_2 of 40µg/m^3. A complete set of results can be found in Annex 2.

Figure 7 - Discrete Receptors Exceeding the Annual Mean EU Limit Value for NO_2 in 2017



Local Dispersion Modelling Results - Source Apportionment

To help inform the development of measures listed in Part 2 of the TFS, source apportionment of road traffic vehicle categories has been undertaken as a function of the total NO_X concentration. Table 2 and Figure 8 show results for the source apportionment exercise based on the modelled discrete receptors, for the modelled baseline year of 2017.

Source apportionment results have been calculated for three different selections of the modelled receptors:

1. Average across all modelled receptors – This provides an average at all modelled receptors and so is useful when considering possible measures to test and adopt. It will however understate road NO_x concentrations in problem areas;
2. Average across all receptors with NO_2 concentrations greater than 40µg/m^3 – This provides an average at receptors exceeding the EU limit value. This provides an indication of source apportionment in areas known to be a problem and so would hopefully show greater results when testing and adopting measures; and
3. At the receptor with maximum road NO_x concentration - Provides the NO_x source apportionment at the receptor with the highest predicted road NO_x concentration. This is likely to be in the area of most concern and so a good place to test and adopt measure. Any gains predicted by measures are however likely to be greatest at this location and so would not represent gains across the whole modelled area.

When considering the average NO_x concentration across all modelled receptors, road traffic accounts for 54.4µg/m^3 (70.4%) of 77.3µg/m^3. Of this 54.4µg/m^3, Cars account for the most (28.3%) of any of the vehicle types. LGVs also account for a relatively high proportion of the overall predicted NO_x concentration at 24.5%.

When considering the average NO_x concentration at receptors with an NO_2 concentration greater than 40µg/m^3, road traffic accounts for 73.1µg/m^3 (75.8%) of 96.4µg/m^3. Of this 73.1µg/m^3, Cars account for the most (30.1%) of any of the vehicle types. LGVs also account for a relatively high proportion of the overall predicted NO_x concentration at 25.2%.

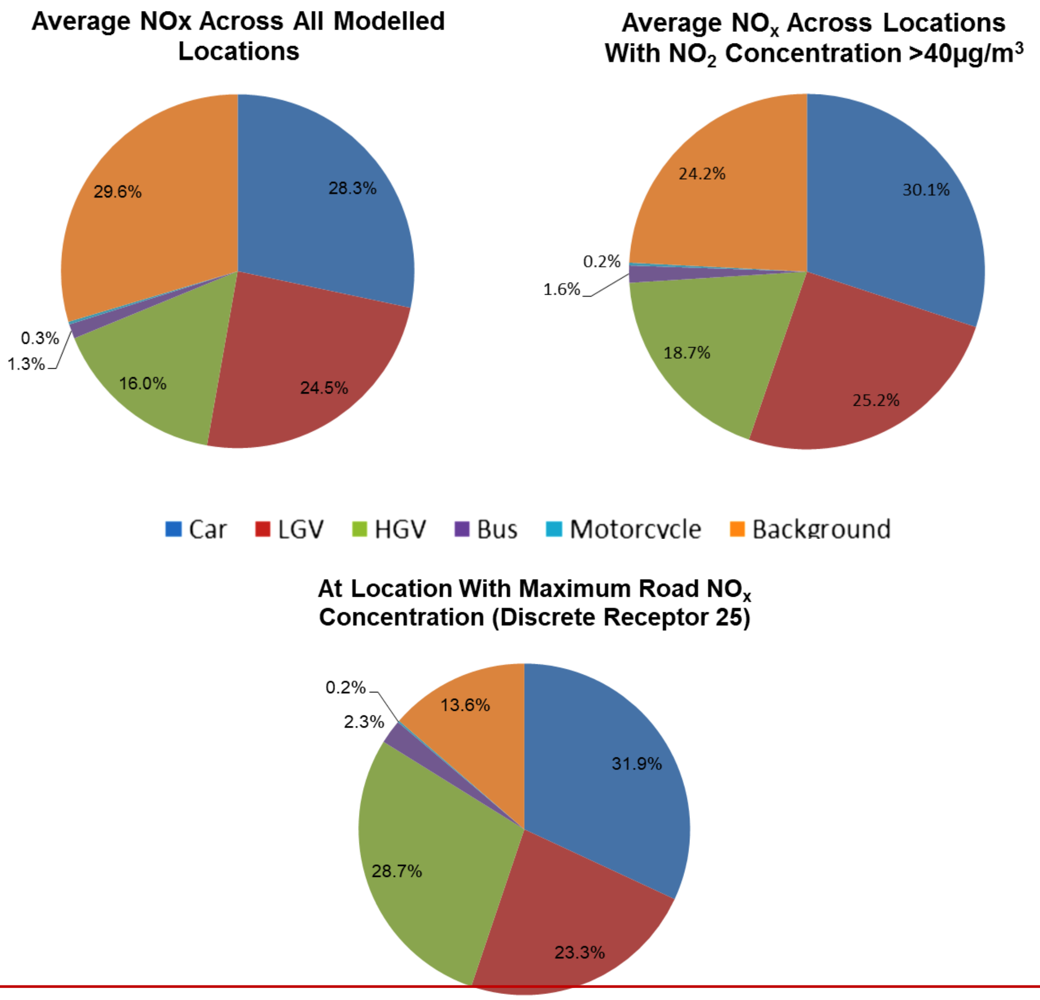
At the receptor with the maximum road NO_x concentration (Discrete receptor 25), road traffic accounts for 151.9µg/m^3 (86.4%) of 175.8µg/m^3. Of this 151.9µg/m^3, Cars account for the most (31.9%) of any of the vehicle types. HGVs are the second highest contributor to the overall predicted NO_x concentration at 50.4µg/m^3 of NO_x representing 28.7% of the overall predicted NO_x concentration.

Table 2 - Source Apportionment Results

Results	All Vehicles	Car	LGV	HGV	Bus	Motorcycle	Background
Average Across All Modelled Receptors							
NO_x Concentration (µg/m^3)	54.4	21.9	18.9	12.4	1.0	0.2	22.9
Percentage of Total NO_x	70.4	28.3	24.5	16.0	1.3	0.3	29.6
Percentage Contribution to Road NO_x	100	40.2	34.8	22.8	1.9	0.4	-
Average Across All Locations With NO_2 Concentration Greater Than 40µg/m^3							
NO_x Concentration (µg/m^3)	73.1	29.0	24.3	18.0	1.5	0.2	23.3
Percentage of Total NO_x	75.8	30.1	25.2	18.7	1.6	0.2	24.2
Percentage Contribution to Road NO_x	100	39.6	33.3	24.7	2.1	0.3	-
At Location With Maximum Road NO_x Concentration (Discrete receptor 25)							

NO_x Concentration (µg/m³)	151.9	56.1	40.9	50.4	4.1	0.3	24.0
Percentage of Total NO_x	86.4	31.9	23.3	28.7	2.3	0.2	13.6
Percentage Contribution to Road NO_x	100	37.0	26.9	33.2	2.7	0.2	-

Figure 8 - Pie Charts showing Source Apportionment Results (NO_x Concentrations)



Local Dispersion Modelling Results - Summary

The discrete receptor modelled concentrations suggest there is a greater problem than originally predicted by the PCM national model. In comparison with the PCM results, the local dispersion modelling has predicted much higher NO_2 concentrations suggesting compliance will not be met by 2019. Furthermore, the 2017 diffusion tube results for BB09 and BB28, which are both situated along the A10 road link, also report concentrations significantly above those predicted by the PCM national model.

The reason for the difference between the PCM national model predictions and those obtained from the local dispersion model is likely to be two-fold:

- Improved resolution of local data model inputs to the local dispersion model, i.e. traffic flows, fleet composition, average vehicle speeds, queuing parameters and road geometry. This will reduce the number of assumptions that are otherwise adopted in the PCM national modelling; and
- Verification of the local dispersion model against local air quality monitoring data, which will improve the accuracy of the model concentration predictions. The PCM national modelling is only verified against monitoring data obtained from the AURN, monitoring sites of which are more sparse and further from the study area.

The Joint Air Quality Unit (JAQU) have validated the local dispersion modelling exercise and have concluded that it provides for an accurate reflection of the air quality along the A10 PCM exceedance stretch. The Council therefore consider that the findings from the local dispersion modelling exercise supersede the PCM national model predictions, thereby providing for a revised baseline air quality position along Census ID 78365, i.e. the annual mean NO_2 concentration results from the local dispersion model replace the PCM model predictions. It has also been agreed that the projected local dispersion modelling results should form the basis of assessing whether any measures will help to bring forward compliance.

On this basis, it is therefore concluded that further consideration to possible measures to be implemented is required, with non-compliance against the annual mean EU limit value of 40μg/m^3 for NO_2 suitably demonstrated in 2017 along the A10 PCM exceedance stretch (Census ID 78365).

Part 2: Developing a long list of measures for addressing the exceedances

This section should provide a long list of possible measures to be considered for each road link. Local authorities should consider the source apportionment set out in part 1.

The NO_x source apportionment presented in Part 1 of this study has been taken in to account when developing a long list of measures for addressing the exceedances. This showed that cars are the biggest local transport contributor to NO_x concentrations on the A10, followed by LGVs then HGVs.

The Broxbourne Transport Strategy (September 2017) addresses some of the key issues with regards to congestion on the A10. It highlights the need to balance priorities in the approach the Strategy takes to providing the highway capacity on the A10 to cater for the future increase in demand to travel. The intention is to ensure capacity improvements in the area do not draw in additional trips from other strategic north-south links such as the A1 and M11. Furthermore, the Broxbourne Local Plan (2018-2033) contains seven overarching objectives including a specific desire in relation to transport to:

> *"Ensure that growth and regeneration can be effectively and safely accommodated by Broxbourne's transport network and that as many journeys as possible are by bus, rail, walking and cycling so that people have a safe, viable and attractive alternative to driving".*

The A10 has been recognised as an important road link where many of the strategic measures have been focused. As a consequence, improvements are already being made to ensure congestion and worsening of traffic is avoided in future years. Furthermore, the A10, including the PCM exceedance stretch, has been declared as an AQMA, which acknowledges the need to implement further air quality focused measures to reduce pollution levels on this road link.

The Council are presently focusing on the development of a Single Air Quality Action Plan to cover the AQMA No.1 extension, AQMA No.4 Eleanor Cross Road, AQMA No.5 Monarchs Way, AQMA No.6 Great Cambridge Road/College Road and AQMA No. 7 High Road. The PCM exceedance stretch is located within AQMA No.6. Therefore several measures that will be promoted within the AQAP will have direct implications on this road link. The AQAP will provide a robust, evidence-based plan for the Broxbourne AQMAs and will reflect good practice, whilst taking into account political, financial and practical considerations inherent in reducing emissions.

The following list of measures have been developed with some delivered since the identified baseline year of 2015 for projected exceedance. Some of these interventions have already been delivered through a range of funding streams which provide improvements designed to increase capacity and reduce congestion to benefit the operation of the highway network. The main benefits will include improvements to journey times, improved capacity and through flow at junctions. In terms of air quality benefits, these improvements will allow reductions in car idling time and the resultant reductions of NO_x and NO_2 emissions at junctions in this locality. Other measures proposed are longer term and are also described below.

