SOUTH GLOUCESTERSHIRE COUNCIL – TARGETED FEASIBILITY STUDY TO DELIVER NITROGEN DIOXIDE CONCENTRATION COMPLIANCE IN THE SHORTEST POSSIBLE TIME

Local authorities covered	South Gloucestershire Council (SGC)

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.***

We have one road link, a section of the A4174 (Census ID 17633), projected to have an exceedance and this road link is managed by South Gloucestershire Council (SGC). The A4174 is a major ring road running around the northern and eastern edge of Bristol from the A38 at Filton, under the M32 motorway through to Frenchay, Bromley Heath, Emersons Green, Kingswood, Warmley and Longwell Green, before joining the A4 at Hicks Gate junction near Keynsham.

The road link under consideration is 792.7 m in length, and is located between the junctions to the A4017 and M32, along Frenchay (**Figure 1**). The road link forms a strategic road link connecting Frenchay to the M32 and A4017.

The results from the PCM indicates that the road link is projected to have the following annual mean NO_2 concentrations:

- 43.0 µg/m^3 in 2018;
- 41.1 µg/m^3 in 2019;
- 39.0 µg/m^3 in 2020;
- 36.7 µg/m^3 in 2021.

SGC monitors NO_2 levels in the area. Diffusion tubes are installed in correspondence of residential receptors along the A4174 and, in the last 4 years (2014-2017) no exceedances of the annual average limit have been recorded. **Table 1** presents the bias adjusted monitoring results for 2015, 2016 and 2017.

Table 1: SGC Diffusion Tube Monitoring Results (µg/m^3)

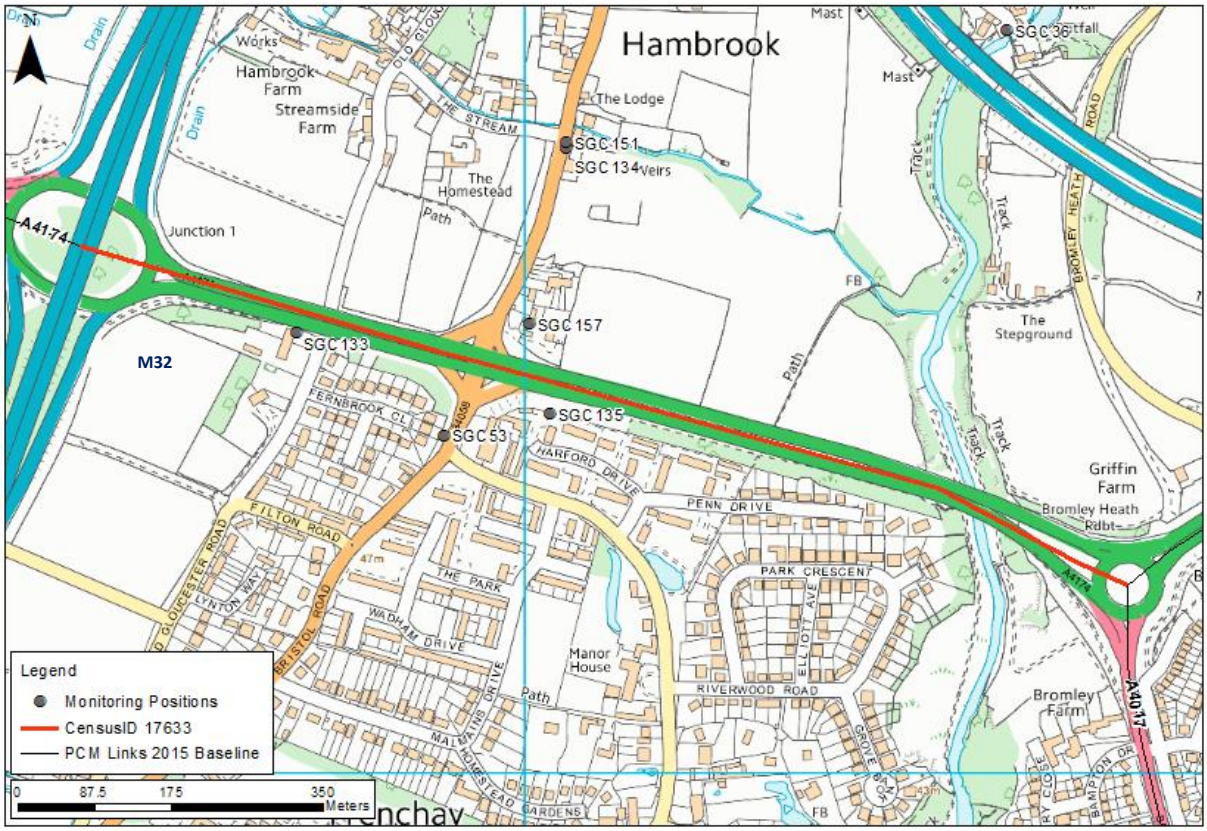
Site ID	Site Name	Distance from the Kerb	2015 Bias Adjusted (0.82)	2016 Bias Adjusted (0.88)	2017 Bias Adjusted (0.91)
SGC53	Hambrook – Bristol Road Rear of 17 Fenbrook Close	6.5(1)	30.0	33.7	27.9
SGC133	Hambrook - 123 Old Gloucester Road façade (dp)	10.4	28.4	30.7	25.6
SGC135	Frenchay – Harford Drive Dyrham Flats lp	24.5	26.8	28.5	27.4
SGC157	Hambrook - Bristol Road Poplars House (façade)	30.8(1)	27.0(2)	28.7	25.3

Notes:

(1) The distance from the kerb for receptors SGC53 and SGC157 refers to Bristol Road, not to the PCM link

(2) *The annualised 2015 NO_2 concentration for SGC157 is 30.5 µg/m^3 as the data capture was below 75%.*

Figure 1: Link 17633 Location & Monitoring Positions



Monitoring results indicate a decrease of between 2.3 and 16.4 % between 2015 and 2017.

The difference in NO_2 concentrations between what is reported in the PCM model and diffusion tube results could be due to residential properties being located further away from the kerb, while the PCM model estimates concentrations at 4m from the kerb.

