Bath and North East Somerset Air Quality Strategy

Bath and North East Somerset Council

T4 Transport Modelling Forecast Report

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Bath and North East Somerset Air Quality Strategy

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Contents

Acronyms and Abbreviations

ANPR	Automatic Number Plate Recognition
AQMA	Air Quality Management Area
B&NES	Bath and North East Somerset
CAZ	Clean Air Zone
Defra	Department for Environment, Food & Rural Affairs
DfT	Department for Transport
EFT	Emission Factor Toolkit
GBATH	Greater Bath Area Transport Study
HGV	Heavy Goods Vehicle
JAQU	Joint Air Quality Unit
LGV	Light Goods Vehicle
NTM	National Transport Model
NTEM	National Trip End Model
PT	Public Transport
(Web)TAG	Transport Analysis Guidance

1. Introduction

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 Bath and North East Somerset Council (B&NES). B&NES has monitored and endeavoured to address air quality in Bath, and wider B&NES, since 2002. Despite this, Bath has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO_2) and these are predicted to continue until 2025 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, B&NES, 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 B&NES will achieve sufficient air quality improvements in the shortest possible time. In line with Government guidance B&NES is working towards 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 B&NES to produce an Outline Business Case (OBC) and Full Business Case (FBC) 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 Bath. The OBC assessed the shortlist of options set out in the Strategic Outline Case[3], and proposed a preferred option including details of delivery. The FBC develops the preferred option set out in the OBC, detailing the commercial, financial and management requirements to implement and operate the scheme. The OBC and FBC form a bid to central government for funding to implement the CAP.

1.1 Purpose of this Report

This document is written to support the OBC and FBC and sets out the transport modelling forecasting which outlines the approach taken to model the baseline and the model outputs. The scheme forecasts and model outputs will follow once the transport modelling work is completed for testing the CAZ charging and non-charging options.

[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] Bath and North East Somerset Council Clean Air Plan: Strategic Outline Case, March 2018 (http://www.bathnes.gov.uk/sites/default/files/siteimages/Environment/Pollution/strategic_outline_case_bath_28.03.2018_with_annexes.pdf)

2. Scope of Assessment

2.1 Model extent

The SATURN highway model covers the city of Bath, Chippenham and Melksham in the simulation network, with Bristol and surrounding countryside and villages within the buffer network. The Bath SATURN highway model extent is shown in Figure 2-1. It also shows the location of the nitrogen dioxide exceedances (over 40µg/m^3) in Bath and the FBC CAZ boundary.

