Bristol Clean Air Plan

Local Plan Air Quality Modelling Methodology Report (AQ2)

January 2019

Bristol Clean Air Plan

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Acronyms and Abbreviations

ADMS	Atmospheric Dispersion Modelling System
ANPR	Automatic Number Plate Recognition
ATC	Automatic Traffic Counters
AQMA	Air Quality Management Area
BCC	Bristol City Council
CAZ	Clean Air Zone
COPERT	Computer Programme to calculate Emissions from Road Transport
Defra	Department for Environment, Food & Rural Affairs
DfT	Department for Transport
EFT	Emission Factor Toolkit
GBATS	Greater Bristol Area Transport Model
HGV	Heavy Goods Vehicle
JAQU	Joint Air Quality Unit (Defra and the Department for Transport)
LDV	Light Duty Vehicle
LSOA	Lower Super Output Area
$\mu g/m^3$	micrograms per cubic metre
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides (taken to be NO_2 + NO)
PCM	Pollution Climate Mapping
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10 micrometres
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5 micrometres
SGC	South Gloucestershire Council

1. Introduction

1.1 Background

Poor air quality is the largest known environmental risk to public health in the UK[1]. Investing in cleaner air and doing more to tackle air pollution are priorities for the EU and UK governments, as well as for Bristol City Council (BCC). BCC has monitored and endeavored to address air quality in Bristol since 2002. Despite this, Bristol has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO_2) and these are predicted to continue until 2023 without intervention.

In 2017 the government published a UK Air Quality Plan for Nitrogen Dioxide[2] setting out how compliance with the EU Limit Value for annual mean NO_2 will be reached across the UK in the shortest possible time. Due to forecast air quality exceedances, BCC, along with 27 other Local Authorities, was directed by Minister Therese Coffey (Defra) and Minister Jesse Norman (DfT) in 2017 to produce a Clean Air Plan (CAP). The Plan must set out how BCC will achieve sufficient air quality improvements in the shortest possible time. In line with Government guidance BCC is considering implementation of a Clean Air Zone (CAZ), including both charging and non-charging measures, in order to achieve sufficient improvement in air quality and public health.

Jacobs has been commissioned by BCC to produce an Outline Business Case (OBC) for the delivery of the CAP; a package of measures which will bring about compliance with the Limit Value for annual mean NO_2 in the shortest time possible in Bristol. The OBC assesses the shortlist of options set out in the Strategic Outline Case[3], and proposes a preferred option including details of delivery. The OBC forms a bid to central government for funding to implement the CAP.

This document is written to support the OBC and provides details of the air quality modelling methodology used to reach the conclusions of the OBC.

1.2 Purpose of this Report

This report sets out the air quality modelling methodology and outlines the approach taken to model the air quality impacts, including a description of the modelling methods used, details of monitoring data for calibration of the model and a description of how transport model outputs have been fed into the air quality modelling. It also sets out how the emissions from vehicles of different Euro standards have been calculated and projected, together with how changes in primary NO_2 emission fraction, f-NO_2, have been taken into account.

The air quality modelling methodology is described in detail, in order that a full understanding and approval of the approach can be made by JAQU. This report should be read alongside AQ1 (Air Quality Tracking Table) which is included in Appendix A.

[1] Public Health England (2014) Estimating local mortality burdens associated with particular air pollution. https://www.gov.uk/government/publications/estimating-local-mortality-burdens-associated-with-particulate-air-pollution
[2] https://www.gov.uk/government/publications/air-quality-plan-for-nitrogen-dioxide-no2-in-uk-2017
[3] Bristol Council Clean Air Plan: Strategic Outline Case, March 2018 (https://democracy.bristol.gov.uk/documents/s19804/Clean%20Air%20Plan%20-%20Cabinet%20Report%20and%20Appendices%20-%20Final%20with%20Early%20Measures%20Fund%20included%20-with%20legal.pdf)

2. Air Quality Model Specification

2.1 Model Selection

The latest Emission Factor Toolkit (EFT) version available at the time of the study (v8.0.1a) was used to model the selected road traffic emissions. The use of this emission model is specified in JAQU's 'Transport and Air Quality' guidance and this version (v8.0.1a) of the EFT was provided directly from JAQU for use in the study. The EFT is based on the European Environment Agency's COPERT emission tool. The EFT allows users to calculate road transport pollutant emission rates for Oxides of Nitrogen (NO_X), Primary Nitrogen Dioxide (f-NO_2) and Particulate Matter (PM_{10} & $PM_{2.5}$) for a specified year, road type, vehicle speed and vehicle fleet composition.

Dispersion modelling has been undertaken using ADMS-Roads version 4.1, which is one of the "standard" models recommended in JAQU's 'Transport and Air Quality' guidance. The model is approved by Defra and used extensively in the United Kingdom. Typical applications include modelling for review and assessment, quantification of air quality action plan measures, including Low Emission Zones, Clean Air Zones, etc., and the assessment of new developments through the planning process.

The ADMS 'Advanced Canyon Module' has been used to allow for a more accurate representation of the dispersion patterns within street canyons, including asymmetrical canyons. The study area includes Bristol city centre, which comprises a large number of street canyons. The dispersion of emissions from traffic is influenced by the presence of tall buildings, or other obstacles such as trees, along roads, which leads to elevated roadside pollutant concentrations. To capture this phenomenon, where necessary, buildings and other obstacles within the study area have been represented within ADMS.

2.2 Air Quality Base Model Year

The model base year is 2015, with monitoring data for this year used to verify and adjust the modelled concentrations. The use of a later base year was not possible due to a number of locations where road works, relating to new MetroBus routes, caused temporary, significant disruptions to traffic flows, which would not therefore have been representative.

2.3 Air Quality Model Domain

The model domain includes all roads that are listed within the national Pollution Climate Mapping (PCM) model for the study area, as exceeding the annual mean Limit Value in 2021 for NO_2 (as published by Defra), as well as roads where annual mean NO_2 concentrations are known to exceed the national air quality objective, based on the most recent review and assessment report published by BCC.

