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

Local authorities covered	Bournemouth Borough Council

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

Part 1: Understanding the problem

Bournemouth Borough Council (BBC) is required to address the ministerial direction to identify options to deliver air quality improvements and achieve compliance with the European Union (EU) Ambient Air Quality Directive 2008/50/EC as quickly as possible.

Using the Pollution Climate Mapping (PCM) model, the Government has identified road links which are predicted to exceed the annual mean limit value for nitrogen dioxide (NO_2). This includes two census sites along the A338 Wessex Way (Table 1 & Figure 1). According to the PCM model forecasts, census ID 7998 will not achieve compliance until 2019 and census ID 26967 is not forecast to achieve compliance until 2021. It should be noted that Bournemouth has no Air Quality Management Areas (AQMA's).

Third wave local authorities road links in exceedance									
Local authority	Road link	Census ID	Annual mean nitrogen dioxide concentration All figures are provided in µg/m³ and 40 µg/m³ is the statutory annual mean limit value for NO_2.					Source apportionment for total NO_x (figures may not sum to 100% due to rounding)	Road management
			2017	2018	2019	2020	2021		
Compliant in 2021									
Bournemouth Borough Council	A338	26967	46	45	43	41	39	4% Regional background, 4% Urban background (non-traffic), 9% Urban background (traffic), 38% Diesel cars, 9% Petrol cars, 20% Diesel LGVs, 0% Petrol LGVs, 6% HGVr, 2% HGVa, 7% Buses	LA
Bournemouth Borough Council	A338	7998	43	41	40	38	36	5% Regional background, 7% Urban background (non-traffic), 11% Urban background (traffic), 37% Diesel cars, 9% Petrol cars, 20% Diesel LGVs, 0% Petrol LGVs, 7% HGVr, 2% HGVa, 4% Buses	LA

Table 1. DEFRA computer modelling predicted exceedances

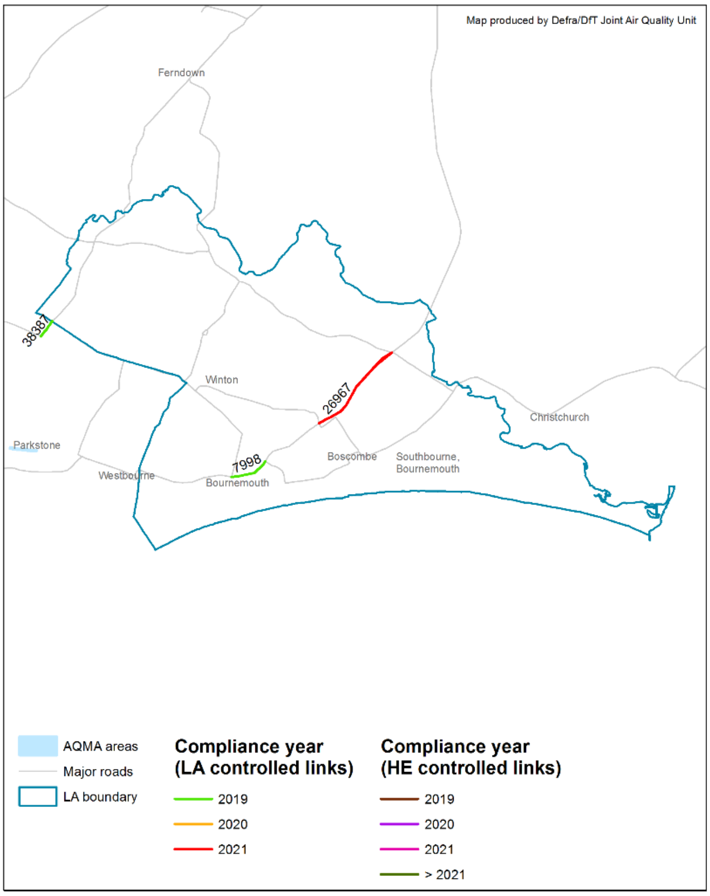


Figure 1. DEFRA Map detailing predicted computer modelling exceedance locations

The data from the Bournemouth Borough Council (BBC) diffusion tubes, congestion data and the location of the nearest receptors does not support the modelled air quality data provided by the PCM model. Local data suggests that there will be no exceedance in locations 7998 and 26967, however, it is acknowledged that this assessment is based on data using diffusion tubes and not chemiluminescence which does not meet the requirement of EN14212:2005.

The A338 is a main strategic transport route into the town, especially in peak periods, and is used to access a number of employment centres, including the Lansdowne and Wessex Fields, as well as the Hospital and a number of retail parks.

Information on the Location 26967

Figure 2 below is a satellite image from google maps showing the A338. The section concerned starts from the Cooper Dean roundabout extending West to Springbourne roundabout. The section over Cooper Dean Roundabout is, in part, elevated forming part of the flyover of the A3060. The nearest receptors are located on Cooper Dean Drive and Littledown Drive.

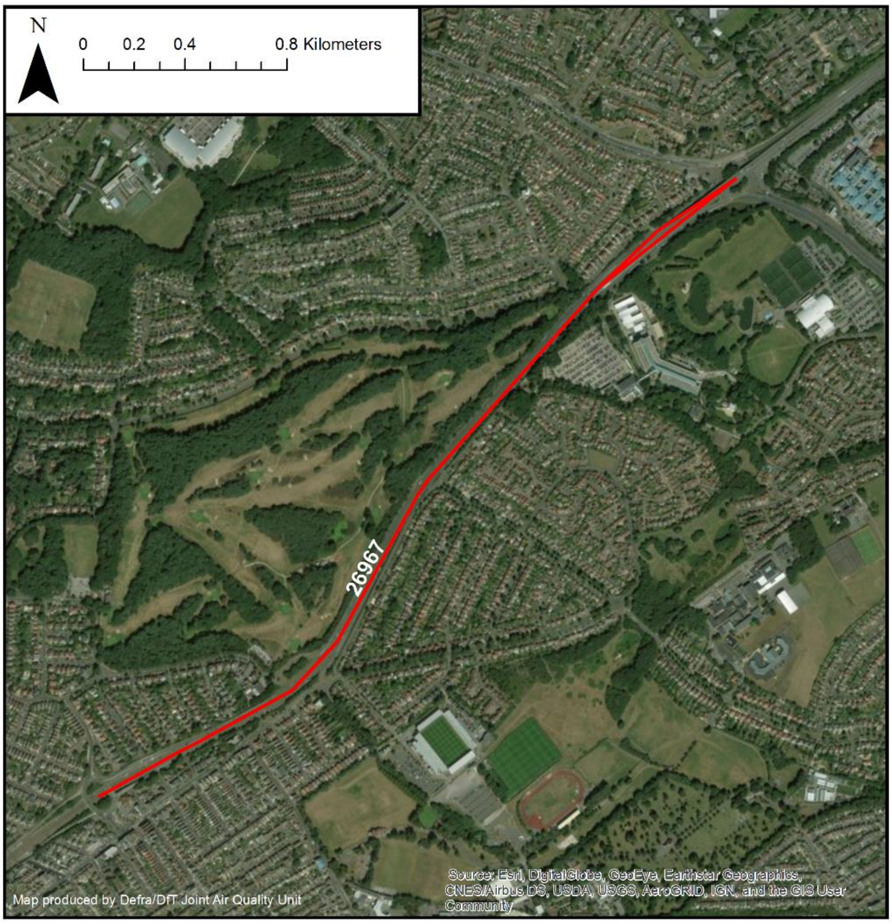


Figure 2. Satellite view of location 26967 on the A338

The nearest diffusion tube location (BK17) to the area of predicted exceedance, is located at the Cooper Dean Roundabout shown by the yellow dot at the roundabout in figure 3 below.