Therefore, although PCM NO_2 levels can be considered representative of concentrations at which the public may be exposed on the cycling/pedestrian paths that runs alongside the A4174, residential receptors are unlikely to be exposed to concentrations above the Air Quality limit.

It is noted that the cycling/pedestrian paths are approximately 1m from the kerbside along the road link, so exposure levels are likely to be higher than those predicted by the PCM model. However, the purpose of this study is to achieve compliance with legal limits, and this will be assessed as per the PCM model (4m from the kerb) and local monitoring locations.

Additionally, it is believed that prolonged congestion during busy hours is the main cause of the high annual average concentrations on the road link. We expect the NO_2 concentrations in the short term to be higher during the peak hours, but note that the legal limit for short-term exposure (over the averaging period of 1 hour) is 200µg/m^3 (not to be exceeded more than 18 times a year) and the focus of this study is to achieve compliance with the legal limit for annual average NO_2 concentrations (40µg/m^3).

To understand the nature of the problem on this road link we have estimated the source apportionment using the available 2017 Automatic Traffic Count (ATC) data. The source apportionment was calculated using the Defra TG (16) NO_2 Source Apportionment Guidance. **Table 2** presents the 2015 PCM contributors to total NOx concentration on this road link in comparison to the 2017 NOx source apportionment based on the local traffic data.

The split between Petrol and Diesel Cars, LGVs and HGV types is not currently available for the local model area, however similar data is available for the greater Bristol area from the ongoing Bristol Feasibility Study. The splits between vehicle types used in Bristol Feasibility Study was therefore used to allow for result comparisons. The total NOx apportionment is based on the 2017 monitoring results at SGC133 due to the monitoring location being most representative of the link's conditions.

Two speed alternatives have been used to determine the estimated emissions which was then apportioned to the various vehicle fleets. A speed of 46 kph was used to directly compare the results to the average speed for urban roads (outside of London) used in the PCM, and 59.7 kph was provided by the local ATC data. Emissions were noted as being slightly higher when speed is reduced.

Table 2: Source Apportionment

Vehicle Fleet Description	2015 (PCM Model)	2017 (based on the ATC Local Model at receptor SGC133)	
	Total NOx Apportionment (Speed: 46 kph)	Total NOx Apportionment (Speed: 46 kph)	Total NOx Apportionment (Speed: 59.7 kph)
Petrol Cars	6.2 %	2.1 %	2.2 %
Diesel Cars	26.5 %	22.0 %	22.9 %
Petrol LGVs	0.1 %	0.0 %	0.0 %
Diesel LGVs	17.2 %	2.7 %	2.8 %
Articulated HGVs	9.0 %	2.1 %	1.8 %
Rigid HGVs	10.0 %	8.0 %	7.1 %
Buses	2.1 %	0.2 %	0.2 %
Motorcycles (Petrol)	0.3 %	0.3 %	0.4 %
Background sources	28.6 %	62.6 %	62.6 %

Based on the 2017 traffic information, the main contributors of NOx emissions are diesel cars (~25%) and HGVs (~9%), which the PCM results support. However, the PCM results indicate higher contributions from HGVs and LGVs than local traffic data – 19% and 17% in the PCM model compared with 10% and 3% based on the local traffic data.

The background contribution based on the local ATC model appears to be higher than the PCM one because the local model, at this stage, only considered the A4174 link road. This means that all other road sources are considered as "background sources". The high contribution of "background sources" to NOx emissions for the local receptors highlights the likely high contribution of roads that join the A4174 in this area – the A4017, Bristol Road and the M32. It is important that measures considered in this study take into account the contributions from these adjoining roads and improve the air quality of these roads as well as the A4174. This will be better quantified in the latter stages of the study.

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.

Since 2015, we have implemented a range of measures whose impact on air quality would not be represented in the PCM model. These are:

1. In 2014, major works were undertaken at A4174 and Bristol Road junction (Hambrook Crossroads) which involved improvements to the signalised junction and to cycle and pedestrian crossings facilities
2. Entire fleet of council pool cars switched to electric in early 2017
3. Higher standard buses used on A4174 thanks to successful Clean Bus Technology Funding (CBTF**)** bids by Bristol, South Gloucestershire and Bath and North-East Somerset Councils in 2015 and 2017.
4. Major maintenance work to the southern Bromley Heath Viaduct on the A4174, starting in July 2017 and completed in April 2018, which has had an impact on traffic flows on the A4174.
5. Access West and Sustainable Transport Transition Year funding, along with the work done by North Bristol SusCom, has enabled engagement with businesses, communities and schools to promote sustainable travel choices.

In addition to the measures above, which have already been implemented, there are several other measures, that are planned yet not implemented, that could have an impact on air quality at this location:

1. **Metrobus** - a joint project between South Gloucestershire Council, Bristol City Council and North Somerset Council to provide a rapid, high capacity public transport system by using a combination of segregated busways, bus lanes, priority at junctions and off-bus ticketing. This scheme will impact on air quality at the A4174 in three ways:
    a. An improvement to the bus fleet in the identified exceedance area (Euro VI as a minimum), with services started 29 May 2018, although the mode shift impact is not likely to be fully felt until later in 2018.
    b. Opening of the Stoke Gifford link in December 2017, connecting the A4174 west of M32 Junction 1 at Harry Stoke to the Great Stoke Way. This new link road forms an essential part of the Metrobus route. Although now operational, the mode shift impact of Metrobus along this route is not expected to be fully felt until late 2018.
    c. Expected increase in bus passengers through the identified exceedance area as a result of the improved journey time and frequency, and thus a corresponding reduction in car journeys.
2. **MetroWest –** improved rail services and infrastructure. Phase 2 of this project proposes to re-open the Henbury Line to an hourly spur passenger service and increase train services to Yate to a half-hourly service, with new rail stations at Henbury, North Filton and Ashley Down. Funding for this project has not yet been secured.
3. **GoUltraLowWest** - a grant funded project by OLEV (Office for Low Emission Vehicles) for investment in the promotion of electric vehicles throughout the West of England region. This will include installation of electric vehicle charging points at strategic locations in SGC, likely to be focused on the north and east fringe areas. Installation is likely to begin by March 2019, but continue until 2020.
4. An **Office for Low Emission Vehicles (OLEV)** funding grant in 2017 to the four West of England local authorities and First Bus, which could will help unlock a £28m investment by First, to potentially transform a significant part of their fleet (up to 110 vehicles) into bio-methane powered buses.