Existing Measures

- Dissemination of Up to Date Information About Air Quality (Completed Annually)

Results of NO_2 diffusion tube network are updated annually on the Broxbourne air quality webpages to promote awareness of air quality issues in the Borough. Webpages were also updated to include maps of the existing AQMAs which have been declared for exceedances of annual mean NO_2. Educating the public of the existing air quality issues is intended to motivate changes in behaviour to ensure that the physical measures which are implemented have a good success rate.

- Travel Planning – Various (On-going)

Use of planning conditions and obligations to require developers to adopt measures which will reduce transport emissions such as requesting travel and business plans and installing electric vehicle recharging infrastructure. A number of sites within Broxbourne have included cycle parking facilities, electric vehicle charging points and travel plans to meet planning conditions.

There are further proposals to extend the implementation of Area Wide Travel Plans with employers in Hoddesdon, Waltham Cross, Brookfield and Park Plaza with an emphasis on monitoring the success of enforced measures.

Travel Plans are also being considered at all schools across the Borough to manage school drop-off and pick-up peak times. Personalised Journey Planning for specific target groups will also help to manage transport routes.

The Council have in place a car pool which is used by staff to reduce the number of private vehicles being driven to the Council offices. Plans to promote a wider car share scheme have been proposed.

Promotion of cycling routes in the Borough is on-going. Includes the provision of routes and maps for cycling which are periodically produced and updated by Sustrans. There are further proposals to significantly increase the volume of cycle parking at key trip generators within Broxbourne. Further information can be found in the Draft Local Cycling and Walking Infrastructure Plan (2017) which details several measures to prioritise cycle and walking access.

Proposed Measures with Funding Secured

- New Bus Service – Between High Leigh and Broxbourne Station

Funding has been secured for the provision of a new bus service to run every 30 minutes between High Leigh and Broxbourne Station via Hoddesdon Town Centre. The High Leigh

Development will provide £600,000 of subsidy for the service over a five year period. Estimated further cost for continued service over a 10 year period is £2,400,000. The provision of the new bus route is designed to encourage alternative modes of transport through Broxbourne to alleviate the pressure on the A10. Implementation is expected within 5 years of the Local Plan being in place and therefore should be completed by 2021.

- New Bus Service – Between Park Plaza and Walthamstow Cross Station

Working with News International to provide a new bus service running every 15 minutes between Park Plaza and Waltham Cross Station via Waltham Cross Town Centre. A cost of £3,000,000 has been secured to cover the capital costs over a 10 year period. The bus service will encourage the use of public transport by ensuring there is a regular service from the train station to the town centre. Implementation is expected within 5 years of the Local Plan being in place and therefore should be completed by 2021.

- M25 J25 Capacity Improvements

Highways England is committed to funding the M25 J25 capacity improvement scheme in 2020. The work will help reduce the levels of congestion and delays currently experienced by vehicles trying to enter and exit the M25. Although the A10 is not part of the Highways England Strategic Road Network (SRN), the A10 crosses over the M25 which is part of the SRN. Therefore any material changes in the operation of this strategic link will have implications on the A10 and Broxbourne as a whole. Funding of £26,900,000 has been secured based on Broxbourne's preferred scheme.

Proposed Measures

- At Grade Improvement at College Road/A10 Junction

A proposal has been submitted to provide additional northbound and southbound lanes at the junction and increased length of northbound left filter into College Road, and banning all right turns. The intention is to alleviate congestion at the junction. Capital required is estimated to be approximately £1,000,000. Implementation is expected within 5-10 years and therefore should be completed by the end of the Local Plan period of 2033. In regards to bringing forward improvements of the NO_2 concentrations along the A10, this proposed measure may be too long term for consideration.

- Various A10 Junction Improvements

Proposed schemes have been considered to modify the existing 3-am junction on the A10 to provide an at-grade 4-am junction for access into Park Plaza North & West. Further junction amendments have been proposed at the A10 junction with the A121 Monarch's Way and B198 Lieutenant Ellis Way (Park Plaza junction) to provide a 'hamburger' style signalised junction with N/S priority at the intersection. The combined capital cost required for these two schemes is estimated to be £8,200,000. Implementation is expected within 5-10 years and therefore should be completed by the end of the Local Plan period of 2033. In regards to bringing forward improvements of the NO_2 concentrations along the A10, this proposed measure may be too long term for consideration.

- At Grade Improvement at Church Lane/A10 Junction

A capacity improvement scheme has been proposed at Church Lane/A10 junction to provide an additional north-south lane through the junction and ban all right turns and left turns onto the A10. Improvements will aim to manage the traffic flow onto the A10 from the junction to reduce queues and congestion. Capital requirement is estimated to be approximately £1,000,000. Implementation is expected within 5-10 years and therefore should be completed by the end of the Local Plan period of 2033. In regards to bringing forward improvements of the NO_2 concentrations along the A10, this proposed measure may be too long term for consideration.

- Halfhide Lane Link Road

Construction of a new link road immediately to the west of the A10 providing a link from Halfhide Lane north to Hell Wood, where it turns westwards to connect to the Turnford Link Road via a new roundabout, and south to 'The Links' to provide access to Tesco and from the A10 off-slip. Additional link road will reduce build-up of traffic around junction reducing the formation of queues. The design proposal is still required and therefore cost is based on similar proposals. Capital requirement is estimated to be approximately £6,000,000. Implementation is expected within 5 years of the Local Plan being in place and therefore should be completed by 2021.

- New Bus Services from Local Train Stations

There are currently several proposals in discussion with regards to the introduction of new bus services between various train stations and town centres within the Borough. New train stations are also being considered at Turnford and Park Plaza West. The introduction of a stronger public transport network is designed to reduce the pressure on the A10 as the main road link through the Borough to the town centres. Implementation is expected within 5 years of the Local Plan being in place and therefore should be completed by 2021.

- Introduction of Selective Vehicle Detection Systems

A proposal has been considered to introduce selective vehicle detection systems to provide a priority for buses along the old A10. The intention would be to improve the convenience of taking public transport in comparison to a private vehicle therefore reducing the number of cars on the surrounding roads. Capital requirement is estimated to be approximately £80,000 however further assessment is required to determine feasibility. Implementation is expected within 5 years of the Local Plan being in place and therefore should be completed by 2021.

Other Potential Measures

- Review Taxi/Private Hire Vehicle Policy license fees to promote low emission vehicles by ranking charges based on emission levels i.e. lowers fees = lowers emissions.
- Ensure permits and licenses issued by the Council for markets, concessions, and events include standard terms and conditions to ensure good air quality, such as restricting use of solid fuel or generators using diesel or petrol.

- Corridor focused pedestrian improvements to improve the accessibility of town centres within the Borough, focusing on improved crossing points, wider footways and street furniture.
- Car Club - Targeted provision of additional electric car club vehicles.
- Flexible working and home working encouraged
- Provision of high quality, bespoke and accessible information on sustainable travel through personalised journey planning, real time information displays and the use of smartphone based technology to enable individuals to make more informed travel choices.
- Replacement of mini-roundabouts with signal controlled junctions in several locations on the local road network to provide better management of conflicting traffic flows.
- The development of multi-modal interchanges at Broxbourne, Cheshunt and Waltham Cross Stations.
- Promotion of Rail complimented by Station Accessibility Audits - Promotional activity through campaigns. Accessibility Audits carried out at main stations.
- Implementation of Public Transport Infrastructure Improvements - Implementation of Public Transport Infrastructure RTI, enhanced shelters, raised kerbs, bus priority etc.
- Workplace Capital Grant Scheme - Capital grants to encourage the use of sustainable travel modes, such as, cycle storage, lockers and showers.
- Getting about campaign and dedicated travel website - Area wide behaviour change campaign, travel website providing journey planning advice, Area Cycle / Bus maps, promotional activity on-going etc.
- Parking enforcement - Decriminalised parking powers secured, parking enforcement officers target hotspots. CCTV camera car enforces at school zig-zags and bus stop clearways.
- Multi modal / operator smartcard - ITSO compliant smartcard. Backed up with promotional campaigns, bus info via Getting about website etc.
- Behaviour change campaigns to reduce single occupancy car trips - Commuter Challenge, Bike Week, Walk to School Month, etc.
- Transition Travel Choices Campaign - Campaign to target travel behaviour change for those going through key transition in life, i.e. changing jobs, moving house, etc.
- Promotion of sustainable development - Work with Development Control team to support development designed to minimise reliance on private car.
- No idling campaign - Promote no idling campaign at main junctions.
- Job Seeker Travel Scheme - Working with Job centres to promote cycling through bike voucher scheme and training.
- Apprentice Travel Scheme - Assisting apprentices' access employment and learning through sustainable travel.
- Closure and relocation of public access points – re-routing of public footpaths and open spaces to locations away from exceedance area.

Part 3: Assessing deliverability/feasibility and delivering a short list

For each of the measures identified in part 2, local authorities should set out an assessment of deliverability including how long it would take to deliver each measure and whether it is practicably feasible to deliver. Based on this assessment of deliverability and *feasibility, the local authority should develop a short list of measures to take forward to part 4 of the report.*

Existing Measures

As discussed in Part 2 of this study, there are a couple of measures that are already being implemented that will likely help towards bringing forward compliance along the A10 PCM exceedance stretch. These will be continued as planned and include:

- Dissemination of Up to Date Information About Air Quality (Completed Annually) - A soft measure designed to help educated the public to raise awareness of air quality issues in the Borough; and

- Travel Planning - Use of planning conditions to require developers to adopt measures designed to reduce transport emissions, with a focus on those developments which will have an impact on the A10 PCM exceedance stretch.

New Measures

In this section, consideration if given to whether any of the measures included in the long list in Part 2 of this study are practically deliverable in time to be able to bring forward compliance on the A10 road link. It should be noted that the base year dispersion modelling carried out as part of this study have predicted greater exceedances than those reported by the PCM model. Furthermore, the monitoring data along the A10 stretch have shown concentrations well above the annual mean NO_2 AQS objective. Therefore the measures that will be brought forward to Part 4 in this study have been selected such that their outcomes may also continue past the proposed PCM compliance year of 2019.

Refer to Annex 3 - Measures Matrix Table which summarises the findings of an evaluation of each proposed measure to determine the likelihood of successful implementation and suitability for further analysis of likely outcomes. A summary of the measures which have been scoped out and those which will be carried forward can be found below.

Measures Rejected due to Deliverability Issues

The original list in Part 2 contained several measures which could be potentially delivered to achieve compliance. After careful consideration, the following have been rejected due to deliverability issues:

- *Measure No. 4: At Grade Improvement at Church Lane/A10 Junction*
- *Measure No. 5: Various A10 Junction Improvements*
- *Measure No. 6: At Grade Improvement at Church Lane/A10 Junction*

The above three measures are part of the Broxbourne Transport Strategy and will be implemented as part of the Local Plan commitments. However, with regards to bringing forward compliance along the A10 PCM exceedance stretch, the time frames for implementing the improvements are beyond those required to impact compliance. As a minimum, deliverability is expected to be between 5 and 10 years.