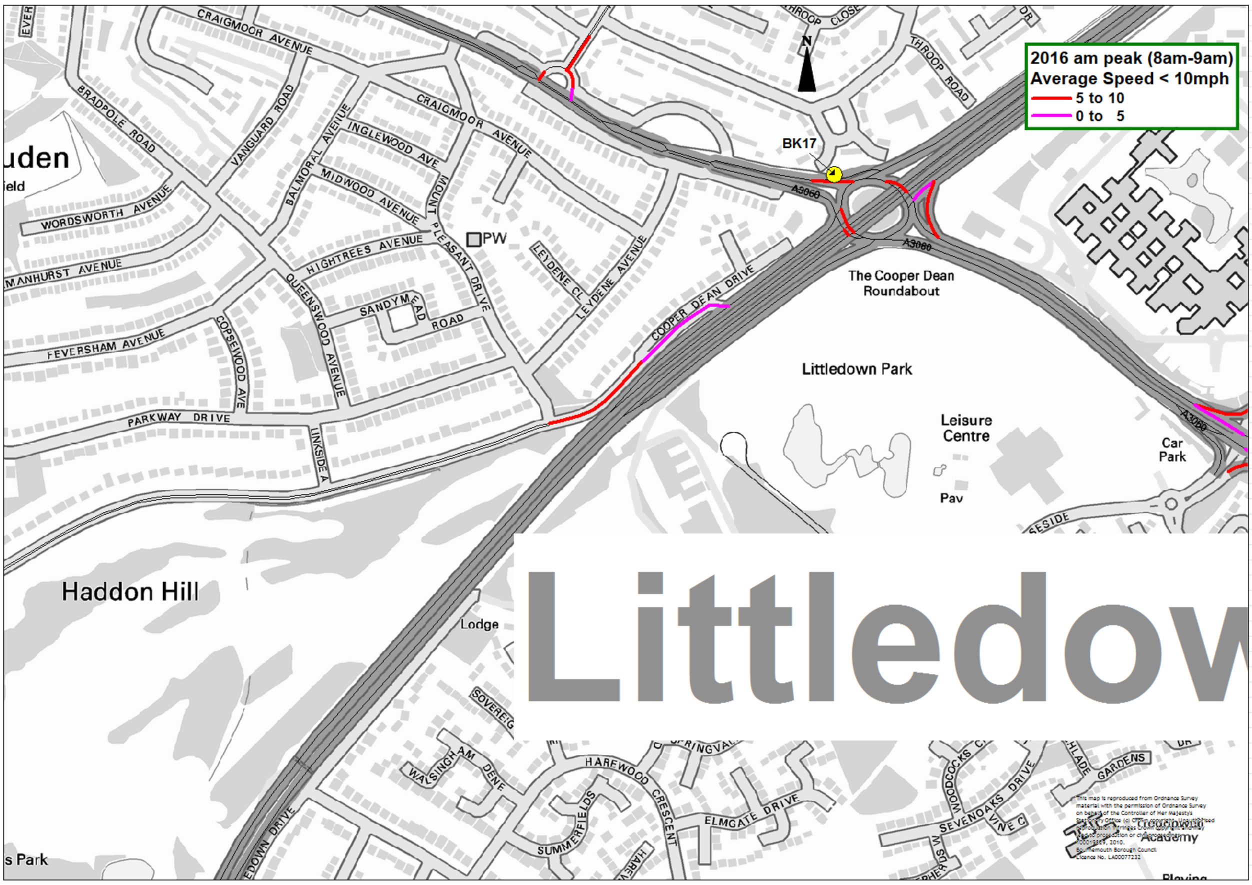


Figure 3. Monitoring site for BK17 located next to the Cooper Dean roundabout and shows am peak average speeds (Red shows links with average speeds less than 5mph & Magenta less than 10mph). Note that there are no congested links on the A338 link 26967

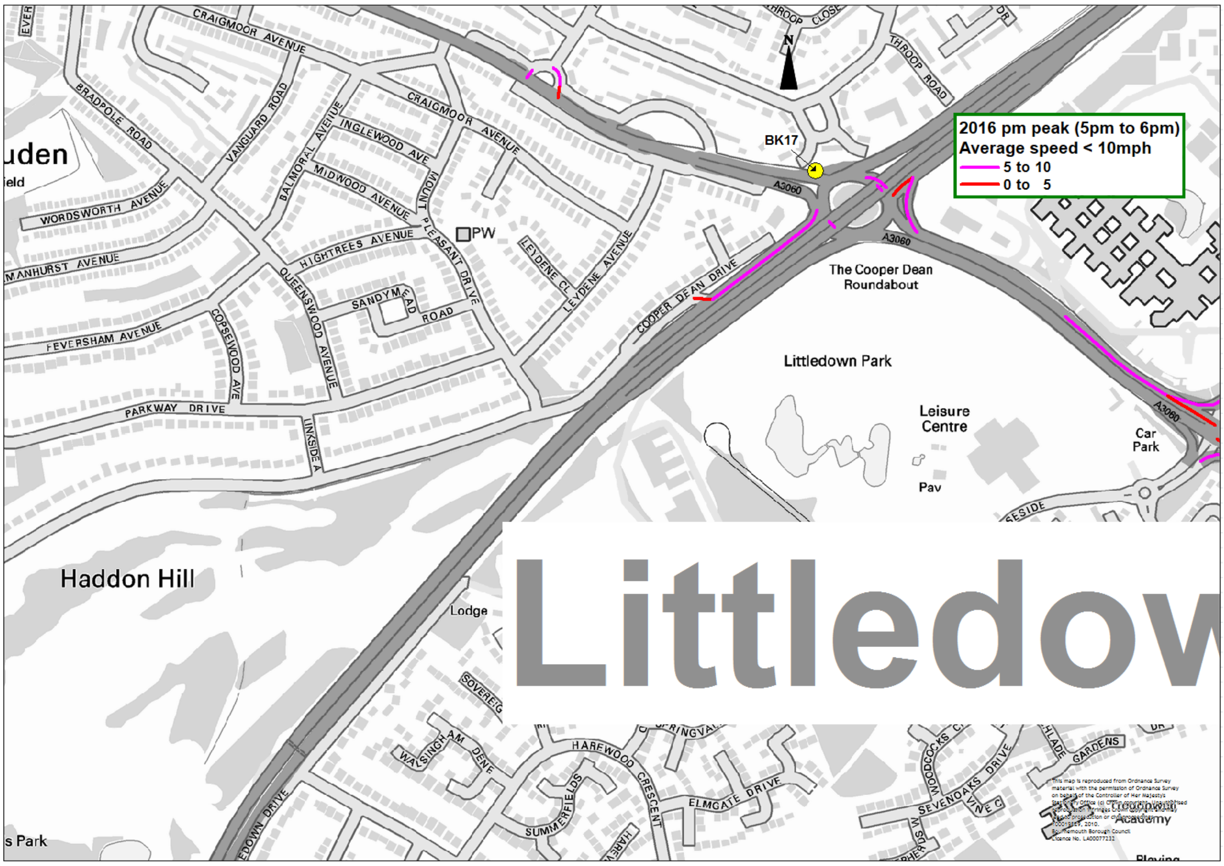


Figure 4. Monitoring site for BK17 located next to the Cooper Dean roundabout and shows pm peak average speed s (Red shows links with average speeds less than 5mph & Magenta less than 10mph). Note that there are no congested links on the A338 link 26967

Figures 3 & 4 above also show congestion data, the areas of red show highest levels of congestion at peak times. Note that whilst the monitoring tube BK17 is not located on the A338 itself, it is located at the roundabout in an area of peak period congestion, there has not been an exceedance at this BK17 location over the last 5 years.

The monitoring data is shown in Table 2 below, last year's result being 29.8 micrograms per cubic metre.

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2016 (%) (2)	NO_2 Annual Mean Concentration ($\mu g/m^3$) (3)				
					2012 (Bias Factor: 0.90)	2013 (Bias Factor: 0.86)	2014 (Bias Factor: 0.84)	2015 (Bias Factor: 0.78)	2016 (Bias Factor: 0.85)
CM1	Urban Background	Continuous	97.4%	97.4%	15.5	14.5	13.1	12.2	13.9
BK04	Roadside	DT	100.0%	100.0%	33.5	34.3	33.8	27.8	32.8
BB11	Roadside	DT	100.0%	100.0%	17.2	16.9	17.0	12.9	14.6
BK13	Roadside	DT	91.7%	91.7%	35.6	31.9	31.5	29.2	35.8
BK14	Kerbside	DT	100.0%	100.0%	39	34.5	37.7	29.9	31.6
BB15	Urban Background	DT	97.2%	97.2%	15.6	14.6	14.1	11.5	13.6
BK16	Roadside	DT	100.0%	100.0%	28.1	26.9	26.9	20.5	22.9
BK17	Roadside	DT	100.0%	100.0%	35.8	31.7	34.5	27.3	29.8

Table 2. Diffusion Tube monitoring data

As part of the Bournemouth International Growth Programme funded by the Dorset LEP, Bournemouth Borough Council has submitted a joint planning application with Dorset County Council to build a new junction and link road from the A338 to Wessex Fields, which is an allocated employment site. The scheme is in two phases, of which Phase 1 has funding through the LEP and Phase 2 is currently unfunded. Phase 1 will enable 500 jobs and Phase 2 will enable a further 1,500 jobs. The new junction will be situated to the north- east of the Census ID 26967, as shown in the computer-generated image in figure 5 below.

The Wessex Fields Business District currently accommodates 10,000 jobs with a plan to expand this to 12,000. The new road layout will improve access to and from the Wessex Fields Business District and The Royal Bournemouth and Christchurch Hospital. It will enable the Wessex Fields Business District to reach its full economic potential with improved connectivity from the A338, the wider strategic road network, and Bournemouth Airport.

The Planning Application includes a Construction Environmental Management Plan including mitigating measures. Commencement of construction for Phase 1 is programmed to be Spring 2019 subject to the determination of the application.

Once completed the new road layout will create a more resilient road network and enable more reliable journey times. Modelling shows that traffic flow on the A338 will remain unaffected whilst congestion will be eased on Castle Lane East and surrounding roads

Figure 5. Computer generated image of the proposed new junction (Phase 1 & 2) at Wessex Fields as seen from the north looking south.

Information on Location 7998

Figure 6 below shows location 7998, a further section of the Wessex Way, identified by the PCM modelling to have an exceedance until 2018.