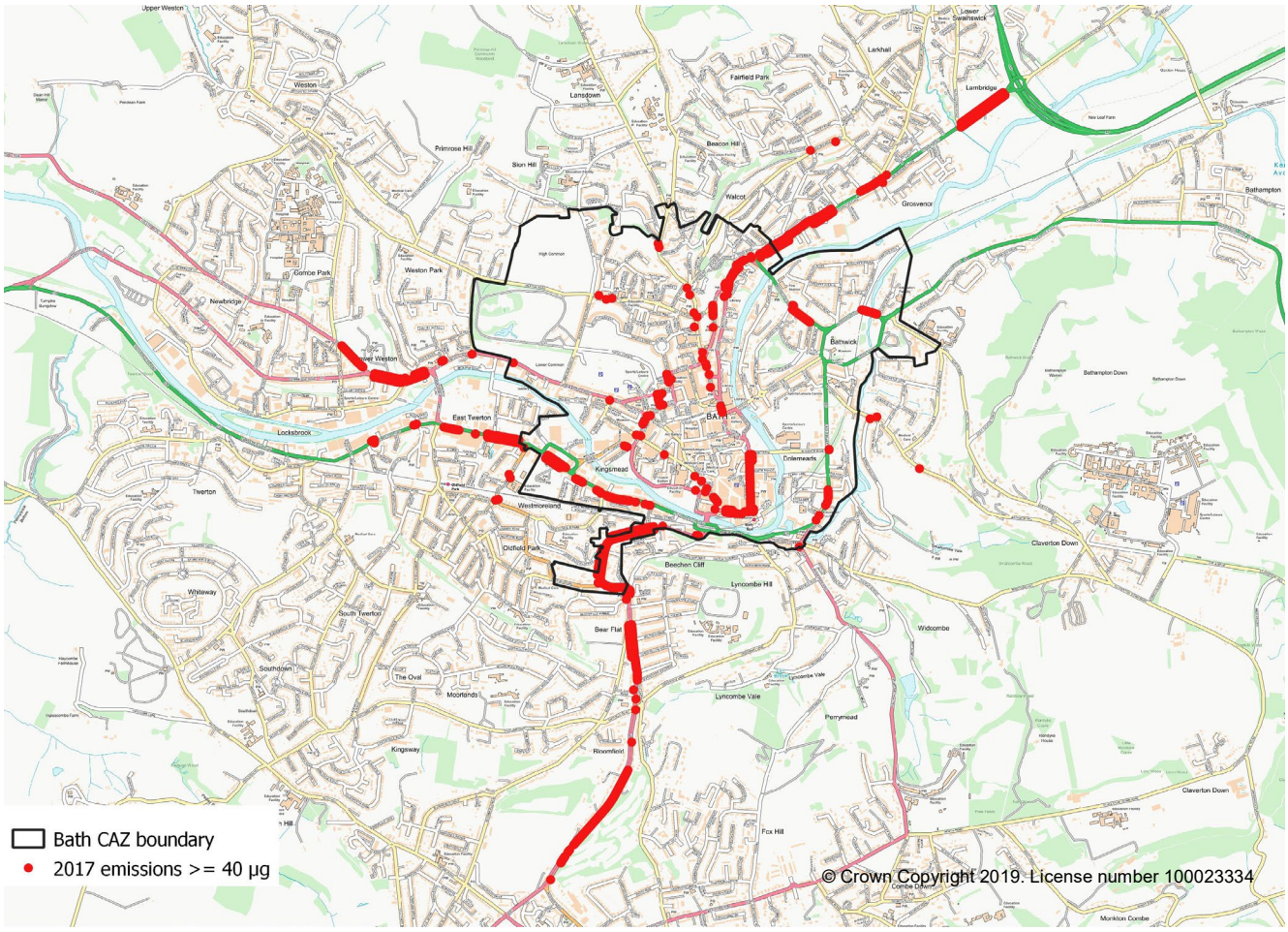


Figure 2-1: Bath Model Extent and 2017 Exceedances

2.2 Time periods

The SATURN Highway Assignment Model represents vehicle-based movements across Bath and surrounding area for a weekday morning peak hour (08:00-09:00), an average inter-peak hour (10:00-16:00) and an evening peak hour (17:00-18:00).

2.3 Model Years

The air quality model base year is 2017 as the air quality monitoring data was made available for the project in early 2018.

The compliance year was initially calculated using the model runs of each of the options undertaken within the Strategic Outline Case, and an understanding of the time taken to deliver each proposed scheme. This assessment has suggested that the year of compliance could be as early as 2020. However, more detailed modelling undertaken for the FBC has indicated the first year of compliance will not be until 2021. Hence the

modelled compliance year is 2021. A 2031 model will also be developed, to assess the impact of the CAZ 10 years after the compliance year.

2.4 CAZ Boundary

The design of the Bath's CAZ was derived in an iterative process during engagement with the public and stakeholders, and spatial analysis focused around aspects of the existing Residential Parking Zones and potential rat running routes. Figure 2-2 shows the proposed FBC CAZ boundary.