- *Measure No. 11: Issue of permits and licenses for markets, concessions and events to ensure good air quality* – Although this measure would be straight forward to implement and will improve air quality in the Borough as a whole, it is not specific to the A10 PCM exceedance stretch. There are no areas along this road link where markets, concessions and events are likely to take place.
- *Measure No. 12: Corridor focused pedestrian improvements* – Due to the nature of the Borough, widening footways and improving pedestrian access to town centres in Broxbourne will be difficult due to the narrow roads and congested town centres. This measure is also unlikely to have a significant impact on the A10 PCM exceedance stretch.
- *Measure No. 16: Replacement of mini-roundabouts with signal controlled junctions* – There are no mini-roundabouts along the A10 that could be changed to signal controlled junctions. Junctions are a hot spot for pollution along the A10 PCM exceedance stretch however they are already controlled by signals. Furthermore, implementation of such a measure will likely take a long time in order to secure funding and involve all relevant stakeholders.
- *Measure No. 17: Promotion of rail complimented by Station Accessibility Audits* - In order to successfully implement this measure a dedicated role will be required to carry out audits and focus on the promotion of rail activities. Additional funding would be needed for such a role and it is unlikely to significantly impact the PCM A10 exceedance stretch. Therefore it is considered that resources are best placed elsewhere.
- Measure No. 19: *Workplace capital grant scheme* – This measure will require investment by businesses which will inevitably result in a delay in moving this forward. Therefore it is likely to take longer to achieve than the short listed measures detailed below. Nonetheless, involving local business to encourage changes in commuting behaviours amongst employers will help show a united stance across the Borough.
- *Measure No. 21: Parking enforcement* – This measure is not strictly applicable to the A10 PCM exceedance stretch as there are not many areas along the road link where parking is available. The congestion found on the A10 is not associated with parked cars blocking the roadway and therefore this measure was deemed to not be applicable.
- *Measure No. 22: Multi modal/operator smartcard* – Funding will need to be secured to support the integration of smartcards into the public transport network. Will need to work with all transport operators in the Borough which will take time to build relationships and assess feasibility of implementation. If it is carried out it will likely be a long time before improvements are realised.
- *Measure No. 25: No idling campaign* – Similar to measure No. 21, idling vehicles are not a significant issue along the A10 PCM exceedance stretch. It is also difficult to enforce successfully as it requires wardens patrolling the area to issue fines. This measure has therefore been scoped out as it will not significantly improve NO_2 concentrations along the A10.
- *Measure No. 27: Closure and relocation of public access points* – There are no viable re-routing options available at the most sensitive locations of exceedance. This measure is also an avoidance measure rather than designed to directly improve air quality. It will not help to bring forward compliance and therefore has been scoped out.

Shortlisted Measures

The long list of measures detailed in Part 2 of this study has been narrowed down to a shortlist of 10 measures which will be taken forward to Part 4. These measures can be delivered sufficiently quickly, are practically feasible, and are most likely to bring forward compliance on the A10 PCM exceedance stretch. Each of the measures has been assessed in terms of deliverability, taking into account factors such as the time it will take to implement the measure, whether there is the necessary infrastructure in place and the amount of resources required. In comparison to those measures that have been scoped out on feasibility grounds, the following are considered to be the most appropriate measures in order to bring forward compliance.

- *Measure No. 9: Travel Plans* – Travel plans have already been implemented within the borough however there are more opportunities for plans to be prepared to target specific groups. Travel plans at schools are relatively easy to implement and will help alleviate traffic during drop-off and pick-up peak times. It will also have the added benefit by generating a more in depth understanding of travel demands in the borough. It is likely that raising awareness amongst targeted groups via the implementation of travel plans will have an impact on behavioural transport patterns and in turn reduce congestion on the main thoroughfare through Broxbourne (the A10).
- *Measure No. 10: Taxi/Private hire vehicle license fees* – Targeting taxis and private hire vehicles will help to reduce emissions on the road network. Incentives will encourage low emission vehicles with the intention to remove diesel vehicles entirely. It is a straight forward measure to implement that will have a direct impact on the types of vehicles travelling along the A10.
- *Measure No. 13: Car club/Car sharing schemes* – The Council already have a car pool in place which is working successfully. Extending this car share scheme will be relatively straight forward to do as the framework is already in place. The aim will be to reduce the number of single occupancy trips travelling through the borough.
- *Measure No. 14: Flexible working and home working encouraged* – Will help reduce traffic flows during peak times. Can be implemented fairly quickly by engaging with local businesses. Should reduce the amount of commuter traffic using the A10.
- *Measure No. 15/20: Provision of accessible information on sustainable travel/Dedicated travel website* – Provision of a dedicated website for public facing materials will help to raise awareness of sustainable modes of transport. Will act as a centre point for feeding information of other measures which are designed to encourage behavioural changes e.g. Measure No. 14 and No. 23. Combined implementation of these behaviour measures will have the most success in reducing the use of private vehicles which is the largest source of NO_2 emissions on the A10 PCM exceedance stretch.
- *Measure No. 18: Implementation of public transport infrastructure improvements* – Improvement to bus shelters will help encourage the use of buses across the Borough. Buses do not contribute to a significant source of NO_2 emissions on the A10 PCM exceedance stretch which suggests buses use alternative routes through the towns. Shifting people away from the A10 by travelling on public transport should reduce the emissions associated with cars on the A10. Is relatively easy to implement if the funding is available.
- *Measure No. 23: Behaviour change campaigns* – Educating the public and changing attitudes towards public transport will have an overarching positive

impact. Combined with other listed measures, a modal shift is possible along the A10.

- *Measure No. 24/26: Transition travel choices campaign/ job seeker and apprentice travel schemes* – Targeting specific groups of people who are already about to change their routine will be an easy way of changing attitudes. Will provide alternative options to those who may not have necessarily considered different transport routes. Will be easy to implement in a short space of time and will have a knock on effect on the vehicle composition of the A10.

Notable Measures

The below 5 measures are part of the Broxbourne Transport Strategy and therefore there is not much flexibility on when these measures will be implemented. Nonetheless, the measures could indirectly improve air quality along the A10 PCM exceedance stretch despite not being undertaken on the A10 itself. As there is limited control as to how and when these measures will be implemented they have not been included in the TFS, principally because quantification of the likely improvements directly to the A10 are too uncertain at this time.

- *Measure No.1: New bus service between High Leigh and Broxbourne*
- *Measure No.2: New bus service between Park Plaza and Waltham Cross Station*
- *Measure No. 3: M25 J25 Capacity Improvements*
- *Measure No. 7: Halfhide Lane link road*
- *Measure No. 8: Introduction of selective vehicle detection systems*

Due to the relatively short time frame available to implement measures designed to bring forward compliance, the nature of the measures have been focused on changing behaviours rather than physical changes to the road network which will take time and resources to implement. The short list of measures selected to move forward to Part 4 will therefore be evaluated further to determine the likelihood of bringing forward compliance.

Part 4: Evidencing the short listed measures to identify options that could bring forward compliance

In this section, local authorities should set out the likely effectiveness of the shortlisted measures in bringing forward compliance. Local authorities should assess each option against the Primary Critical Success Factor.

From the completion of Part 3 above a shortlist of ten measures has been taken forward to the Part 4 stage of the Target Feasibility Study, these are:

- Measure 9 - Travel plans.
- Measure 10 - Review Taxi/Private Hire Vehicle Policy license fees to promote low emission vehicles by ranking charges based on emission levels i.e. lowers fees = lowers emissions.
- Measure 13 - Car Club / Car Sharing Schemes.
- Measure 14 - Flexible working and home working encouraged.
- Measure 15 - Provision of high quality, bespoke and accessible information on sustainable travel through personalised journey planning, real time information displays and the use of smartphone based technology to enable individuals to make more informed travel choices.
- Measure 18 - Implementation of Public Transport Infrastructure Improvements - Implementation of Public Transport Infrastructure RTI, enhanced shelters, raised kerbs, bus priority etc.
- Measure 20 - Getting about campaign and dedicated travel website - Area wide behaviour change campaign, travel website providing journey planning advice, Area Cycle / Bus maps, promotional activity on-going etc.
- Measure 23 - Behaviour change campaigns to reduce single occupancy car trips - Commuter Challenge, Bike Week, Walk to School Month, etc.
- Measure 24 - Transition Travel Choices Campaign - Campaign to target travel behaviour change for those going through key transition in life, i.e. changing jobs, moving house, etc.
- Measure 26 - Job Seeker Travel Scheme - Working with Job centres to promote cycling through bike voucher scheme and training. Apprentice Travel Scheme - Assisting apprentices' access employment and learning through sustainable travel.

These measures had been taken forward as they have been initially assessed as the most likely measures to positively effect NO_2 concentrations along the exceedance link and to help achieve compliance in the fastest time possible. Each measure will impact the existing traffic fleet that passes on the A10, the impact upon the fleet has been identified over three areas:

- **Impact on Road Traffic Flow** – A change in the number of a certain vehicle type within the total number of vehicles for the road link, reducing numbers within the vehicle type and also affecting the percentage mix of vehicle types.
- **Impact on Vehicle Fleet Composition (Engine Type and/or Euro Standard)** – Upgrading the fleet composition within a vehicle fleet to show a greater proportion of the fleet are lesser polluting vehicles, therefore reducing the overall emissions from the fleet.
- **Impact on Average Vehicle Speed** – Changing the speeds of vehicles passing

through the road link by alleviating congestion to allowing traffic to become more free-flowing or imposing a certain speed limit that matches a certain emission bracket for the majority of polluting vehicles.

Measures Testing

The 2017 baseline dispersion modelling and the air quality monitoring data review (presented in Part 1), suggest NO_2 concentrations reported along the A10 PCM exceedance stretch are significantly worse than previously predicted by the PCM national model. The local dispersion modelling has been accepted by JAQU in place of the PCM predictions, and therefore forms a revised baseline position with regards to air quality along the PCM exceedance stretch.

The local dispersion model was run in future years to ascertain when compliance will likely be achieved. Traffic inputs were factored to each future year using the relevant Trip End Model Presentation Program (TEMPro) factors. TEMPro is a modelling tool designed to allow users to look at the growth in trip ends, using actual and forecast data supplied by the DfT. The following growth factors were applied to adjust the 2017 flows:

- **2018:** 1.0123
- **2019:** 1.0245
- **2020:** 1.0367
- **2021:** 1.0489
- **2022:** 1:0571
- **2023:** 1.0654
- **2024:** 1.0736
- **2025:** 1:0818
- **2026:** 1.0900
- **2027:** 1.0981
- **2028:** 1.1062

Table 3 details the annual mean NO_2 concentrations at the worst-case receptor (R25) between 2017 (baseline year) and 2028 (the year compliance is achieved), in the absence of any intervention measures being implemented, as predicted by the local dispersion modelling exercise. The receptor R25 is located at grid reference point 535335, 202322, which is on the east side of the A10 PCM exceedance stretch, approximately 72m north of the College Road Junction.

