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

Local authorities covered	South Tyneside Council

Further information on the content of each section is set out in the guidance.

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 NO_2 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 South Tyneside Council (the Council) has two road links (Census IDs 6746 and 77767) projected to have an exceedance of the annual mean EU Limit Value of 40µg/m^3 for nitrogen dioxide (NO_2), both of which are located on the A194 corridor.

The projected corridor of exceedance is a stretch of the A194 from the junction with Hedworth Lane through to junction with the A1300 John Reid Road. The A194 is a strategic road link which connects South Shields Town Centre to the strategic road network (A194M). The defined corridor also includes the A19, which forms part of the strategic road network with the corridor being managed by Highways England.

Road Census ID 6746 covers the A194 from the junction with A194/A19 Lindisfarne through to the junction between the A194/A1300 (John Reid Road). Road Census ID 77767 covers the A194 from the junction with Hedworth Lane and runs through to the A194/A19 Lindisfarne junction.

Through the Council's statutory Local Air Quality Management (LAQM) duties, in 2006 the specified area of the A194 was also declared as an Air Quality Management Area (AQMA) due to exceedances of the annual mean Air Quality Strategy (AQS) objective for NO_2[1]. An Air Quality Action Plan (AQAP) for this area was prepared in 2010 and is scheduled to be updated in 2018.

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

[1] https://uk-air.defra.gov.uk/aqma/details?aqma_ref=483

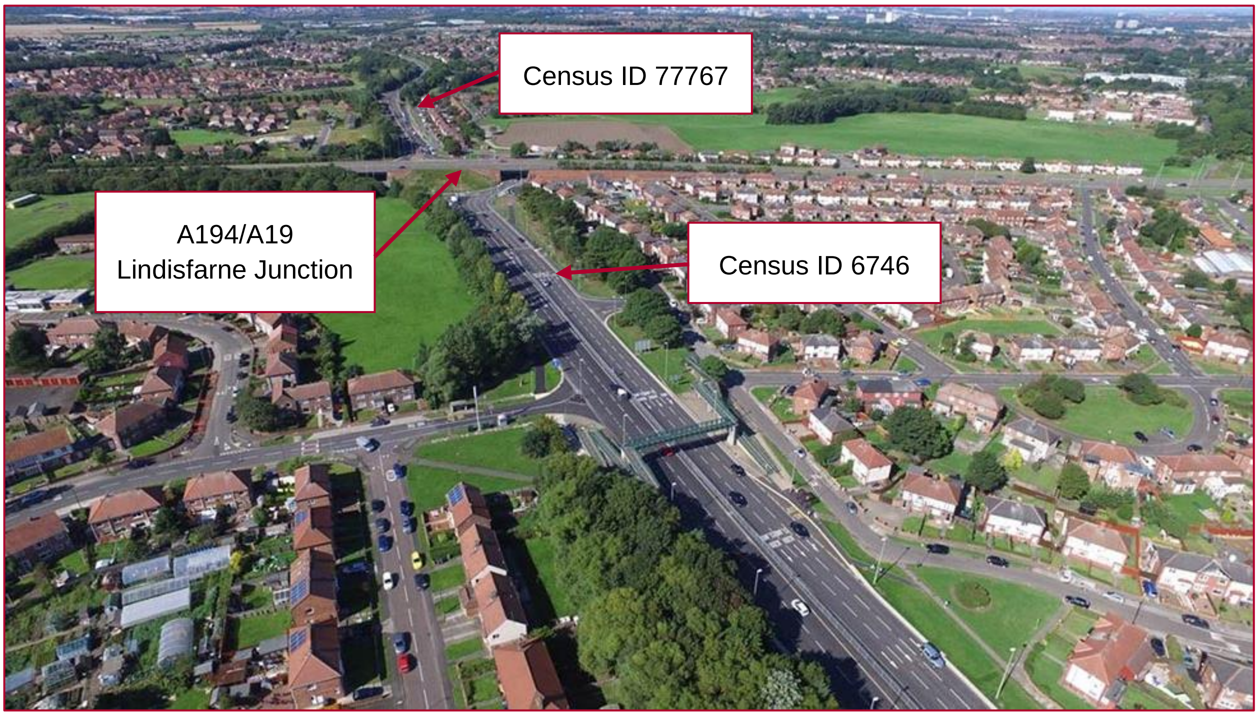
- Characterise the air quality issue along the A194 PCM exceedance stretches, as identified in the national modelling; and
- Identify measures which could reduce the concentration of NO_2 along the A194 PCM exceedance stretches as quickly as possible, with the principal objective of bringing forward 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 A194 PCM exceedance stretches, whilst Figure 2 provides an aerial view of the A194/A19 Lindisfarne roundabout junction with both A194 PCM exceedance stretches visible (post Lindisfarne improvement scheme).

Figure 1 - Predicted A194 PCM Exceedance Stretches in South Tyneside

Figure 2 - Aerial View of the A194/A19 Lindisfarne Junction with both A194 PCM Exceedance Stretches Visible



PCM Findings

Road Census ID 6746

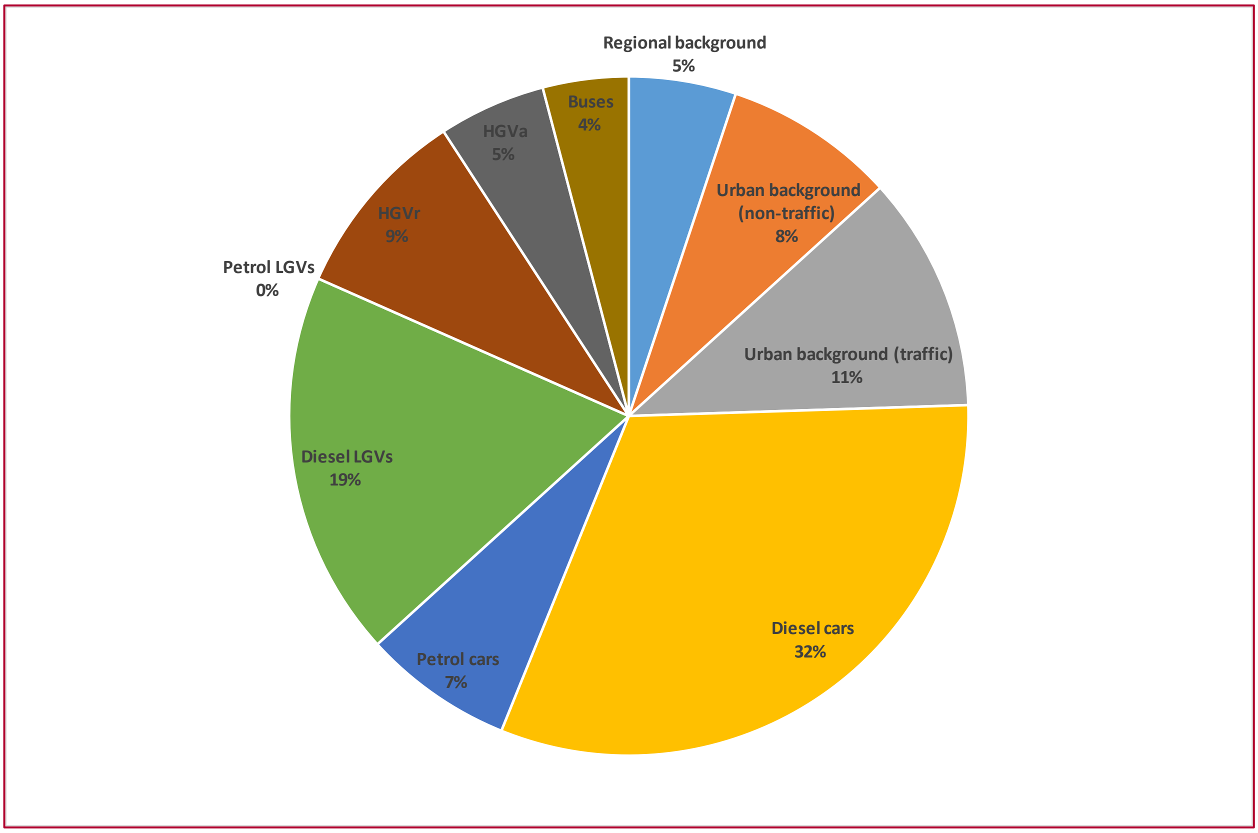
The results from the PCM model show that the Census ID 6746 road link is predicted to have the following annual mean NO_2 concentrations, with compliance with the annual mean NO_2 EU Limit Value of 40µg/m^3 projected to be achieved in 2019.

- 43µg/m^3 in 2017;
- 41µg/m^3 in 2018;
- 40µg/m^3 in 2019;
- 38µg/m^3 in 2020; and
- 36µg/m^3 in 2021.

In line with the PCM predictions, compliance could therefore be brought forwards if annual mean NO_2 concentrations are reduced by at least 1µg/m^3 in 2018. A 3µg/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 different 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) for Census ID 6746



The PCM based NO_x source apportionment for Census ID 6746 would suggest that in 2015, 24% of the total NO_x concentration is attributable to regional and urban background sources (including traffic), whilst the remaining 74% is associated with local road traffic sources (note, the sum does not exactly equal 100% due to rounding). Of this 74%, diesel cars have been identified to be the principal source, contributing 31% of the total NO_x. Petrol cars comparatively contribute significantly less at only 7%. Diesel Light Goods Vehicles (LGVs) contribute 18%, whilst rigid and articulated Heavy Goods Vehicles (HGVs) contribute towards 9% and 5% of the total respectively. Buses are predicted to contribute only 4% 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 6746 the traffic data from corresponding DfT Count Point ID 6746 (E 434000, N 563700) has been applied. The 2015 DfT traffic data for this link was estimated based upon the previous year's traffic flow on the link. Annual Average Daily Flows (AADFs) with associated fleet composition are provided.

Figure 4 shows the traffic composition at DfT count point ID 6746 for the year 2015, for which a total AADF of 44,413 was recorded with a Heavy Duty Vehicle (HDV) proportion of 3.3%, whilst the general AADF trend at this location since the year 2000 is provided in Figure 5.

Figure 4 - Fleet Composition on the A194 Census ID 6746, as defined at DfT Count Point ID 6746 (2015)