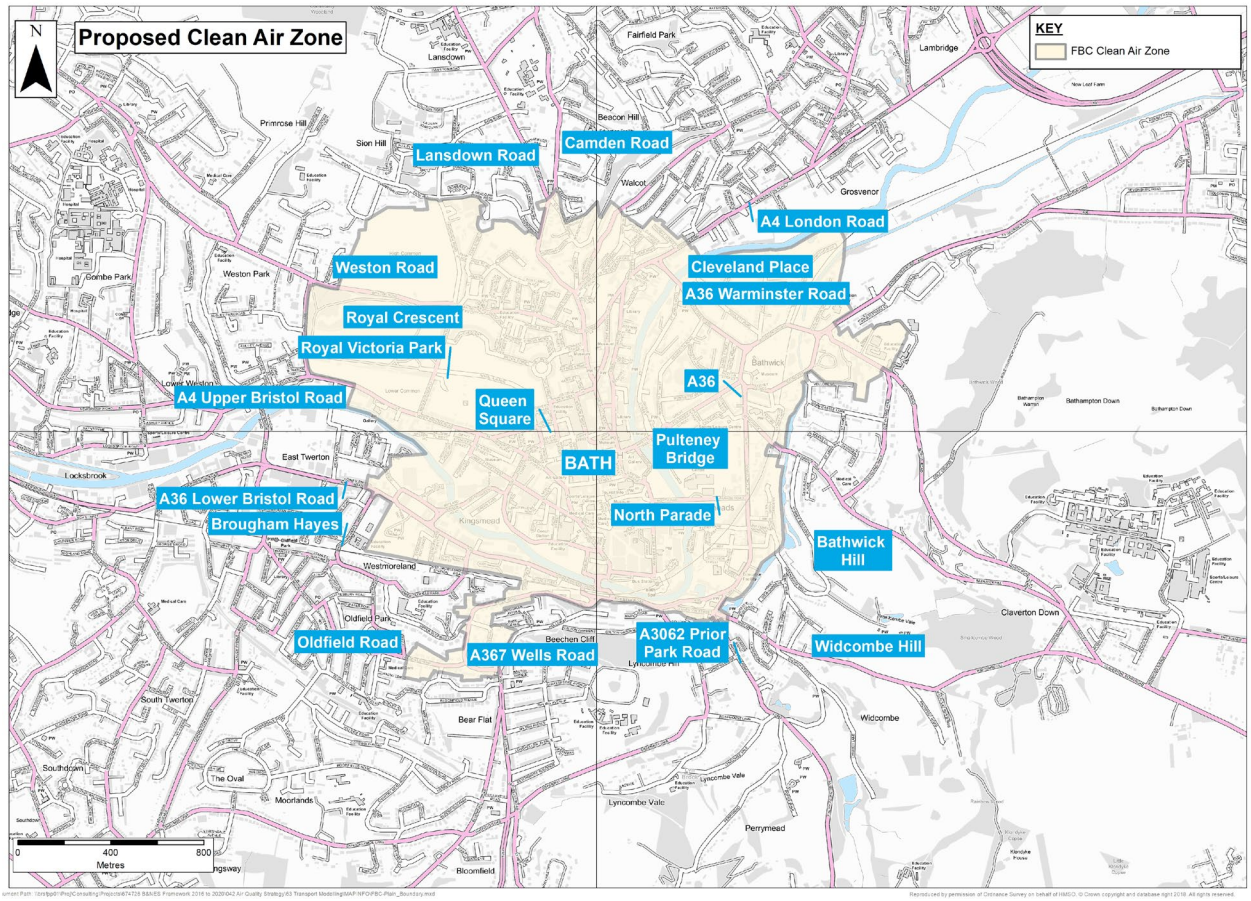


Figure 2-2: Bath Clean Air Zone Area – Proposed FBC Boundary

It should be noted that the options comparison modelling was undertaken based on an earlier version of the proposed boundary due to the evolving nature of the project, as shown in Chapter 6, during the development of the OBC. The boundary used for OBC modelling purposes is shown in Figure 2-3. For the FBC, the proposed FBC boundary was used to model the final proposed option, the results of which are shown in Chapter 7.