Table 3 - Model results for all years without measures

Year	Annual Mean NO_2 Concentration ($\mu g/m^3$)	Year	Annual Mean NO_2 Concentration ($\mu g/m^3$)
2017	77.0	**2023**	51.9
2018	72.7	**2024**	48.6
2019	68.4	**2025**	45.6
2020	64.4	**2026**	43.1
2021	59.9	**2027**	40.7
2022	55.5	**2028**	38.7

It can be seen that assuming no measures are implemented, compliance with the annual mean EU limit value for NO_2 will not be achieved until 2028. Further modelling and assessment was then carried out to determine the ability for the implementation of the above short-listed measures to bring forward compliance from 2028. For each measure, a quantification of the potential improvements associated to the measure has been identified based on similar identified schemes that have been implemented across the UK. The impact upon the fleet, as discussed above, has been split into three areas (impact on road traffic flow, vehicle fleet composition and average vehicle speed). In addition, to assess against the Primary Critical Success Factor (PCSF), an initial quantification of annual NO_x emissions (kg/yr) has been completed for each individual measure to estimate possible NO_x reductions. To complete this quantification the Emissions Factors Toolkit (EFT) v8.0.1.a has been used.

The impact of each measure and the estimated annual NO_x emissions (kg/yr) is shown below.

Measure 9 - *Travel Plans*

Impact on Road Traffic Flow:

3% reduction in total car numbers.

Travel plans are designed to change behaviours towards travel. Studies such as Cairns et al, 2004 and Newson, Cairns and Davies, 2010 have shown that work travel plans can reduce car use by between 5 - 10%, which would have a direct impact on the number of cars on the roads. School travel plans can show similar improvements, reducing the number of pupils using private vehicles to get to school. In a case study of a school in Devon, over a three year period the number of children travelling by car almost halved.

It is very difficult to estimate exactly what impact this will have on the number of cars travelling on the PCM exceedance stretch as it is largely dependent on the uptake of travel plans and the number of the cars using the PCM link travelling to work/school. A conservative working assumption of 3% reduction in cars on the PCM exceedance stretch has presently been assumed for this measure.

Impact on Vehicle Fleet Composition:

No impact from measure.

Travel Plans can be used to encourage the uptake of electric and low emission vehicles. This could alter the composition of the vehicle fleet and increase the number of low emission vehicles on the roads. Currently 26% of the NO_x emissions on the PCM exceedance stretch are associated with diesel cars. Travel plans will likely help reduce the number of diesel cars on the roads which will in turn help to reduce NO_x emissions. However, uptake is likely to be slow and therefore changes to fleet composition are unlikely to be significant. Therefore, for the purposes of this study it has been assumed no change will occur to vehicle fleet composition.

Impact on Average Vehicle Speed:

No impact from measure.

The introduction of travel plans won't directly impact vehicle speeds. However, a reduction of vehicles on the local road network will likely increase speeds slightly by reducing the number of queues and congestion. No evidence has been sourced detailing studies quantifying the likely reduction in queuing traffic as a function of travel plans and therefore it is difficult to assume a change in speed in order to assess the change in NO_x emissions. A conservative approach has therefore been taken, which is to maintain the current speeds as assumed in the base scenario.

Estimated Maximum NO_x Annual Emissions (with measure):

2018: 5,638kg/yr - Reduction of 77kg/yr

2019: 5,238kg/yr - Reduction of 477kg/yr

2020: 4,856kg/yr - Reduction of 859kg/yr

2021: 4,475kg/yr - Reduction of 1,240kg/yr

Measure 10 - Review Taxi/Private Hire Vehicle Policy license fees

Impact on Road Traffic Flow:

No impact from measure.

A review of taxi/private vehicle policy is unlikely to reduce the number of vehicles using the PCM exceedance stretch. The measure will focus on changing the fleet composition to shift towards more low emission vehicles rather than removing vehicles entirely. Therefore, there is unlikely to be any change to actual traffic flow numbers.

Impact on Vehicle Fleet Composition:

0.5% increase in Euro 6 car vehicles and a 0.5% decrease in Euro 2-4 car vehicles.

A breakdown on the number of taxis using the PCM exceedance stretch is unfortunately not available. However, it is known that approximately 76% of the total traffic flow is derived from a combination of cars, which includes taxis. The PCM exceedance stretch is a key road link to London and London Airports and therefore use of the A10 by taxis is likely to be quite high.

The measure will only be able to influence changes to taxi/private hire vehicles within Broxbourne. A phased approach, similar to one carried out in York which offers discounts that can be put towards the purchase of new or used low emission vehicles, with a deadline of all drivers meeting certain Euro standards by a specified year, is considered most feasible. The case study is documented in Local Measures to Encourage the Uptake of Low Emission Vehicles, Good Practice Summary Guide.

In regards to the impact on the vehicle fleet composition, it has been assumed there will be a slight shift towards Euro 6 vehicles and a reduction in the older Euro 3 and 4 vehicles.

Impact on Average Vehicle Speed:

No impact from measure.

Similar to the impact on traffic flow, there is unlikely to be any change in average vehicle speed on the PCM exceedance stretch. Focus is on fleet composition rather than number of vehicles on the road and their average speed.

Estimated Maximum NO_x Annual Emissions (with measure):

2018: 5,704kg/yr - Reduction of 11kg/yr

2019: 5,301kg/yr - Reduction of 414kg/yr

2020: 4,915kg/yr - Reduction of 800kg/yr

2021: 4,536kg/yr - Reduction of 1,179kg/yr

Measure 13 - Car Club / Car Sharing Schemes

Impact on Road Traffic Flow:

Car traffic flow reduced by 50 vehicles.

Car club members typically reduce their annual household mileage and car ownership. According to one study completed by Cairns and Harmer (https://como.org.uk/why/), 30.6% of those surveyed reduced their car ownership after joining a car club. Therefore, the impact on traffic flow whilst positive may not be of a level which will achieve the PCSF, depending on who chooses to join the scheme.

There is expected to be an overall reduction of cars on the roads. For each vehicle introduced as part of the club car, 10.5 vehicles are estimated to be removed from the road. This is dependent on uptake of the scheme and the number of cars available in the programme. For the purposes of this study it has been conservatively estimated that there will be a reduction of 50 cars travelling on the PCM exceedance stretch.

Impact on Vehicle Fleet Composition:

No impact from measure.

Car Clubs substitute private vehicles with electric vehicles or low emission vehicles. Car Club cars will be the latest Euro standards.

Will likely alter the Euro standard composition on the road. However, the change in composition is unlikely to be substantial as the change will be small compared to the number of other cars on the road. It is estimated that 76% of the traffic along the PCM exceedance stretch are cars/taxis. Nonetheless, 26% of total NO_x emissions are currently associated with diesel cars. A reduction in diesel cars on the roads will be evident which will have some impact on NO_x emissions.

Based on the assumption that only 50 cars will be removed, the shift in fleet composition is not likely to aid achievement of the PCSF and so has not been assessed.

Impact on Average Vehicle Speed:

No impact from measure.

Average speeds along the PCM exceedance stretch will likely increase due to the reduction in number of cars as the uptake of Car Club membership increases. Increase in speed will be associated with a reduction in congestion on the road. Change in speed however is unlikely to aid achievement of the PCSF and so has not been assessed.

Estimated Maximum NO_x Annual Emissions (with measure):

2018: 5,711kg/yr - Reduction of 4kg/yr

2019: 5,309kg/yr - Reduction of 406kg/yr

2020: 4,923kg/yr - Reduction of 792kg/yr

2021: 4,539kg/yr - Reduction of 1,176kg/yr

Measure 14 - Flexible working and home working encouraged

Impact on Road Traffic Flow:

No impact from measure.

Flexible working and home working will help reduce the number of private vehicles on the roads during peak times. Dependent on uptake from local businesses, there is potential to slightly reduce the traffic flow on the PCM exceedance stretch. The national diurnal profile already shows how traffic flows shift depending on the day, e.g. Monday and Tuesday have the highest flows during peak times and Friday the lowest. This difference is based on the assumption that workers are more likely to take Friday off. Encouraging home/flexible working will help portray a similar change in flow on a local level. It should be noted that home working has been found by Moeckel, 2017 and Abreau e Silva, 2017 to increase the number of non-commuter trips due to the additional time people have to spend on other activities, e.g. travelling to a preferred grocery store or more leisure trips.

As a consequence the impact on overall traffic flow is likely to be minimal. The model will however include changes to the diurnal profile showing changes to when cars are on the roads.

Impact on Vehicle Fleet Composition:

No impact from measure.

The fleet composition will unlikely change as a result of encouraging this measure. It is shifting the time of day or day of week people are travelling rather than changing the overall composition of the traffic on the road.

Impact on Average Vehicle Speed:

No impact from measure.

Average speeds may increase during the peak times where traffic flows have been reduced due to an increase in the number of people working from home rather than commuting into work alleviating congestion. However, off-peak traffic may slightly increase which could result in a decrease in speed at different times in the day. As a result, speeds have been maintained at the base level assumptions to be conservative.

Measure 18 - Implementation of Public Transport Infrastructure Improvements

Impact on Road Traffic Flow:

1% reduction in total car numbers.

Improving access and efficiency of public transport will encourage the use of alternative modes of transport. Should therefore result in a decrease in the number of cars on the road as less people use their own private vehicles for travel. A conservative approach has been taken due to the lack of well-defined studies estimating the likely impacts on traffic flows.

Impact Onto Vehicle Fleet Composition:

No impact from measure.

The fleet composition will likely shift away from cars as the most prevalent transport type towards an increase in buses as uptake of public transport becomes more popular. However, buses make up a small proportion of the overall traffic flow on the PCM exceedance stretch, which suggests it is not a specific bus route and therefore the composition of the fleet is unlikely to change significantly.

Impact on Average Vehicle Speed:

No impact from measure.

Improved public transport infrastructure will assist in alleviating pressure at junctions and bus stops to reduce congestion and may in turn result in increased traffic speeds. Only 1% of the traffic on the PCM exceedance stretch is from busses and therefore infrastructure improvements will unlikely be carried out directly on the road link. Therefore, speed is unlikely to be affected significantly.

Estimated Maximum NO_x Annual Emissions (with measure):

2018: 5,711kg/yr - Reduction of 4kg/yr

2019: 5,301kg/yr - Reduction of 414kg/yr

2020: 4,910kg/yr - Reduction of 805kg/yr

2021: 4,517kg/yr Reduction of 1,198kg/yr

Measure 26 - Job Seeker Travel Scheme

Impact on Road Traffic Flow:

1% reduction in total car numbers.

Similar to Measure 9, travel schemes will help encourage the reduction of private vehicle use. These schemes are targeting specific audiences rather than large groups as with the travel plans. It is assumed a similar reduction of 1% in traffic flows is likely.

Impact on Vehicle Fleet Composition:

No impact from measure.

Travel schemes can be used to encourage the uptake of electric and low emission vehicles. This could alter the composition of the vehicle fleet and increase the number of low emission vehicles on the roads. Currently 26% of the NO_x emissions on the PCM exceedance stretch are associated with diesel cars. Travel schemes will likely help reduce the number of diesel cars on the roads which will in turn help to reduce NO_x emissions. However, uptake is likely to be slow as it is largely dependent on uptake and how many people are targeted and follow through with investing in a new car. Therefore, for the purposes of this study it has been assumed no change will occur to vehicle fleet composition.