The new buses, which could start running by 2019, will contribute to reducing air pollution levels across the West of England area, and specifically the new Metrobus services (see above) will be part of this and use this section of the A4174.

5. An **OLEV** funding grant to switch 20% of other council fleet vehicles to electric by 2021.
6. **Bristol Clean Air Plan**, which is currently assessing 5 options to ensure compliance with NO2 levels across the city. All options consider either a charging Clean Air Zone or restricting the entry/movement of diesel vehicles in the city. There may be a negative short-term impact on NO2 levels at the A4174 ring road, as polluting vehicles re-route along the ring road rather than entering the city. However, work to date indicates that the measure would impact sufficient "through" vehicle trips to also improve air quality outside of the CAZ, including the exceedance area identified by the PCM model. A high-level assessment predicted that the introduction of the CAZ will result in a decrease of approximately 25% in NO2 annual mean concentration at SGC133 between 2016 and 2021, maintaining levels below the Air Quality Standard.
7. Improvements to cycling and walking infrastructure as part of maintenance works to **Bromley Heath Viaduct**, including a new shared use footpath as an extension to the viaduct. Completed in April 2018, but impact to be felt by late 2018.
8. The proposed new **Junction 18A on the M4,** which would reduce traffic on this road link accessing the M4 via the M32. However this scheme is not expected to be implemented in the timescales required for this study.

The impact on air quality of the measures listed above can be assessed as Part 4 of this study. However, we cannot be certain at this part of the study that they will have brought this road link into compliance. We have therefore considered a range of new measures that may bring forward compliance on this road link. These measures draw upon the information collected in Part 1 of the study, as well as experience of other local authorities in developing their Clean Air Plans. Although regional measures could be considered as part of the long list, we have focused on measures that are likely to have an immediate impact locally, to bring forward compliance on the road link. Regional and long-term measures, such as a workplace parking levy across SGC, or changes to planning policy, will be considered as part of our ***long-term strategy.***

The **new measures considered as part of this study** can be grouped into three themes:

1. Encouraging mode shift from car to more sustainable modes of transport, with the aim of reducing NO2 emissions from cars on the road link. This can be done through:
    - Expansion of relevant Park and Ride sites (near A4174)
    - Localised workplace parking levy for North Fringe businesses
    - Expansion of Car Club in local area
    - Subsidised/free bus travel to key local businesses
    - New/improved cycling infrastructure at a strategic scale
2. Improving the standard of vehicles using the road link, through:
    - Increase Euro Standard requirements for taxi and private hire vehicles in licensing agreement
3. Improvements to the flow of traffic on the road link, particularly at Hambrook Crossroads, leading to smoother traffic and lower NO2 emissions from all vehicle types (including LGVs and HGVs). Measures include:
    - Enforcement of 2+ lane on A4174
    - Soft gating provided to limit traffic movements from neighbouring junctions (westbound only)
    - Ban turns at Hambrook Crossroads to reduce delays

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, all measures that have been implemented since 2015 will be assessed in Part 4 of the study. These are:

1. Improvements to walking and cycling and other infrastructure at Hambrook Crossroads - 2015
2. Council pool cars switched to electric - early 2017
3. Cleaner buses used on A4174 – May 2018
4. Works to Bromley Heath Viaduct, completed April 2018
5. Promotion of sustainable travel choices on an ongoing basis

The impact of these options will be reflected in the traffic data collected for this study, and therefore be included in the 2017 base model.

Measures planned but not implemented

Some of the measures that have been planned but not yet implemented, as discussed in Part 2 of this study, have been discarded at this stage as they are not practically deliverable in time to bring forward compliance on this road link. As discussed in part 1 above, this road link is projected to become compliant in 2020 (according to the PCM model). This project aims to bring forward compliance, so any proposed measures must contribute to bringing about compliance in 2019. This means for any measure to be shortlisted, it must be deliverable by the end of 2018 to bring forward compliance.

For this reason, the following measures have been discarded:

- Metrowest - funding has not yet been approved, delivery is currently programmed for 2021 at the earliest.
- Installation of EV charging points through the OLEV grant - installation is unlikely to be complete before mid-2019, with any impact on air quality likely to be too late to bring forward compliance.
- Bristol Clean Air Plan – implementation of a Clean Air Zone unlikely before end of 2019.
- Proposed Junction 18A on the M4 – implementation unlikely before 2020.

The shortlisted measures (planned but not yet implemented) are:

- Bus fleet improvements, from Metrobus and OLEV grant
- Stoke Gifford link road
- Switching 20% of other council pool vehicles to electric by 2021.

New measures

As explained above, measures that cannot be delivered by the end of 2018 have been rejected at this stage. Some measures have also been rejected due to practical considerations. The new measures that have been discarded are:

- Expansion of relevant Park and Ride sites (near A4174) – not deliverable before 2021 based on previous experience (within the council and elsewhere in the region).
- Increase Euro Standard requirements for taxi and private hire vehicles in licensing agreement - even if operators were not given a reasonable lead-in time to upgrade their vehicles, this measure would not be deliverable before 2020.

This is due to the need for a formal consultation process and for the measure to commence at the start of a financial year.

- New/improved cycling infrastructure at a strategic scale – locally, cycling infrastructure has been upgraded as part of the improvements to Hambrook Crossroads and Bromley Heath Viaduct. Further improvements would require improving regional links – implementation is not possible by the end of 2018. A bike hire scheme would not be appropriate in this location (as it is a ring road and not a city-centre location) and would not be deliverable in the required timescales.
- Localised workplace parking levy for businesses in the north fringe area until alternative transport for those accessing these businesses by car can be provided it would not be practicable to establish a workplace parking levy. It would also not be deliverable by the end of 2018.
- Expansion of Car Club in local area – there are many existing schemes in the market, and Car Clubs are typically not appropriate for commuting trips. Since the predominant cause of exceedances on this road link is prolonged congestion at peak hours (linked to commuting), Car Clubs would not have a noticeable impact on air quality. Additionally, such measures would not be deliverable by the end of 2018.