The domain also includes all potential displacement routes which may affected by the measures, identified from the traffic model.

Figure 1 shows the domain for the study, which covers the majority of urban areas within Bristol, extending into South Gloucestershire Council (SGC), including the Air Quality Management Areas (AQMAs) (Bristol AQMA, Staple Hill AQMA, Kingswood AQMA and Cribbs Causeway AQMA). The study area extends well beyond the road network that will be affected by changes in traffic in order that the health impacts can be quantified by incorporating all densely populated areas of population (in some cases very small changes in concentrations applied across a large population base can account for significant health impacts).

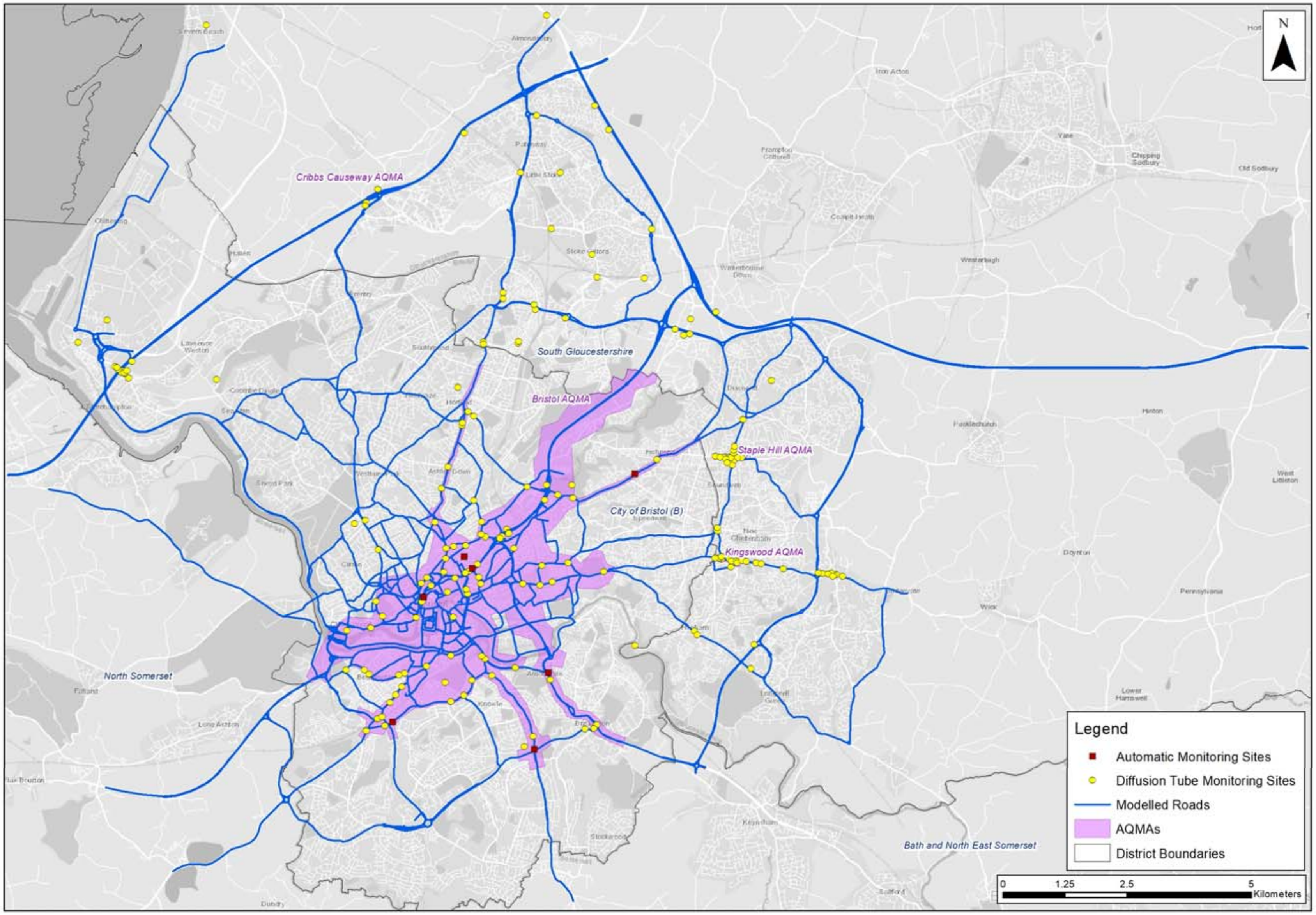

Figure 1 – Study Area Showing Modelled Roads, AQMA and 2015 Monitoring Sites

2.4 Air Quality Model Receptor Locations

The following receptor locations have been included in the model:

- Address base information will be used to calculate population-weighted mean concentration values for each Lower Super Output Area (LSOA), which will then be used within the distributional analysis. These will be modelled at a height of 1.5 m to represent relevant exposure. These receptors have not been included in this Target Determination exercise.
- Selected monitoring site locations have been used to verify and calibrate the model. These include automatic and passive (diffusion tube) monitors.
- For each link included in the PCM model, multiple receptors have been included within the model at a height of 2 m and at a distance of 4 m from the kerbside on both sides of the road. For each link, the receptor with the maximum predicted concentration has been used to facilitate a comparison between the local model results and the PCM model.
- A representative set of worst-case receptors for each location identified as either exceeding or likely to exceed the NO_2 annual mean Air Quality Objective. These will be modelled at a height of 1.5 m to represent relevant exposure for the Air Quality Objectives.

A subset of the receptors listed above (i.e. the third bullet point) has been selected to assess compliance with the NO_2 Limit Value through the target determination process with JAQU. The receptors selected for compliance have been selected at least 25 m from major junctions and are representative of at least a 100 m length of road (as detailed in the Air Quality Directive (Annex III: A, B, and C)). A number of receptors have been modelled along each relevant PCM link and the worst-case concentration are reported for this Target Determination exercise.