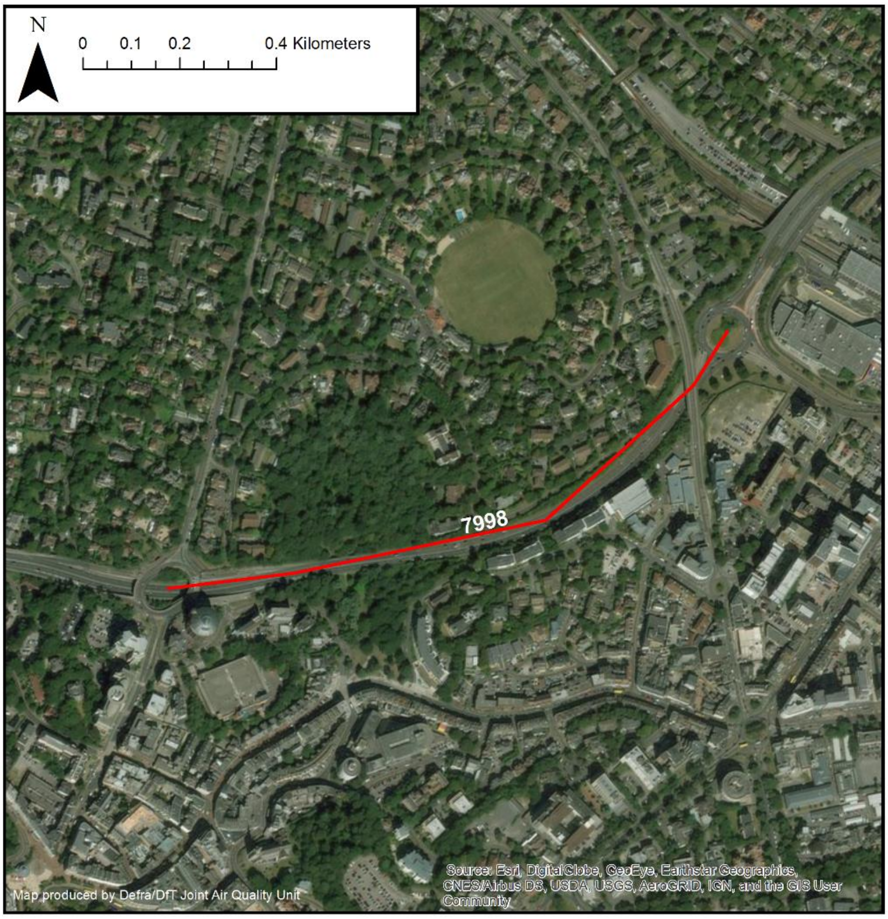


Figure 6. Satellite view of location 7998 on the Wessex Way A338.

Alongside this section of road are a number of businesses (offices), retirement properties and university halls of residence. All of the properties are set back from the road.

Figure 7 below shows the closest monitoring site located at St Pauls roundabout. Figures 7 and 8 also show congestion data, the areas of red show highest levels of congestion at peak times.

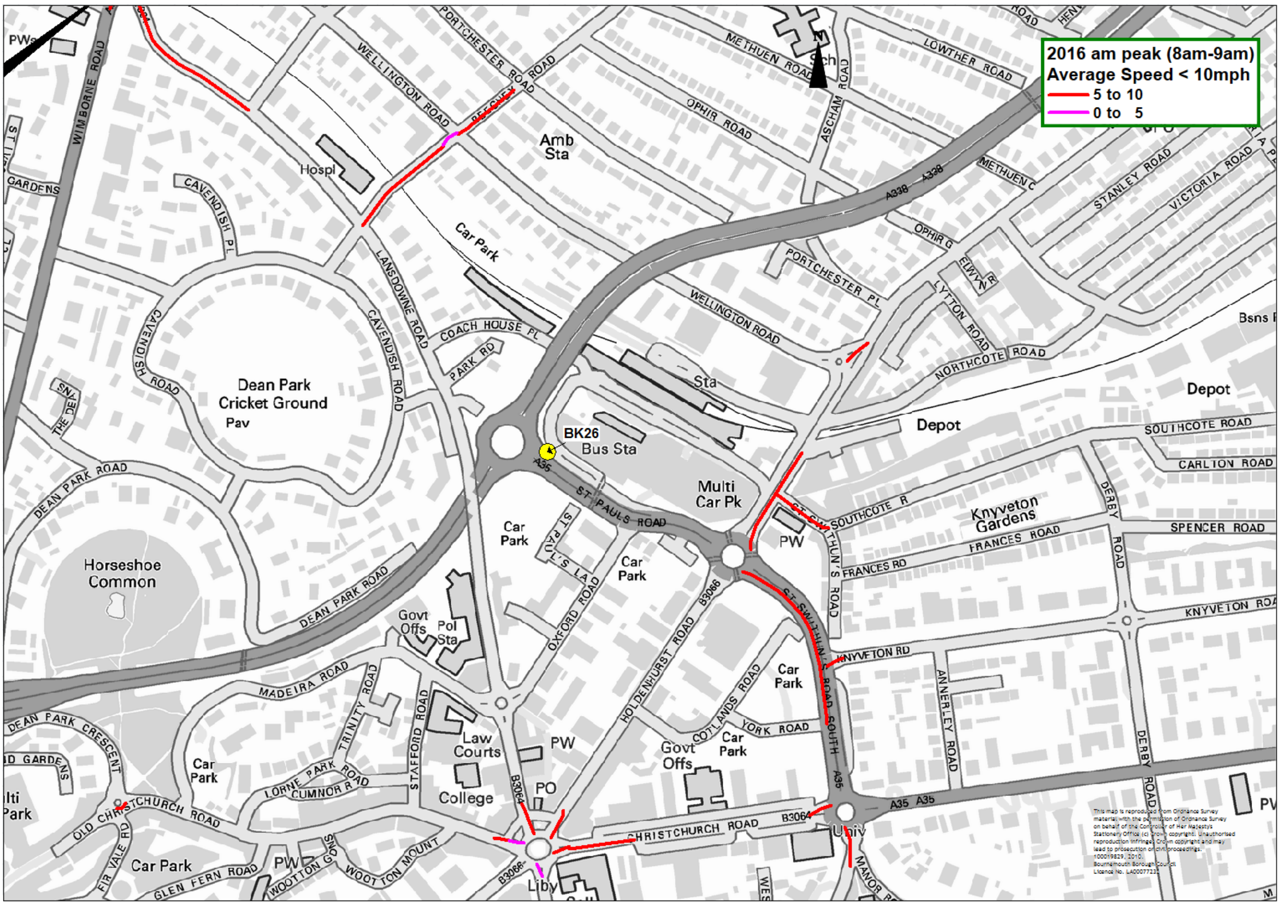


Figure 7. Monitoring site for BK26 located next to the St Pauls roundabout. Shows am peak average speeds (Red shows links with average speeds less than 5mph & Magenta less than 10mph). Note that there are no congested links on the A338 link 7998

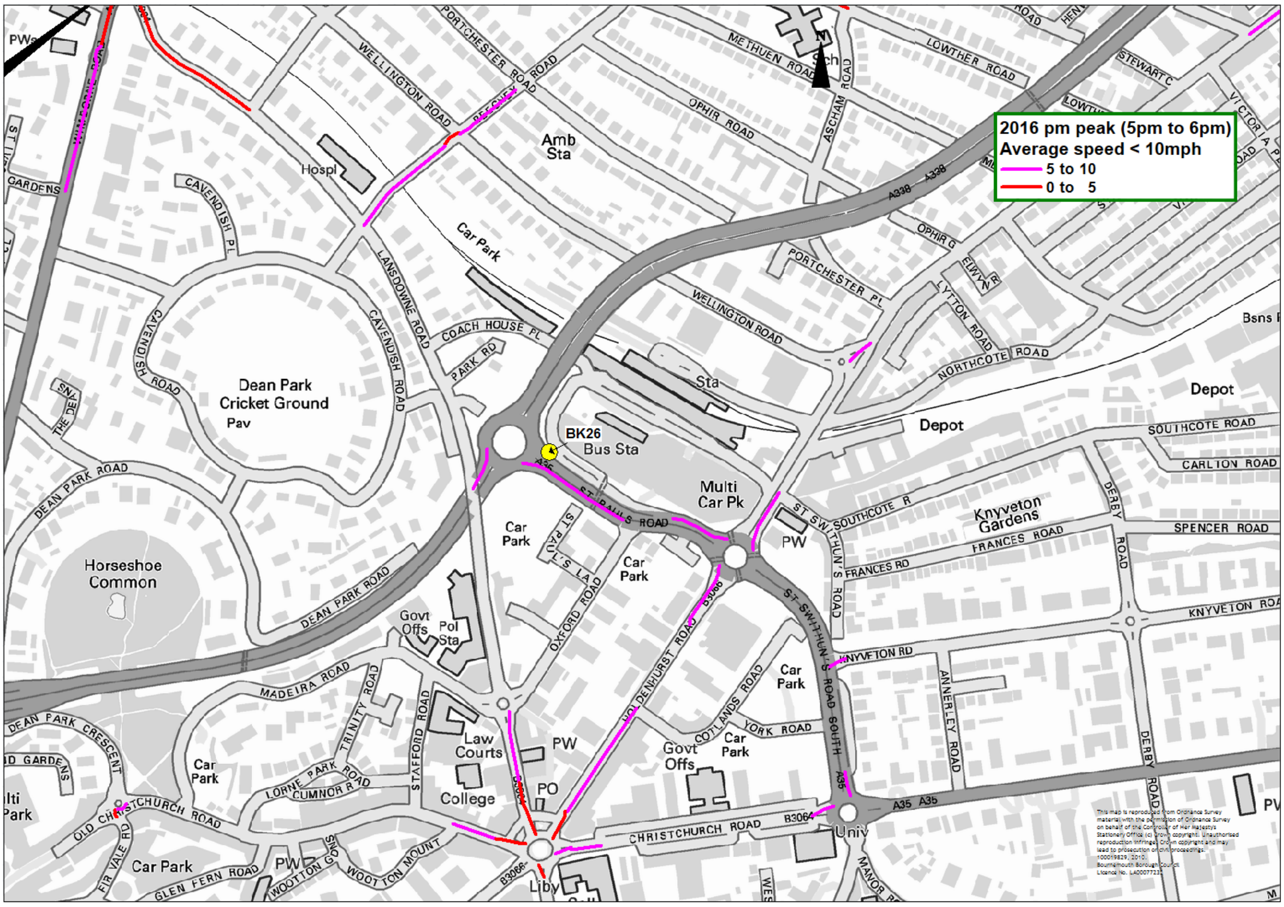


Figure 8. Monitoring site for BK26 located next to the St Pauls roundabout and shows pm peak average speeds (Red shows links with average speeds less than 5mph & Magenta less than 10mph). Note that there are no congested links on the A338 link 7998

The monitoring data in Table 3 shows there were exceedances at this site in 2012 and 2013 but since then the Nitrogen Dioxide concentrations have fallen, showing a year on year improvement.