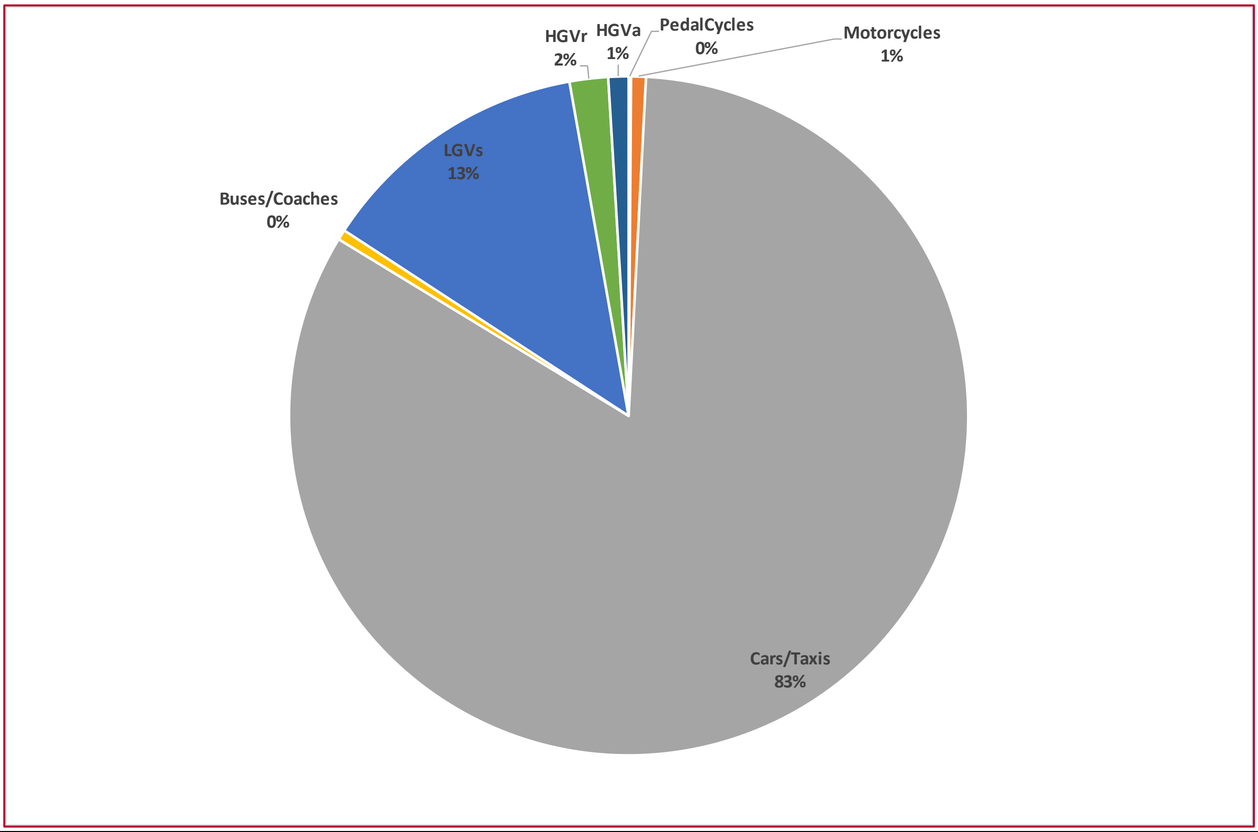
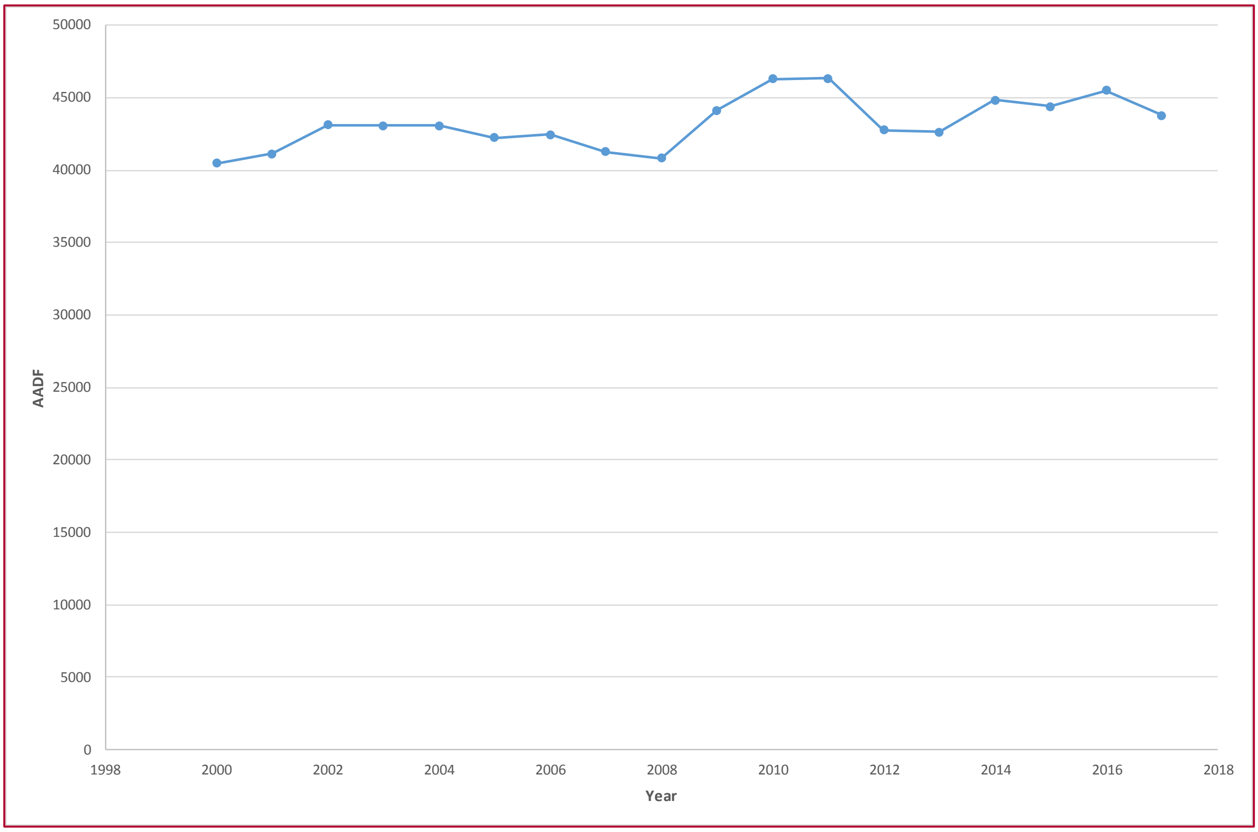


Figure 5 - AADF Trend on the A194 Census ID 6746, as defined at DfT Count Point ID 6746



Road Census ID 77767

The results from the PCM model show that the Census ID 77767 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 also projected to be achieved in 2019.

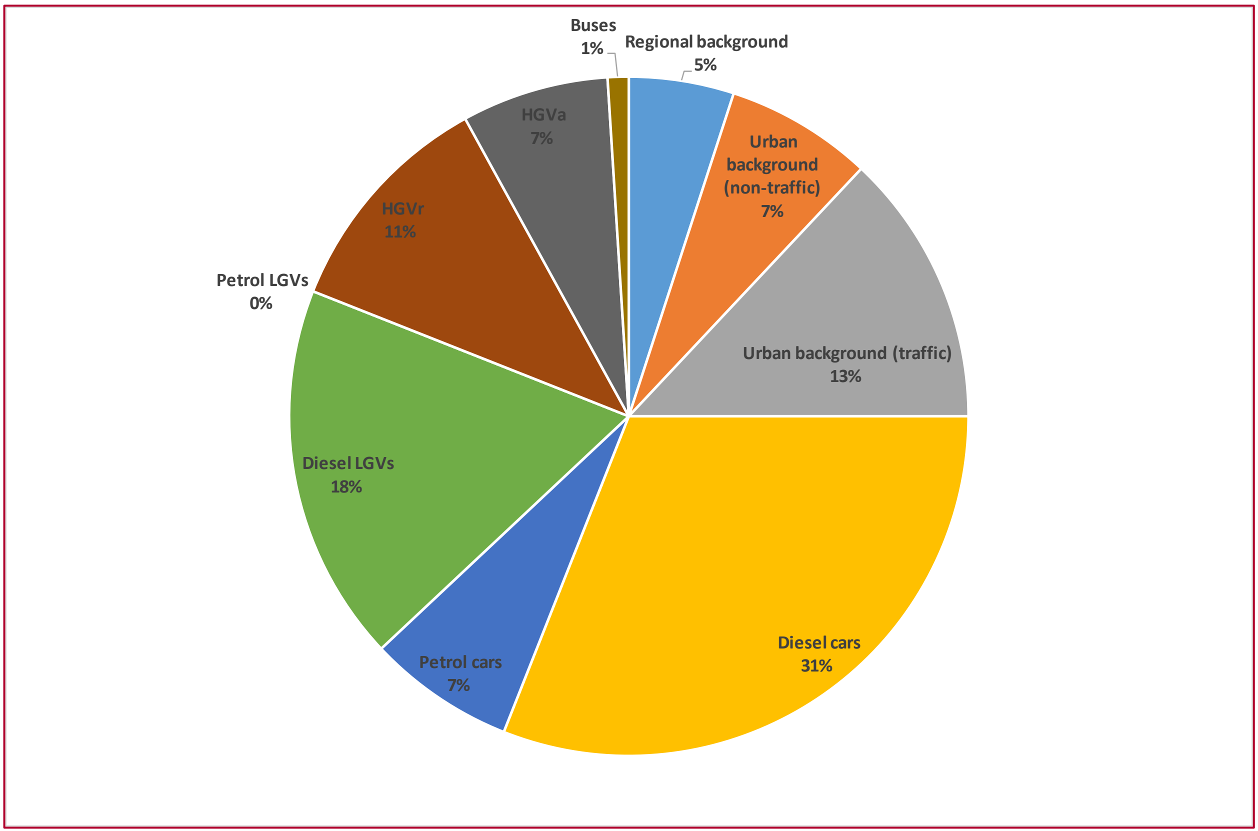
- 43µg/m^3 in 2017;
- 41µg/m^3 in 2018;
- 40µg/m^3 in 2019;
- 38µg/m^3 in 2020; and
- 36µg/m^3 in 2021.

In line with the PCM predictions, compliance could therefore be brought forwards if annual mean NO_2 concentrations are reduced by at least 1µg/m^3 in 2018. A 3µg/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 ***6***. It is worth noting that over time, the relative contribution to total NO_x concentrations from different sources will change in line with changes to the local fleet composition and traffic flow parameters.

Figure 6 - PCM based Total NO_x Concentration Source Apportionment (2015) for Census ID 77767



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 77767 the traffic data from corresponding DfT Count Point ID 77767 (E 433600, N 563440) has been applied. The 2015 DfT traffic data for this link was estimated based upon the previous year's traffic flow on the link. Annual Average Daily Flows (AADFs) with associated fleet composition are provided.

Figure 7 shows the traffic composition at DfT count point ID 77767 for the year 2015, for which a total AADF of 43,859 was recorded with a Heavy Duty Vehicle (HDV) proportion of 3.5%, whilst the general AADF trend at this location since the year 2000 is provided in figure 8.

Figure 7 - Fleet Composition on the A194 Census ID 77767, as defined at DfT Count Point ID 77767 (2015)

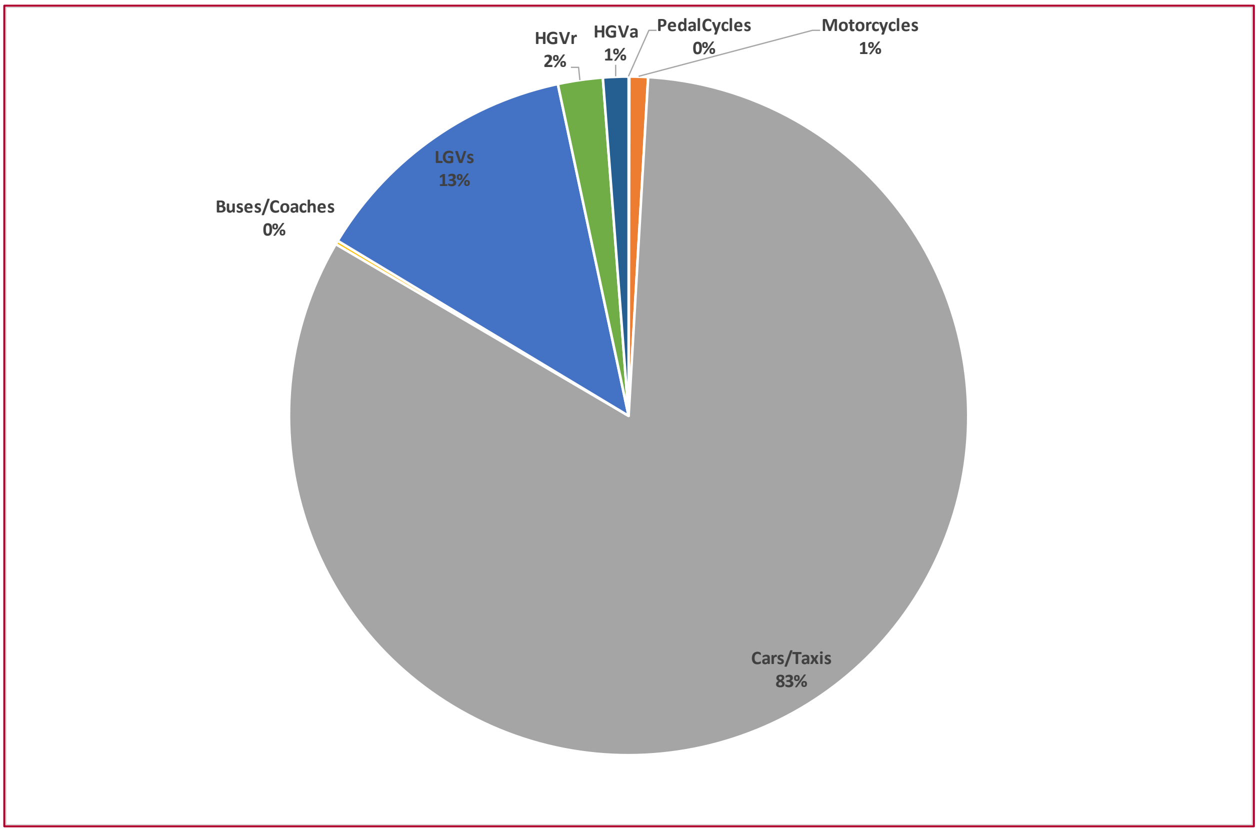
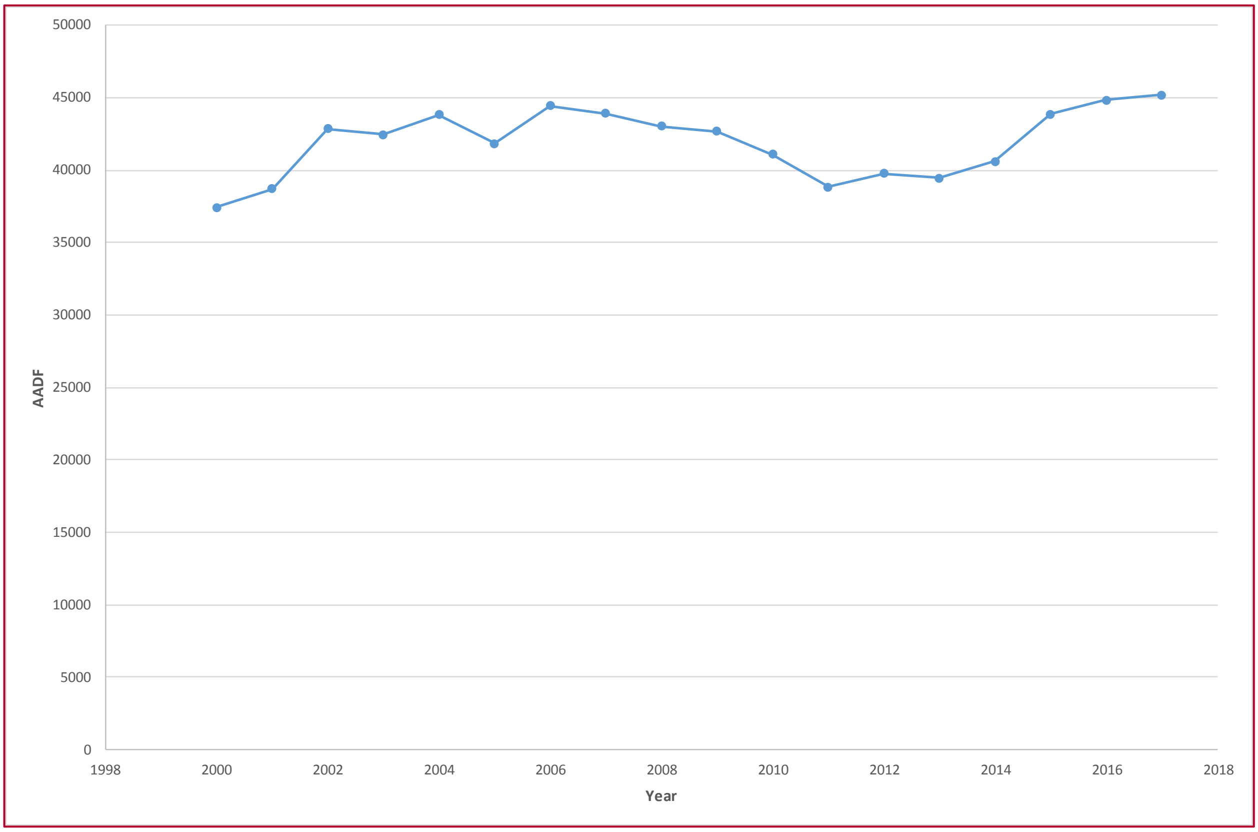