3. Air Quality Base Year Modelling

3.1 Meteorological data

An appropriate base year and meteorological site location has been used when considering meteorological data, as per Defra Technical Guidance, TG(16) (Defra, 2016). The meteorological station located at Filton Airfield in Bristol is considered to be the nearest and most representative meteorological station. Data from this station has thus been used for the year 2015.

As recommended by Defra's Technical Guidance TG(16) (Defra, 2016), meteorological, background pollution, monitoring and emissions data have all been derived from the same base year as the model (i.e. 2015). Table 1 provides more detail of the meteorological site location and modelled parameters. Figure 2 illustrates a wind rose of pre and post processed meteorological data.

Table 1: Meteorological Site location and Modelled Parameters

Meteorological Site	Filton Airfield
OS Grid reference	360057, 180491
Surface Roughness	Met site: 0.5m ; Dispersion Site: 1m
Minimum Monin Obukhov Length	30

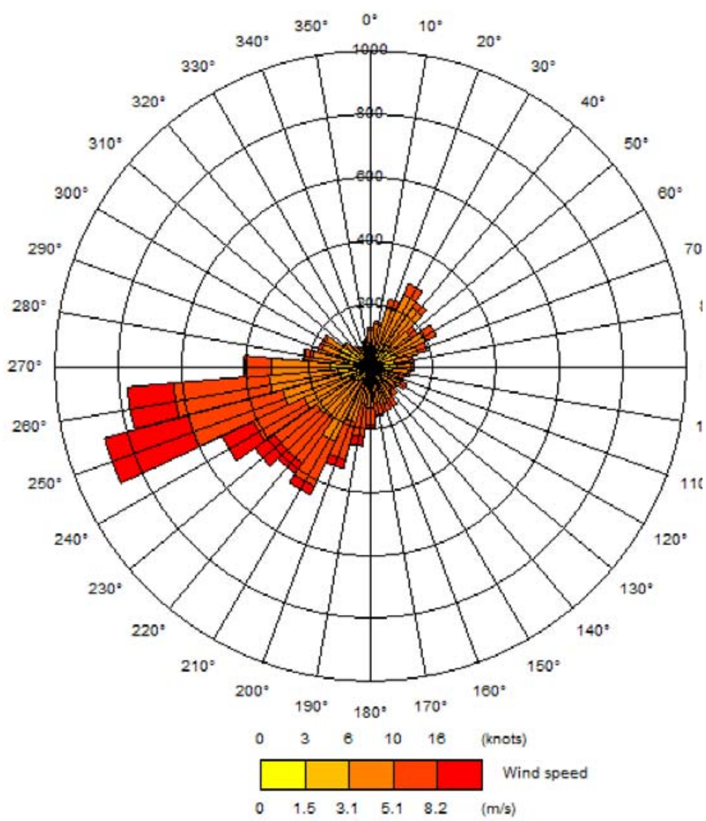

Figure 2: Wind Speed and Direction Data for Filton Airfield 2015

3.2 Traffic Input Data

Traffic flows by vehicle type have been sourced from the transport model SATURN (GBATS). The following vehicle types are considered: cars (diesel and petrol, including taxis), LGVs, HGVs (rigid and articulated) and buses (including coaches). Motorcycles are not considered given their low numbers and the lack of data available.

HGV emissions have been adjusted in accordance with TG16 for roads with a gradient of over 2.5%, which is intended to account for the increase in emissions when the HGVs are driving uphill.

Proportions of rigid and articulated HGVs have been estimated from Automatic Traffic Counter (ATC) data and/or Automatic Number Plate Recognition (ANPR) data, and taxi proportions taken from the ANPR data.

Vehicle speeds have been sourced from SATURN and adjusted, where required, based on experience and local knowledge. Traffic master data has been used to compare speeds at key locations, but no changes to speeds were included. Further assessment of any differences noted will be provided in the Sensitivity Test Report (more details regarding what will be included in the Sensitivity Test will be provided in the OBC).

The fleet composition has been obtained from local ANPR data to provide vehicle details. Emissions have been calculated using the EFT 'Advanced User Euro Split' to reflect the local ANPR data.

Road links have been manually adjusted to reproduce the actual road geometry making use of Ordnance Survey Mastermapping.

3.3 NO_X/NO_2 emissions assumptions

The EFT has been used to calculate location specific f-NO_2 values based on the fleet composition for each location for which traffic NO_x emissions are calculated.

In accordance with JAQU's 'Transport and Air Quality' guidance, in order to calculate total NO_2 concentrations from NO_X concentrations, the LAQM NO_X to NO_2 calculator v6.1 (with user defined f-NO_2) has been used.

3.4 Background Pollutant data

Background NO_x, NO_2 and PM_{10} concentrations, for the 2015 base year, have been derived from Defra's background mapped data https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2015 based on COPERT 5.0. An interpolation process of background concentrations was undertaken, and results extracted to all modelled receptors. A calibration between the extracted, interpolated results with the 2015 urban background diffusion tube air quality monitoring stations was been undertaken. The measured nitrogen dioxide concentration within the modelling domain was compared to the mapped background. It was found that mapped background nitrogen dioxide concentrations were lower than the monitored values, and therefore all mapped background nitrogen dioxide concentrations have been calibrated by applying a factor of 3.37%. Mapped background concentrations of PM_{10} and $PM_{2.5}$ have not been adjusted.

3.5 Measurement data for model calibration

Modelled NO_x and PM concentrations have been verified against the 2015 BCC and SGC automatic monitoring stations and, in the case of NO_2, at a selection of diffusion tubes. Data have been collected in accordance with TG16 and have been bias-adjusted.

All roadside automatic monitoring stations have been included, while a screening of diffusion tube data has been performed to ensure the data used are not significantly affected by non-road sources. The verification, and subsequent calibration, process follows the TG16 guidance. Table 2 provides further detail of the monitoring sites used in the calibration process. Monitors with names beginning “CM” are continuous monitors while those beginning “DT” are diffusion tubes. Figure 1 shows the location of monitors available for 2015 in BCC and SGC.