Site ID	Site Type	Monitoring Type	Valid Data Capture for Monitoring Period (%) (1)	Valid Data Capture 2016 (%) (2)	NO_2 Annual Mean Concentration (µg/m^3) (3)				
					2012 (Bias Factor: 0.90)	2013 (Bias Factor: 0.86)	2014 (Bias Factor: 0.84)	2015 (Bias Factor: 0.78)	2016 (Bias Factor: 0.85)
CM1	Urban Background	Continuous	97.4%	97.4%	15.5	14.5	13.1	12.2	13.9
BK04	Roadside	DT	100.0%	100.0%	33.5	34.3	33.8	27.8	32.8
BB11	Roadside	DT	100.0%	100.0%	17.2	16.9	17.0	12.9	14.6
BK13	Roadside	DT	91.7%	91.7%	35.6	31.9	31.5	29.2	35.8
BK14	Kerbside	DT	100.0%	100.0%	39	34.5	37.7	29.9	31.6
BB15	Urban Background	DT	97.2%	97.2%	15.6	14.6	14.1	11.5	13.6
BK16	Roadside	DT	100.0%	100.0%	28.1	26.9	26.9	20.5	22.9
BK17	Roadside	DT	100.0%	100.0%	35.8	31.7	34.5	27.3	29.8
BK18	Roadside	DT	100.0%	100.0%	35	31.8	33.6	27.3	28.9
BK20	Roadside	DT	100.0%	100.0%	**44.5**	38.5	35.7	31.6	33.3
BK23	Kerbside	DT	100.0%	100.0%	**42.6**	**40.5**	38.5	26.9	29.6
BK24	Kerbside	DT	75.0%	75.0%	30.2	28	29.0	21.2	24.9
BK25	Roadside	DT	100.0%	100.0%	39.5	36.8	35.9	25.6	28.2
BK26	Kerbside	DT	83.3%	83.3%	**43.7**	**41.6**	39.4	32.2	30.6

Table 3. Air Quality Monitoring Data

Monitoring Data Methodology

Diffusion Tubes are supplied and analysed by South Yorkshire Air Quality Samplers using 50% triethanolamine (TEA) in acetone preparation method. The local bias factor is applied using a co-location study at the Bournemouth AURN station.

Sources that relate to the predicted exceedance

Sites 26967 and 7998 are located on the A338 dual carriageway or 'Wessex Way' which is the main route into Bournemouth. Congestion data indicates that travel along this route is most likely to be from commuters travelling to work or school due to the congestion occurring at Peak times. During holiday periods, it is also the main route for visitors to the Town.

The population of Bournemouth is 197,700, 130,400 of which are of working age. There are 6.88 million visitors to Bournemouth each year including 5,798,000 day-visits and 1,060,000 visitors staying overnight.

There are several large financial institutions in the Town Centre, Bournemouth Train Station and Bus Station are located close to the dual carriageway. At the Northern end of the Wessex Way, Castle Lane runs perpendicular to the route providing access via the Cooper Dean roundabout (which is a further area of congestion during peak times) eastwards to Bournemouth Hospital, Tesco's Superstore, JP Morgan and Christchurch; and westwards to both the Mallard Road and Castlepoint Shopping centres The Bournemouth Vitality Stadium and conferencing suites are also located close to the Cooper Dean roundabout and is a trip generator on match days.

The national source apportionment data (table 4) provided by JAQU details that the highest proportion of vehicles are diesel cars at 38% followed by diesel LGV's at 20%.

Roads in exceedance	Census ID	2017	2018	2019	2020	2021	Source apportionment
A338	26967	46	45	43	41	38.69	38% diesel cars; 20% LGV diesel; 9% cars petrol; 7% buses; 6% HGVr; 2% HGVa
A338	7998	43	41	39.9	38	36	

Table 4. Source Apportionment data

It is considered unlikely that the source apportionment data for buses and HGV's represents the local data. There is little bus activity on the A338, and the proportion of HGV's using this route is low as there is little industrial activity in the town and cross channel activity uses the Port of Poole to the west of Bournemouth, accessed via the A31.

BBC consider that it is important that the Authority has a better understanding of the current situation and consider it unlikely that the predicted exceedance will be as severe as modelled using the PCM national model. Additional air quality monitoring has been installed and along with local traffic data has been used to undertake local air quality modelling to determine whether the PCM modelling is accurate and to demonstrate compliance with the requirements of AAQD.

Local Air Quality Modelling

This section outlines the approach undertaken for local air quality modelling, including air quality modelling of baseline and '*with option'* scenarios, in order to evidence the deliverability of a short list of measures and determine if options to bring forward compliance are required.

Atmospheric Dispersion Model Selection

The Baseline and With Option scenarios were assessed using Cambridge Environmental Research Consultants (CERC) atmospheric dispersion modelling system for roads (ADMS-Roads v4.1.1).

ADMS-Roads applies advanced algorithms for the height-dependence of wind speed, turbulence and stability to produce improved predictions of air pollutant concentrations within the given model domain. It can predict long-term and short-term concentrations, as well as calculations of percentile concentrations.

ADMS-Roads is a validated model, developed in the UK by CERC. The model validation process includes comparisons with data from the UK's Automatic Urban Rural Network (AURN) and specific verification exercises using standard field, laboratory and numerical data sets. CERC is also involved in European programmes on model harmonisation, and their models were compared favourably against other EU and U.S. EPA systems. Further information in relation to this is available from the CERC web site at http://www.cerc.co.uk/environmental-software/model-validation.html .

Atmospheric Dispersion Modelling Process

The procedures involved in undertaking the dispersion modelling assessment are outlined below:

- Collation of input data – traffic data (flows, speeds, vehicle classifications, road network mapping, receptor coordinates and meteorological data;
- Input of data in to the ADMS-Roads model for the scenarios to be modelled;
- Development of emissions inventories, using Defra's EFT '*Detailed Option 1'* (v8.0.1). Default petrol/diesel splits were used. *User Euro* tab based on EFT default for the respective years assessed.
- Running the ADMS-Roads model for each considered scenario;
- Conversion of modelled NO_X concentrations to NO_2 concentrations using Defra's NO_x-NO_2 calculator v6.1, this includes inputs of f-NO_2 at each individual receptor;
- Addition of Defra background concentrations to the modelled concentrations with the

background road sector contribution removed for trunk and A roads to avoid double counting of the road source component;

- Verification and adjustment of modelled road-NO_x contributions from the assessed road network through analysing the ADMS-Roads modelled road-NO_x outputs versus specific monitored road-NO_x for the base year scenario (2017);

- Comparison of predicted NO_2 concentrations adjacent to PCM Census IDs 26967 and 7998.

Traffic Data

Traffic data comprising Annual Average Daily Flow (AADF), traffic composition and average link speeds (km/h) were used in the modelling as provided for the PCM links and surrounding displacement routes. Appropriate assumptions were made with respect to traffic speeds on the approach to and progress through junctions.

AADF and vehicle classifications were derived from BBC Automatic Traffic Count (ATC), BBC Manual Classified and DfT AADF surveys. The split according to 'local' and 'strategic' trips were derived using outputs from the South-East Dorset Multi Modal Model (SEDMMM). Data were provided for the following scenarios:

- Base/verification year of 2017;

- Baseline projected for the years 2018, 2019, 2020 and 2021;

- *With Option* for the years 2018, 2019, 2020 and 2021 for census ID 26967.

It was deemed beneficial to carry out modelling for the 'With Option' scenario at the same time as the baseline modelling. The '*With Option'* scenario contains '*smarter travel choices'* behaviour change programme alongside improved active travel infrastructure for walking and cycling, and improvements to public transport infrastructure. These '*smarter travel choices'* are predicted to reduce local trips in 2019 by 5% and by 10% in both 2020 and 2021.

The spatial scope for the assessment focused on the two PCM Census ID's in addition to the following:

- Castle Lane East and West;

- Richmond Hill;

- Wimbourne Road; and

- St Paul's Road

Time Varying Emissions

Diurnal profiles were used to represent the changes in traffic flow throughout a 24-hour period by adjusting the emission rate for each link present at the ADMS model interface to reflect diurnal variation in monitored traffic conditions. The monitored traffic data was sourced from 2016 and 2017 ATC counts for the A338. A summary of the time varying factors used in the model is shown in **Tables 5 and 6** below.