Figure 8 - AADF Trend on the A194 Census ID 77767, as defined at DfT Count Point ID 77767



Local Information

Although the A194 PCM exceedance stretches have previously been highlighted through the LAQM regime to be at risk of exceeding the annual mean NO_2 AQS objective, and whilst the Council do undertake air quality monitoring at locations within the study area, no detailed modelling studies which encompass the study area have been undertaken since the completion of the Lindisfarne improvement scheme. Therefore, initially there was limited local data available to understand the source apportionment on these road links, other than that available through the PCM national model.

To address this, in addition to collating various pre-existing local datasets, the Council have sought to undertake a local Automatic Number Plate Recognition (ANPR) survey and associated local dispersion modelling exercise, in order to provide an improved insight in to the air quality along the A194 PCM exceedance stretches.

This section therefore details the available pre-existing local information, and the findings of the local surveys undertaken by the Council to inform the direction of this TFS.

Local Context

The defined area of the A194 has the residential catchments of Low Simonside, Hedworth, Scotch Estate and Primrose in close proximity, with housing on both sides of the A194 carriageway. The A194/A1300 corridor provides emergency access to South Shields District Hospital and South Shields Fire Station so has increased prominence. Further to this, there are two schools (Simonside Primary and St. Marys RC Primary) in close proximity of the corridor, so some of the defined traffic can be attributed to journeys relating to the school run.

Freight and businesses use the A194 corridor as it provides access into the Port of Tyne, which is an internationally recognised deep-sea port terminal. Bede Industrial Estate is accessed by the A194/Shaftesbury Avenue junction, which lies just outside of the corridor. Given this information it is expected that there will be increased freight movements along the corridor.

To establish bus movements, the Council has liaised with the local bus operators in terms of the services operating within the corridor. The commercial services operating within the defined corridor have an engine specification of Euro 5 and above. Given this information, the Council will not be targeting improvements in the commercial bus operation. However, the Council will be looking at improving engine specification of buses operating under the Nexus (Tyne and Wear Passenger Transport Executive) Subsidised Bus Network, which includes scholar services.

Local Air Quality Monitoring

Through the undertaking of LAQM statutory duties, the Council has a firm understanding of air quality within the specified area of the A194, with an extensive air quality monitoring regime in place.

The local Council monitoring sites do not meet the siting requirements of the Ambient Air Quality Directive (AAQD) and therefore are not considered suitable for direct comparison against the EU limit value. Nevertheless, the Council air quality monitoring data is still considered to provide a useful insight into the air quality within the study area and can be compared against the annual mean NO_2 AQS objective, and so is presented and discussed within this section.

The Council monitor NO_2 using a network of passive diffusion tube monitoring sites and continuous analysers across their administrative area. In 2017 the network encompassed 40 passive diffusion tube sites and three continuous analysers. Nine of these diffusion tube monitoring sites and one of the continuous analysers are sited within the extent of the study area. Figure 9 illustrates these sites relative to the A194 PCM exceedance stretches, whilst Table 1 provides recent (2016 and 2017) annual mean NO_2 concentration data at these locations.

Figure 9 - Location of Council Monitoring Sites adjacent to the A194 PCM Exceedance Stretches

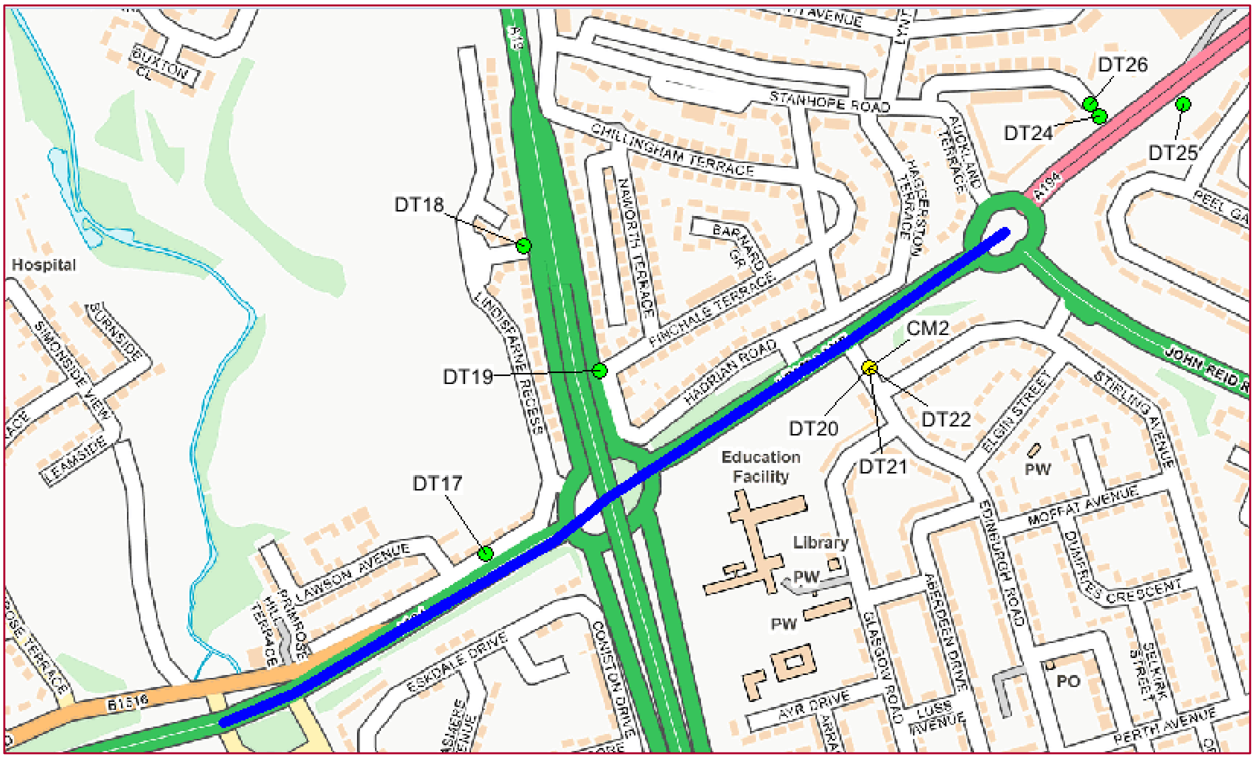


Table 1 - Annual Mean NO_2 Concentrations in 2016 and 2017 at Council Monitoring Sites adjacent to the A194 PCM Exceedance Stretches

Site ID	X (m)	Y (m)	Annual Mean 2016 (µg/m^3)	Annual Mean 2017 (µg/m^3)
DT17	433658	563497	35.1	27.6
DT18	433698	563825	36.7	23.4
DT19	433780	563692	33.8	33.4
DT20	434068	563695	30.4	28.9
DT21	434068	563695	31.5	29.0
DT22	434068	563695	30.6	28.7
DT24	434313	563963	**40.6**	32.8
DT25	434402	563976	**41.9**	28.4
DT26	434303	563977	32.2	28.0
CM2	434068	563695	22.1	25.0

Notes: DT = Diffusion tube, CM = Continuous monitor.
Results in **bold** denote exceedance of the annual mean NO_2 AQS objective.

There were no exceedances of the annual mean NO_2 AQS objective observed in 2017 at any of the Council monitoring sites adjacent to the A194 PCM exceedance stretches, whilst exceedances were recorded at two sites (DT24 and DT25) in 2016.

The closest of these monitoring locations to the A194 PCM exceedance stretches is Site DT17 (roadside), located approximately 10m north from the A194 carriageway along Census ID 77767. Annual mean NO_2 concentrations of 35.1µg/m^3 and 27.6µg/m^3 were recorded at this site in 2016 and 2017 respectively.

CM2 Lindisfarne Roundabout, Jarrow, is the closest continuous monitoring analyser to the A194 PCM exceedance stretch, which is located on Edinburgh Road approximately 25m south of the A194 carriageway along Census ID 6746. The annual mean NO_2 concentrations at this location were 22.1µg/m^3 and 25.0µg/m^3 for 2016 and 2017 respectively.

By way of comparison, the highest annual mean NO_2 concentration recorded by the Council's monitoring in 2017 was at Site DT27, with a concentration of 39.0µg/m^3 recorded, which is adjacent to the A194 Jarrow Road, approximately 1.5km from the A194 PCM exceedance stretch.

Local Traffic Flows

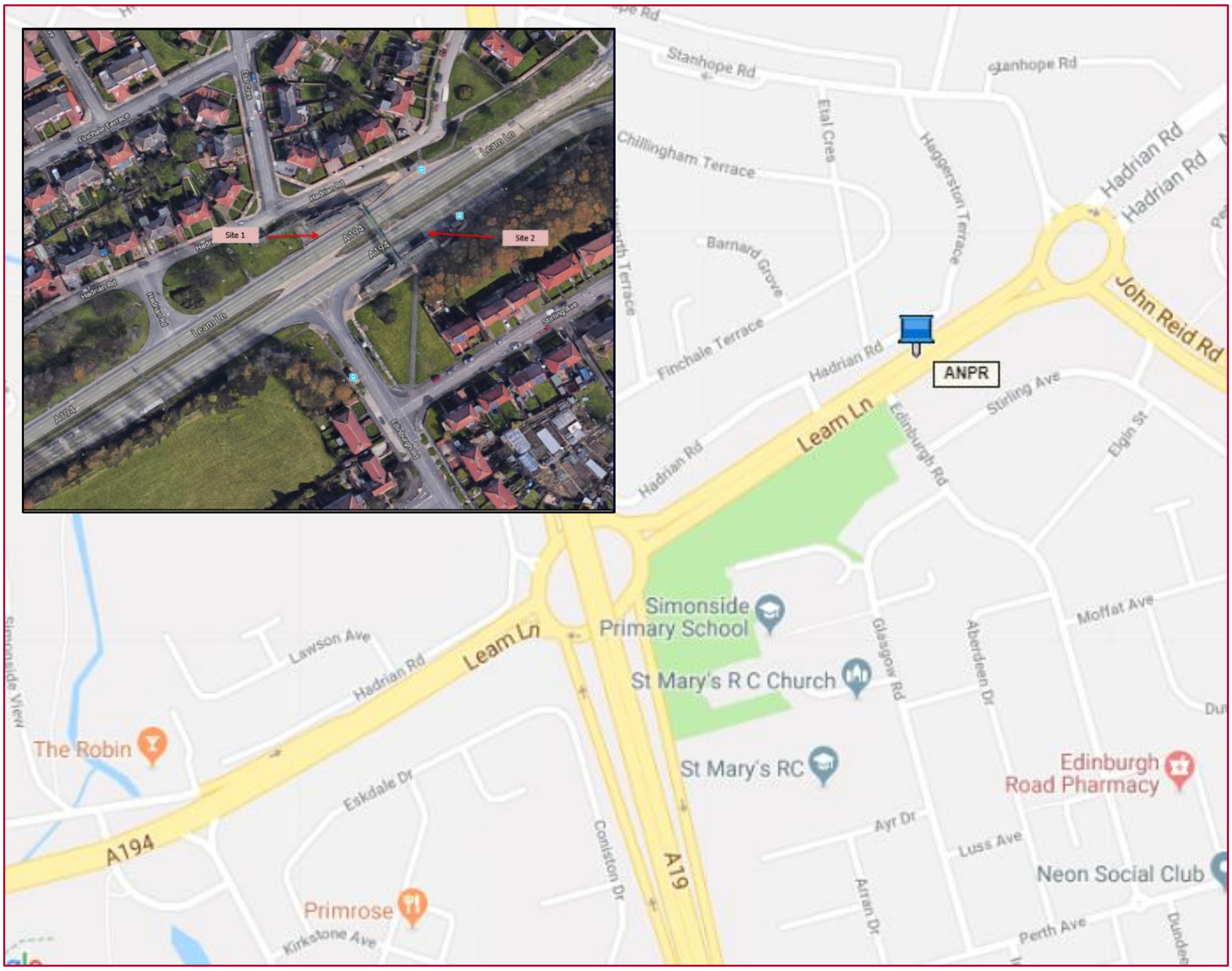
A number of traffic surveys have been undertaken on the roads located within the A194 PCM exceedance stretches, including turning counts and queuing surveys. The queue survey outputs from September 2017 are available and will be used as input to the local dispersion modelling exercise.