All monitoring sites have QA procedures in place. Diffusion tube data have been bias-adjusted and annualised where necessary. BCC's continuous analysers also follow a QA/QC programme as described below:

- daily checks on the lines, data transfer, analyser operation and data quality to ensure analysers and communications are working and faults are reported as soon as possible;
- sites visited once a month by a trained AURN Local Site Operator (LSO) to change the filters and check the analysers;
- analysers are serviced and re-calibrated at six monthly intervals by the equipment suppliers; and
- results of all service, maintenance and calibration checks are held and used for ratification and scaling of the data.

Annual reports on air quality for LAQM purposes for BCC can be found at https://www.bristol.gov.uk/pests-pollution-noise-food/air-quality and for SGC at http://www.southglos.gov.uk/environment-and-planning/pollution/pollution-control-air-quality/air-quality-reports/. Reports include details of QA/QC undertaken for monitoring.

Table 2 Details of Monitoring Sites used in Model Calibration

Monitoring Site ID	Location	Distance from kerb (m) of model domain	In Canyon?	On gradient?	Measured NO_2 Concentration 2015 (µg/m^3)	Adjusted Modelled Concentration 2015 (µg/m^3)
SGC58	365327, 172141	2.5	No	No	20.4	15.4
SGC68	364631, 173886	1.5	Yes	No	40.5	86.9
SGC70	364533, 173896	3.7	Yes	No	31.0	44.2
SGC71	365075, 175918	7.4	No	No	23.6	16.7
SGC72	364990, 175920	2.2	No	No	32.2	25.7
SGC93	364979, 173801	2.1	Yes	No	29.2	59.6
SGC95	365078, 173846	3.1	Yes	No	34.3	42.5
SGC96	365164, 173832	2.5	Yes	No	34.2	39.4
SGC97	365361, 173804	1.2	Yes	No	32.3	47.1
SGC105	364932, 176147	2.1	No	No	26.7	33.3
SGC129	357508, 181059	1.5	No	No	29.5	35.4
SGC130	357488, 181011	1.5	No	No	26.8	27.1
SGC133	363736, 178507	10.6	Yes	No	28.4	32.5
SGC135	364029, 178413	1.5	Yes	No	26.8	21.3
SGC143	366815, 173574	4.1	Yes	No	25.6	46.0
SGC145	367107, 173531	6.9	Yes	No	25.6	20.1
SGC147A	364586, 174495	2.2	Yes	No	38.7	67.6
BCC163	359435, 176574	2.7	Yes	No	37.0	82.4
463	362926, 175590	5.1	Yes	No	39.7	83.9
BCC307	360747, 175328	3.1	Yes	No	36.6	56.8
BCC21	359030, 175298	0.8	No	No	51.6	92.4
BCC407	359829, 174370	1.4	Yes	No	43.1	61.1

Monitoring Site ID	Location	Distance from kerb (m) of model domain	In Canyon?	On gradient?	Measured NO_2 Concentration 2015 (µg/m^3)	Adjusted Modelled Concentration 2015 (µg/m^3)
BCC426	359517, 174153	0.5	Yes	No	32.5	46.0
BCC157	359119, 174090	2.4	Yes	No	53.3	110.0
BCC497	359268, 174132	1.9	Yes	No	41.8	37.7
BCC373	359747, 173774	14.9	Yes	No	38.3	53.7
375	359645, 173683	6.8	No	No	41.1	39.7
BCC363	359075, 173613	3.2	Yes	No	39.2	68.3
BCC374	359507, 173595	1.1	Yes	No	47.1	55.7
BCC370	359775, 173513	0.7	Yes	No	37.7	41.7
BCC371	359813, 173373	1.6	Yes	No	44.8	57.9
BCC365	359520, 173264	11.1	No	No	36.5	22.5
BCC23	359555, 173166	4.2	Yes	No	45.3	61.6
BCC147	358514, 172691	1.0	Yes	No	60.1	166.8
BCC254	357118, 172429	2.7	Yes	No	54.4	80.5
BCC4	359903, 171850	3.1	Yes	No	53.3	88.4
BCC403	360508, 171676	0.5	Yes	No	41.5	53.2
BCC466	357466, 171622	1.9	Yes	No	34.0	67.2
BCC472	358226, 171284	2.1	Yes	No	40.0	62.8
BCC473	358105, 171124	1.6	Yes	No	49.6	62.7
BCC470	359213, 170997	2.5	Yes	No	38.7	47.2
BCC474	357990, 170979	2.1	Yes	No	38.5	56.4
BCC418	357737, 170642	2.2	Yes	No	63.7	73.6
215	358042, 170582	5.6	Yes	No	44.2	61.3
BCC318	358667, 173110	4.6	Yes	No	91.2	280.7
206	358667, 173108	5.1	Yes	No	90.9	291.6
BCC2	358628, 173011	4.2	Yes	No	69.2	185.9
SGC22	364116, 172413	2.1	Yes	Yes	28.7	45.6
SGC73	364902, 175843	0.5	Yes	Yes	40.4	51.9
SGC90	364665, 173925	0.8	Yes	Yes	33.2	26.7
SGC98	365463, 173785	2.1	Yes	Yes	37.0	41.1
SGC128	364587, 174431	3.7	Yes	Yes	33.2	36.5
SGC132	364178, 172337	3.2	Yes	Yes	29.2	60.2
SGC142	366613, 173597	2.5	Yes	Yes	29.7	51.3
SGC146	365910, 173680	0.4	Yes	Yes	41.8	55.3
BCC493	359677, 176758	4.9	Yes	Yes	36.4	45.8
BCC494	359558, 176850	3.1	Yes	Yes	38.4	46.9
BCC303	361368, 175170	5.9	Yes	Yes	46.1	72.0
BCC159	358891, 174608	1.2	Yes	Yes	44.1	53.6
BCC312	359832, 174616	1.4	Yes	Yes	36.8	44.4
BCC295	359913, 174316	0.4	Yes	Yes	63.3	164.3
BCC22	359111, 173885	5.1	Yes	Yes	49.7	46.9
BCC405	361051, 173743	0.5	Yes	Yes	53.1	72.1
BCC496	362296, 173620	4.7	Yes	Yes	39.3	81.9
BCC9	358729, 173499	0.1	Yes	Yes	48.0	61.0