This leaves us with five new measures that can be shortlisted at this stage. These are:

- Targeted subsidised/free bus travel to north fringe businesses – deliverable by 2018
- Enforcement of 2+ lane on A4174 – deliverable by 2018
- Use of 'soft gating' to limit traffic movements from neighbouring junctions (likely to be westbound only) – deliverable by end of 2018
- Banning of some traffic movements at Hambrook Crossroads to reduce delays – deliverable by end of 2018 via an Experimental TRO and some minor physical works.

We note that the air quality problem on this road link is localised, and heavily influenced by prolonged congestion during busy times, which impacts on neighbouring roads including the M32. Hence relieving congestion at the Hambrook Junction and thus the resultant queuing traffic, without encouraging traffic to enter the road link, is likely to be the most effective practically achievable measure in achieving 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.

The primary means by which short-listed options have been assessed is through traffic simulation and air quality modelling. Assumptions relating to the development the various models can be found below.

A PTV VISSIM micro-simulation traffic model, validated in 2013 and representative of the traffic situation in 2015 has been utilised as the starting point for the assessment. In order to establish current baseline traffic conditions, the 2015 model has been updated as follows:

- Amendments to the network to reflect highway interventions implemented between 2015 and 2017; and
- Re-calibration of 2015 traffic data to 2017 levels based on historic 'link' flows from the Highways England WebTRIS dataset and permanent automatic traffic count (ATC) data provided by South Gloucestershire Council (SGC). Given the short time-scales, it was not possible to re-validate the model to an independent dataset such as average network travel times.

The model has been used to provide Annual Average Daily Traffic (AADT) flows, percentage of Heavy Goods Vehicles (HGV), average speeds and average-maximum queue lengths at the A4174 Hambrook crossroads. AADT volumes have been calculated by applying two factors to the AM and PM peak model flows. Factors were derived from Highways England WebTRIS data in a number of strategic locations within the modelled area.

The first factor, f_1, represents the ratio between peak hour traffic and daily volume on a typical Tuesday to Thursday weekday. The second factor, f_2, represents the ratio between the daily traffic on a typical weekday and the average daily traffic over the year, including weekends and holiday periods. Based on these, the formulae for estimating AADT is as follows:

$$AADT = \frac{AM+PM\ peak\ volume}{f_1 \times f_2}$$

The values of f_1 and f_2 applied to AM and PM peak light vehicle (LV) and heavy vehicle (HV) modelled flows can be seen in **Table 3**.

	LV	HV
f1	0.312	0.206
f2	1.107	1.381

Table 3 – AADT Conversion Factors

The outputs from this updated VISSIM model has been used to inform and develop an air quality dispersion model. The dispersion modelling has been undertaken using ADMS-Roads version 4.1 using vehicle emission factors from the EFT version 8.0.1a. A detailed model has been set up for the A4174 between the M32 and A4017, as well as the surrounding area. The model has been verified and adjusted on the basis of year 2017 measurements from 2 NO_2 monitoring locations situated across South Gloucestershire. Sensitivity testing has been carried out to assess the impact of including other, less suitable NO_2 monitoring locations as verification sites.

The model has been run at receptors representing locations designed to be comparable to the Government's Pollution Climate Mapping (PCM) model, which is used to report compliance with the EU Limit Values. LAQM receptors representing locations relevant to the air quality objectives (facades of residential buildings, schools, hospitals etc.) along the considered road network have not been included yet in the air quality model as a result of time constraints. However, the PCM locations are closer to the roadside (i.e. the emission source) than the LAQM receptors, and are therefore considered to be worst case. This will not influence the outcomes of the study.

Inputs, assumptions and outputs related to the traffic modelling are presented in T1 Traffic Model Development Report. This includes AADT, %HGV and average speeds at key points in the modelled road network for the baseline and Options models.

Inputs and assumptions used for the air quality modelling are described in both the AQ1 Local Plan Air Quality Modelling Tracking Table and AQ2 Local Plan Air Quality Modelling Methodology Report, which also includes the full methodology. AQ3 Air Quality Modelling Report presents the results of the air quality modelling in greater detail.

Background concentrations

Estimated background concentrations in the study area have been determined for 2017 and the future year 2019 using Defra's background maps (Defra, 2018b) The background concentrations are set out in Table 4 and have been derived as described in the Air Quality Modelling Methodology Report (AQ2). The background concentrations are all well below the objectives.

Table 4: Estimated Annual Mean Background Pollutant Concentrations in 2017, 2019 and 2020 (µg/m^3)

Year	NO_2
2017	14.0 – 18.4
2019	13.5 – 15.2
2020	12.9 – 14.4
Objectives	**40**

Baseline Dispersion Model

Concentrations of NO_2 have been modelled at receptors placed every 10 m along the road at 4 m from the kerb edge and 2 m in height. The worst-case receptor for each link is then used to define the NO_2 concentration associated with each link and is reported in spreadsheet TD1. Receptors within 25 m from major junctions have been excluded.

The modelled road components of NOx have been adjusted from those predicted by the model based on a comparison with local measurements.

The results of both the PCM and local models are presented in Table 5 below. Results for the 2017 Baseline local model for the A4174 links are also showed in Figure 2.

Table 5: 2017 PCM and ADMS Model Results

Census ID*	Link Description	2017 PCM Model Results (µg/m^3)	2017 Local Model Results (µg/m^3)
17633	West of A4174 / Bristol Road Junction	45	51
17633	East of A4174 / Bristol Road Junction	45	45

* The Census IDs for these links are identical, as per the PCM model, but have been assessed as separate links either side of the junction, as a result of the differences in traffic volume, composition and speed

The PCM and ADMS model results indicate that the links either side of the A4174 / Bristol Road Junction are both non-compliant with regards to the EU limit values in the 2017 Baseline scenario. The ADMS model results support the PCM model results in relation to the eastern link, as the modelled concentrations are identical. However, the PCM model results for the link to the west of the junction are significantly lower (6 µg/m^3) than those produced by the ADMS model.