Full details of the available traffic data for the A194 PCM exceedance stretches, and the adjacent roads also included in the local dispersion modelling exercise, are provided in Annex 2.

ANPR Survey Findings

An ANPR survey was undertaken along the A194 PCM exceedance stretches, between 8th to 10th June inclusive, thereby providing data for a Friday (where Friday is a representative weekday), Saturday and Sunday. Two ANPR cameras were installed on the footbridge passing over the eastern A194 PCM exceedance stretch (Census ID 6746) recording two of the three lanes on both eastbound and westbound carriageways. In addition, Manual Classified Count (MCC) cameras were also installed at the same location to capture total traffic flow and to quantify the capture rate of the ANPR data. The survey was designed to capture total traffic flow, diurnal profile, fleet composition (including petrol/diesel/electric split) and Euro classification across both the eastbound and westbound stretches of the A194 carriageway. AADF was taken from the MCC, whilst Euro and fleet composition was obtained from the ANPR datasets. The ANPR survey location is illustrated in Figure 10.

Figure 10 - ANPR Survey Location



The 24-hour total traffic flows obtained for the 8th, 9th and 10th June 2018 were 51706, 41571 and 35954 respectively. This information was used to derive a 24-hour AADF of 48008 for the A194. This is slightly greater than the AADF of 43762 for 2017, as estimated along the A194 at DfT Count Point 6746.

Figure 11 shows the fleet composition along the A194 at the survey location. Cars account for 84% of the total fleet, followed by LGVs at 12%. Rigid HGVs and Articulated HGVs constitute 2% and 1% of the total fleet respectively, whilst the categories of Buses and Coaches and Motorcycles represent a negligible (<1%) fraction of the total fleet.

Figure 11 - Fleet Composition

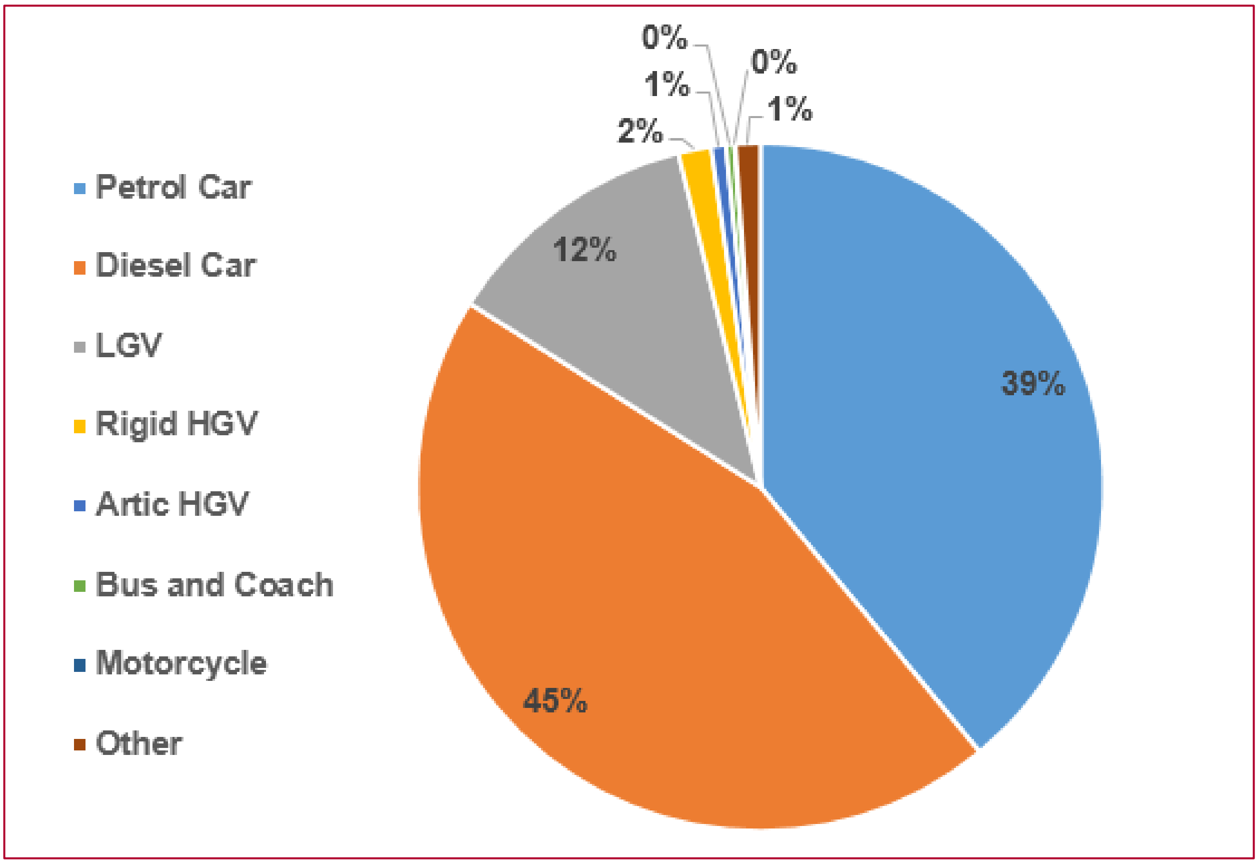


Figure 12 illustrates the Petrol and Diesel Splits for Cars, LGVs and Buses and Coaches based on the ANPR survey data. All Rigid and Articulated HGVs are diesels. The survey results identified that diesel and petrol accounts for 53% and 46% of the total cars respectively, with the remaining 1% being either hybrid or all electric. All LGVs and Buses and Coaches were also found to be diesel.

Figure 12 - Petrol and Diesel Split for Cars, LGVs and Buses and Coaches

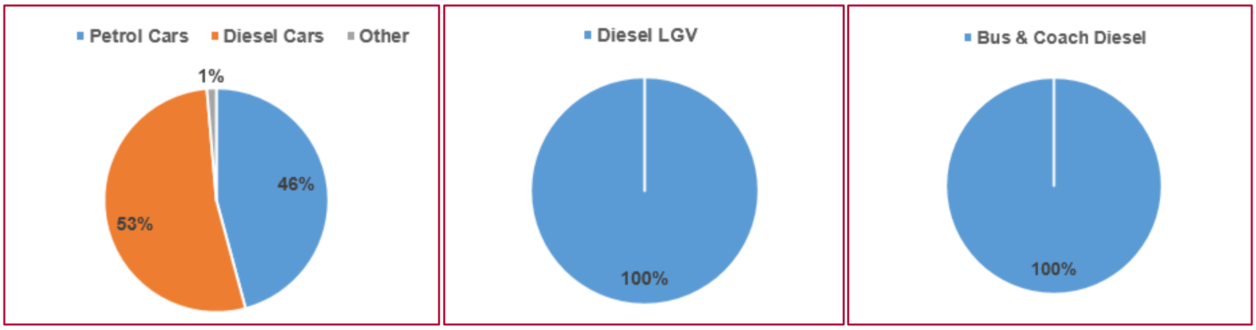


Figure 13 and Figure 14 *present the default national Euro proportions (blue headed tables) relative to the local Euro proportions derived from the* ANPR survey data for the A194 (orange headed tables), for Cars and LGVs respectively (tables taken directly from the EFT v8.0.1.a). *The* survey data show that both Cars and LGVs are predominantly comprised of Euro 4 standard vehicles or higher for both petrol and diesel vehicles. Both petrol and diesel cars were found to have comparable proportions of the Euro 4, 5 and 6 vehicles to the national default Euro proportions. In line with national assumptions, Euro 5 standard vehicles comprise the largest fraction of petrol and diesel Cars and diesel LGVs. The vast majority (60%) of petrol LGVs are of Euro 4, which is contrary to the national euro proportion for Euro 4 petrol LGVs of only 20%.

Figure 13 - Euro Proportions for Diesel and Petrol Cars

Petrol Car	Default Euro Proportions 2017 - England (not London)	User Euro Proportions 2017 - England (not London)
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.01	0.00
4Euro 3	0.11	0.00
5Euro 4	0.23	0.31
6Euro 5	0.34	0.36
7Euro 6	0.20	0.20
7Euro 6c	0.12	0.12

Diesel Car	Default Euro Proportions 2017 - England (not London)	User Euro Proportions 2017 - England (not London)
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.00	-
4Euro 3	0.06	0.00
5Euro 4	0.19	0.22
6Euro 5	0.40	0.44
7Euro 6	0.22	0.21
7Euro 6c	0.13	0.12
7Euro 6d	0.00	-

Figure 14 - Euro Proportions for Diesel and Petrol LGVs

Petrol LGV	Default Euro Proportions 2017 - England (not London)	User Euro Proportions 2017 - England (not London)
1Pre-Euro 1	-	-
2Euro 1	0.00	-
3Euro 2	0.03	-
4Euro 3	0.11	-
5Euro 4	0.20	0.60
6Euro 5	0.34	-
7Euro 6	0.32	0.40
7Euro 6c	-	-

Diesel LGV	Default Euro Proportions 2017 - England (not London)	User Euro Proportions 2017 - England (not London)
1Pre-Euro 1	-	-
2Euro 1	0.00	-
3Euro 2	0.01	-
4Euro 3	0.05	0.00
5Euro 4	0.20	0.26
6Euro 5	0.41	0.51
7Euro 6	0.33	0.23
7Euro 6c	-	-
7Euro 6d	-	-

Figure 15 shows the default national Euro proportions (blue headed tables) relative to the local Euro proportions derived from the ANPR survey data for the A194 (orange headed tables), for Rigid and Articulated HGVs (tables taken directly from the EFT v8.0.1.a). Euro VI is the largest national default proportion of Rigid HGVs (55%), whilst Euro V was found to be the largest proportion of Rigid HGVs (55%) locally. In line with national assumptions, Euro VI standard vehicles comprise the largest fraction of Articulated HGVs locally (51% locally vs 72% nationally).

Figure 15 - Euro Proportions for Rigid and Articulated HGVs

Rigid HGV	Default Euro Proportions 2017 - England (not London)		User Euro Proportions 2017 - England (not London)
1Pre-Euro I	-		-
2Euro I	-		-
3Euro II	0.01		-
4Euro III	0.09		0.02
5Euro IV	0.08		0.16
6Euro V_EGR	0.07		0.14
7Euro V_SCR	0.20		0.41
8Euro VI	0.55		0.28
9Euro II SCRRF	-		-
10Euro III SCRRF	-		-
11Euro IV SCRRF	-		-
12Euro V EGR + SCRRF	-		-

Note: No emissions factors available for HGV SCRRF (Retrofits) therefore standard Euro class emissions factors will be assumed even if fleet i

Artic HGV	Default Euro Proportions 2017 - England (not London)		User Euro Proportions 2017 - England (not London)
1Pre-Euro I	-		-
2Euro I	-		-
3Euro II	0.00		-
4Euro III	0.02		0.00
5Euro IV	0.03		0.09
6Euro V_EGR	0.06		0.10
7Euro V_SCR	0.18		0.30
8Euro VI	0.72		0.51
9Euro II SCRRF	-		-
10Euro III SCRRF	-		-
11Euro IV SCRRF	-		-
12Euro V EGR + SCRRF	-		-

Figure 16 shows the default national Euro proportions (blue headed tables) relative to the local Euro proportions derived from the ANPR survey data for the A194 (orange headed tables), for Buses and Coaches (tables taken directly from the EFT v8.0.1.a). Euro VI is the largest proportion of Buses and Coaches nationally (40%), whilst Euro IV was found to the largest proportion of Buses and Coaches locally (47%) with only 21% of Euro VI vehicles observed. No Euro II Buses and Coaches were observed in the local fleet.