Monitoring Site ID	Location	Distance from kerb (m) of model domain	In Canyon?	On gradient?	Measured NO_2 Concentration 2015 (µg/m^3)	Adjusted Modelled Concentration 2015 (µg/m^3)
BCC156	357709, 173018	3.5	Yes	Yes	38.9	80.9
BCC155	357838, 172713	1.4	Yes	Yes	39.9	66.6
BCC10	361218, 171429	4.8	Yes	Yes	49.3	84.0
BCC175	362147, 170525	0.6	Yes	Yes	52.9	71.9
BCC242	357510, 170401	3.2	Yes	Yes	61.7	94.2
BCC438	360903, 170024	0.1	Yes	Yes	43.1	55.9
270	360903, 170024	0.1	Yes	Yes	39.3	60.1

There are a number of monitoring sites that have not been included in the model verification. All of these sites are included in Table 3 below with reasons for exclusion from the verification. Some sites are located too far away (>15 m) from the modelled roads to provide a robust verification of the local road contribution to concentrations, with others not located on modelled roads or the sites are affected by other very localised sources, such as bus stops. These sites, along with their distances from the kerb of the nearest modelled road, are presented in Table 3 below.

Table 3 Details of Monitoring Sites not used in Model Calibration

Monitoring Site ID	Location	Distance from kerb (m) of model domain	Reason for exclusion from verification
SGC10	360266, 179136	3.7	Adjacent roads not included in the modelled domain
SGC13	361523, 178732	2.7	Adjacent roads not included in the modelled domain, and gap in building information relevant to canyons
SGC17	364830, 173878	29.9	Located over 15m from the modelled domain
SGC23	364854, 173717	0.1	Located adjacent to a bus stop, not accounted for in model
SGC27	364866, 173835	2.1	Adjacent roads not included in the modelled domain
SGC34	362395, 182544	32.4	Located over 15m from the modelled domain
SGC35	362118, 183031	32.2	Located over 15m from the modelled domain
SGC36	364556, 178856	39.3	Located over 15m from the modelled domain
SGC45	363265, 180539	3	Cannot be located / construction work to expand bus lane
SGC54	365256, 171656	14.7	Located at entrance of retail industrial park - at traffic light where adjacent roads not included in model domain
SGC60	365101, 176688	7.2	Adjacent roads not included in the modelled domain
SGC61	364926, 175926	2.1	Adjacent roads not included in the modelled domain, and gap in building information relevant to canyons
SGC62	364909, 175908	0.4	Adjacent roads not included in the modelled domain
SGC63	359487, 182479	54.9	Located over 15m from the modelled domain
SGC67	364671, 173877	3.4	Located at an intersection - outside of canyon, however likely to be affected in real world
SGC69	364597, 173892	1.5	Adjacent roads not included in the modelled domain
SGC74	364885, 175772	0.5	Adjacent roads not included in the modelled domain
SGC78	364909, 176016	1.5	Adjacent roads not included in the modelled domain, and gap in building information relevant to canyons
SGC79	364913, 176067	1.9	Adjacent roads not included in the modelled domain, and gap in building information relevant to canyons
SGC87A	357739, 181334	24	Located over 15m from the modelled domain
SGC87B	357739, 181334	24	Located over 15m from the modelled domain

Monitoring Site ID	Location	Distance from kerb (m) of model domain	Reason for exclusion from verification
SGC87C	357739, 181334	24	Located over 15m from the modelled domain
SGC92	364968, 173836	1.9	Adjacent roads not included in the modelled domain
SGC108	360613, 181680	22.3	Located over 15m from the modelled domain
SGC116	366882, 173562	1.4	Concentrations affected by adjacent gradient road, which is not included in model
SGC117	359874, 178259	4.2	Adjacent roads not included in the modelled domain
SGC118	359875, 178207	2.3	Adjacent roads not included in the modelled domain
SGC119	360263, 179250	3.4	Adjacent roads not included in the modelled domain
SGC124	360918, 178905	47.9	Located over 15m from the modelled domain
SGC125	360891, 179005	10.4	Adjacent roads not included in the modelled domain
SGC137	366984, 173563	2.5	Adjacent roads not included in the modelled domain
SGC138	366941, 173558	1.4	Adjacent roads not included in the modelled domain
SGC139	366890, 173561	1.6	Adjacent roads (affected by gradients) not included in the modelled domain
SGC140	366879, 173594	22.1	Located over 15m from the modelled domain
SGC141	366705, 173581	8.2	Located adjacent to petrol station exit lane
BCC486	352785, 177858	16.3	Located over 15m from the modelled domain
BCC483	352484, 177735	57.4	Located over 15m from the modelled domain
BCC396	352593, 177673	20.3	Located over 15m from the modelled domain
BCC398	352501, 177698	21.7	Located over 15m from the modelled domain
BCC492	359445, 176627	1.3	Road width / distance of DT from modelled domain
BCC300	363365, 175883	2.1	Cannot be located (over predicted as coordinates place DT within the road)
BCC161	359152, 175733	0.2	Cannot be located
BCC464	362927, 175592	6.2	Located in same position as 463 (Continuous Monitor)
BCC260	361140, 175366	3.6	Adjacent slip roads not included in the modelled domain
BCC261	361103, 175059	0	Cannot be located
BCC311	359677, 175057	1.4	Distance from roads included in the modelled domain (i.e. adjacent roads not accounted for in model)
BCC325	361667, 175103	10.4	Distance from roads included in the modelled domain (i.e. adjacent roads not accounted for in model)
BCC263	360343, 174473	30	Located over 15m from the modelled domain
BCC461	360381, 174405	14.9	Cannot be located
BCC462	360385, 174381	38.5	Located over 15m from the modelled domain
BCC487	360243, 174327	0.5	Adjacent roads not included in the modelled domain
BCC488	360205, 174291	4.4	At junction of an on ramp, and located below the road (on ramp elevation not accounted for in model)
BCC314	357751, 174063	1.8	Located in a taxi waiting area, not accounted for in model
BCC429	360484, 174096	4.9	Located at Bus Stop
BCC406	361576, 173806	0	Cannot be located
BCC441	359645, 173683	6.8	Located in same position as Continuous Monitor 375
BCC20	359567, 173629	6.7	On review, it was noted that this DT was placed upside down, area covered by an automatic monitor (375) and BCC374 DT, therefore excluded as results unreliable
BCC15	359294, 173485	1.8	Area around DT is locally known for stop-start-traffic, which has not been accounted for in the model, which is not represented in the traffic model and therefore excluded.
BCC423	358623, 173386	16.4	Located over 15m from the modelled domain, and located at the entrance of parking area at the Children's hospital