Table 5 – 26967 Time Varying Factors

Hour	Weekday	Saturday	Sunday
1	0.09	0.22	0.35
2	0.06	0.14	0.17
3	0.05	0.10	0.17
4	0.05	0.08	0.13
5	0.08	0.09	0.10
6	0.25	0.17	0.16
7	0.84	0.39	0.31
8	1.79	0.69	0.48
9	2.04	1.13	0.74
10	1.45	1.49	1.29
11	1.29	1.83	1.89
12	1.36	1.91	1.93
13	1.36	1.86	2.15
14	1.33	1.96	2.17
15	1.53	2.02	2.01
16	1.64	1.96	1.85
17	1.87	1.76	1.78
18	1.99	1.55	1.54

Hour	Weekday	Saturday	Sunday
19	1.75	1.37	1.37
20	1.26	1.01	1.17
21	0.79	0.78	0.87
22	0.53	0.59	0.67
23	0.38	0.50	0.44
24	0.22	0.41	0.27
Total	**24**	**24**	**24**

Table 6 – 7998 Time Varying Factors

Hour	Weekday	Saturday	Sunday
1	0.09	0.26	0.37
2	0.05	0.17	0.26
3	0.05	0.10	0.17
4	0.05	0.10	0.11
5	0.09	0.09	0.10
6	0.26	0.17	0.15
7	0.79	0.36	0.32
8	1.82	0.69	0.54
9	1.98	1.13	0.74
10	1.51	1.49	1.30
11	1.34	1.74	1.84

Hour	Weekday	Saturday	Sunday
12	1.37	1.88	1.99
13	1.40	1.95	2.12
14	1.45	1.93	1.94
15	1.49	1.70	1.96
16	1.61	1.66	1.74
17	1.93	1.63	1.69
18	2.06	1.69	1.64
19	1.69	1.41	1.41
20	1.12	1.18	1.14
21	0.71	0.84	1.01
22	0.54	0.68	0.70
23	0.39	0.62	0.46
24	0.23	0.53	0.28
Total	**24**	**24**	**24**

Meteorological Data

ADMS-Roads utilises hourly sequential meteorological data; including wind direction, wind speed, temperature, precipitation and cloud cover, to facilitate the prediction of pollution dispersion.

Meteorological data used in the model were obtained from the Met Office observing stations at Bournemouth Airport with missing cloud cover from the Isle of Portland for 2017. These stations are considered to provide representative data for the assessment.

Selection of Monitoring Locations for Verification

BBC undertakes diffusion tube monitoring of NO_2 at 30 locations throughout the borough. Two of these sites, BK17 and B26 are located close to the PCM links. Annual mean concentrations of NO_2 at these locations are provided in **Table 7** below.

Table 7 – BCC Diffusion Tube Monitoring Data

Site Name	Site Type	PCM Link	Annual Mean NO_2 Concentrations (µg/m^3)		
			2015	2016	2017
BK17 – Castle Lane West	Roadside	26967	27.3	29.8	29.1
BK26 – St Pauls Road	Kerbside	7998	32.2	30.6	35.9

Selection of Receptors

Receptors were placed c.a. every 50m along each PCM link (both NE bound and SW bound) and adjoining roads Castle Road West and East.

To comply with the PCM model and facilitate direct comparison, each receptor was modelled at 4m from the kerb, at a height of 2m above ground level, whilst adhering to the criteria referenced by Annex III of the *EU Directive 2008/50/EC* which state that receptors should be:

- Representative of at least 100m of road length;
- At least 25m from the edge of a major junction; and
- Within 10m of the kerbside

Figures 1A and 2A in Appendix A show the location of the modelled receptors.

Conversion of NO_x to NO_2

The Defra NO_X to NO_2 calculator (v6.1, released November 2017) was applied to modelled road-NO_X outputs to convert for annual mean NO_2 concentrations. This was used in both the model and model verification.

f-NO_2

Primary NO_2 fractions (f-NO_2) have been calculated using the guidance notes on the NAEI website[1] and within JAQU guidance[2].. The NO_2 inputs for the dispersion model were calculated by multiplying the f-NO_2 for each PCM link (average between NEB and SWB flows) by the NO_X emissions for each road link.

Model Validation

The ADMS-Roads dispersion model has been validated for road traffic assessments and is considered to be fit for purpose. Model validation undertaken by the software developer Cambridge Environmental Research Consultants (CERC) is unlikely to have included validation in the vicinity of the scheme considered in this assessment. It is therefore necessary to perform a comparison of model results with local monitoring data at relevant locations.

Model Verification

[1] http://naei.defra.gov.uk/data/ef-transport
[2] https://my.huddle.net/workspace/38210068/files/#/55872101

The comparison of modelled concentrations with local monitored concentrations is a process termed ‘verification’. Model verification investigates the discrepancies between modelled and measured concentrations, which can arise due to the presence of inaccuracies and/or uncertainties in model input data, modelling and monitoring data assumptions. The following are examples of potential causes of such discrepancy:

- Estimates of background pollutant concentrations;
- Meteorological data uncertainties;
- Traffic data uncertainties;
- Model input parameters, such as ‘roughness length; and
- Overall limitations of the dispersion model.

Full details of the model verification process specific to the modelling assessment are provided in the ‘Assessment Verification Methodology’ section below.

Model Precision

Residual uncertainty may remain after systematic error or ‘model accuracy’ has been accounted for in the final predictions. Residual uncertainty may be considered synonymous with the ‘precision’ of the model predictions, i.e. how wide the scatter or residual variability of the predicted values compare with the monitored true value, once systematic error has been allowed for. The quantification of model precision provides an estimate of how the final predictions may deviate from true (monitored) values at the same location over the same period. Suitable local monitoring data for verification is used for model verification.

An evaluation of model performance has been undertaken to establish confidence in model results. LAQM.TG16 identifies a number of statistical procedures that are appropriate to evaluate model performance and assess the uncertainty. The statistical parameters used in this assessment are:

- Root mean square error (RMSE);
- Fractional bias (FB); and
- Correlation coefficient (CC)

A brief explanation of each statistic is provided in **Table 8** and further details can be found in Defra’s LAQM.TG16 document.

Table 8 – Model Performance Statistics

Parameter	Description	Ideal value
RMSE	RMSE is used to define the average error or uncertainty of the model. The units of RMSE are the same as the quantities compared.	0.00

Parameter	Description	Ideal value
	If the RMSE values are higher than 25% of the Objective being assessed, it is recommended that the model inputs and verification should be revisited in order to make improvements. For example, if the model predictions are for the annual mean NO_2 Objective of 40 µg/m^3, if an RMSE of 10µg/m^3 or above is determined for a model it is advised to revisit the model parameters and model verification. Ideally an RMSE within 10% of the air quality Objective would be derived, which equates to 4µg/m^3 for the annual mean NO_2 Objective.	
Fractional Bias	It is used to identify if the model shows a systematic tendency to over or under predict. FB values vary between +2 and -2 and has an ideal value of zero. Negative values suggest a model over-prediction and positive values suggest a model under-prediction.	0.00
Correlation Coefficient	It is used to measure the linear relationship between predicted and observed data. A value of zero means no relationship and a value of 1 means absolute relationship. This statistic can be particularly useful when comparing a large number of model and observed data points.	1.00

The calculations were carried out after model adjustment to provide information on the improvement of the model predictions as a result of the application of the verification adjustment factors.

Assessment Verification Methodology

The verification process involves a review of the modelled pollutant concentrations against corresponding monitoring data to determine how well the air quality model has performed. Depending on the outcome it may be considered that the model has performed adequately and that there is no need to adjust any of the modelled results LAQM.TG (16)[3].

Alternatively, the model may perform outside of the ideal performance limits as stated by LAQM.TG16 (i.e. model agrees within +/-25% of monitored equivalent). There is then a need to check all the input data to ensure that it is reasonable and accurately represented in the air quality modelling process.

[3] Defra (2018) Local Air Quality Management Technical Guidance (TG16), London: Defra

Where all input data, such as traffic data, emissions rates, and background concentrations have been checked and considered as reasonable, then the modelled results require adjustment to best align with the monitoring data. This may either be a single verification adjustment factor to be applied to the modelled concentrations across the study area, or a range of different adjustment factors to account for different zones in the study area e.g. major roads, local roads.

The adjustment was applied to the NO_x road source contribution (road-NO_x) and not total NO_2, given that ADMS-Roads was used to predict road-NO_x only. This ensured that any adjustment was applied to road-NO_x prior to being used in the NO_x to NO_2 conversion process.

The model has been run to predict the 2017 annual mean road-NO_x contribution at BCC diffusion tubes BK17 and BK26. The model outputs of road-NO_x have been compared with the 'measured' road-NO_x, which was determined from the NO_2 concentrations measured using diffusion tubes at the monitoring locations, utilising the NO_x from NO_2 calculator provided by Defra and the NO_2 background concentration.

The modelled versus monitored NO_2 concentrations are presented in **Table 9**. The initial comparison between the predicted concentrations and monitoring data illustrates that the model tends to under predict NO_2 concentrations at monitoring site BK17 and over predicts at site BK26.