Local monitoring indicates that annual mean NO_2 concentrations are below the EU limit values at the facades of local sensitive receptors. The modelled locations (4m from the kerb) are much closer to the road and are expected to have higher predicted concentrations.

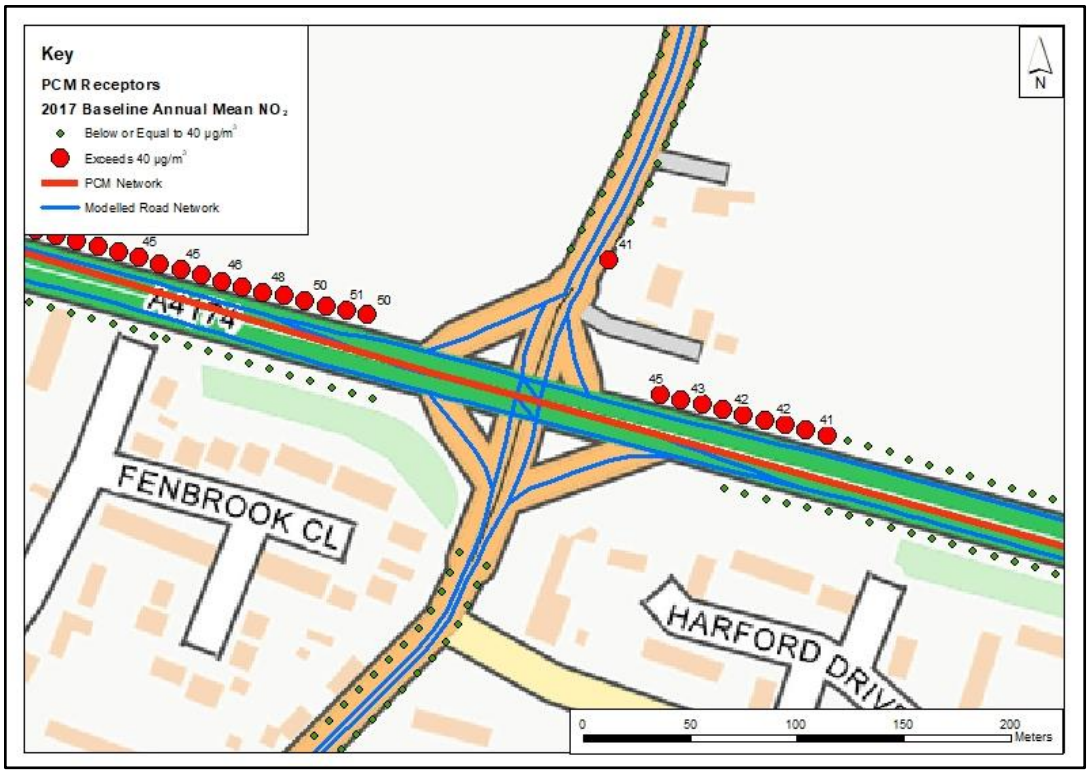


Figure 2: Predicted NO_2 concentrations in 2017 on PCM links relevant to the EU Limit Value

Since the 2017 Base Model still showed exceedances, it is concluded that measures already implemented since 2015 have not reduced NOx levels to below legal limits, and further improvements to air quality are required.

To assess the impact of other measures, Future Baseline models have been created. With key junctions on the A4174 ring road and M32 motorway currently operating at or above capacity during peak periods, traffic growth during the period from 2017 to 2020 has been assumed to be negligible or nil.

With this in mind, zero growth in traffic flows has been applied to the 2017 VISSIM model to derive a 2019 Future Baseline and 2020 Future Baseline. These Future Baseline models includes measures planned but not yet implemented (Option 1):

Option 1 (or Future Baseline scenarios) – Measures planned but not yet implemented including:

- Bus fleet improvements due to the newly launched Metrobus service. All buses using this link road as part of Metrobus are Euro 6. However, approximately 50% of the buses using this link are not part of the Metrobus service, but the fleet composition of these buses is unknown. We have therefore assumed that the fleet composition for all buses excluding Metrobus on this link follow standard EFT fleet composition. The exact proportions of each Euro standard assumed for buses on this link are shown in report AQ3.
- Stoke Gifford link road – this is expected to have negligible or nil impact on traffic flows or vehicle composition on the A4174 road link, given the demand elasticity of the ring road, so has not been included in the traffic or air quality modelling.
- Switching 20% of other council pool vehicles to electric by 2021 – this is expected to have negligible or nil impact on vehicle composition on the A4174 road link, as this represents an insignificant proportion of vehicles using the ring road during the AM and PM peak periods. For this reason, this component of Option 1 has not been included in the modelling.

The 2019 Future Baseline scenario is not represented by changes in the traffic model but by a change in the fleet composition in the EFT and modification of the bus fleet composition based on the assumptions described above and in the report AQ3. The AADT, %HGV and average speeds related to this scenario are the same as those for the 2017 Base Model. The 2019 Baseline scenario results of the PCM and local models are presented in Table 6 and Figure 3.

Table 6: 2019 PCM and ADMS Model Results

Census ID*	Link Description	2019 PCM Model Results (µg/m^3)	2019 ADMS Model Results (µg/m^3)
17633	West of A4174 / Bristol Road Junction	41	44
17633	East of A4174 / Bristol Road Junction	41	39