Figure 16 - Euro Proportions for Buses and Coaches

Buses	Default Euro Proportions 2017 - England (not London)		User Euro Proportions 2017 - England (not London)
1Pre-Euro I	-		-
2Euro I	-		-
3Euro II	0.03		-
4Euro III	0.13		0.00
5Euro IV	0.10		0.47
6Euro V_EGR	0.08		0.08
7Euro V_SCR	0.25		0.23
8Euro VI	0.40		0.21
9Euro II SCRRF	-		-
10Euro III SCRRF	-		-
11Euro IV SCRRF	-		-
12Euro V EGR + SCRRF	-		-

Note: Emissions factors (scaled) are available for Bus SCRRF (Retrofits) therefore user defined fleet may be used

Coaches	Default Euro Proportions 2017 - England (not London)		User Euro Proportions 2017 - England (not London)
1Pre-Euro I	-		-
2Euro I	-		-
3Euro II	0.03		-
4Euro III	0.13		0.00
5Euro IV	0.10		0.47
6Euro V_EGR	0.08		0.08
7Euro V_SCR	0.25		0.23
8Euro VI	0.40		0.21
9Euro II SCRRF	-		-
10Euro III SCRRF	-		-
11Euro IV SCRRF	-		-
12Euro V EGR + SCRRF	-		-

Figure 17 shows the default national Euro proportions (blue headed tables) relative to the local Euro proportions derived from the ANPR survey data for the A194 (orange headed tables), for Full Hybrid Petrol and Diesel Cars (tables taken directly from the EFT v8.0.1.a). Euro 6 standard comprises the largest proportion of Full Hybrid Petrol Cars both nationally (62%) and locally (68%). Euro 6 standard is also the largest proportion of Full Hybrid Diesel Cars nationally with 87%, whilst Euro 5 standard was found to be the largest proportion locally with 100%.

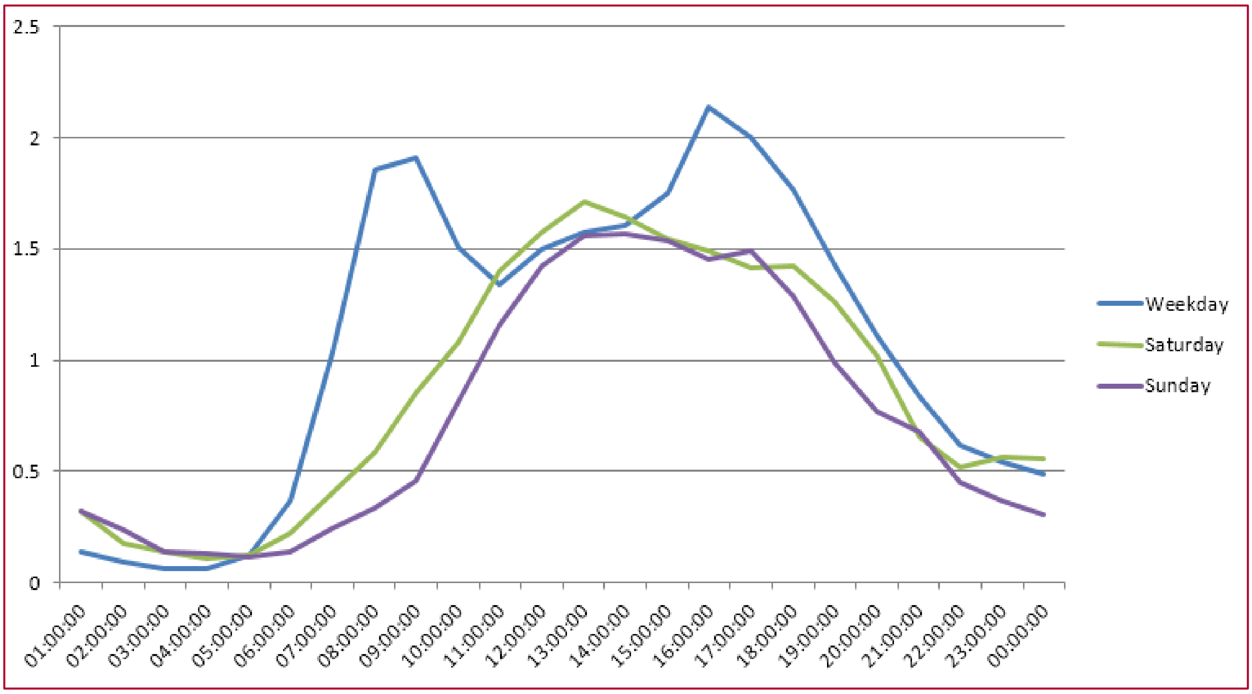
Figure 17 - Euro Proportions for Full Hybrid Petrol and Diesel Cars

Full Hybrid Petrol Car	Default Euro Proportions 2017 - England (not London)	User Euro Proportions 2017 - England (not London)
1Pre-Euro 1	-	-
4Euro 3	0.00	-
5Euro 4	0.09	0.02
6Euro 5	0.29	0.30
7Euro 6	0.32	0.35
7Euro 6c	0.30	0.33

Full Diesel Hybrid Car	Default Euro Proportions 2017 - England (not London)	User Euro Proportions 2017 - England (not London)
6Euro 5	0.13	1.00
7Euro 6	0.37	-
7Euro 6c	0.49	-
7Euro 6d	-	-

Figure 18 illustrates the diurnal profile in traffic flows at each hour throughout the day on 8th (Friday – representative Weekday), 9th (Saturday) and 10th (Sunday) June 2018. The a.m. and p.m. peaks, inter-peak and off-peak periods are clearly visible on the Friday, whilst the profile on the Saturday and Sunday show a characteristic single peak later in the day (with the Sunday exhibiting a lower flow than the Saturday).

Figure 18 - Diurnal Traffic Flows



Local Dispersion Modelling

A local dispersion modelling study was undertaken to assess annual mean NO_2 concentrations across the A194 PCM exceedance stretches, with 2017 taken to be the baseline year. 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 study, with traffic data used as input to the model derived from a combination of available sources, including:

- 2017 DfT traffic count data (AADF and fleet composition);
- June 2018 ANPR survey data (AADF, fleet composition, Euro composition and diurnal profile);
- 2018 Traffic data for Census ID 6746 used in the PCM model was used for A194 Learn Lane (AADF and fleet composition);
- 2016 and 2017 Council ATC survey data (AADF, fleet composition and average speed); and
- 2014 Council ATC survey data (AADF and fleet composition).

Where required, traffic data inputs were growthed to the baseline year of 2017 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. A factor of 0.99375 was applied to 2014 flows.

Meteorological data for the year 2017 from Newcastle airport, approximately 16km NW from the A194 PCM exceedance stretches, was used as a model input.

Annual mean NO_2 concentrations were predicted for the 2017 baseline scenario at receptors plotted 4m from the kerb of the A194 PCM exceedance stretches to facilitate direct comparison against the PCM model predictions - referred to as 'PCM receptors'. 198 discrete receptors were initially added, ultimately 128 of these discrete receptors were retained as being considered representative locations along the PCM exceedance stretches (9 excluded due to being located in adjacent roads, whilst 61 were removed due to being within 25m of a major junction). All PCM receptors were included at a height of 2m.

Further 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 PCM Receptors

There are no exceedances predicted at any of the modelled discrete receptors. The maximum annual mean NO_2 concentration on Census ID 6746 was predicted to be 36.4μg/m^3 at the PCM receptor 162, whilst the maximum annual mean NO_2 concentration on Census ID 77767 was predicted to be 40.0μg/m^3 at the PCM receptor 76. Both of these values are below the annual mean EU limit value of 40μg/m^3, suggesting that compliance along both Census IDs 6746 and 77767 has already been achieved by 2017.

Local Dispersion Modelling Results - Source Apportionment

To help inform the development of measures required as Part 2 of the TFS, source apportionment of the road traffic vehicle categories has been undertaken. Table 2 and Figure present the results of the NO_x concentration source apportionment exercise based on the modelled discrete PCM receptors, for the modelled baseline year of 2017.

Source apportionment results have been calculated for two different categories of the modelled receptors:

- Average across all modelled receptors – This provides an average at all modelled receptors and so is useful when considering possible measure to test and adopt. It will however understate road NO_x concentrations in problem areas; and
- At the receptor with maximum road NO_x Concentration along each Census - Provides the

NO_x source apportionment at the receptor with the highest predicted road NO_x concentration. This is likely to be in the areas 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 these locations and so would not represent gains across the whole modelled area.

When considering the average NO_x concentration across all modelled discrete receptors, road traffic accounts for 35.6µg/m^3 (60%) of 59.5µg/m^3. Of this 35.6µg/m^3, Cars account for the most (56%) of any of the vehicle types. LGVs also account for a relatively high proportion of the overall predicted NO_x concentration at 33%.

At the receptor with maximum the maximum road NO_x concentration on Census ID 6746 (PCM Receptor 162), road traffic accounts for 37.4µg/m^3 (61%) of 61.2µg/m^3. Of this 37.4µg/m^3, Cars account for the most (56%) of any of the vehicle types. LGVs are the second highest contributor to the overall predicted NO_x concentration with 28%.

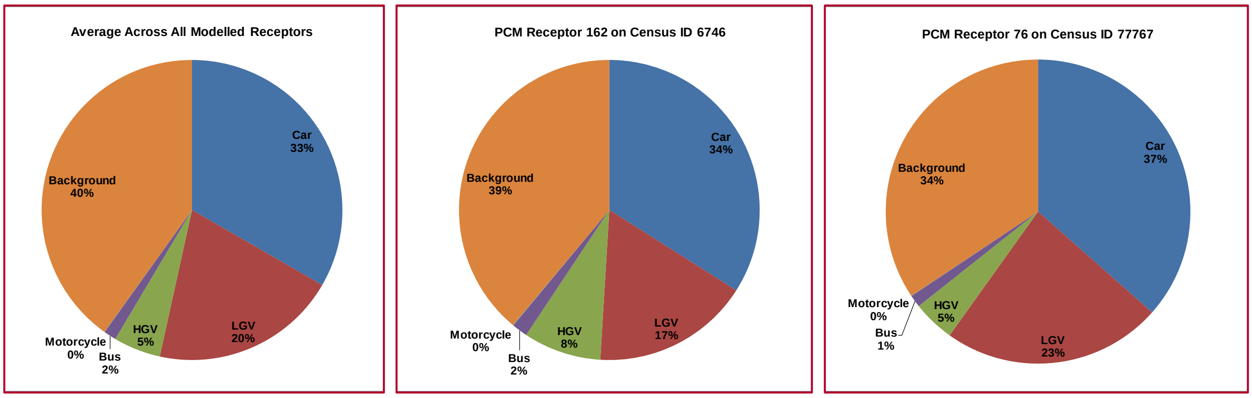
At the receptor with maximum the maximum road NO_x concentration on Census ID 77767 (PCM Receptor 76), road traffic accounts for 45.5µg/m^3 (66%) of 69.3µg/m^3. Of this 45.5µg/m^3, Cars account for the most (56%) of any of the vehicle types. LGVs are the second highest contributor to the overall predicted NO_x concentration with 36%.

Table 2 - NO_x Source Apportionment Results

Results	All Vehicles	Car	LGV	HGV	Bus	Motorcycle	Background
Average Across All Modelled Receptors							
NO_x Concentration (µg/m^3)	35.6	19.8	12.0	3.0	0.8	0.0	23.9
Percentage of Total NO_x	60%	33%	20%	5%	1%	0%	40%
Percentage Contribution to Road NO_x	100%	56%	33%	8%	2%	0%	-
At Location on Census ID 6746 with Maximum Road NO_x Concentration (PCM Receptor 162)							
NO_x Concentration (µg/m^3)	37.4	20.8	10.4	5.1	1.0	0.0	23.8
Percentage of Total NO_x	61%	34%	17%	8%	2%	0%	39%
Percentage Contribution to Road NO_x	100%	56%	28%	14%	3%	0%	-
At Location on Census ID 77767 with Maximum Road NO_x Concentration (PCM Receptor 76)							
NO_x Concentration (µg/m^3)	45.5	25.3	16.2	3.1	0.9	0.0	23.8
Percentage of Total NO_x	66%	37%	23%	4%	1%	0%	34%

Percentage Contribution to Road NO_x	100%	56%	36%	7%	2%	0%	-

Figure 19 - NO_x Source Apportionment Results



Local Dispersion Modelling Results - Summary

The discrete receptor modelled concentrations suggest that there are no exceedances of the EU limit value along the A194 PCM exceedance stretches at locations of relevant public access and exposure.

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 stretches, with the PCM model predicting 43µg/m^3 along both of the A194 PCM exceedance stretches (Census IDs 6746 and 77767) in 2017.