Impact on Average Vehicle Speed:

No impact from measure.

The introduction of travel schemes won't directly impact vehicle speeds. However, a reduction of vehicles on the local road network will likely increase speeds slightly by reducing the number of queues and congestion. No evidence has been sourced detailing studies quantifying the likely reduction in queuing traffic as a function of travel plans and therefore it is difficult to assume a change in speed in order to assess the change in NO_x emissions. A conservative approach has therefore been taken, which is to maintain the current speeds as assumed in the base scenario.

Estimated Maximum NO_x Annual Emissions (with measure):

2018: 5,711kg/yr - Reduction of 4kg/yr

2019: 5,301kg/yr - Reduction of 414kg/yr

2020: 4,910kg/yr - Reduction of 805kg/yr

2021: 4,517kg/yr Reduction of 1,198kg/yr

Measure 15 - Provision of high quality, bespoke and accessible information on sustainable travel

Measure 20 - Getting about campaign and dedicated travel website

Measure 23 - Behaviour change campaigns to reduce single occupancy car trips

and

Measure 24 - Transition Travel Choices Campaign

Impact on Road Traffic Flow:

1% reduction for each measure in total car numbers.

It would be anticipated that each measure 15, 20, 23 and 24 will gradually reduce the number of vehicles on the roads through on-going education and wider awareness of alternative modes of transport. Improving public transport routes to make them more effective will reduce the number of people relying on private vehicles. Diesel and petrol cars are the highest contributors to NO_x emissions along the PCM exceedance stretch so an increase uptake of alternative transport options should help reduce NO_x emissions.

Studies by Stopher et al, 2009 and Davies, 2012 have shown that soft measures aimed at altering behavioural changes can reduce car-as-drive trips by between 5 - 15%. A 1% reduction in car traffic flows has been applied to the PCM exceedance stretch for each measure to conservatively assess the impact. The combined impact of Measures 15, 20, 23 and 24 is 4%.

Impact on Vehicle Fleet Composition:

No impact from these measures.

The fleet composition will likely shift away from cars as the most prevalent transport type towards an increase in buses as uptake of public transport becomes more popular. This will likely take some time to see with regards to the actual numbers. The Euro standards of buses will need to be regulated to ensure new buses on the roads are meeting the appropriate standards to keep emissions down. Furthermore, better education will result in the increased uptake of low emission vehicles over time.

The change to fleet composition will be small and the contribution of buses to NO_x emissions is only 1%. Therefore any change is likely to be insignificant. For this study it has been assumed there will be no change.

Impact on Average Vehicle Speed:

No impact from these measures.

Average speed along the PCM exceedance stretch may increase due to the reduction of vehicles on the road causing a reduction in congestion. However, depending on the assigned bus routes, if there is an increase of buses using the PCM road link the speed will not change dramatically as buses tend to drive at a slower speed and block traffic. The changes to speed are unlikely to be significant and therefore haven't been changed from the base assumptions.

Estimated Maximum NO_x Annual Emissions:

For each measure with a 1% reduction in car numbers:

2018: 5,711kg/yr - Reduction of 4kg/yr

2019: 5,301kg/yr - Reduction of 414kg/yr

2020: 4,910kg/yr - Reduction of 805kg/yr

2021: 4,517kg/yr Reduction of 1,198kg/yr

Summary

A summary of the estimated changes in the existing traffic fleet attributed to the implementation of each short-listed measure is provided in Table 4.

Table 4 - Estimated Reductions from Proposed Measures

Measure No.	Description	Estimated Reduction
9	Travel Plans	3% reduction in cars

10	Review of Taxi/Private hire vehicle license fees	0.5% increase in Euro 6
13	Car Clubs	50 cars removed from the road
15	Journey planning initiatives	1% reduction in cars
18	Improvements to public transport infrastructure	1% reduction in cars
20	Travel website	1% reduction in cars
23	Behavioural change travel campaign	1% reduction in cars
24	Transition travel choice campaign	1% reduction in cars
26	Job seeker travel scheme	1% reduction in cars

The dispersion model was run to take into consideration the best case scenario, i.e. the implementation of all short-listed measures in combination. The traffic flows and Euro compositions were amended based on the assumed cumulative improvements associated with the measures, as outlined individually in Table 4 above.

Assuming all 9 (it was concluded that measure 14 - Flexible working and home working encouraged – would not lead to any perceived road traffic and therefore air quality benefits) shortlisted measures are implemented in combination, it is estimated there will be a 9% reduction of cars on the road (measures 9, 15, 18, 20, 23, 24 and 26), a further reduction of 50 cars on the road (measure 13) and an increase of 0.5% of Euro 6 cars (measure 10).

The dispersion model was initially run for the first year of non-compliance, 2027, to determine whether implementation of all measures in combination would bring forwards compliance to 2027 from the currently projected 2028 compliance year in the absence of any measures. Should compliance be shown to be brought forwards, the same 'with all measures' scenario would be run for 2026 and then sequentially for preceding years, until such a point that it could be shown that compliance could not be brought further forwards.

Table 5 presents a comparison of the annual mean NO_2 concentration predicted at the worst case receptor (R25) if no measures are implemented and if all measures are implemented, for the years 2028, 2027 and 2026.

Table 5 - Annual Mean NO_2 Concentrations at the Worst Case Receptor (R25) With and Without All Measures Implemented

Year	Annual Mean NO_2 Concentration ($\mu g/m^3$)	
	Without Measures	With All Measures
2028	38.7	-
2027	40.7	39.7
2026	43.1	42.0

It can be seen that compliance can only be brought forward by one year even if all the shortlisted measures were to be implemented in combination. This suggests that even if the estimated reductions predicted for each individual measure are still considered to be overly ambitious, the ability to bring forward compliance through implementation of the short-listed measures is minimal and is unlikely to bring about significant improvements to the overall NO_2 concentrations along the A10 PCM exceedance stretch.

This would suggest that more significant intervention(s) is required in order to positively affect the air quality along the A10 PCM exceedance stretch (Census ID 78365).

Clean Air Zone Assessment

The introduction of a Clean Air Zone (CAZ) along the A10 PCM exceedance stretch is a more substantial intervention that would likely bring forward compliance at a much faster rate than the proposed short-listed measures, which are predicted to only bring forward compliance by one year (2028 to 2027). Preliminary consideration has therefore been given to the associated air quality benefits that may be realised through implementation of a CAZ along the A10 PCM exceedance stretch, although it is stressed that these findings presented herein are only preliminary and further more detailed consideration as to the feasibility of adopting a CAZ along the A10 and surrounding area is warranted.

Table 3.3 of the UK Plan for tackling roadside nitrogen dioxide concentrations, Technical Report (July 2017), details the likely proportions of non-compliant vehicles by response to the presence of a charging CAZ. These proportions are replicated below in Table 6 and have been used to adjust the traffic flows and Euro classes within the dispersion model to determine the potential improvements to NO_2 concentrations along the A10 PCM exceedance stretch if a CAZ was implemented.

Table 6 - Proportions of Non-Compliant Vehicles by Response to the Presence of a Charging CAZ

Response	Cars %	LGVs %	HGVs %	Buses %	Coaches %
Upgrade	22	25	44	62	41
Cancel	16	12	13	38	26
Change mode	23	4	0	0	0
Avoid	23	17	13	0	0
Pay	16	42	29	0	32

The CAZ framework for England defines four classes of access restriction targeting particular vehicle types. The sequence of different CAZ classes (A to D) progressively targets more vehicle types, starting with the most polluting vehicles first. Table 7 details the four CAZ classes.

Table 7 - Classes of Charging CAZ

CAZ Class	Vehicles Included
A	Buses, coaches and taxis
B	Buses, coaches, taxis and HGVs
C	Buses, coaches, taxis, HGVs and LGVs
D	Buses, coaches taxis, HGVs, LGVs and cars

The local dispersion model was run for the two most stringent CAZ classes (CAZ C and CAZ D) only. Based on the source apportionment exercise carried out in Part 1, it is evident that buses and coaches have an insignificant impact on total NO_x concentrations along the A10 PCM exceedance stretch. Therefore, the CAZ classes that put the emphasis on managing buses and coaches along the A10 will unlikely have a significant impact on overall NO_2 concentrations. Furthermore, the NO_x concentration source apportionment for the A10 PCM exceedance stretch is fairly equally split between cars, LGVs and HGVs, suggesting an all-encompassing measure is required to reduce total NO_x emissions and in turn the overall NO_x/NO_2 concentrations along the A10.

The traffic flows and Euro compositions were adjusted based on the assumptions outlined in Table 6. The cancel, change mode and avoid responses would result in a reduction of each vehicle type and the upgrade response shifted a proportion of the non-compliant Euro vehicles to complying Euro standards. The pay response resulted in no change to the Euro vehicle composition or traffic flows.

The local dispersion model was run for the years 2020 and 2025. The year 2020 was selected as it was considered the earliest a CAZ along the A10 PCM exceedance stretch could be realistically implemented. The year 2025 was chosen to represent a suitable increment (5 years) in order to carry out linear interpolation of the results.

Clean Air Zone Assessment - Results

Class C CAZ

Out of the 38 discrete receptors modelled in 2020 there were predicted to be 15 locations exceeding the annual mean EU limit value of 40µg/m^3 when no CAZ was implemented. After implementing the Class C CAZ, the number of exceedances reduced to 6. As a consequence, it can be seen that although the Class C CAZ reduced overall NO_2 concentrations in 2020, the A10 PCM exceedance stretch is still not compliant. In 2025 there was still 1 discrete receptor exceeding the EU limit value of 40µg/m^3 when the Class

C CAZ was introduced, suggesting that even by 2025 compliance is still not met with a Class C CAZ in place. Linear interpolation was carried out to predict the annual mean NO_2 concentrations in the interim years between 2020 and 2025 and to also predict when compliance would be achieved through extrapolation beyond 2025. The results of the dispersion modelling can be found in Table 8 and the linear interpolation is detailed in Table 9.

Table 8 - Number of Exceedances and Annual Mean NO_2 Concentration at the Worst Case Receptor (R25) With and Without the Class C CAZ Implemented

Year	Number of Exceedances		Annual Mean NO_2 Concentration ($\mu g/m^3$)	
	No CAZ	With CAZ	No CAZ	With CAZ
2020	15	6	64.4	55.7
2025	2	1	45.6	40.9

Table 9 - Linear Interpolation of the 2020 and 2025 Annual Mean NO_2 Concentrations at the Worst Case Receptor (R25) With the Class C CAZ Implemented

Year	Annual Mean NO_2 Concentration ($\mu g/m^3$)
2020	55.7 – Modelled Concentration
2021	52.7
2022	49.8
2023	46.8
2024	43.9
2025	40.9 – Modelled Concentration
2026	38.0

It can be seen that from the above results that even with a Class C CAZ in place, compliance can only be brought forward from 2028 to 2026. In comparison to the NO_2 reductions predicted as a result of implementing all 9 of the softer measures, compliance can only be brought forward by one further year. This shows that the Class C CAZ does not go far enough to significantly bringing forward compliance.