Monitoring Site ID	Location	Distance from kerb (m) of model domain	Reason for exclusion from verification
BCC6	361262, 173412	4.6	Located at junction, not all roads affected included in modelled area
BCC305	360661, 173373	21.2	Located over 15m from the modelled domain
BCC436	361013, 173352	4.3	Cannot be located
BCC11	358813, 173342	2.8	Located at a parking garage (unable to located DT)
BCC12	359155, 173184	6.1	Cannot be located
BCC113	359254, 172694	4.9	Relocated out of road, to building façade, within parking garage area
BCC154	357601, 172481	3.8	Located adjacent to canal / away from receptors / affected by wind directions
BCC125	359214, 171917	0.1	Adjacent roads not included in the modelled domain
BCC8	359836, 171903	40.1	Located over 15m from the modelled domain
BCC5	358723, 171704	1.2	Located along a building, which the model interprets as a canyon - however building is not solid, therefore excluded
BCC99	357099, 171627	5.6	Located at junction, and adjacent roads not included in the modelled domain
BCC320	361178, 171566	15.5	Located over 15m from the modelled domain
BCC413	360043, 171508	4.2	Model does not account for bus lane separately
BCC420	358277, 171562	5.1	DT located on a small local traffic circle, was presented as a straight intersection in the model. Therefore, the model under predicts at this location and it has been excluded.
BCC422	358168, 171525	3.3	DT likely to be affected by canyon & DT located on 2 roads - one of which is not accounted for in the model
BCC467	357568, 171537	1.8	Distance from roads included in the modelled domain (i.e. adjacent roads not accounted for in model)
203	361178, 171566	15.5	Located over 15m from the modelled domain
BCC417	359635, 171413	3.5	Located at Bus Stop
BCC469	359479, 171114	5.6	Located at junction, and adjacent roads not included in the modelled domain
BCC419	357832, 170686	2.6	Distance from roads included in the modelled domain (i.e. adjacent roads not accounted for in model)
BCC239	357880, 170506	1.3	Adjacent roads not included in the modelled domain
BCC439	358038, 170581	4	Located in same position as Continuous Monitor 215
BCC478	362091, 170447	15.9	Located over 15m from the modelled domain
BCC479	361917, 170442	7	Distance from roads included in the modelled domain (i.e. adjacent roads not accounted for in model)
BCC14	360872, 170291	3.4	Model does not account for bus lane separately

3.6 Treatment of Canyons

Accurate dispersion modelling in urban areas can be difficult due to the presence of obstacles (buildings, trees, walls, etc.) that modify the wind flow locally and therefore can alter dispersion. This is especially the case what is termed “street canyons”, where buildings on both sides of the road can lead to the formation of vortices and recirculation of air flow that can trap pollutants and restrict dispersion (often termed as the “canyon effect”). Although street canyons were once defined as narrow streets where the height of buildings on both sides of the road is greater than the road width, there are numerous examples whereby broader streets may also be considered as street canyons, where buildings result in reduced dispersion and elevated concentrations (which may be demonstrated by monitoring data). The model domain in Bristol has a large number of street canyons, both due to the presence of buildings, but also retaining walls, trees etc. Appendix B contains a table showing the parameters of the canyons included within the advanced canyon module of the ADMS-Roads model. Canyons have determined using the ADMS advanced street canyon. Building locations and heights were defined using a combination of OS mapping and Google street view.

3.7 Treatment of Gradients

Emissions on roads with gradients have been adjusted following the method outlined in TG(16) and guidance from JAQU. The methodology is based on an analysis of the emission factors published for use within the COPERT 4 model. Older vehicles are based on the emission factors published in August 2007, and newer vehicles are based on the September 2014 update. The TG(16) and JAQU method is to adjust emissions for pre-2014 HDVs only, with no adjustment for later model vehicles or LDVs.

3.8 Treatment of Flyovers

Where major flyovers were identified, though the use of Google street view and local knowledge, roads have been assigned an elevation within the ADMS-Roads model to account for this. In particular the M32 and part of the Brunel Way flyovers were considered and assigned a height of 6m.

3.9 Train Emissions

Trains have not been explicitly included in the model.

3.10 Diurnal Profile for Emissions

Figure 3 shows the diurnal profile for emissions used in the modelling. These flow profiles for the traffic have been derived from the national profiles published by DfT. These profiles for total traffic volumes have thus been assumed to apply to emissions, regardless of any diurnal profiles in speed or congestion.