Table 9 – Data Used in Model Verification Before Adjustment

Monitoring Site	Road	2017 Measured Data (µg/m^3)	Modelled Road-NO_x (µg/m^3) – before adjustment	Measured Road-NO_x (µg/m^3) (from NO_x:NO_2 calculator	Measured Annual Mean NO_2 Concentration (µg/m^3) – before adjustment	% Difference
BK17	7998	29.10	15.30	37.0	18.26	-37.25
BK26	26967	35.9	61.36	47.0	42.06	17.16

To provide a conservative assessment, an adjustment factor has not been applied to site BK26 as the factor would be <1. As such the results for PCM link 7998 can be viewed as worst case.

As concentrations at BK17 are under-predicted, an adjustment factor was calculated. The road-NO_x adjustment factor was determined as the slope of the best fit line between the 'measured' road contribution and the model derived road contribution, forced through zero (**Figure 9**). This factor (2.42) was then applied to the modelled road-NO_x concentration for BK17 to provide adjusted modelled road-NOx concentrations (as shown in **Table 10**). The total nitrogen dioxide concentrations were then determined by inputting the adjusted modelled road-NO_x concentrations and the background NO_2 concentration into the NO_x to NO_2 calculator.

Figure 9 – Comparison of Measured Road-NO_x with Unadjusted Modelled Road-NO_x

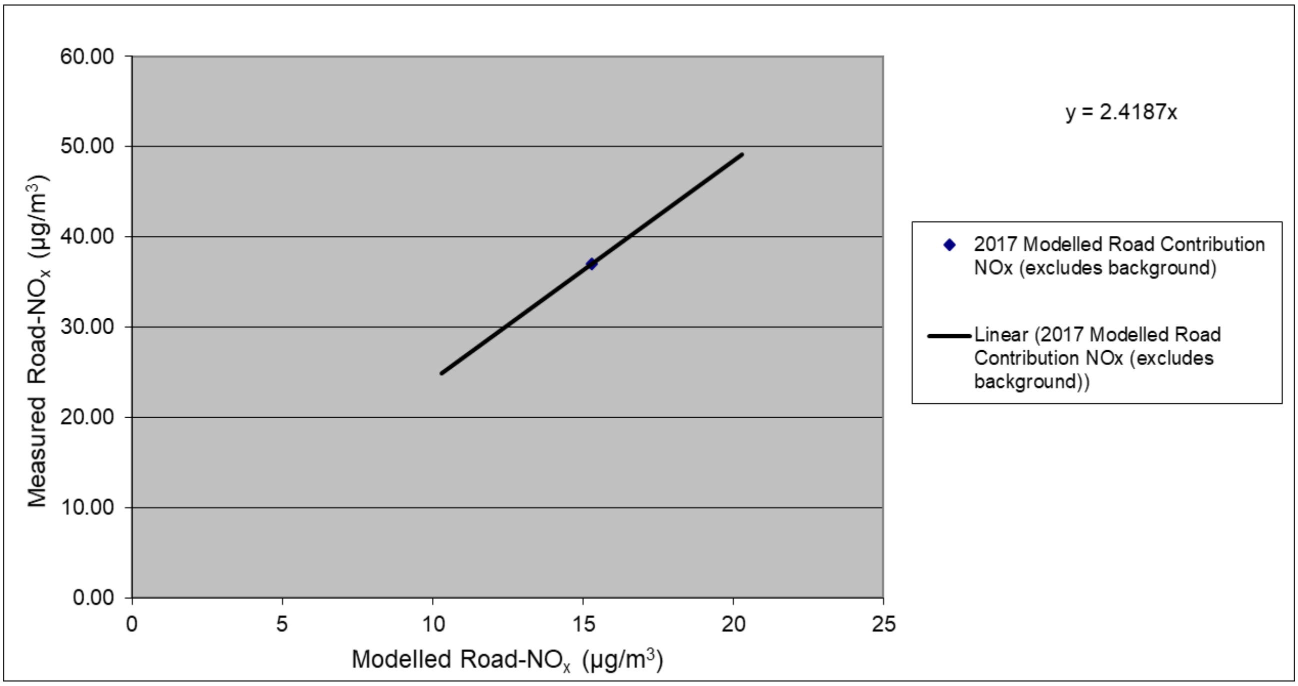


Table 10 – Data Used in Model Verification After Adjustment

Monitoring Site	Road	2017 Measured Data (µg/m^3)	Measured Annual Mean NO_2 Concentration (µg/m^3) – after adjustment	% Difference
BK17	7998	29.1	29.1	0.03

Model Uncertainty

To assess the uncertainty of a model, the RMSE is the simplest parameter to calculate providing an estimate of the average error of the model in the same units as the modelled predictions. It is also often easier to interpret the RMSE than the other statistical parameters and therefore it has been calculated in this assessment to understand the model uncertainty.

The RMSE value calculated for BK17 (after verification) was 0.0, which is the ideal value listed in **Table 8**. Therefore, model performance, with the adjustment factor applied, is considered to be robust.

Assumptions and Limitations

There are uncertainties associated with both measured and predicted concentrations. The model (ADMS Roads) used in this assessment relies on input data (including predicted traffic flows), which also have uncertainties associated with them. The model itself simplifies complex physical systems into a range of algorithms. In addition, local micro-climatic conditions may affect the concentrations of pollutants that the ADMS Roads model will not take into account.

In order to reduce the uncertainty associated with predicted concentrations, model verification has been carried out following guidance set out in LAQM.TG16. As the model has been verified against local monitoring data and adjusted accordingly, there can be reasonable confidence in the predicted concentrations.

Due to the uncertainty surrounding the accuracy of future year background concentrations, a precautionary approach has been taken whereby for the future scenarios, an assumption of no improvement in background concentrations has been adopted. This approach is considered to provide a conservative assessment.

As a result of time limitations, it has not been possible to carry out the grid modelling at a resolution of 10mx10m up to 50m from the PCM link.

However, as shown in **Figures A1 and A2**, in Appendix 1, the receptors modelled cover a long stretch of both PCM links including some adjoining roads. The data in **Tables 11 and 12** indicate that NO_2 concentrations within 4m of the modelled links will be well below the limit value for NO_2. These concentrations would be expected to reduce further with increased distance from the roads. As such, it is considered that grid modelling is not necessary as areas with the highest NO_2 concentrations have already been considered.

Model Results

Full results of the dispersion modelling for the baseline scenarios are provided in **Tables 11 and 12** below.

Table 11 – 26967 Baseline Annual Mean NO_2 Concentrations (µg/m^3)

Receptor	X, Y	Adjacent Road	Baseline Annual Mean NO_2 Concentrations (µg/m^3)				
			2017	2018	2019	2020	2021
1	410915, 92893	26967 - NEB	26.4	25.2	24.2	22.9	21.6
2	410960, 92916	26967 - NEB	26.0	24.9	23.8	22.6	21.3
3	411004, 92939	26967 - NEB	24.7	23.6	22.6	21.4	20.1
4	411048, 92963	26967 - NEB	24.7	23.6	22.6	21.4	20.1
5	411091, 92989	26967 - NEB	24.9	23.8	22.7	21.6	20.3
6	411131, 93019	26967 - NEB	23.9	22.8	21.8	20.6	19.3
7	411167, 93053	26967 - NEB	23.4	22.4	21.3	20.2	18.9
8	411198, 93091	26967 - NEB	22.3	21.3	20.4	19.3	18.1
9	411224, 93133	26967 - NEB	21.8	20.8	19.9	18.8	17.7
10	411248, 93177	26967 - NEB	21.7	20.8	19.8	18.8	17.6
11	411271, 93222	26967 - NEB	21.2	20.2	19.3	18.3	17.2
12	411295, 93266	26967 - NEB	21.4	20.4	19.5	18.4	17.3
13	411318, 93310	26967 - NEB	21.1	20.2	19.3	18.2	17.2

Receptor	X, Y	Adjacent Road	Baseline Annual Mean NO_2 Concentrations (µg/m^3)				
			2017	2018	2019	2020	2021
14	411342, 93354	26967 - NEB	21.8	20.8	19.9	18.8	17.7
15	411365, 93398	26967 - NEB	21.9	20.9	20.0	18.9	17.8
16	411389, 93442	26967 - NEB	21.5	20.5	19.6	18.6	17.5
17	411416, 93484	26967 - NEB	21.8	20.8	19.9	18.8	17.7
18	411446, 93524	26967 - NEB	22.5	21.5	20.5	19.4	18.2
19	411476, 93564	26967 - NEB	22.1	21.1	20.2	19.1	17.9
20	411509, 93602	26967 - NEB	22.6	21.6	20.6	19.5	18.3
21	411542, 93640	26967 - NEB	22.6	21.6	20.6	19.5	18.3
22	411575, 93677	26967 - NEB	22.8	21.7	20.8	19.6	18.4
23	411608, 93714	26967 - NEB	22.9	21.8	20.8	19.7	18.5
24	411641, 93752	26967 - NEB	22.6	21.6	20.6	19.5	18.3
25	411674, 93789	26967 - NEB	22.8	21.7	20.8	19.6	18.4
26	411707, 93827	26967 - NEB	22.6	21.6	20.6	19.5	18.3
27	411740, 93864	26967 - NEB	22.9	21.8	20.8	19.7	18.5
28	411773, 93902	26967 - NEB	22.8	21.8	20.8	19.7	18.5
29	411806, 93939	26967 - NEB	23.1	22.0	21.0	19.9	18.7
30	411842, 93975	26967 - NEB	24.0	22.9	21.8	20.6	19.4
31	410919, 92845	26967 - SWB	32.4	31.0	29.6	28.1	26.4
32	410964, 92867	26967 - SWB	32.0	30.7	29.3	27.8	26.1
33	411008, 92891	26967 - SWB	32.5	31.1	29.8	28.2	26.4
34	411052, 92914	26967 - SWB	31.8	30.5	29.1	27.6	25.9
35	411096, 92939	26967 - SWB	31.5	30.2	28.9	27.3	25.6
36	411136, 92968	26967 - SWB	32.4	31.0	29.7	28.1	26.3
37	411174, 93001	26967 - SWB	32.5	31.0	29.6	28.0	26.2
38	411209, 93036	26967 - SWB	32.2	30.7	29.3	27.7	25.9