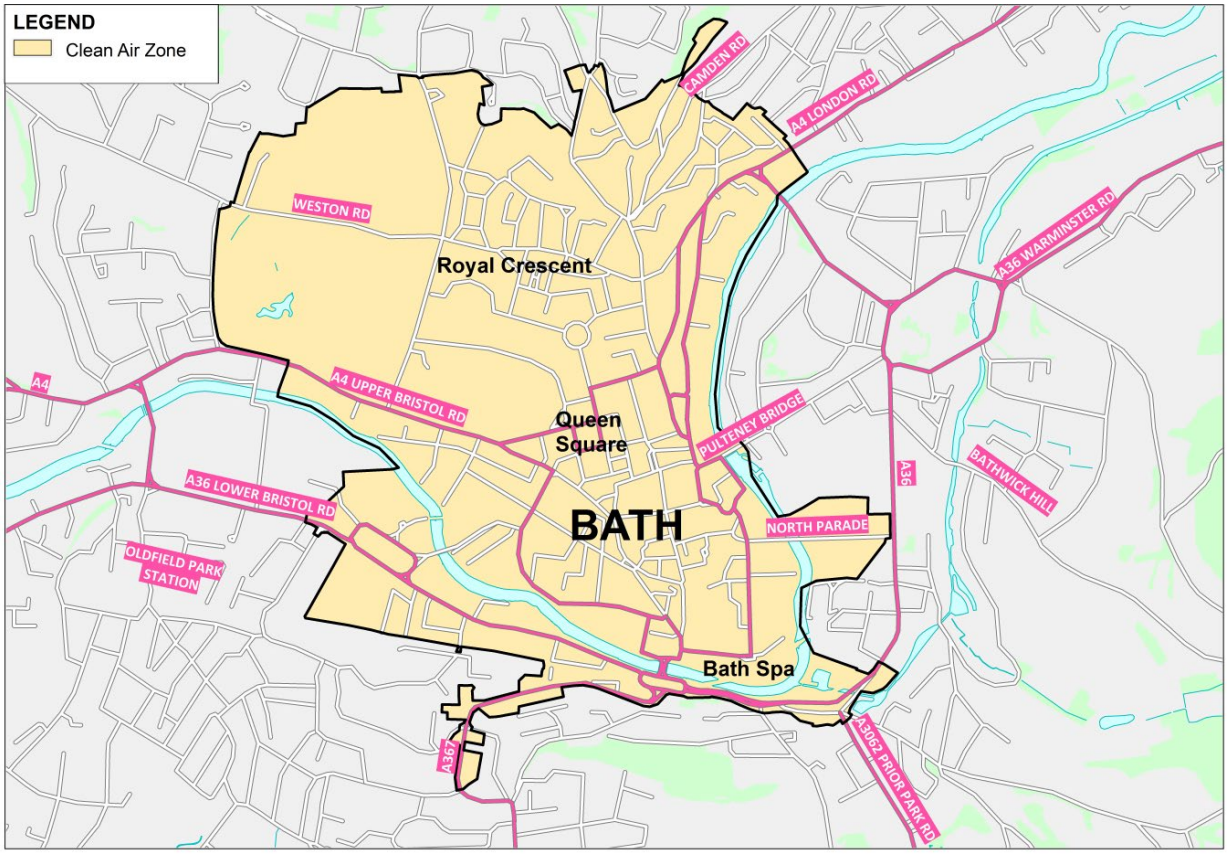


Figure 2-3: Bath Clean Air Zone Area – Modelled OBC Boundary

3. Modelling methodology

This modelling methodology summarises the detailed methodology found in FBC-13 Local Plan Transport Modelling Methodology Report (T3) in Appendix E of the FBC, bringing together an overview of all the components of how the baseline and option testing has been carried out using the Bath Transport Model.

3.1 Base and Baseline

3.1.1 Model Development

The FBC-13 Local Plan Transport Modelling Methodology Report (T3) in Appendix E of the FBC, chapters 4 and 5, outline the modelling methodology for the Baseline model. It states that in the absence of a reliable variable demand model, for 2021 a fixed demand forecast matrix would be used, then for 2031 a forecast demand matrix produced using a simple variable demand model would be used for the baseline, in conjunction with the highway assignment model. This has been agreed with JAQU as the most appropriate method via a technical note submitted on 1/5/18 and agreed by JAQU on 8/5/18.

To build the 2021 and 2031 models the developments identified in the Uncertainty Log have been added to the 2017 base matrices and the growth constrained to TEMPRO for each area. TEMPRO v7.2 car growth has been applied by area, time period and user class within the model, which can be attributed to model zones. These have been adjusted for fuel and income growth for 2021. Light and heavy goods vehicle growth is based on forecasts produced by the National Transport Model (NTM) as advised by WebTAG. Goods vehicles are not subject to change by the variable demand model.

The 2021 and 2031 Baseline highway models developed have been adapted to be able to model the implementation of a charging CAZ. The matrices have been split by compliance for each user class using the surveyed Automatic Number Plate Recognition (ANPR) data.