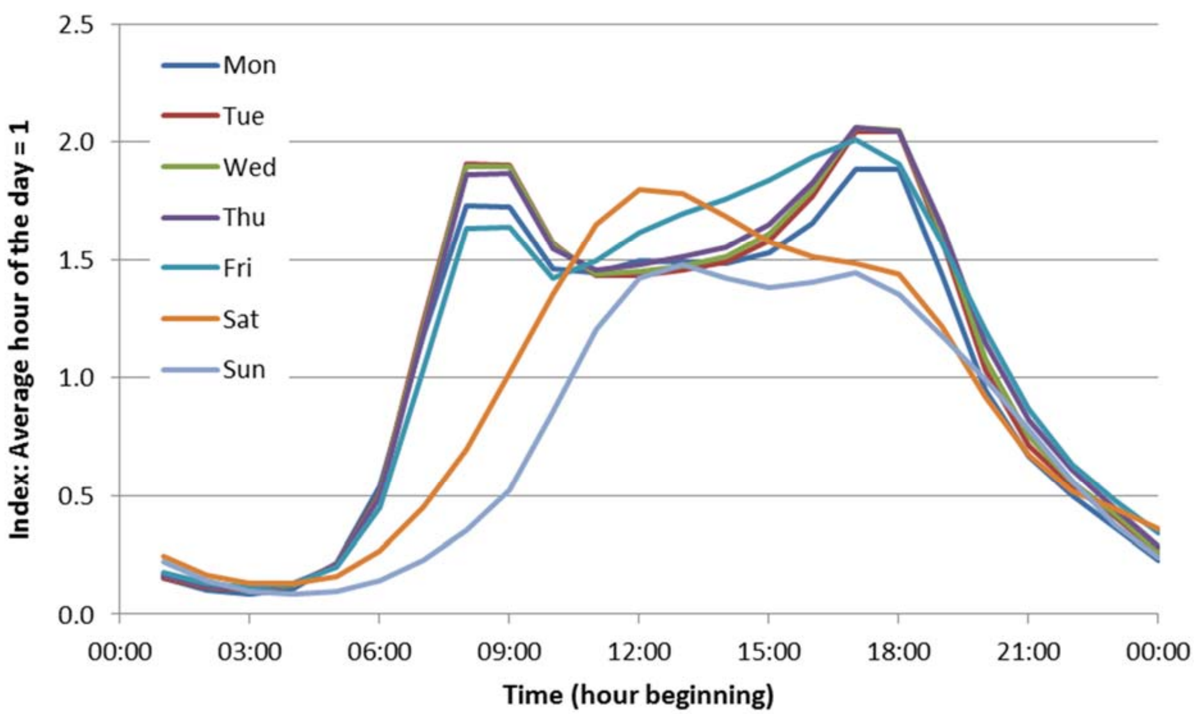

Figure 3: Diurnal Profile for Vehicle Emissions Used in the Modelling

4. Baseline Projections Modelling (without measures)

4.1 Base Year (2015) – for model verification

The latest available version of the transport model that covers BCC is based on the year 2014. A 2015 transport model has been developed using growth factors from 2014 to 2015 (see T3 ‘Local Plan Transport Modelling Methodology Report’ for more details).

4.2 Target Compliance Year (2021) - without measures

In line with achieving compliance in the shortest possible time, the target compliance year of 2021 and the 2021 traffic flows by vehicle type were extracted from the 2021 GBATS traffic model.

The 2017 ANPR fleet composition data has been used as the basis for a forecast of the 2021 fleet, since it accurately reflects the local situation. These data have been combined with the anticipated changes in the national fleet set out in the EFT in order to develop a 2021 fleet composition.

In order to calculate future fleet emissions 10 years beyond compliance (2031 Baseline) in order to inform the options appraisal, changes in the national fleet proportions have been applied to the local fleet data established from the ANPR data.

5. Projections Modelling (with measures)

5.1 Target Compliance Year (2021) - with measures

The impact of measures on air quality have been evaluated for the compliance year 2021. In particular, the effect of measures on the fleet composition in specific areas has been represented in the air quality model.

The 2021 traffic flows have been provided by the GBATS model, which has been used to assess each scenario. Details of the methodology for this assessment are provided in Chapter 5 of T3 'Local Plan Transport Modelling Methodology Report'. Changes in the fleet composition have been estimated using data provided by JAQU on the rate of replacement of existing vehicles with new/used vehicle combined with local ANPR data.

In order to calculate future fleet emissions 10 years beyond compliance (2031 baseline) in order to inform the options appraisal, the effect of measures on the traffic flows has been modelled in GBATS 2031 model. The fleet has been estimated using a similar method to 2021, using local ANPR data to reflect the local circumstances and accounting for changes in the national fleet proportions.

Appendix A. AQ1 Air Quality Tracking Table

Ref	Requirement	LA Proposal Description
A	**Air quality model specification**	
A.1	**Model selection**	
A.1.1	Details of emissions model based on COPERT 5 emissions to be used.	Emission Factor Toolkit Version 8.0.1a
A.1.2	Gradient effects included?	Yes, for roads with a gradient greater than 2.5% in accordance with TG(16)
A.1.3	Details of air quality dispersion model to be used.	ADMS-Roads 4.1
A.1.4	Canyon effects included?	The ADMS 'Advanced Canyon Module' has been used
A.1.5	Tunnels and flyovers included?	Included (e.g. M32 and part of Brunel Way flyovers considered)
A.2	**Air quality model domain**	
A.2.1	Please provide a map (in report) showing model domain in relation to exceedance locations identified in PCM model.	A map is included in the report AQ2
A.2.2	Locally identified exceedance locations included?	Yes
A.2.3	Domain includes displacement routes?	Yes
A.3	**Air quality model receptor locations**	
A.3.1	Details of receptor grid size and other receptor locations.	The Address Base data (coupled with a broad scale receptor grid) will be used to calculate population-weighted mean concentration values. We have modelled at monitoring site locations and receptors for each link modelled in the PCM model, at 2 m height and 4 m distance from the kerbside. A receptor for each location identified as either exceeding or likely to exceed the NO_2 limit between the most recent historic assessment and projected years inclusive.
A.3.2	Methods to be used to assign subset of receptors for AQD assessment requirements.	Receptors have been modelled at least 25 m from major junctions and be representative of at least 100m road length. A large number of receptors are modelled on each PCM link at 4 m from the carriageway, 2 m height (at a distance from each other of under 10 m). The worst case receptor on each link (over 25 m from a junction) is reported to JAQU within the TD1 spreadsheet. The model has also been used to ascertain public health impacts and has thus included receptors close to junctions, even where these do not necessarily meet the AQD criteria (and have therefore not been used to derive LV compliance).
B	**Air quality base Year modelling**	
B.1	**General**	
B.1.1	Base year to be used	2015
B.1.2	Details of Meteorological data to be used.	Filton Airport, year 2015
B.2	**Traffic input data**	