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

- Improved resolution of local data model inputs to the local dispersion model, i.e. traffic flows, fleet composition, Euro 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;
- Measures already implemented by the Council post 2015, which have had a positive impact on air quality, principally in the form of the Lindisfarne improvement scheme (see Part 2 for more information). These will not have been taken in to account as part of the PCM national modelling (2015 baseline) but are inherently included within the inputs to the local dispersion model; 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 Automatic Urban and Rural Network (AURN)[2], 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 A194 PCM exceedance stretches (Census ID 6746 and 77767). The Council therefore consider that the findings from the local dispersion modelling exercise supersede the PCM model predictions, thereby

[2] The AURN is the UK air quality monitoring compliance network, which reports compliance against the Ambient Air Quality Directive (2008/50/EC).

providing for a revised baseline air quality position along Census IDs 6746 and 77767, i.e. the annual mean NO_2 concentration results from the local dispersion model replace the PCM model predictions.

On this basis, it is therefore concluded that no further consideration to possible measures to be implemented is required, with compliance against the annual mean EU limit value of $40\mu g/m^3$ for NO_2 suitably demonstrated to have already been achieved by 2017 along the A194 PCM exceedance stretches (Census IDs 6746 and 77767).

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.

Part 1 of the TFS concluded that there was no need to proceed with subsequent parts of the TFS, with compliance against the annual mean EU limit value of 40μg/m^3 for NO_2 suitably demonstrated to have already been achieved by 2017 along the A194 PCM exceedance stretches (Census IDs 6746 and 77767).

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.

Part 1 of the TFS concluded that there was no need to proceed with subsequent parts of the TFS, with compliance against the annual mean EU limit value of 40µg/m^3 for NO_2 suitably demonstrated to have already been achieved by 2017 along the A194 PCM exceedance stretches (Census IDs 6746 and 77767).

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.

Part 1 of the TFS concluded that there was no need to proceed with subsequent parts of the TFS, with compliance against the annual mean EU limit value of $40\mu g/m^3$ for NO_2 suitably demonstrated to have already been achieved by 2017 along the A194 PCM exceedance stretches (Census IDs 6746 and 77767).

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 South Tyneside Council (the Council) had two road links (Census IDs 6746 and 77767) projected to have an exceedance of the annual mean EU Limit Value of 40μg/m^3 for nitrogen dioxide (NO_2), both of which are located on the A194 corridor.

The projected corridor of exceedance is a stretch of the A194 from the junction with Hedworth Lane through to junction with the A1300 John Reid Road. The A194 is a strategic road link which connects South Shields Town Centre to the strategic road network (A194M). The defined corridor also includes the A19, which forms part of the strategic road network with the corridor being managed by Highways England.

Road Census ID 6746 covers the A194 from the junction with A194/A19 Lindisfarne through to the junction between the A194/A1300 (John Reid Road). Road Census ID 77767 covers the A194 from the junction with Hedworth Lane and runs through to the A194/A19 Lindisfarne junction.

In order to determine a more accurate local position on compliance with the annual mean NO_2 limit value, the Council undertook a local Automatic Number Plate Recognition (ANPR) survey and associated local dispersion modelling exercise, in order to provide an improved insight in to the air quality along the A194 PCM exceedance stretches.

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 dispersion modelling study, with traffic data used as input to the model derived from a combination of available sources. Further 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 receptors for a 2017 baseline scenario. The maximum annual mean NO_2 concentration on Census ID 6746 was predicted to be 36.4μg/m^3 at the PCM receptor 162, whilst the maximum annual mean NO_2 concentration on Census ID 77767 was predicted to be 40.0μg/m^3 at the PCM receptor 76.

In line with the local model results at discrete receptors, at all receptor locations representative of relevant public access and therefore potential exposure, no exceedances of the annual mean EU limit value of 40μg/m^3 are predicted. This suggests that compliance along both Census IDs 6746 and 77767 had already been achieved by 2017.

Therefore, 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 stretches, with the PCM model predicting 43μg/m^3 along both of the A194 PCM exceedance stretches (Census IDs 6746 and 77767) in 2017.

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

- Improved resolution of local data model inputs to the local dispersion model, i.e. traffic flows, fleet composition, Euro 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;
- Measures already implemented by the Council post 2015, which have had a positive impact on air quality, principally in the form of the Lindisfarne improvement scheme (see Part 2 for more information). These will not have been taken in to account as part of the PCM national modelling (2015 baseline) but are inherently included within the inputs to the local dispersion model; 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 A194 PCM exceedance stretches (Census ID 6746 and 77767). 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 IDs 6746 and 77767, 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 was no need to proceed with subsequent parts of the TFS, with compliance against the annual mean EU limit value of 40µg/m^3 for NO_2 suitably demonstrated to have already been achieved by 2017 along the A194 PCM exceedance stretches (Census IDs 6746 and 77767).

Notwithstanding the above, due to the timings of reaching the above conclusion (i.e. through completion of the local ANPR survey and associated dispersion modelling exercise) relative to the need to progress the TFS, the Council had already prepared Parts 2 to 4 of the TFS. These were originally prepared relative to the PCM model baseline and were then only partially updated relative to the revised baseline position, i.e. that as determined from the local dispersion modelling exercise, which supersedes the PCM model predictions.

Conclusion

A local dispersion modelling study has demonstrated that compliance against the annual mean EU limit value of 40µg/m^3 for NO_2 had already been achieved by 2017 along the A194 PCM exceedance stretches (Census ID 6746 and 77767). On this basis, it was concluded that no further consideration to possible measures to be implemented was required.

Notwithstanding the above, the Council remain committed to taking a proactive stance to ensuring positive improvements in air quality continue. The Council will therefore consider further measures that can be implemented, with a collaborative approach with the various stakeholders to be coordinated, in particular ensuring that a joined up approach with the other regional authorities across the north-east is at the forefront of any further action.

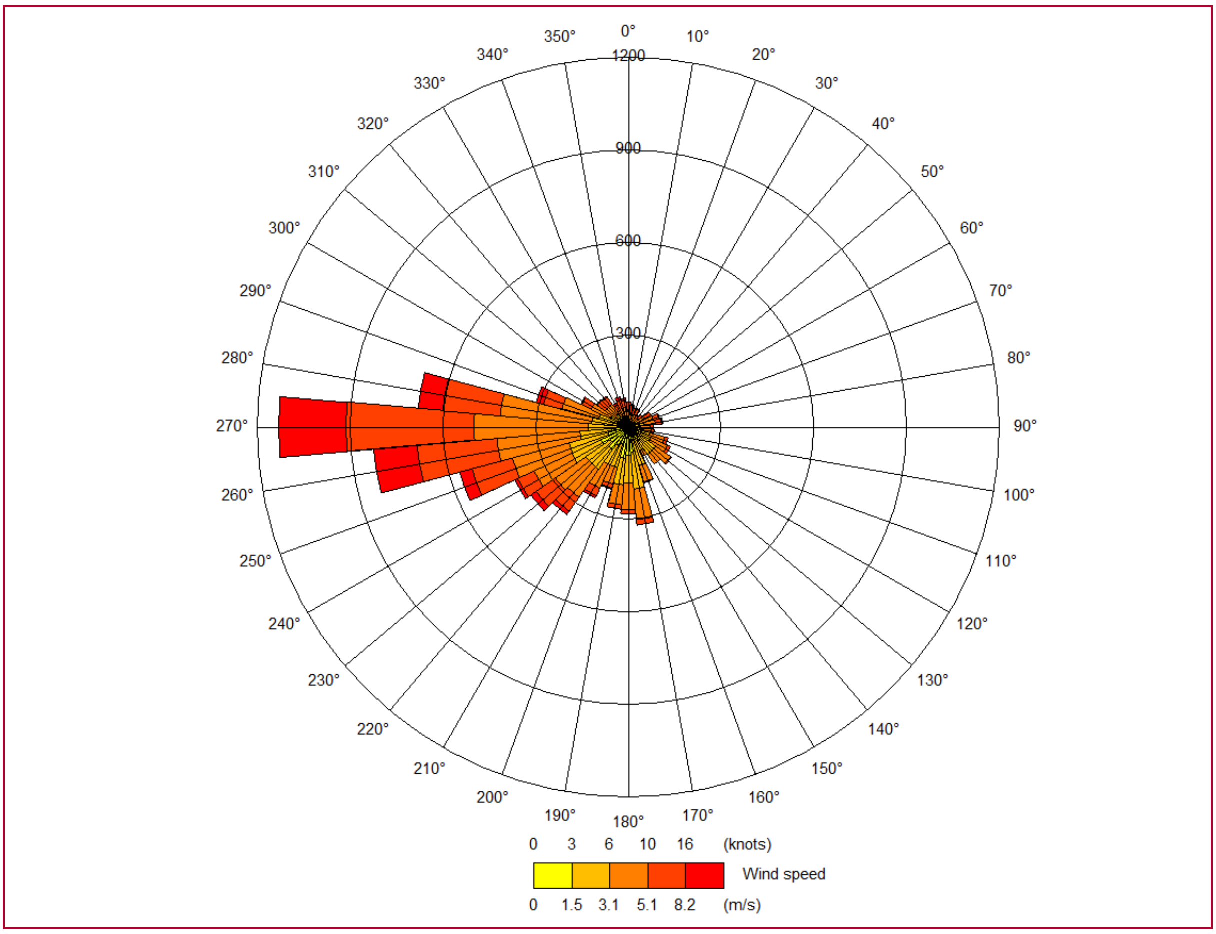
Annex 1: Model Inputs and Verification

Model Inputs

Meteorological Data

Meteorological data from a representative station is required by the dispersion model. 2017 meteorological data from Newcastle Airport's weather station, approximately 16km northwest from the A194 PCM exceedance stretches, 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 Newcastle 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 Newcastle includes 8,729 lines of usable hourly data out of the total 8,760 for the year, i.e. 99.6% 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 2018 ANPR survey (carried out at 434074, 563743), the Department for Transport (DfT) Traffic Counts website, traffic data used in the Pollution Climate Mapping (PCM) model and Council Automatic Traffic Counters (ATC) survey data for years 2014, 2017 and 2018, as detailed in Table A.1 and Table A.2. A growth factor of 0.99375 was calculated using Tempro to apply to the 2014 ATC traffic count to 2017. Fleet compositions for 2017 were kept consistent with the fleet compositions observed in the original data source.

Traffic speeds were based on information derived from Council ATC surveys 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.

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 Table A.2, whilst the modelled roads are presented in Figure A.2.

Table A.1 - Traffic Data used in ADMS-Roads Assessment for the A194 PCM Exceedance Stretches

Link Name	2017								Speed (kph)
	AADT	**% Petrol Car**	**% Diesel Car**	**% LGV**	**% Rigid HGV**	**% Artic HGV**	**% Bus and Coach**	**% Motorcycle**	
A1300 a	23429	38.9	44.9	14.1	1.3	0.2	0.3	0.4	55
A19 b	43928	35.9	41.4	15.8	3.1	3.0	0.1	35.9	98
A194 Newcastle Road c	46977	45.2	38.2	12.7	1.8	0.9	0.5	0.7	56
Auckland Terrace d	1884	41.3	47.6	8.5	0.3	0.0	1.8	0.5	38
Edinburgh Road e	1516	37.3	43.1	9.9	1.6	0.7	6.5	0.9	38
Hedworth Lane f	402	38.1	44.0	12.9	1.7	0.8	1.2	1.4	45
Roman Road g	487	37.8	43.6	11.7	2.5	1.1	2.8	0.7	39

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: Growth factor of 0.99375 was applied for 2014 to 2017

Note 3: Growth factors weren't applied to 2016 ATC traffic data for Roman Road as the survey was undertaken within December 2016 and connects onto the A194 for which a detailed ANPR survey was completed

[a] 2017 DfT count for Census ID 37622

[b] 2017 DfT count for Census ID 36092

[c] 2018 PCM model traffic data for Census ID 6746

[d] 2014 Council ATC traffic data (applied observed ANPR diesel/petrol split for cars)

[e] 2017 Council ATC traffic data (applied observed ANPR diesel/petrol split for cars and artic/rigid split for HGVs)

[f] 2017 Council ATC traffic data (applied observed ANPR diesel/petrol split for cars and artic/rigid split for HGVs)

[g] 2016 Council ATC traffic data (applied observed ANPR diesel/petrol split for cars and artic/rigid split for HGVs)

Table A.2 - ANPR Data used in ADMS-Roads Assessment for the A194 PCM Exceedance Stretches

Link Name	2017												
	AADT	% Car					% LGV	% HGV		% Buses/Coaches		% Motorcycle	Speed (kph)
		Petrol	Diesel	Full Hybrid Petrol	Full Hybrid Diesel	EV		Rigid	Artic	Diesel	Hybrid		
A194 E	48008	39.0	45.0	0.9	0.0	0.3	12.2	1.5	0.7	0.4	0.0	0.0	55
A194 W a	49554	39.0	45.0	0.9	0.0	0.3	12.2	1.5	0.7	0.4	0.0	0.0	98