Receptor	X, Y	Adjacent Road	Baseline Annual Mean NO_2 Concentrations (µg/m^3)				
			2017	2018	2019	2020	2021
39	411241, 93075	26967 - SWB	32.4	30.9	29.5	27.9	26.1
40	411268, 93117	26967 - SWB	32.6	31.1	29.7	28.0	26.2
41	411292, 93161	26967 - SWB	32.3	30.8	29.4	27.8	26.0
42	411314, 93206	26967 - SWB	34.1	32.5	31.1	29.4	27.5
43	411336, 93250	26967 - SWB	34.7	33.1	31.6	29.9	27.9
44	411358, 93295	26967 - SWB	34.9	33.4	31.9	30.1	28.1
45	411380, 93340	26967 - SWB	35.2	33.6	32.1	30.3	28.4
46	411403, 93385	26967 - SWB	35.4	33.8	32.3	30.5	28.5
47	411426, 93429	26967 - SWB	39.2	37.5	35.8	33.8	31.6
48	411455, 93470	26967 - SWB	36.3	34.7	33.1	31.3	29.2
49	411486, 93508	26967 - SWB	33.2	31.7	30.3	28.6	26.8
50	411518, 93547	26967 - SWB	32.4	30.9	29.5	27.9	26.1
51	411552, 93584	26967 - SWB	31.3	29.9	28.5	26.9	25.2
52	411584, 93622	26967 - SWB	32.3	30.8	29.4	27.8	26.0
53	411617, 93660	26967 - SWB	32.7	31.2	29.8	28.2	26.3
54	411650, 93697	26967 - SWB	32.5	31.1	29.6	28.0	26.2
55	411683, 93735	26967 - SWB	32.7	31.2	29.8	28.2	26.3
56	411716, 93773	26967 - SWB	32.7	31.2	29.8	28.1	26.3
57	411748, 93811	26967 - SWB	33.4	31.9	30.4	28.7	26.9
58	411781, 93848	26967 - SWB	32.7	31.2	29.8	28.2	26.4
59	411814, 93886	26967 - SWB	32.8	31.3	29.9	28.3	26.4
60	411849, 93921	26967 - SWB	31.4	30.0	28.6	27.1	25.3
61	411884, 93957	26967 - SWB	32.0	30.6	29.2	27.6	25.8
62	412070, 94329	Castle Lane W - EB	28.2	26.8	25.5	24.0	22.4
63	412021, 94342	Castle Lane W - EB	26.5	25.3	24.0	22.6	21.2

Receptor	X, Y	Adjacent Road	Baseline Annual Mean NO_2 Concentrations (µg/m^3)				
			2017	2018	2019	2020	2021
64	411972, 94350	Castle Lane W - EB	29.7	28.2	26.8	25.1	23.4
65	411923, 94363	Castle Lane W - EB	31.2	29.6	28.1	26.4	24.6
66	411879, 94386	Castle Lane W - EB	30.9	29.4	27.9	26.2	24.4
67	411838, 94414	Castle Lane W - EB	30.2	28.7	27.2	25.5	23.8
68	411797, 94442	Castle Lane W - EB	28.6	27.2	25.8	24.2	22.6
69	411754, 94467	Castle Lane W - EB	29.3	27.8	26.4	24.8	23.1
70	411709, 94489	Castle Lane W - EB	26.2	24.9	23.7	22.3	20.8
71	412081, 94289	Castle Lane W - WB	25.9	24.7	23.5	22.1	20.7
72	412033, 94303	Castle Lane W - WB	24.9	23.7	22.6	21.3	20.0
73	411985, 94317	Castle Lane W - WB	24.9	23.7	22.5	21.2	19.8
74	411937, 94332	Castle Lane W - WB	25.1	23.9	22.7	21.3	19.9
75	411891, 94350	Castle Lane W - WB	24.0	22.8	21.7	20.4	19.1
76	411848, 94376	Castle Lane W - WB	23.6	22.4	21.3	20.0	18.8
77	411807, 94404	Castle Lane W - WB	23.6	22.5	21.4	20.1	18.8
78	411764, 94430	Castle Lane W - WB	22.4	21.4	20.3	19.1	17.9
79	411721, 94455	Castle Lane W - WB	21.8	20.8	19.8	18.6	17.5
80	412385, 94207	Castle Lane E - EB	33.4	31.9	30.5	28.8	26.9
81	412431, 94187	Castle Lane E - EB	30.8	29.4	28.1	26.6	24.9
82	412473, 94161	Castle Lane E - EB	30.3	29.0	27.7	26.2	24.6
83	412513, 94131	Castle Lane E - EB	30.4	29.0	27.8	26.3	24.6
84	412550, 94097	Castle Lane E - EB	30.9	29.6	28.3	26.7	25.1
85	412586, 94063	Castle Lane E - EB	32.0	30.6	29.3	27.7	25.9
86	412627, 94033	Castle Lane E - EB	30.7	29.3	28.0	26.5	24.9
87	412340, 94183	Castle Lane E - WB	30.1	28.8	27.5	26.0	24.3
88	412386, 94163	Castle Lane E - WB	27.7	26.5	25.3	23.9	22.5

Receptor	X, Y	Adjacent Road	Baseline Annual Mean NO_2 Concentrations (µg/m^3)				
			2017	2018	2019	2020	2021
89	412430, 94139	Castle Lane E - WB	26.0	24.9	23.8	22.6	21.2
90	412471, 94111	Castle Lane E - WB	24.9	23.9	22.8	21.6	20.3
91	412509, 94079	Castle Lane E - WB	23.7	22.7	21.7	20.6	19.4
92	412547, 94046	Castle Lane E - WB	23.1	22.1	21.1	20.0	18.9
93	412586, 94015	Castle Lane E - WB	23.0	22.0	21.1	20.0	18.9

Table 12 – 7998 Baseline Annual Mean NO_2 Concentrations (µg/m^3)

Receptor	X, Y	Adjacent Road	Baseline Annual Mean NO_2 Concentrations (µg/m^3)				
			2017	2018	2019	2020	2021
1	408500, 91500	7998 - NEB	20.1	19.3	18.4	17.5	16.6
1	408500, 91500	7998 - NEB	20.6	19.7	18.9	17.9	17.0
2	409500, 91500	7998 - NEB	20.7	19.8	18.9	18.0	17.0
3	409500, 91500	7998 - NEB	20.5	19.6	18.8	17.8	16.9
4	409500, 91500	7998 - NEB	20.5	19.6	18.7	17.8	16.8
5	409500, 91500	7998 - NEB	19.8	19.0	18.2	17.3	16.3
6	409500, 91500	7998 - NEB	19.6	18.7	17.9	17.0	16.2
7	409500, 91500	7998 - NEB	19.3	18.5	17.7	16.8	15.9
8	409500, 91500	7998 - NEB	19.0	18.2	17.4	16.6	15.7
9	409500, 91500	7998 - NEB	19.1	18.3	17.5	16.7	15.8
10	409500, 91500	7998 - NEB	19.0	18.2	17.4	16.5	15.7
11	409500, 91500	7998 - NEB	21.1	20.2	19.3	18.4	17.4
12	408500, 91500	7998 - SWB	20.7	19.9	19.0	18.1	17.1
13	408500, 91500	7998 - SWB	21.6	20.6	19.7	18.8	17.7
14	409500, 91500	7998 - SWB	21.4	20.5	19.6	18.7	17.6
15	409500, 91500	7998 - SWB	21.1	20.2	19.3	18.4	17.4

Receptor	X, Y	Adjacent Road	Baseline Annual Mean NO_2 Concentrations (µg/m^3)				
			2017	2018	2019	2020	2021
16	409500, 91500	7998 - SWB	22.2	21.2	20.3	19.3	18.2
17	409500, 91500	7998 - SWB	21.8	20.9	20.0	19.0	17.9
18	409500, 91500	7998 - SWB	22.3	21.4	20.4	19.4	18.3
19	409500, 91500	7998 - SWB	22.5	21.5	20.6	19.5	18.4
20	409500, 91500	7998 - SWB	22.5	21.5	20.5	19.5	18.4
21	409500, 91500	7998 - SWB	22.6	21.7	20.7	19.7	18.6
22	409500, 91500	7998 - SWB	23.3	22.3	21.3	20.2	19.1

The Limit Value for annual mean NO_2 concentrations is 40µg/m^3. The results from **Tables 11 and 12** shows that the concentrations do not exceed the annual mean Limit Value at any modelled receptors in any of the baseline scenarios at either of the PCM road links. Furthermore, the NO_2 concentration is expected to decrease each year.