3.1.2 ANPR Data

The 2017 ANPR surveys were undertaken in November and the analysis (including tabulated data) and use is discussed fully in FBC-14 ANPR Data Analysis and Application Report in Appendix E of the FBC.

The ANPR data has been used to determine the compliance splits of the current fleet when compared to the CAZ framework criteria relating to Euro Standards. The registration data from the ANPR surveys have been cross referenced with data purchased from Carweb to gain information on vehicle type, fuel type and Euro standard. The ANPR data has also been used to split the taxi fleet from the car matrices and the coaches from the HGV matrices, by applying global factors, by time period. Full details of this process are provided in FBC-14 ANPR Data Analysis and Application Report, included in Appendix E of the FBC.

The base year compliance splits have been determined from the 2017 ANPR sites directly and baseline splits have been adjusted to 2021 and 2031 using the fleet projection tool within the Emission Factor Toolkit. These compliance splits will be applied to the model matrices for each user class (Car, Taxi, LGVs, Coaches and HGVs).

3.1.2.1 Matrix User Class and Compliance Splits

The highway model has 4 user classes: Car (employer's business), Car (non-employer's business), LGV, HGV. These have been split into 12 user classes using the following methodology:

1) Split the Car user classes into Car and Taxi user classes;
2) Split the HGV user class into HGV and Coach user classes;
3) Split Car, Taxi, LGV, and Coach matrices into compliant and non-compliant using the time period splits;
4) Split the HGV matrices into compliant and non-compliant by corridor and time period. This process was undertaken using matrix estimation to manipulate the compliant matrices by corridor.

3.1.2.2 Post-Processing

The ANPR data collected has also been used to determine the HGV rigid/artic split by compliance and fuel type splits for cars and LGVs. This has been used to add more detail to the modelled outputs via post processing, to produce inputs into the Emission Factor Toolkit.

The ANPR was used directly to split the bus trips by link outside of the traffic model. Since buses are expected to maintain the existing routes, it is not necessary for the traffic model to reflect which buses are compliant or noncompliant, but this information is required for the Emission Factor Toolkit runs, therefore is handled during post-processing.

The Emissions Factors Toolkit (EFT) is published by Defra and the Devolved Administrations to assist local authorities in carrying out Review and Assessment of local air quality as part of their duties under the Environmental Act 1995. The EFT allows users to calculate road vehicle pollutant emission rates for NOx, PM10, PM2.5 and CO2 for a specified year, road type, vehicle speed and vehicle fleet composition.

3.1.2.3 Euro Standard Splits

The EFT has national Euro Standard splits within it. These have been overwritten with splits calculated from the 2017 ANPR data directly and projected forward to 2021 and 2031.

3.1.3 2017 Base Compliance Splits

The FBC-14 ANPR Data Analysis and Application technical note Appendix E, Chapter 2, explains the derivation of the 2017 base compliance splits. Table 3-1 shows the 2017 compliance data by time period and Table 3-2 shows the 2017 HGV compliance data by corridor.

Table 3-1: 2017 Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	54.7%	45.3%	54.5%	45.5%	54.5%	45.5%
LGV	13.8%	86.2%	15.3%	84.7%	13.5%	86.5%
HGV rigid	41.7%	58.3%	38.2%	61.8%	33.0%	67.0%
HGV artic	60.7%	39.3%	61.5%	38.5%	61.7%	38.3%
HGV	45.4%	54.6%	43.7%	56.3%	42.9%	57.1%
Taxi	28.7%	71.3%	28.4%	71.6%	24.4%	75.6%
Bus	21.4%	78.6%	17.4%	82.6%	21.1%	78.9%
Coach	42.1%	57.9%	45.8%	54.2%	49.7%	50.3%
Total	47.0%	53.0%	47.1%	52.9%	49.3%	50.7%
Car/Taxi	54.0%	46.0%	53.6%	46.4%	53.6%	46.4%
Bus/Coach	22.9%	77.1%	20.2%	79.8%	24.0%	76.0%

Table 3-2: 2017 HGV Compliance by Corridor

Corridor	AM	IP	PM
NW	38.40%	38.20%	37.70%
NE	50.50%	48.50%	48.10%
SE	30.40%	30.40%	23.30%
SW	43.30%	39.20%	31.10%

3.1.4 2021 Baseline Compliance Splits

The fleet projection tool within the EFT version 8 has been used to project the euro standard splits from the 2017 ANPR data to the Baseline year of 2021. The FBC-14 ANPR Data Analysis and Application Report, Chapter 4, details this process and the outputs. A summary of the projected 2021 compliance data by time period is provided in Table 3-3 and Table 3-4 shows the projected 2021 HGV compliance data by corridor.