Class D CAZ

Out of the 38 discrete receptors modelled in 2020 there were predicted to be 15 locations exceeding the annual mean EU limit value of 40µg/m³ when no CAZ was implemented. After implementing the Class D CAZ the number of exceedances reduced to 1. As a consequence, it can be seen that although the Class D CAZ reduced overall NO_2

concentrations in 2020, the PCM exceedance stretch is still not compliant. In 2025 there were no discrete receptors exceeding the EU limit value of 40µg/m^3 when the Class D CAZ was introduced, showing that compliance has been met. Linear interpolation was carried out to predict the annual mean NO_2 concentrations in the interim years between 2020 and 2025 to also predict whether compliance could be achieved prior to 2025. The results of the dispersion modelling can be found in Table 10 and the linear interpolation is detailed in Table 11.

Table 10 - Number of Exceedances and Annual Mean NO_2 Concentration at the Worst Case Receptor (R25) With and Without the Class D CAZ Implemented

Year	Number of exceedances		Annual Mean NO_2 Concentration (µg/m^3)	
	No CAZ	CAZ	No CAZ	CAZ
2020	15	1	64.4	46.2
2025	2	0	45.6	32.4

Table 11 - Linear Interpolation of the 2020 and 2025 Annual Mean NO_2 Concentrations at the Worst Case Receptor (R25) With the Class D CAZ Implemented

Year	Annual Mean NO_2 Concentration (µg/m^3)
2020	46.2 – Modelled Concentration
2021	43.4
2022	40.7
2023	37.9
2024	35.2
2025	32.5 – Modelled Concentration

It can be seen that from the above results that with a Class D CAZ in place, compliance can be brought forward from 2028 to 2023. This suggests that the implementation of a Class D CAZ is the most effective measure in bringing forward compliance along the PCM exceedance stretch. It is therefore recommended that further work be undertaken to investigate in detail the feasibility of implementing a Class D CAZ on the A10 PCM exceedance stretch and the surrounding area within Broxbourne Borough Council.

A complete set of results for both Class C and Class D CAZs can be found in Annex 2.

Part 5: Setting out a preferred option

In this section, local authorities should set out a summary of their preferred option to bringing forward compliance (where such measures exist). Where new measures have been identified that could bring forward compliance, local authorities should also assess a range of Secondary Critical Success Factors in order to identify the preferred option.

Summary

The Pollution Climate Mapping (PCM) national model identified that Broxbourne Borough Council (the Council) had one road link (Census ID: 78365) projected to have an exceedance of the annual mean EU Limit Value of 40µg/m^3 for nitrogen dioxide (NO_2). The road link under consideration is a section of the A10, from its junction with the B198, College Road to its junction with the B156. This road link is managed by the Council's Highways Team.

In order to determine a more accurate local position on compliance with the annual mean NO_2 limit value, the Council undertook local dispersion modelling exercise to provide an improved insight in to the air quality along the A10 PCM exceedance stretch.

The ADMS-Roads model (version 4.1.1) and the Emissions Factors Toolkit (EFT version 8.0.1.a) were used for the purposes of the local dispersion modelling study, with traffic data used as input to the model derived from a combination of available sources. Details of the model inputs and model verification process can be found in Annex 1, whilst Annex 2 provides the model predicted annual mean NO_2 concentration results.

Annual mean NO_2 concentrations were predicted at discrete and generic receptor groups for a 2017 baseline scenario. Annual mean concentrations above 40µg/m^3 were predicted at 29 discrete receptor locations along the A10 PCM exceedance stretch. The maximum annual mean NO_2 concentration at a discrete receptor was predicted to be 77.0µg/m^3 (discrete receptor 25).

In comparison with the PCM modelled results, the local dispersion modelling results suggest there is a discrepancy with regards to the annual mean NO_2 concentrations predicted along the PCM exceedance stretch, with the PCM model predicting 44µg/m^3 along the A10 PCM exceedance stretch in 2017 (Census ID 78365). Furthermore, the 2017 diffusion tube results for BB09 and BB28, which are both situated along the A10 road link, report concentrations significantly above those predicted by the PCM national model.

The reason for the difference between the PCM national model predictions and those obtained from the local dispersion model is likely to be two-fold:

- Improved resolution of local data model inputs to the local dispersion model, i.e.

traffic flows, fleet composition, average vehicle speeds, queuing parameters and road geometry. This will reduce the number of assumptions that are otherwise adopted in the PCM national modelling; and

- Verification of the local dispersion model against local air quality monitoring data, which will improve the accuracy of the model concentration predictions. The PCM national modelling is only verified against monitoring data obtained from the AURN, monitoring sites of which are more sparse and further from the study area.

The Joint Air Quality Unit (JAQU) have validated the local dispersion modelling exercise and have concluded that it provides for an accurate reflection of the air quality along the A10 PCM exceedance stretch (Census ID 78365). The Council therefore consider that the findings from the local dispersion modelling exercise supersede the PCM model predictions, thereby providing for a revised baseline air quality position along Census ID 78365, i.e. the annual mean NO_2 concentration results from the local dispersion model replace the PCM model predictions.

On this basis, Part 1 of the TFS concluded that there is a much greater problem than initially thought and compliance against the annual mean EU limit value of 40μg/m^3 is unlikely to be achieved by 2019, as predicted by the PCM model. Further local dispersion modelling was undertaken to ascertain the new predicted year of compliance based on the revised 2017 baseline findings. It was determined that compliance would now not be achieved until 2028.

The long list of measures detailed in Part 3 was narrowed down to a more concise list of suitable measures that could easily be implemented along the A10 PCM exceedance stretch. Further dispersion modelling was undertaken to determine the impact of these measures. An assessment of the best case scenario (i.e. all measures being implemented in combination) concluded that compliance could only be brought forward by one year to 2027. Therefore it was deemed necessary that a more substantial change was required to the road network to significantly speed up compliance.

Chosen Measure – Implementation of a CAZ

The implementation of a CAZ was therefore considered as the most viable option to ensure compliance along the A10 PCM exceedance stretch is achieved within a reasonable time frame. Dispersion modelling in Part 4 was used to estimate the level of success such a measure would have. The preliminary assessment found that implementing a Class C CAZ brought forwards compliance to 2026, whilst a Class D CAZ may bring compliance further forwards to 2023.

Despite the initial encouraging findings, it has been noted that given the time constraints and limitations surrounding data availability, further assessment is still required to fully determine the feasibility of implementing a CAZ on the A10 PCM exceedance stretch and the surrounding area within Broxbourne Borough Council.

The detailed CAZ feasibility study will need to identify the necessary scope of the scheme in terms of geographical extent, i.e. the area which should be subject to restriction, as well as consider and recommend which class of CAZ is preferred, i.e. which vehicle types should be affected by restriction given the relative impacts on emissions at current and predicted traffic levels. The dispersion modelling in Part 4 has provided an initial understanding of the impact of different classes of CAZ, however, several national traffic assumptions have been used within the model and therefore the results may not accurately reflect the current situation in Broxbourne. Localised traffic data is required to fully evaluate the impact of each CAZ class. Consideration will also need to be made with regards to the benefits of charging or not charging for access. The study will need to outline the overall costs and benefits of a CAZ, the economical and societal impacts, the optimum geographical locations and how it could be implemented and enforced successfully.

The following steps are therefore required to help support the implementation of a CAZ in Broxbourne:

- A number of Automatic Number Plate Recognition (ANPR) surveys should be undertaking, including along the A10 PCM exceedance stretch and the surrounding road network. It is important to use local data when developing a CAZ to ensure it has been designed to fit the specific requirements of the local area. The minimum scope of the ANPR survey is proposed to be as follows:
  - 72 hour period (representative weekday, Sat and Sun inclusive);
  - Processed output from the ANPR will include traffic flow, petrol/diesel/electric split, fleet composition, euro classification and diurnal profile; and
  - Locations of the survey will be determined after a detailed evaluation of the surrounding road network is undertaken.
- Detailed dispersion modelling over a wider geographical extent using the results of the ANPR surveys will need to be undertaken to determine the boundaries of the CAZ. The updated modelling will supersede the work carried out in Part 4 of this TFS to provide a more precise picture of the current situation. Scenario modelling based on the different CAZ classes and various proposed implementation years will also be required to provide a more precise understanding of how the various CAZ classes will influence annual mean NO_2 concentrations along the PCM exceedance stretch and the extent at which compliance will be brought forward. The results of the detailed modelling will help to identify options for the location of the CAZ and quantify the benefits it will have on the surrounding area.
- Transport modelling is required to forecast changes in travel demand, road traffic, public transport and active mode use over time as a result of changing economic conditions, local land-use policies and development and transport improvement and interventions. The transport model will also help to test the impacts of the different CAZ options and how behaviours on the road network will change as a result of individual transport interventions.
- A detailed timeline for implementation needs to be laid out based on the results of the dispersion modelling exercise. This will include the likely costs required to implement the CAZ and the time it will take for the measure to have an impact on when compliance is likely to be achieved.

Conclusion

Table 12 below summarises the overall conclusions of the study and the next steps that are required to help bring forward compliance along the A10 PCM exceedance stretch.

Table 12 - Summary of the Targeted Feasibility Study

Road link	PCM identified link?	Summary of exceedance	Measures identified that could bring forward compliance	For any new measures, please set out costs and timeframe
Census ID 78365	Yes – this link was identified as having an exceedance in the PCM national modelling.	The PCM national modelling has projected that this link will be compliant in 2019. However updated local dispersion modelling has determined compliance is unlikely to occur until 2028. JAQU validated that the local dispersion modelling supersedes the PCM national model findings and therefore measures implemented will need to bring forward compliance from 2028. Summary of predicted NO_2 concentrations at the worst case receptor along the A10 PCM exceedance stretch: 2018: 77 µg/m^3, 2019: 73 µg/m^3 2020: 68 µg/m^3 2021: 60 µg/m^3 2022: 56 µg/m^3 2023: 52 µg/m^3 2024: 49 µg/m^3 2025: 46 µg/m^3 2026: 43 µg/m^3 2027: 41 µg/m^3 2028: 39 µg/m^3	After an evaluation of several softer measures it was determined that a more extensive measure was required to significantly bring forward compliance. It was determined that the implementation of a CAZ is therefore the most viable measure to ensure compliance is achieved in a reasonable timeframe. Preliminary assessment has found that implementing a Class C CAZ may bring forwards compliance to 2026, whilst a Class D CAZ may bring compliance further forwards to 2023.	Due to time constraints, further detailed modelling, including carrying out several traffic surveys (ANPR surveys, etc) is still required to set out the overall feasibility of implementing a CAZ in Broxbourne. The modelling will help to determine the geographic extent required to achieve compliance and evaluate the costs and benefits of implementing the various CAZ options.