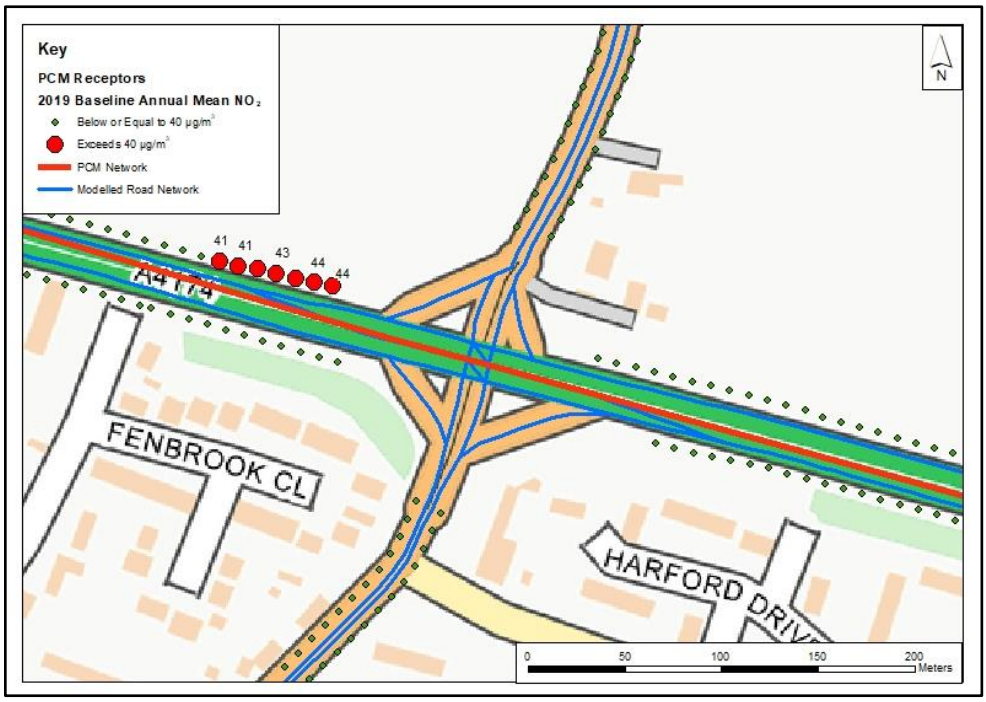


Figure 3: Predicted NO_2 concentrations in the 2019 Baseline Scenario on PCM links relevant to the EU Limit Value

The PCM model results indicate non-compliance with the EU limit values on the links either side of the junction in the 2019 Baseline scenario. However, the results of the local model indicate that annual mean NO_2 concentrations are non-compliant to the west of the junction, but compliant to the east. The model results to the west of the junction are not dissimilar, as the ADMS results are 3 µg/m^3 higher than the PCM results to the west of the link, and 2 µg/m^3 lower to the east.

Since Option 1 (the Future Baseline scenario) cannot achieve compliance in 2019, we modelled the Future Baseline 2020 scenario. This involved projecting the fleet composition to 2020 in the EFT, and incorporating the bus fleet composition changes as described above and in report AQ3. The AADT, %HGV and average speeds related to this Option are the same as those for the 2017 Base Model. The 2020 Baseline scenario results of the PCM and local models are presented in Table 7 and Figure 4.

Table 7: 2020 PCM and ADMS Model Results

Census ID*	Link Description	2020 PCM Model Results (µg/m^3)	2020 ADMS Model Results (µg/m^3)
17633	West of A4174 / Bristol Road Junction	39	41
17633	East of A4174 / Bristol Road Junction	39	37

The PCM model results indicate compliance with the EU limit values on the links either side of the junction in the 2020 Baseline scenario. However, the results of the local model indicate that annual mean NO_2 concentrations are compliant to the east of the junction, but not to the west. The model results to the east and west of the junction are not dissimilar, as the ADMS results are 2 µg/m^3 higher than the PCM results to the west of the link and 2 µg/m^3 lower to the east.

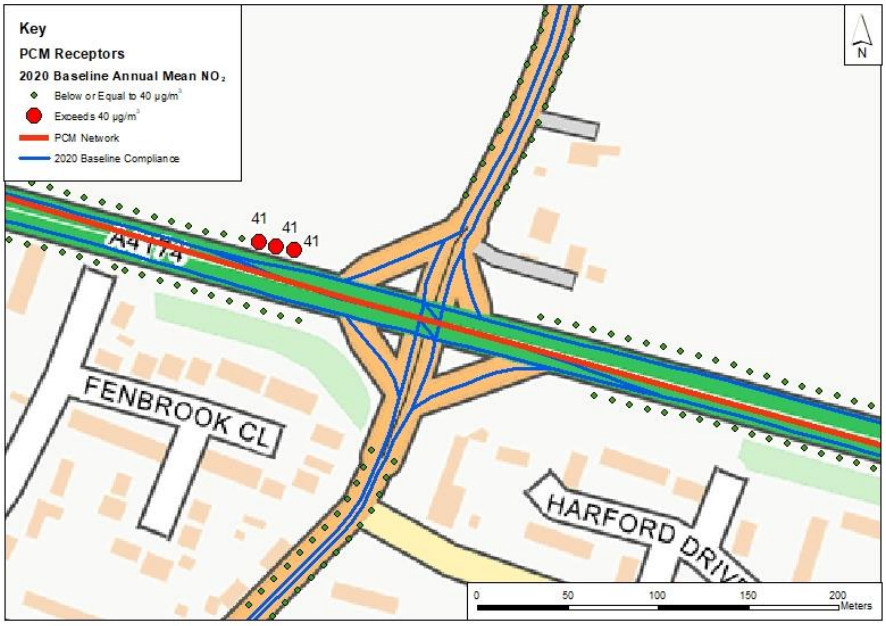


Figure 4: Predicted NO_2 concentrations in the 2020 Baseline Scenario on PCM links relevant to the EU Limit Value

Options 2-4, which represent new measures, were then assessed to test whether compliance could be brought forward to 2019. The assessment of these Options is detailed below.

Option 2 – Targeted subsidised/free bus travel to north fringe businesses

Given the demand elasticity of the ring road, any mode shift caused by this option would be quickly replaced by more cars, and therefore this option is not expected to impact on traffic flows or air quality. Based on these reasons, this option has been discarded from the traffic and air quality modelling work.

Option 3 – Enforcement of westbound A4174 2+ lane on the approach to the A4174 Hambrook crossroads.

This option has been modelled in the traffic model by moving 50% of vehicles using the 2+ lane to the general traffic lanes. However, the overall network delay output from the traffic model for this option is marginally greater than that for the 2017 base model, as shown in Table 8 below. This measure is therefore expected to have a negligible impact on congestion in the network, and therefore a negligible impact on air quality on the road link.