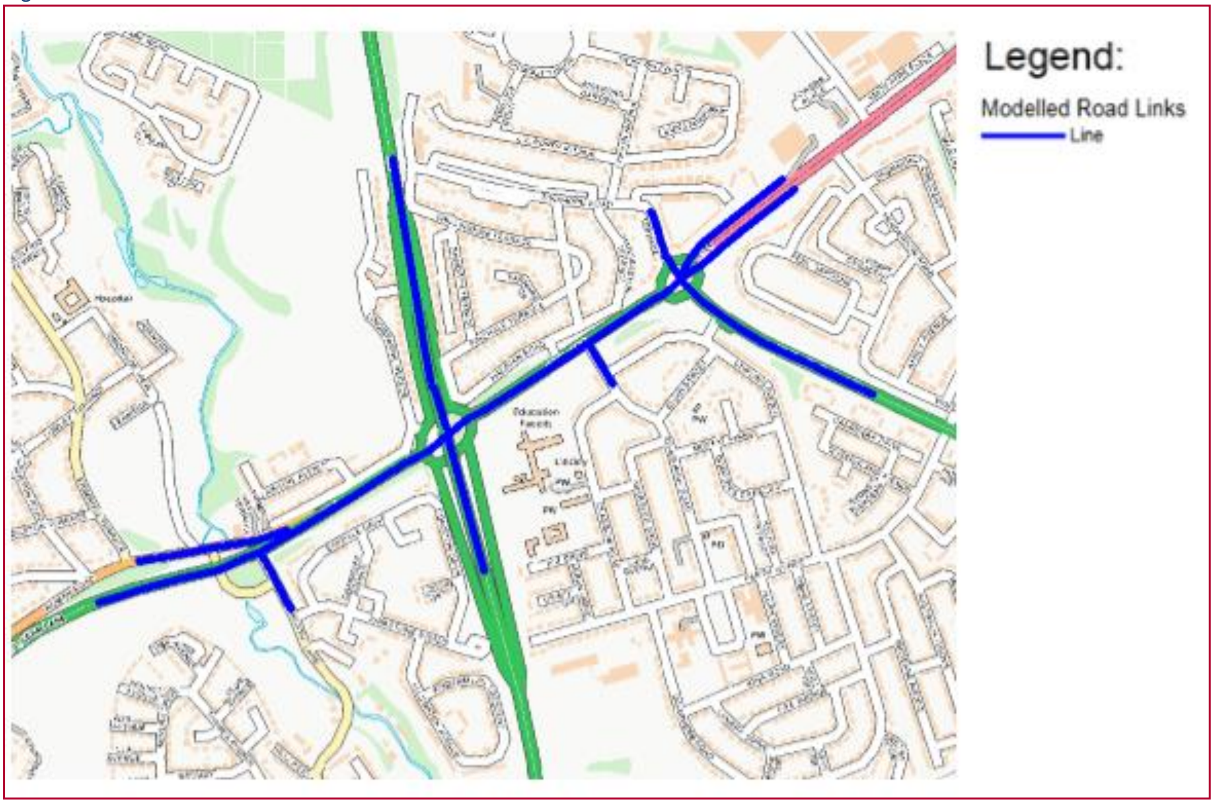
Note 1: Speeds have been reduced to simulate queues at junctions, traffic lights and other locations where queues are known to be an issue.

Note 2: The survey was carried out in June 2018 along A194 E - the survey data were taken to be representative for 2017.

[a] Traffic flow derived from a ratio of A194 E ANPR and DfT counts multiplied by the A194 W DfT count

[a] Proportions of vehicles on A194 W derived from ANPR A194 E counts

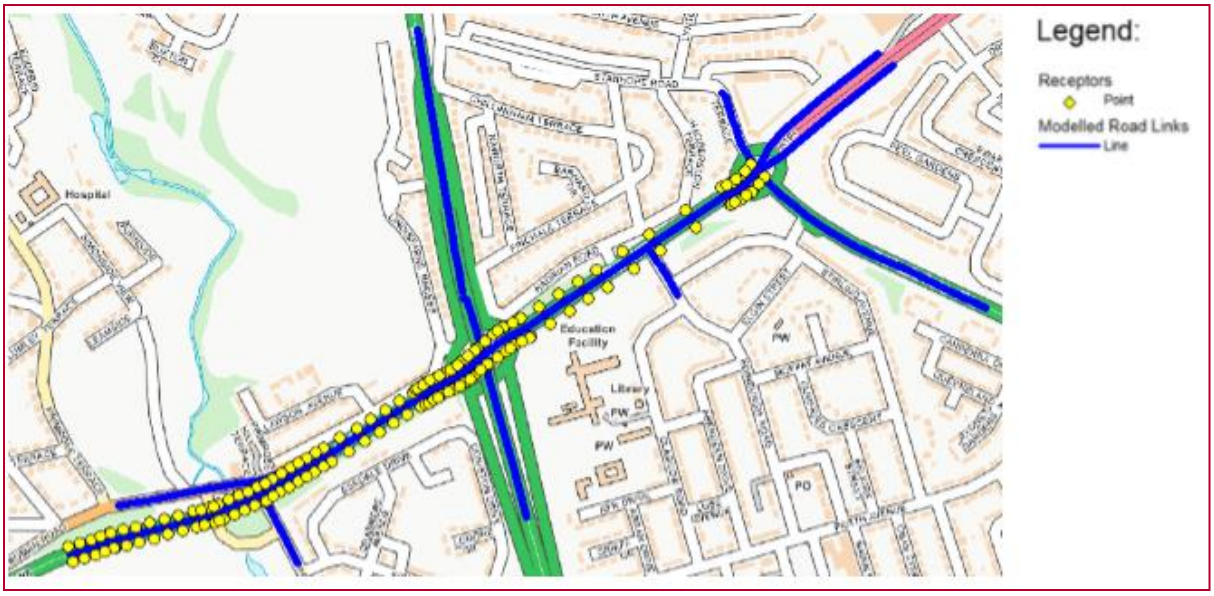
Figure A.2 - Modelled Roads



Receptors

Discrete receptors ('PCM receptors') included within the model have been located at 4m distance from each road link along the A194 PCM exceedance stretches at a height of 2m, as illustrated in Figure A.3.

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

There are several monitoring sites adjacent to the A194 PCM exceedance stretch and along other roads adjacent to the A194 which are within the modelled domain. The following monitoring locations are located adjacent to the A194 PCM exceedance stretches:

- Diffusion tube DT17, located approximately 11.5m north of the A194 western PCM exceedance stretch along Hadrian Road – a residential access road running parallel with the A194 (433658, 563497);
- Continuous monitor CM2, located approximately 25m south of the A194 eastern PCM exceedance stretch along Edinburgh Road (434068, 563695); and
- Triplicate Site consisting of diffusion tubes DT20, DT21 and DT22, collocated with CM2.

The following monitoring locations are located further afield from the A194 PCM exceedance stretches, but still within the modelled domain:

- Diffusion tube DT19, located approximately 100m north of the A194 PCM western exceedance stretch adjacent to the A19s northern approach to the Lindisfarne Roundabout (433780, 563692);
- Diffusion tube DT18, located approximately 270m north of the A194 PCM western exceedance stretch adjacent to the A19s northern approach to the Lindisfarne Roundabout (433698, 563825);
- Diffusion tube DT24, located approximately 200m east of the A194 western PCM exceedance stretch along Hadrian Road which connects via roundabout to the A194 (434313, 563963); and
- Diffusion tube DT26, located approximately 200m east of the A194 western PCM exceedance stretch at the end of Stanhope Road adjacent to Hadrian Road which connects via roundabout to the A194 (433698, 563825).

As triplicate site DT20, DT21 and DT22 forms a colocation study with CM2, these diffusion tubes have been removed from the model verification process, with the continuous monitoring data from CM2 being used in preference.

The Lindisfarne roundabout improvement scheme (completed on 23rd July 2017) introduced major changes to road geometry, traffic flow and fleet composition along the A194 PCM exceedance stretches and other roads within the modelled domain. As the majority of the traffic data (including the detailed ANPR data for the A194) derives from surveys undertaken after the completion of the improvement scheme, monitoring used for model verification needed to reflect this. Therefore, annualised August-December 2017 monitoring data inclusive from the nearby monitoring locations was used for model verification. Annualisation was undertaken using two urban background AURN sites, in line with the methodology detailed in LAQM.TG(16):

- Newcastle Centre (99.2% data capture)
- Sunderland Silksworth (92.6% data capture)

For model verification, the diffusion tube and continuous monitoring data for 2017, as collected and processed by South Tyneside Council, are presented in

Table A.**3**, along with the annualised values reflecting completion of the Lindisfarne improvement scheme which have been used for model verification purposes (Post Lindisfarne Annualised 2017 NO_2 Concentrations).

Table A.3 - Local Monitoring Data Available for Model Verification

Site ID	X	Y	% Data Capture for Monitoring Period (2017)	2017 NO_2 Concentrations (µg/m^3)	Post Lindisfarne Annualised 2017 NO_2 Concentrations (µg/m^3)
DT17	433658	563497	100%	27.6	26.0
DT18	433698	563825	100%	23.4	21.5
DT19	433780	563692	100%	33.4	32.3
DT24	434327	563960	100%	32.8	36.7
DT26	434304	563975	100%	28.0	27.5
CM2	434068	563695	99.6%	27.6	24.8

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 post Lindisfarne annualised mean concentrations for 2017 reflecting completion of the Lindisfarne roundabout traffic improvement scheme were used, as presented in

Table A.**3**.

Table A.4 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.4 - Comparison of Unverified Modelled and Monitored NO_2 Concentrations

Site ID	Background NO_2 (µg/m^3)	Monitored total NO_2 (µg/m^3)	Unverified Modelled total NO_2 (µg/m^3)	% Difference (modelled vs. monitored)
DT17	18.4	26.0	25.7	-1.1
DT18	18.4	21.5	21.6	0.5
DT19	18.4	32.3	23.4	-27.5
DT24	17.3	36.7	27.2	-25.9
DT26	17.3	27.5	21.8	-20.8
CM2	17.3	24.8	22.7	-8.5

The model was under predicting at five out of the six 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 for road NO_x rather than NO_2. For the diffusion tube monitoring results used in the calculation of the model adjustment, NO_x was derived from NO_2; these calculations were undertaken using the NO_x to NO_2 Calculator (version 6.1) spreadsheet tool available from the LAQM website.

Table A**.5** 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.5 - 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)
DT17	26.0	40.9	18.4	26.0	7.6	15.0	14.4
DT18	21.5	32.0	18.4	26.0	3.1	6.0	6.3
DT19	32.3	54.2	18.4	26.0	13.9	28.2	9.8
DT24	36.7	64.5	17.3	24.3	19.4	40.1	19.5
DT26	27.5	44.5	17.3	24.3	10.2	20.2	8.6
CM2	24.8	39.0	17.3	24.3	7.5	14.7	10.4

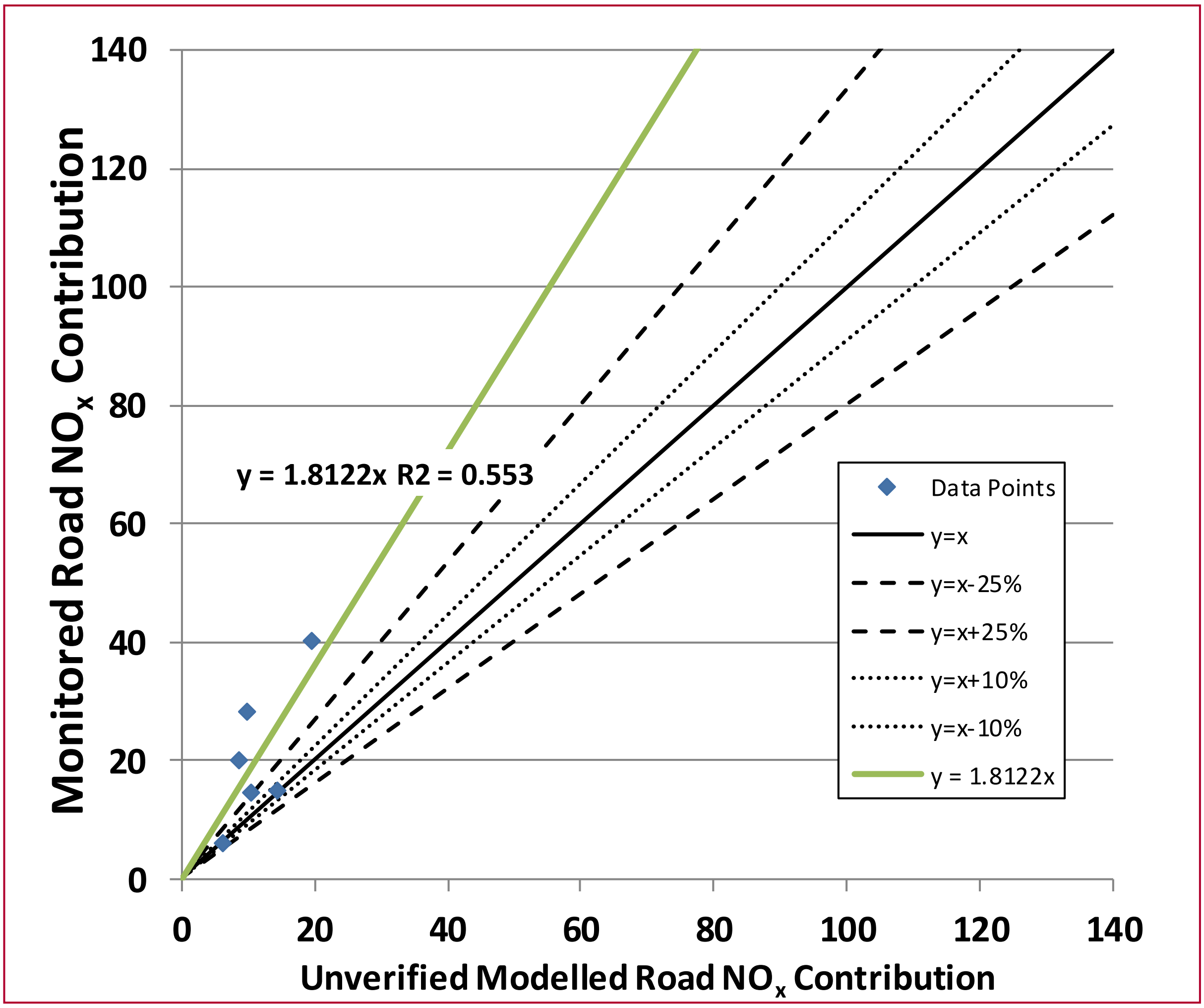
Figure A.4 provides a comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x, and the equation of the trend line based on linear regression through zero. The equation of the trend lines presented in Figure A.4 gives an adjustment factor for the modelled results of 1.812.