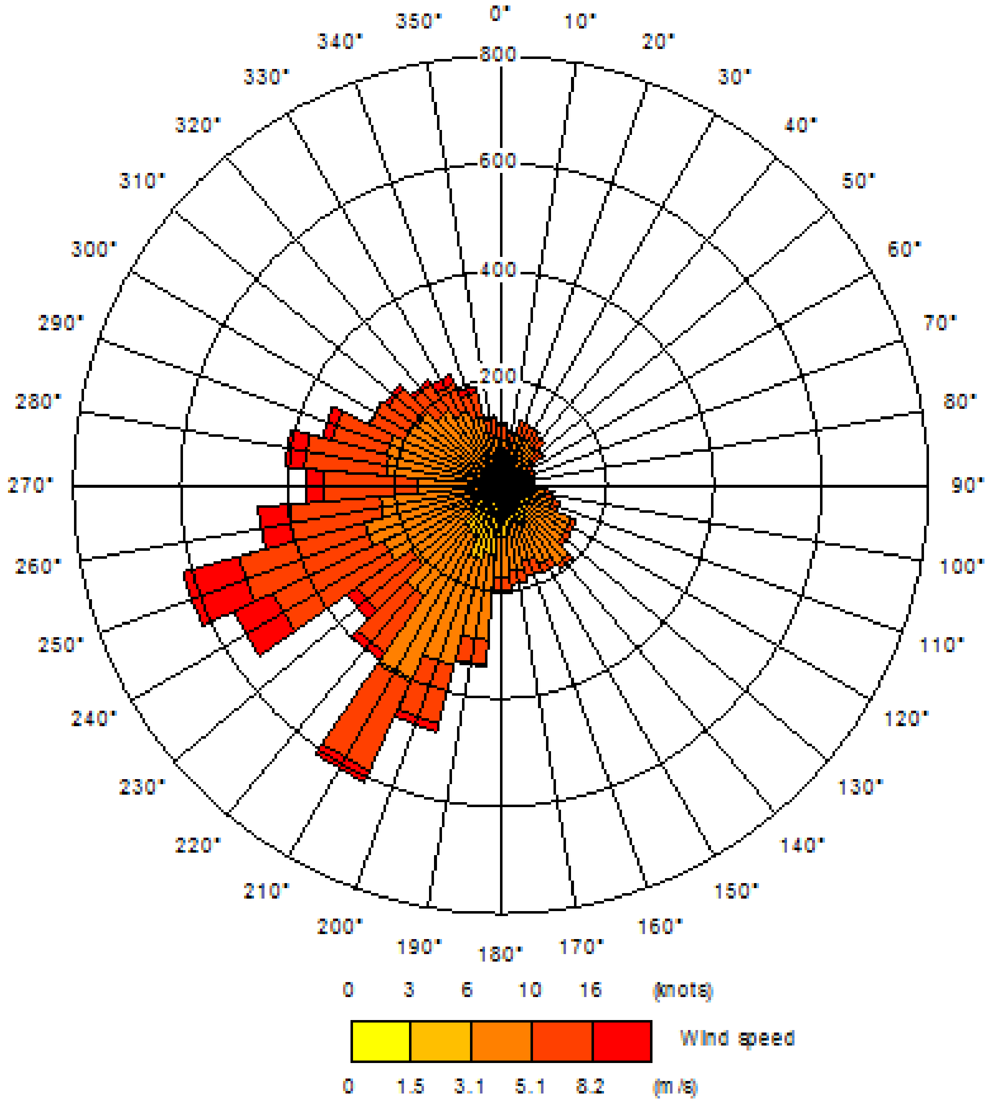
Annex 1: Model Inputs and Verification

Model Inputs

Meteorological Data

Meteorological data from a representative station is required by the dispersion model. 2017 meteorological data from Luton Airport's weather station, approximately 30km northwest from the PCM exceedance stretch, has been used in this assessment. A wind rose for the weather station for the year 2017 is shown in Figure A.1.

Figure A.1 – Wind rose for Luton Airport Meteorological Data 2017



Most dispersion models do not use meteorological data if they relate to calm winds conditions, as dispersion of air pollutants is more difficult to calculate in these circumstances. ADMS-Roads treats calm wind conditions by setting the minimum wind speed to 0.75m/s. It is recommended in LAQM.TG(16) that the meteorological data file be tested within a dispersion model and the relevant output log file checked, to confirm the number of missing hours and calm hours that cannot be used by the dispersion model. This is important when considering predictions of high percentiles and the number of exceedances. LAQM.TG(16) recommends that meteorological data should have a percentage of usable hours greater than 85%. If the data capture is less than 85% short-term concentration predictions should be expressed as percentiles rather than as numbers of exceedances. 2017 meteorological data from Luton includes 8662 lines of usable hourly data out of the total 8,760 for the year, i.e. 98.9% usable data. This is therefore suitable for the dispersion modelling exercise.

Traffic Inputs

The ADMS-Roads assessment incorporates numbers of road traffic vehicles, vehicle speeds on the local roads and the composition of the traffic fleet. The traffic data for this assessment has been derived from the Department for Transport (DFT) Traffic Counts website and the 2015 Air Quality Consultants (AQC) Detailed Assessment. A growth factor was calculated using trends from Hertfordshire County Council Highways data to apply to the 2016 DFT traffic counts and the 2015 AQC data.

Traffic speeds were based on speed limits across the road network. However, where appropriate, the speeds have been reduced to simulate queues at junctions, traffic lights and other locations where queues are known to be an issue. Traffic speeds have been assumed to be consistent across all the modelled scenarios.

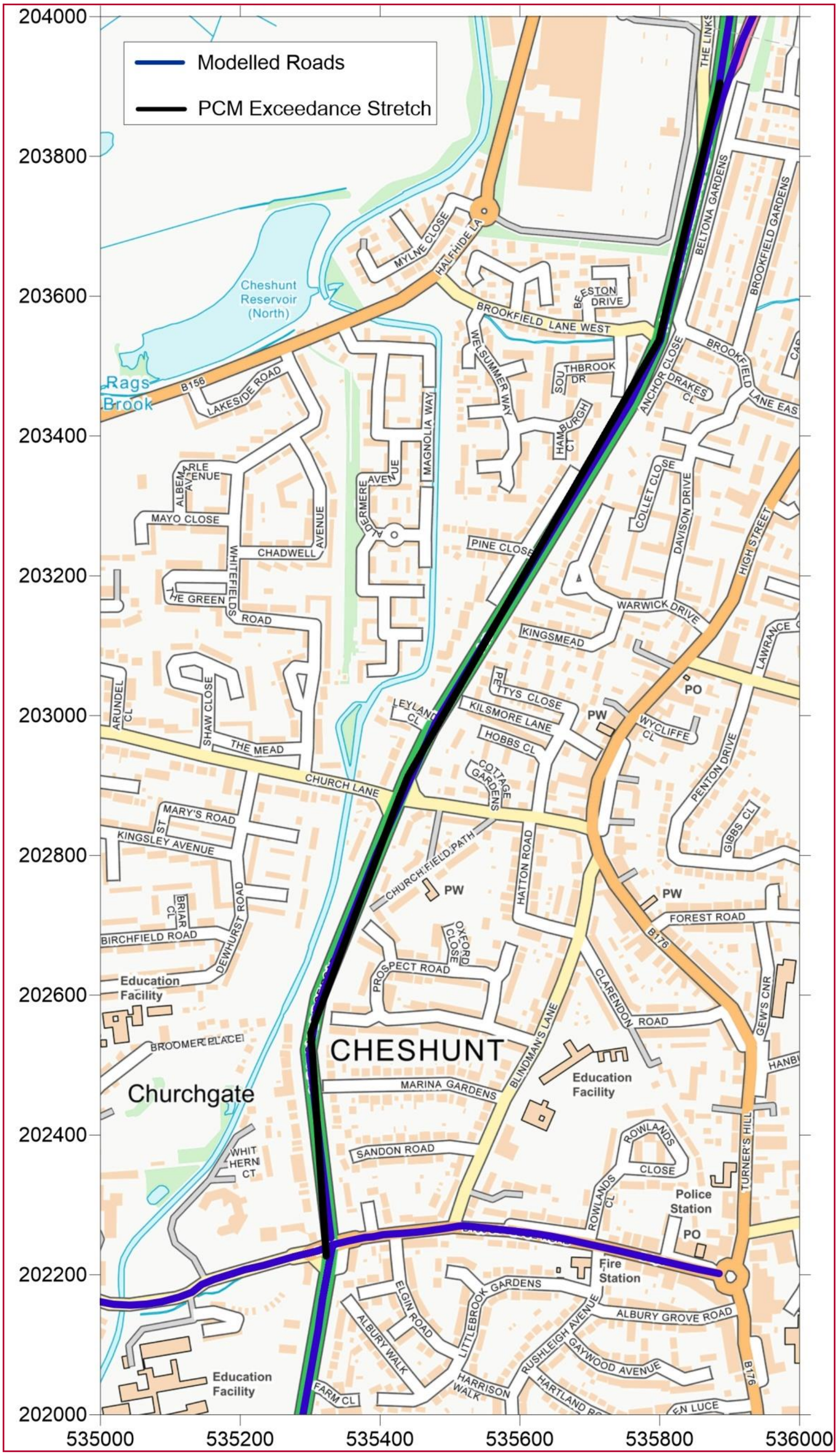
The Emissions Factors Toolkit (EFT) version 8.0.1.a has then been used to determine vehicle emission factors for input into the ADMS-Roads model; these are based upon the traffic data inputs.

Details of the traffic flows used in this assessment are provided in Table A.1 and the modelled roads are presented in Figure A.2.

Table A.1 – Traffic Data used in ADMS-Roads Assessment

Link Name	2017							Speed (kph)
	AADT	% Car	% LGV	% Rigid HGV	% Artic HGV	% Bus and Coach	% Motorcycle	
A10 PCM exceedance stretch	43133	75.1	18.3	3.5	1.7	0.2	1.1	64.4
A10 south of College Road	44143	73.4	18.7	3.3	3.1	0.2	1.3	64.4
A10 north of Halfhide Lane junction	37622	72.5	17.8	5.4	3.0	0.2	1.1	80.5
A10 slip road towards Halfhide Lane	5749	81.5	14.6	2.1	0.3	0.2	1.2	80.5
College Road east	9703	HDV 2%						32
College Road west	7522	HDV 2%						40
Note 1: Speeds have been reduced to simulate queues at junctions, traffic lights and other locations where queues are known to be an issue.								
Note 2: Traffic data on the A10 was calculated using 2016 DfT derived traffic flows. A growth factor of 0.9917 was applied for 2016 to 2017. Traffic data on College Road was calculated using 2015 AQC derived traffic flows. A growth factor of 0.9634 was applied for 2015 to 2017.								