Period	2019 Baseline	2019 Opt. 3	Change	
07:00 – 09:00	836	840	+4	+0%
16:00 – 18:00	1594	1627	+33	+4%

Table 8: Total Network Delay [hours] for Option 3

Additionally, the Future Baseline air quality models show that the westbound lane of the A4174 is compliant in 2019, while the eastbound lane becomes compliant in 2020. Since the 2+ lane is on the westbound A4174, Option 3 is further unlikely to bring forward compliance of the road link as its impact on the eastbound A4174 is minimal. Such a measure would also be very difficult to deliver, as it requires increased police presence and patrols to be effective.

Option 4 - Traffic management improvement measures

- Removal of westbound A4174 right-turn to B4058 Bristol Road to Winterbourne and northbound B4058 Bristol Road right-turn to A4174 from Frenchay at the A4174 Hambrook crossroads. This has been modelled in the traffic model by amending the traffic signal controls i.e. revised staging and green times and reassignment of affected traffic flows to the alternative routes.
- In addition to the above the use of 'soft gating' to limit traffic movements from Bromley Heath roundabout has been implemented. This involves adjusting the peak traffic timings to make sure the impacted links are maintained in harmony with Hambrook and that additional trips are not generated by the additional capacity provided. This is already done on site for the AM peak, effectively holding back traffic until there is capacity, and releasing in larger platoons towards Hambrook Junction.

As demonstrated in Table 9 and Figure 5, the predicted annual mean concentrations of NO_2 in the 2019 Option 4 scenario show compliance with the annual mean EU Limit Value on the PCM links both east and west of the A4174 / Bristol Road junction.

Table 9: 2019 Option 4 Model Results

Census ID*	Link Description	2019 Option 4 Model Results (µg/m^3)
17633	West of A4174 / Bristol Road Junction	40
17633	East of A4174 / Bristol Road Junction	37

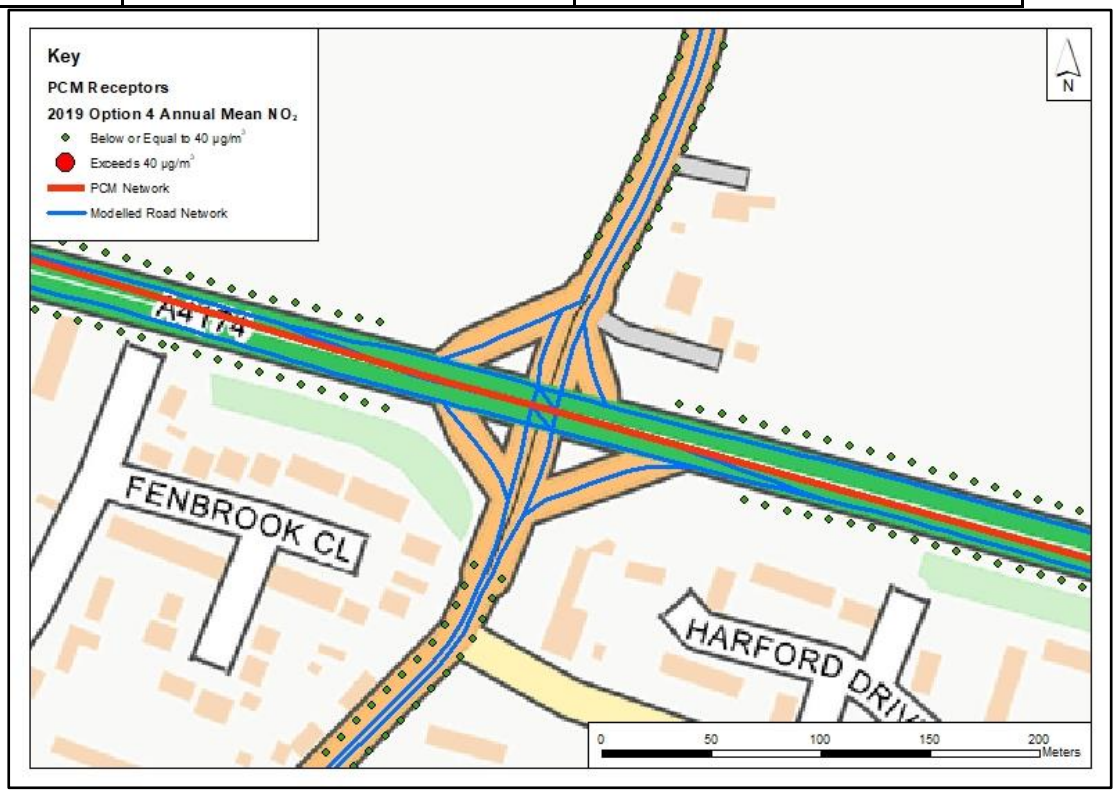


Figure 5: Predicted NO_2 concentrations in the 2019 Option 4 Scenario on PCM links relevant to the EU Limit Value

In addition to the modelling runs described above, sensitivity tests were carried out to assess the impact of several assumptions. Table 1 in Report AQ3 sets out the assumptions and limitations of the models, and identifies which assumptions warranted a sensitivity test. The sensitivity tests are described in detail in Report AQ3, and summarised below.

Sensitivity Test A - Impact of the diurnal profile to emissions in the model.

In the primary models, a diurnal profile was applied to the emissions in the model. The diurnal profile was based on national data, as no local data is available. A sensitivity test was carried out to test the results if a diurnal profile is not applied, and a simple average between AM and PM peak emissions is used for the entire day. The impact of this is a marginal increase in NO_2 levels on the PCM links – approximately 0.2µg/m^3 in the 2019 Future Baseline scenario, and 0.3 µg/m^3 in the 2019 Option 4 scenario. As the NO_2 level is reported to the closest whole number, this would mean that the PCM link would be non-compliant in 2019, with a NO_2 level of 41 µg/m^3 to the west of the junction.