Table 3-3: 2021 Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	79.4%	20.6%	79.3%	20.7%	79.3%	20.7%
LGV	57.5%	42.5%	60.5%	39.5%	56.9%	43.1%
HGV rigid	76.1%	23.9%	73.3%	26.7%	68.7%	31.3%
HGV artic	87.3%	12.7%	87.7%	12.3%	87.8%	12.2%
HGV	78.7%	21.3%	77.5%	22.5%	77.0%	23.0%
Taxi	56.4%	43.6%	55.9%	44.1%	50.8%	49.2%
Bus	45.9%	54.1%	39.6%	60.4%	45.5%	54.5%
Coach	72.9%	27.1%	75.8%	24.2%	78.5%	21.5%
Total	75.1%	24.9%	75.2%	24.8%	75.9%	24.1%

Table 3-4: 2021 HGV Compliance by Corridor

Corridor	AM	IP	PM
NW	67.85%	67.50%	66.62%
NE	89.24%	85.70%	84.99%
SE	53.72%	53.72%	41.17%
SW	76.51%	69.27%	54.96%

3.1.5 2031 Baseline Compliance Splits

The fleet projection tool within the EFT version 8 has been used to project the euro standard splits from the 2017 ANPR data to the Baseline year of 2030, as a proxy for 2031 as the EFT does not go beyond 2030. The FBC-14 ANPR Data Analysis and Application technical note Appendix E, Chapter 4, shows the results from this. Table 3-5 shows the projected 2031 compliance data by time period and Table 3-6 shows the HGV projected 2031 compliance data by corridor.

Table 3-5: 2031 Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	99.26%	0.74%	99.25%	0.75%	99.25%	0.75%
LGV	97.00%	3.00%	97.35%	2.65%	96.93%	3.07%
HGV rigid	98.85%	1.15%	98.67%	1.33%	98.34%	1.66%
HGV artic	99.46%	0.54%	99.48%	0.52%	99.49%	0.51%
HGV	99.01%	0.99%	98.94%	1.06%	98.91%	1.09%
Taxi	97.82%	2.18%	97.77%	2.23%	97.29%	2.71%
Bus	95.90%	4.10%	94.76%	5.24%	95.84%	4.16%
Coach	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Total	98.82%	1.18%	98.85%	1.15%	98.93%	1.07%

Table 3-6: 2031 HGV Compliance Splits by Corridor

Corridor	AM	IP	PM
NW	86.35%	85.90%	84.78%
NE	100.00%	100.00%	100.00%
SE	68.36%	68.36%	52.40%
SW	97.37%	88.15%	69.94%

3.1.6 Final Matrix Adjustments

The Uncertainty Log identifies changes to car and coach parking within Bath City centre by 2021. These changes have been applied to the highway model after splitting the traffic flows into compliant and non-compliant matrices. The reduction in spaces at Avon Street car park and the closure of Saw Close car park result in a movement of trips to Charlotte Street car park, which sees a simultaneous increase in spaces. The reduction of coach parking spaces in the city centre results in the movement of coach trips to Old Down park and ride.

3.2 Clean Air Zone Option Testing

3.2.1 Primary Behavioural Responses

The primary responses have been modelled using the G-BATH highway model using the following methodology, as described in FBC-13 Local Plan Transport Modelling Methodology Report (T3) in Appendix E of the FBC, Chapter 6:

- Pay Charge – no change to the model
- Avoid Zone – a charge has been applied to each inbound link to replicate the expected percentage change from the baseline case of non-compliant cars, LGVs and HGV's within the CAZ;
- Cancel journey / change mode – this has been modelled by reducing the number of trips made by non-compliant vehicles to/from and within the CAZ area, to replicate the expected percentage change from the baseline case; and
- Replace Vehicle – an adjustment to the link flows by extracting select cordon link flows for the non-compliant trips and switching the required proportion of replace vehicles from the non-compliant matrices to the compliant link flows.