Figure A.2 – Modelled Roads



Receptors

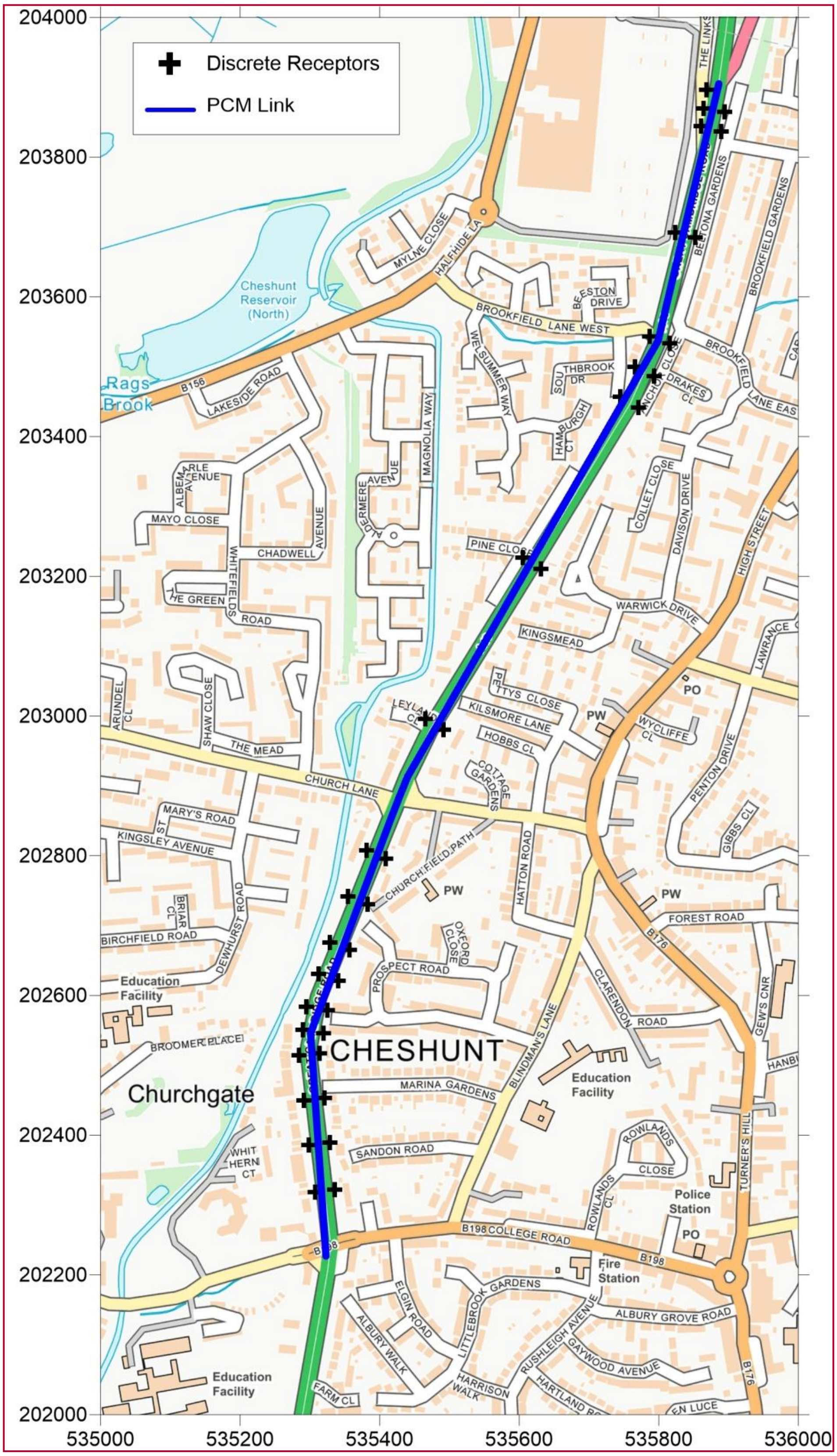
The discrete receptors along the A10 PCM exceedance stretch which represent 4m distance from each road link along the exceedance stretch are shown in Table A.2 and illustrated in

Figure **A.3**. All receptors were measured at a height of 2m and at least 25m from major junctions.

Table A.2 – Discrete Receptors

Receptor ID	X	Y
1	535328	202390
2	535466	202996
3	535298	202386
4	535409	202796
5	535491	202980
6	535816	203533
7	535314	202517
8	535295	202584
9	535329	202676
10	535381	202808
11	535745	203457
12	535787	203543
13	535860	203844
14	535869	203896
15	535284	202514
16	535325	202579
17	535357	202665
18	535771	203441
19	535890	203837
20	535321	202453
21	535290	202551
22	535312	202631
23	535355	202742
24	535605	203226
25	535336	202322
26	535766	203500
27	535823	203692
28	535897	204106
29	535864	203870
30	535307	202319
31	535291	202450
32	535319	202546
33	535341	202621
34	535383	202731
35	535631	203211
36	535793	203486
37	535853	203685
38	535894	203865

Figure A.3 – Receptor Locations



Outputs

Annual mean road-NO_x concentrations were output from the ADMS-Roads model at the specified receptor locations. Following the process of model verification and adjustment, these were combined with relevant background NO_x concentrations obtained from Defra's LAQM 1km resolution background maps and, through the use of the NO_x to NO_2 calculator v6.1, total annual mean NO_2 concentrations determined.

All model predicted annual mean NO_2 concentration results are provided are presented in Annex 2.

Model Verification

For model verification, the diffusion tube data presented in Table A.3 has been used. BB39, BB40, BB41 and BB42 were not used for verification as only 3 months of data was available for 2017.

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

For the verification and adjustment of NO_x/NO_2, the annual mean concentrations for 2017 were used as presented in Table A.3.

Table A.3 below shows an initial comparison of the monitored and unverified modelled NO_2 results for the year 2017, in order to determine if verification and adjustment was required.

Table A.3 – Comparison of Unverified Modelled and Monitored NO_2 Concentrations

Site ID	Background NO_2 (µg/m³)	Monitored total NO_2 (µg/m³)	Unverified Modelled total NO_2 (µg/m³)	% Difference (modelled vs. monitored)
BB09	17.2	50.7	28.1	-44.7
BB27	17.2	38.6	21.3	-44.8
BB28	17.2	71.2	32.7	-54.0
BB35	17.2	36.1	21.5	-40.5

The model was under predicting at all four locations and no further improvement of the modelled results could be obtained on this occasion. Model adjustment was therefore carried out to allow for improvements in the results.

Model adjustment needs to be undertaken based on NOx and not NO_2. NOx concentrations were derived from the monitored NO_2 diffusion tube results used for verification. These calculations were undertaken using a spreadsheet tool available from the LAQM website. Table A.4 provides the relevant data required to calculate the model adjustment based on regression of the modelled and monitored road source contribution to NO_x.

Table A.4 – 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)
BB09	50.7	98.7	17.2	24.0	33.5	74.7	21.6
BB27	38.6	68.7	17.2	24.0	21.4	44.7	7.9
BB28	71.2	157.6	17.2	24.0	54.0	133.6	31.6
BB35	36.1	63.1	17.2	24.0	19.0	39.1	8.3

Figure A.4 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 equation of the trend lines presented in Figure A.4 gives an adjustment factor for the modelled results of 4.082.

Figure A.4 - Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x

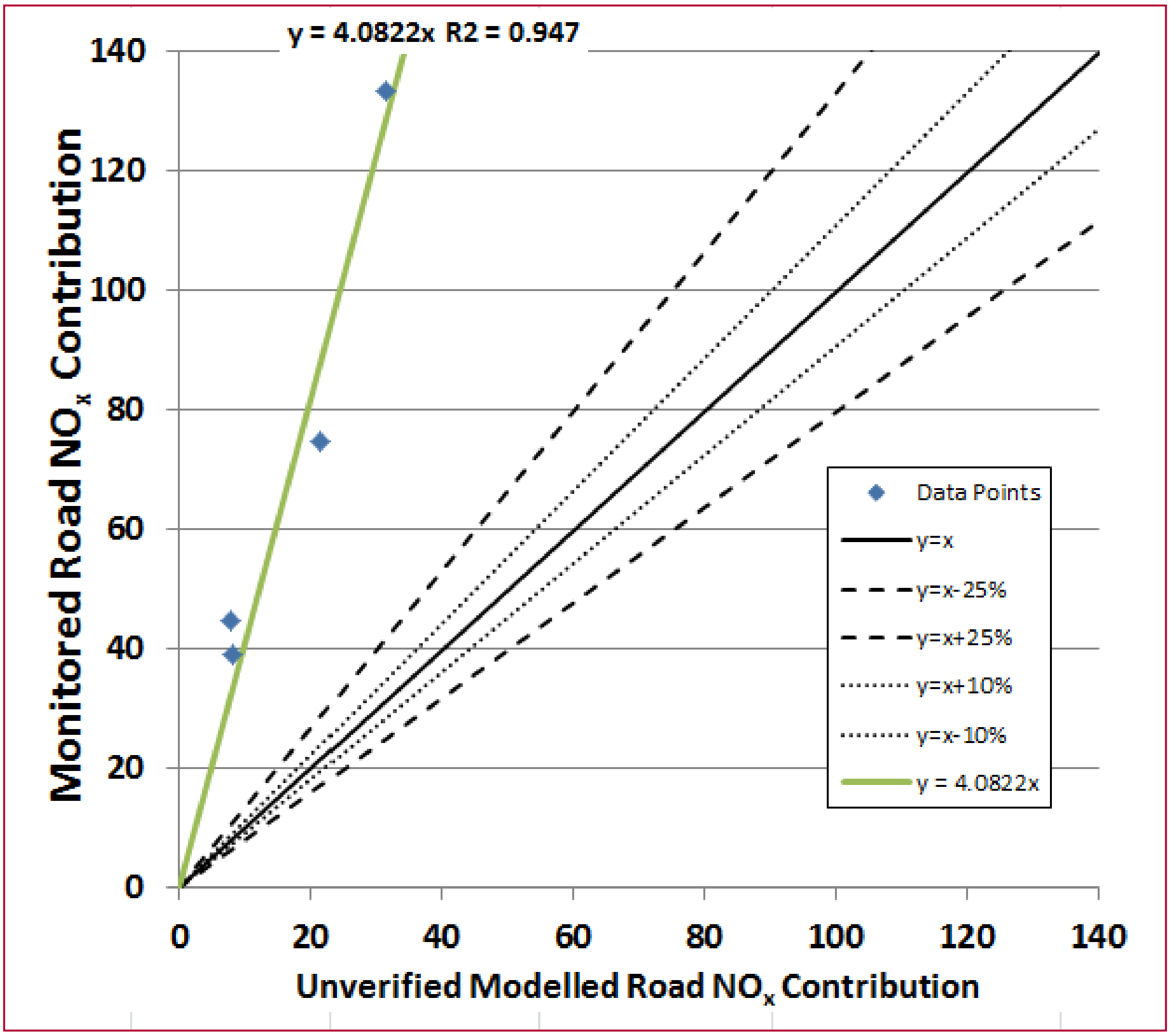


Table A.5 below illustrates the adjusted modelled NO_2 concentrations plotted against monitored NO_2 concentrations. All sites considered show acceptable agreement between the ratios of monitored and modelled NO_2 all being ±25%. A verification factor of 4.082 was therefore used to adjust the model results. A factor of 4.082 reduces the Root Mean Square Error (RMSE) from a value of 25.0 to 3.9µg/m^3.

Table A.5 – 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)
BB09	3.46	4.082	88.0	112.0	55.6	50.7	9.8
BB27	5.65		32.3	56.3	33.1	38.6	-14.3
BB28	4.23		128.9	152.9	69.7	71.2	-2.1
BB35	4.69		34.0	58.0	33.8	36.1	-6.3

Annex 2: Model results: Available on request

Annex 3: Supporting Information for parts 3 and 4: Available on request