Sensitivity Test B – inclusion of other monitoring locations as verification sites

In the primary models, only 2 monitoring locations were used as verification sites – SGC134 and SGC151, both on Bristol Road north of the Hambrook crossroads. These were deemed to be the most suitable sites. However, a different combination of monitoring locations could also be used. Although some of these are less representative of the ring road, or of the roadside conditions, including a greater number of sites for verification could also be considered good practice. For this sensitivity test, a total of 7 sites were used for verification, resulting in an adjustment factor of 1.39, which is significantly lower than the adjustment factor used in the primary model (1.95). This led to a reduction in the NO_2 levels on the PCM link predicted in 2019, both in the Baseline scenario and the Option 4 scenario, to 40 µg/m^3 and 38 µg/m^3 respectively. This implies that compliance could be reached in 2019 with no new measures being implemented, but only marginally.

Sensitivity Test C – impact of sector removal from background concentrations

In the primary models, the "Motorway_In", "Primary_Rd_In" and "Trunk_Rd_In" sectors were removed from the total backgrounds to prevent double counting. However, if it is assumed that the full (unadjusted) backgrounds are incorporated into the PCM model results, then a sensitivity test looking at the use of unadjusted backgrounds in the dispersion model could be presented. This has an impact on the adjustment factor used to calculate road NOx concentrations, taking it from 1.95 to 1.05. This led to a reduction in the NO_2 levels on the PCM link predicted in 2019, both in the Baseline scenario and the Option 4 scenario, to 39 µg/m^3 and 37 µg/m^3 respectively. This implies that compliance could be reached in 2019 with no new measures being implemented, but only marginally.

Summary

The results of our modelling suggest that compliance could be brought forward to 2019 through a series of traffic management improvement measures (Option 4). This reduces the NO_2 concentrations on the PCM link to 40 µg/m^3 in 2019, thus reaching compliance with legal limits, albeit marginally. Our sensitivity tests explore the impact of changing certain assumptions in the air quality modelling, and the results vary – some tests show that the link would be marginally non-compliant in 2019, while some show that the link would be compliant in 2019 without any additional measures.

Despite the sensitivity of the results to small changes in assumptions, Option 4 is shown to have a positive impact on NO_2 levels on the PCM link, reducing them by 4 µg/m^3 in 2019.

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.

This study has considered one road link, a section of the A4174 between the junctions to the A4017 and M32 (Census ID 17633), projected to have an exceedance by the national PCM modelling. Local traffic modelling was carried out to inform a local air quality model. The results of this model showed that the road link would be non-compliant in 2019 without further interventions. A package of measure (Option 4) was shown to successfully bring forward compliance of the road link to 2019. Option 4 included the two items listed below:

- banning certain turns at Hambrook Junction,
- soft gating at the neighbouring Bromley Heath roundabout, and

The implementation of this option will require the following tasks:

1. Install additional diffusion tubes at key monitoring locations
2. Prepare the Temporary traffic order.
3. Configure the changes in the traffic signals controller.
4. Design and implementation of temporary traffic management.
5. Design and amendment of the amended road markings.
6. Provision of temporary traffic signs.
7. Adjustment of the traffic signal timings and reconfiguration of the MOVA dataset.
8. Monitoring of the measures, traffic flows, and AQ data to confirm successful mitigation of impacts
9. Works to finalise the measures when proven successful, i.e. through a full traffic order and rationalization of the kerbing at the junction.

The costs for the works are estimated to be:

- £5,060 For installation of additional diffusion tubes
- £19,300 for the temporary works
- £116,700 for the permanent works.

A breakdown is provided below.

Table 9: Implementation costs for Option 4

Item	Temporary works (£)	Permanent works (£)
Feasibility stage	300	300
Consultation	2,400	2,400
Detail design	1,200	3,100
Planning/orders fees	100	3,400
Non-construction works	600	4,300
Construction works	12,200	86,000
Post-constructions	0	2,000
Sub-total	16,800	101,500
15% risk	2,500	15,200
Total	**19,300**	**116,700**

The temporary works could be implemented within 3-4 months of receiving the funding. These would need to be made permanent once proven to be successful.

This study recommends that Option 4 be taken forward as the preferred option, but that further steps are taken to increase confidence in the pre- and post-scheme NO2 levels at the PCM links. This should be done by installing further diffusion tubes at key monitoring locations prior to implementing the traffic management measures. Once the measures have been implemented on a temporary basis, the additional monitoring can help inform South Gloucestershire Council and JAQU on whether further action is needed to help the PCM link reach compliance.

The results are concluded in the table below.

Road link	PCM identified link?	Summary of exceedance	Measures identified that could bring forward compliance	Costs and timeframe
Census ID 17633	Yes – this link was identified as having an exceedance in the national PCM modelling	The national PCM modelling has projected this link will be compliant in 2020. Summary of NO2 concentration projections: 45 µg/m^3 in 2017; 43 µg/m^3 in 2018; 41 µg/m^3 in 2019; 39 µg/m^3 in 2020; The results of our dispersion model showed the road link to be exceeding legal limits in 2017 and 2019, hence the need for other measures to bring forward compliance. The results from the 2017 and 2019 baseline models are as follows: **Road link west of Hambrook Junction** 51 µg/m^3 in 2017; 44 µg/m^3 in 2019; 41 µg/m^3 in 2020 (assuming compliance in 2021) **Road link east of Hambrook Junction** 45 µg/m^3 in 2017; 39 µg/m^3 in 2019; 37 µg/m^3 in 2020	We have identified one package of measures (Option 4) that could bring forward compliance on this road link to 2019. It includes the two items listed below - Removal of westbound A4174 right-turn to B4058 Bristol Road to Winterbourne and northbound B4058 Bristol Road right-turn to A4174 from Frenchay at the A4174 Hambrook Junction. - the use of 'soft gating' to limit traffic movements from Bromley Heath roundabout The air quality dispersion model results with this package of measures in place leads to the following NO_2 concentrations in 2019 for the road link. **West of Hambrook Junction:** Option 4: 40 µg/m^3; **East of Hambrook Junction:** Option 4: 37 µg/m^3;	Cost: £19,300 for temporary works, which will be required to achieve compliance by 2019. Following this, permanent works will be required to ensure compliance beyond 2019. The cost of permanent works is estimated at £116,700 Timeframe: temporary works can be in place within 3-4 months of funding being made available.