The highest predicted concentration in the 26967 PCM model is 39.23µg/m^3 at receptor 47 (2017). This is below the limit value by 1%.

The highest predicted concentration in the 7998 PCM model is 23.34µg/m^3 at receptor 23 (2017). This is below the limit value by 30%.

In summary, NO_2 concentrations are below the limit value for NO_2 in all baseline scenarios. As such, no measures to bring forward compliance are required.

Appendix 1

Figure 1A – Census ID 7998 Modelled Roads and Modelled Receptors

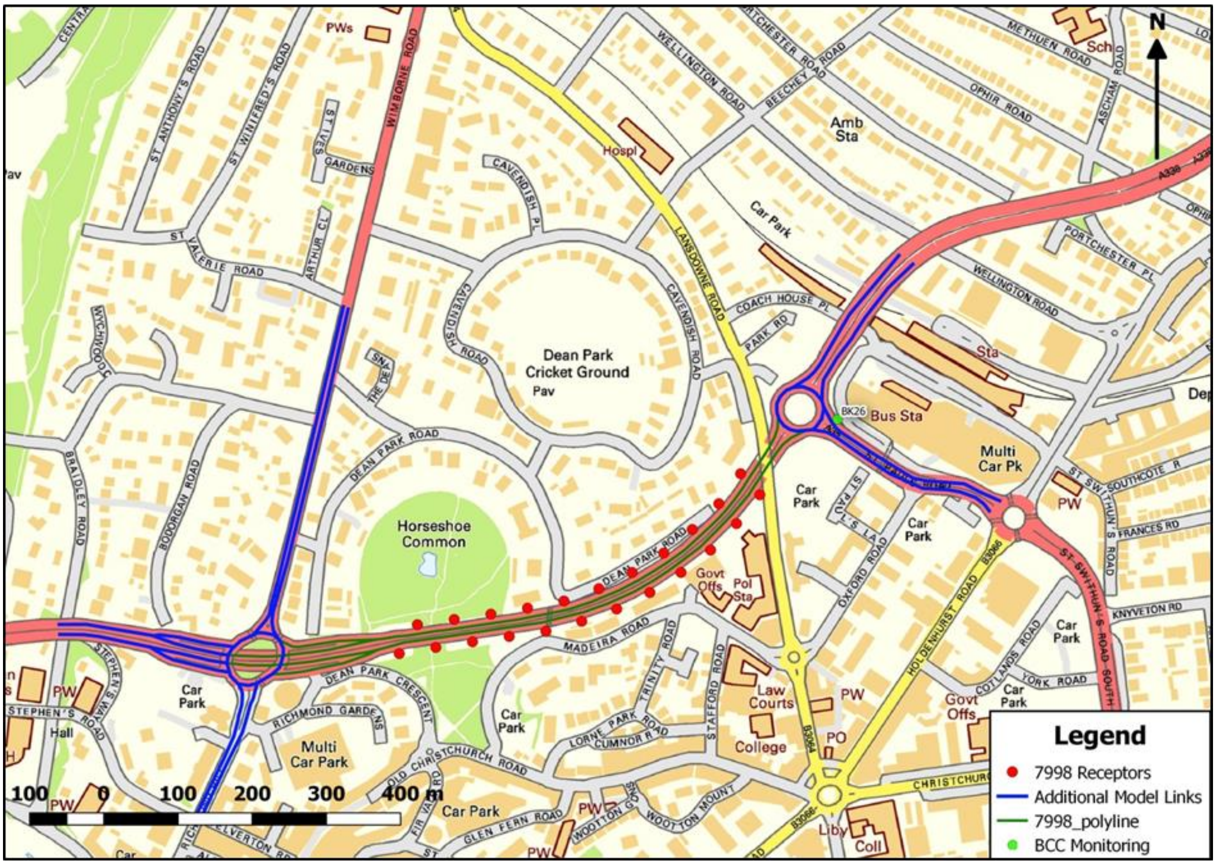
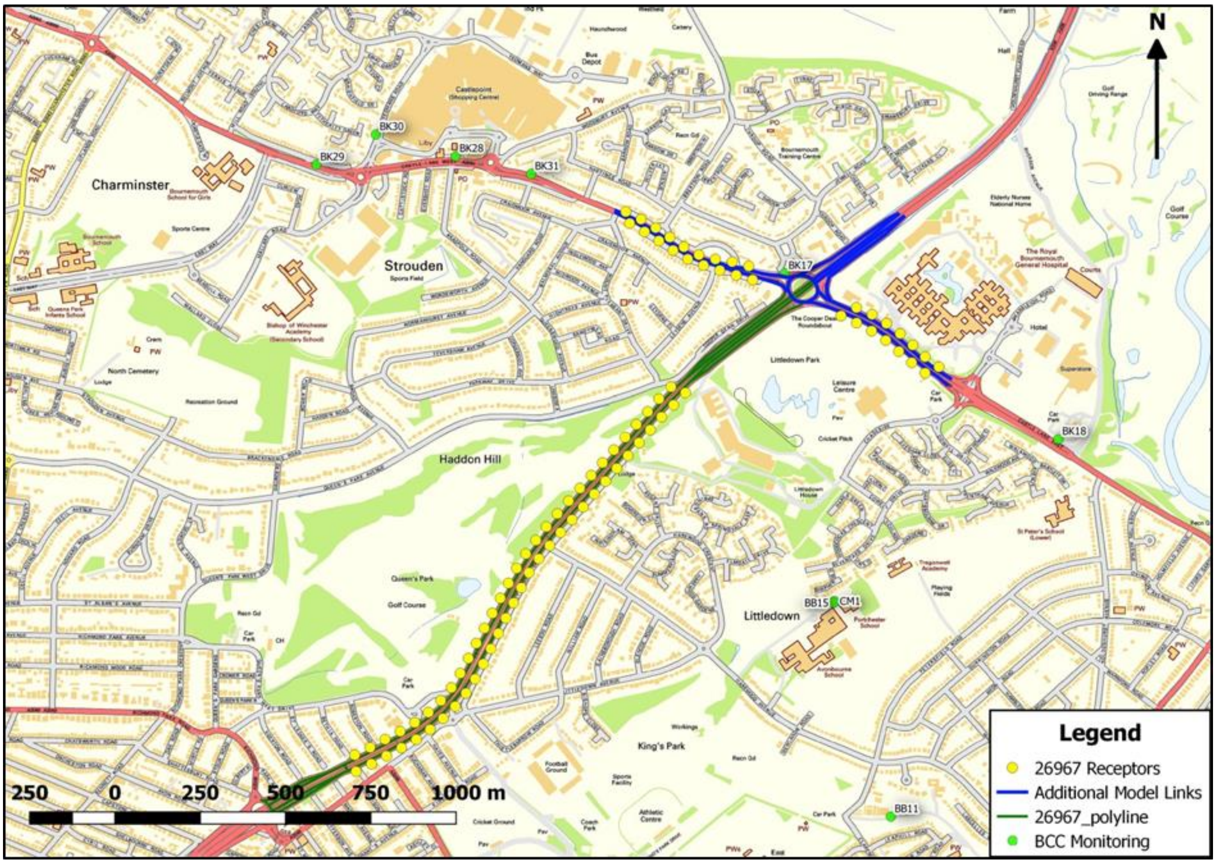


Figure 2A – Census ID 26967 Modelled Roads and Modelled Receptors



Parts 2-4:

Detailed atmospheric dispersion modelling was undertaken for the baseline scenarios of 2017, 2018, 2019, 2020 and 2021 to predict NO_2 concentrations adjacent to each link.

Verified modelling has shown that for all baseline year scenarios, NO_2 concentrations adjacent to each link are well below the air quality limit value and are showing that both links are already in compliance.

Whilst the 'With option' scenario was tested, the measures were not taken forward as the local model shows the road links to be compliant.

Part 5: Setting out a preferred option

Bournemouth Borough Council

Part 5 of the Targeted Feasibility Study should be read in conjunction with Part 1, which provides the modelling data and results. Table 1 below provides an overview of the conclusions to our study.

Table 13 Study Conclusion Overview

Road Link	PCM Identified Link	Summary of exceedance	Measures identified that could bring forward compliance
Census ID 7998	Yes- this link was identified as having an exceedance in the national PCM modelling	The national PCM modelling has projected that this link will be compliant in 2019. Summary of PCM NO_2 concentration projections: 2018: 41µg/m^3 2019: 39µg/m^3 2020: 38µg/m^3 2021: 36µg/m^3 **Rigorously analysed and verified modelling has been conducted using local data. This modelled data shows that the link is already compliant** **2017 data: 23µg/m^3**	Link already compliant and no measures are required to bring compliance forward.
Census ID 26967	Yes- this link was identified as having an exceedance in the national PCM modelling	The national PCM modelling has projected that this link will be compliant in 2021. Summary of PCM NO_2 concentration projections:	Link already compliant and no measures are required to bring compliance forward.

		2018: 44µg/m^3 2019: 43µg/m^3 2020: 40µg/m^3 2021: 38µg/m^3 **Rigorously analysed and verified modelling has been conducted using local data. This modelled data shows that the link is already compliant** **2017 data:39µg/m^3**	