Table A.6 and Figure A.4 show the ratios between monitored and modelled NO_2 for each monitoring location after using an adjustment factor of 1.812.

Table A.6 - Model Verification (Initial)

Site ID	Ratio of monitored road contribution NO_x / modelled road contribution NO_x	Adjustment factor for modelled road contribution NO_x	Adjusted modelled road contribution NO_x (µg/m³)	Adjusted modelled total NO_x (including background NO_x) (µg/m³)	Modelled total NO_2 (based upon empirical NO_x / NO_2 relationship) (µg/m³)	Monitored total NO_2 (µg/m³)	% Difference (adjusted modelled NO_2 vs. monitored NO_2)
DT17	1.04	1.812	26.0	52.0	31.3	26.0	20.4
DT18	0.97		11.3	37.3	24.2	21.5	12.5
DT19	2.88		17.7	43.7	27.3	32.3	-15.3
DT24	2.06		35.3	59.6	34.5	36.7	-5.8
DT26	2.35		15.6	39.9	25.3	27.5	-8.1
CM2	1.41		18.9	43.2	26.9	24.8	8.3

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



Although the model was performing well at most monitoring sites, DT19 was not performing as well and was not showing consistency across similar monitoring sites. Upon closer inspection, DT19 was within close proximity to a number of roads/stretches of roads which were not included within the model (A19 Sip road, Hadrian Road and Finchale Terrace), which would therefore lead to a greater under prediction. DT19 was therefore removed from the model verification process.

Figure A.5 provides a comparison of the Unverified Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x, and the equations of the trend line based on linear regression through zero with the DT19 removed (Final Verification). The equation of the trend line presented in Figure A.5 gives an adjustment factor of 1.686.

Table A.7 and Figure A.6 show the ratios between monitored and modelled NO_2 for each monitoring locations in the Final Verification. All sites considered show acceptable agreement between the ratios of monitored and modelled NO_2 all being within ±25%. A verification factor of 1.686 was therefore used to adjust the model results. A factor of 1.686 reduces the Root Mean Square Error (RMSE) from a value of 5.05 to 3.01.

The adjustment factor 1.686 was applied to the road-NO_x concentrations predicted by the model to arrive at the final NO_2 concentrations. NO_2 results presented and discussed herein are those calculated following the process of model verification using a final adjustment factor of 1.686.

Figure A.5 - Comparison of the Modelled Road Contribution NO_x versus Monitored Road Contribution NO_x (Final)

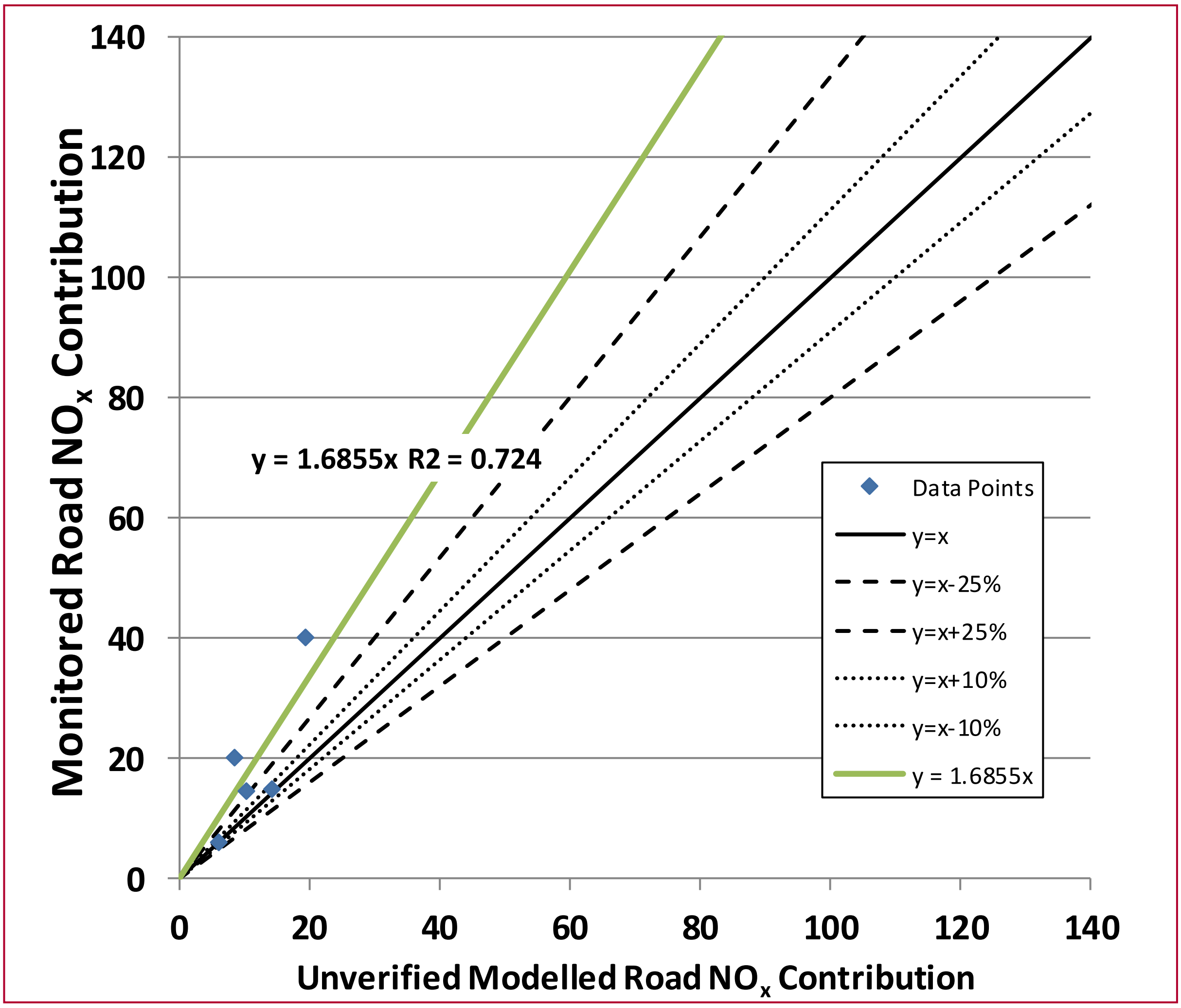


Figure A.6 - Comparison of the Modelled NO_2 versus Monitored NO_2 (Final)

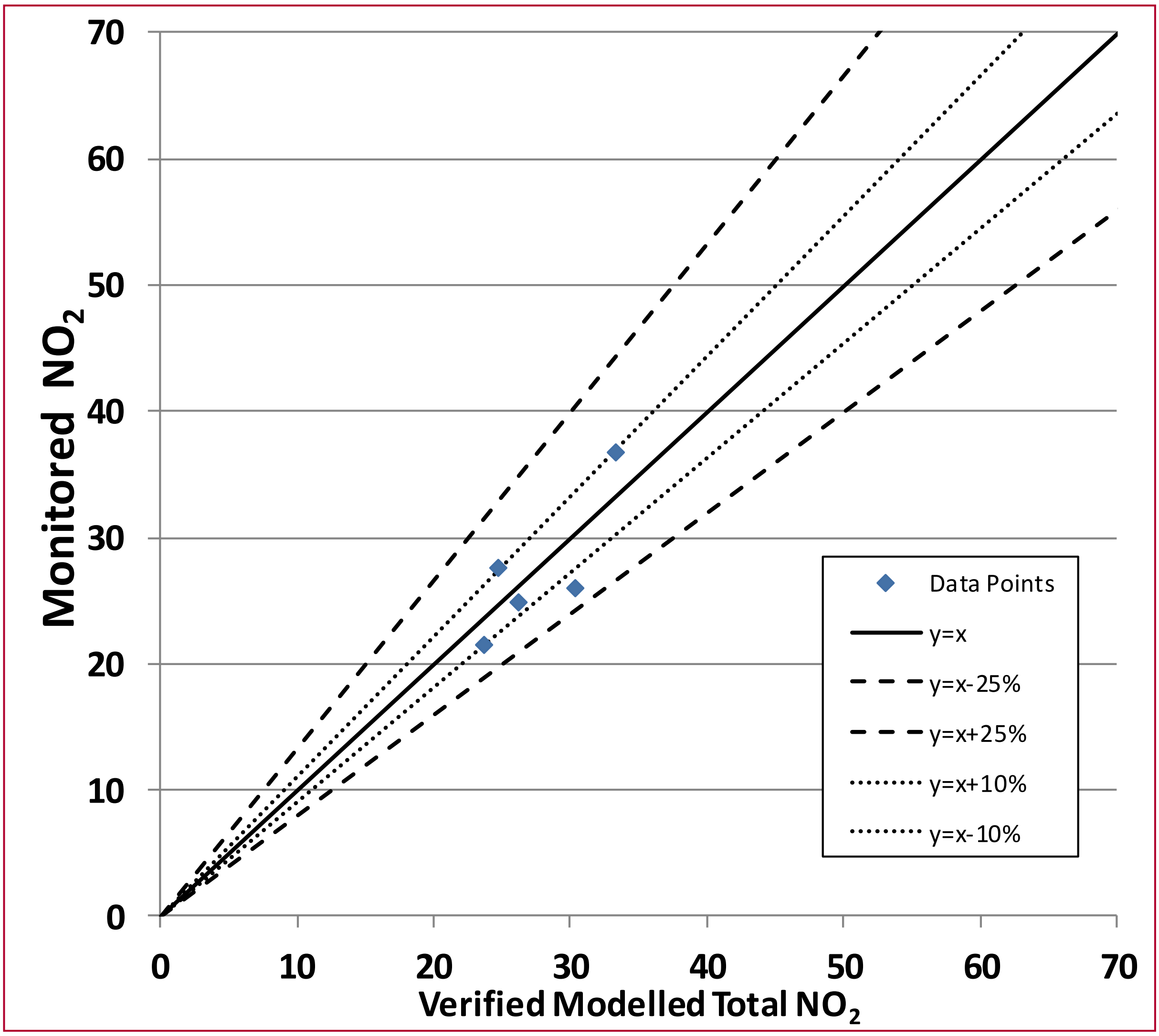


Table A.7 - Model Verification (Final)

Site ID	Ratio of monitored road contribution NO_x / modelled road contribution NO_x	Adjustment factor for modelled road contribution NO_x	Adjusted modelled road contribution NO_x (µg/m³)	Adjusted modelled total NO_x (including background NO_x) (µg/m³)	Modelled total NO_2 (based upon empirical NO_x / NO_2 relationship) (µg/m³)	Monitored total NO_2 (µg/m³)	% Difference (adjusted modelled NO_2 vs. monitored NO_2)
DT17	1.04	1.686	24.2	50.2	30.4	26.0	17.1
DT18	0.97		10.5	36.5	23.8	21.5	10.6
DT24	2.06		32.8	57.2	33.4	36.7	-8.9
DT26	2.35		14.5	38.9	24.7	27.5	-10.1
CM2	1.41		17.6	41.9	26.2	24.8	5.7

Annex 2 – Model results

Available on request