Ref	Requirement	LA Proposal Description
B.2.1	Source of traffic activity data and vehicle types.	SATURN (GBATS). Vehicle types: cars (including taxis), LGVs, HGVs, coaches and buses. Motorcycles are not considered given their low number and lack of data. Taxis and coach matrices will be separated out from the car and HGV matrices respectively in the traffic model, using the ANPR data to provide global proportions. This has enabled testing of CAZs which include different measures for taxis and coaches. For input into the EFT taxis have been combined with cars, and coaches with buses (since separate Euro class definitions are not available).
B.2.2	Details of representation of road locations (achieved through use of a georeferenced transport model or another approach?).	Road links have been manually adjusted to reproduce the actual geometry using OS Mapping.
B.2.3	Source of vehicle fleet composition information (local/EFT).	Local ANPR data. EFT 'Advanced User Euro Split' has been used to estimate emissions.
B.3	**NO_x/NO_2 emissions assumptions**	
B.3.1	Source of primary NO_2 emission fractions (f-NO_2).	The EFT has been used to calculate location specific f-NO_2 values based on the fleet composition for each location for which traffic NO_x emissions are calculated.
B.3.2	Details of method used to calculate projections for f-NO_2 and to calculate NO_2 concentrations from NO_x concentrations.	The LAQM NOx to NO_2 calculator v6.1 with user defined f-NO_2
B.4	**Non-road transport modelling**	
B.4.1	Details of modelling for non-road transport sources.	No non-transport measures are assumed. Only Road sources have been modelled. The exceedances of annual mean NO_2 are predominantly associated with roadside emissions and little evidence supports other sources significant enough to be considered within our modelling approach. No other significant sources known, that are deemed significant to be modelled that are not already accounted for in the Defra background mapping.
B.5	**Measurement data for model calibration**	
B.5.1	Details used for the model calibration e.g. dates, locations.	2015 BCC and SGC monitoring data. All available data have been used (with additional QA checks applied). The latest Local Authority air quality reporting, containing details of locations, can be sourced from https://www.bristol.gov.uk/pests-pollution-noise-food/air-quality and http://www.southglos.gov.uk/environment-and-planning/pollution/pollution-control-air-quality/air-quality-reports/ Map of monitoring locations is included in Report AQ2.
B.5.2	Type of monitoring data (automatic and/or diffusion tubes) used for the model calibration.	Automatic and a selection of diffusion tubes (see point B.5.4). Data have been bias adjusted and annualised.
B.5.3	All available automatic (and/or diffusion tube) monitoring data included in the model calibration.	All roadside automatic monitoring data will be used together with a selection of diffusion tube data. All available monitoring locations have been used, unless there was a good reason not to include them – non-roadside location, uncertainty with traffic data (e.g: on a side street), low data capture <75%, other local factors (localised road works, tube close to other sources not explicitly modelled e.g. a bus stop).

Ref	Requirement	LA Proposal Description
B.5.4	Quality assurance of measurement data.	A screening has been performed to ensure the data used are accurate and representative of the actual baseline conditions.
C	**Projections modelling**	
C.1	**Baseline projections modelling**	
C.1.1	Years to be modelled.	Base year: 2015; Reference year (without measures): 2021. All interim years between baseline and baseline +10 years have been modelled using interpolation methods. Straight line interpolation based on concentrations has been included between 2015 and 2021. More complex interpolation based on EFT emissions has been undertaken for the economic assessment.
C.1.2	Details of method for projected vehicle fleet composition.	Expected rates of new/used vehicles (provided by Defra) have been analysed to project the fleet (EFT 8.0.1a).
C.1.3	Details of method for projected vehicle activity.	SATURN model forecasts which are based on an uncertainty log and constrained to TEMPRO growth. Vehicle splits have been based on ANPR surveys but forecast to baseline year. Further details are provided in 3.1 and 3.6 of the transport tracking table.
C.1.4	Impact of RDE included?	To be determined based on JAQU position on data available at time of assessment.
C.1.5	Details of methods to calculate future fleet emissions 10 years beyond compliance to inform options appraisal (linked with C2.2).	Changes in the national fleet proportions have been applied to the local fleet data established from the ANPR data. Traffic flows have been modelled explicitly in 2031. Fleet composition being determined based on JAQU's fleet projection methodology (using ANPR data for 2015). Interpolation between 2021 and 2031 will be on the basis of concentrations (or emissions in the case of the economic assessment) undertaken using outputs of the EFT.
C.2	**With measures projections modelling**	
C.2.1	Years to be modelled.	Reference year (with measures): 2021. All interim years between baseline and baseline + 10 years will be modelled using interpolation methods.
	Details of method for projected vehicle fleet composition.	The effect of measures on the fleet in specific areas has been taken into account as well as expected rates of new/used vehicles (provided by Defra).
	Details of method for projected vehicle activity.	SATURN (TEMPRO factors)
C.2.2	Details of methods to calculate future fleet emissions 10 years beyond compliance to inform options appraisal.	The effect of measures on the fleet in specific areas has been taken into account as well as changes in the national fleet proportions (that will be applied to the local fleet data established from the ANPR data). Traffic flows have been modelled explicitly in 2031. Fleet composition being determined based on JAQU's fleet projection methodology (using ANPR data for 2015). Straight line interpolation based on concentrations will be included between 2015 and 2021. More complex interpolation based on EFT emissions will be undertaken for the economic assessment.

Appendix B. Canyon Parameters

Details of Street Canyon Parameters Used in the Model – Due to the size of the table, Appendix B will be submitted in the form of an excel file.