3.2.2 Secondary Behavioural Responses

In addition to the primary behavioural responses, JAQU have set out some further assumptions on secondary responses for a charging CAZ for cars in paragraph 3.3 of the Evidence Package. These have been used due to lack of any available local data.

These secondary responses have been applied during the calculation of the upgrade costs and post-processing of the extracted link-based flow data from the Transport Model for the 'replace vehicle' response.

3.2.3 Stated Preference Surveys

Stated preference surveys have been undertaken to determine local behavioural responses to the implementation of a CAZ in Bath. The structure, implementation and outcomes of the survey are provided fully in FBC-30 Stated Preference Survey Report, in Appendix L of the FBC.

3.2.4 Upgrade Costs

In order to determine the primary response rates over a range of CAZ charges from the stated preference surveys, an upgrade cost is required. The HGVs methodology for determining response rates also requires an estimation of an upgrade cost. The upgrade costs of other vehicle types (Taxi, Bus and Coaches) were not used to calculate the primary response rates; rather, the primary response rates for these vehicle types were determined by other information collated, as discussed below.

The methodology for calculating the upgrade costs for all vehicle type is discussed fully in FBC-16 Bath Clean Air Plan: Primary Behavioural Response Calculation Methodology in Appendix E of the FBC.

3.2.5 Proposed Charge Rates

The methodology for determining the proposed charge rates for all vehicle type is discussed fully in FBC-16 and Table 3-7 shows the final proposed charges. These are selected as the minimum charges required to address the air quality exceedances within Bath and is expected to bring about compliance with the European Limit Value for annual mean nitrogen dioxide in the shortest time possible (2021), based on the traffic and air quality modelling.

Table 3-7: Bath CAZ Proposed Charges

Charge Class	Daily Charge
Cars	£9.00
Taxis	£9.00
LGVs	£9.00
HGVs	£100.00
Buses	£100.00
Coaches	£100.00

3.2.6 Calculated Response Rates

The methodology for calculating the primary response rates for all vehicle type is discussed fully in FBC-16 and is summarised as follows:

- Cars - The upgrade cost has been used to determine a range of primary responses for different charge rates using the stated preference survey responses;
- LGVs - The primary response rates are calculated from the stated preference survey responses which were identified as an 'Employers Business' trip purpose. Again, the upgrade cost is used to determine a range of primary responses for different charge rates;
- HGVs - The primary behavioural responses rates for HGVs were determined by comparing the cost to upgrade with the cost of paying the charge throughout a 5-year time period using trip frequency data from the ANPR surveys, with a tipping point of upgrading the vehicle when paying the charge becomes more expensive;
- Taxis - The taxi response rate is based on B&NES enforcing 100% compliance for Taxis through their licensing agreements with taxi operators. An exception has been made for wheelchair accessible taxi vehicles (WAVs) which are likely to be exempted from CAZ charges in order to ensure the continued provision of these services in the face of substantial vehicle upgrade costs;
- Coaches - The initial response rates for coaches were taken from 'Table 2 – Behavioural responses to charging Clean Air Zones' in the Evidence Package, provided by JAQU. An adjustment for school coaches has been made to reflect ongoing discussions with operators of school coach trips;
- Buses - The response rates for buses were determined through discussions between B&NES and bus operators.

An adjustment for foreign vehicles has been applied to the responses rates calculated from the methodology set out above, as foreign vehicles cannot be reliably charged (their details are not captured in the DVLA database in order to determine if the vehicle is compliant and so enforcement can only occur through a manual process with limited powers). The final response rates will assume a 'worst case', i.e. that these vehicles continue to drive within the zone but do not pay the charge. In reality it is unlikely that this will be the case for all foreign vehicles.

Table 3-8 to Table 3-10 show the final primary behavioural response rates for the CAZ Class D, Alternative CAZ Class D and the CAZ Class C with Traffic Management (TM) respectively, by vehicle type, produced by the methodology set out above and the charge rates in Table 3-7. These are the response rates that have been applied to the core modelling scenarios within the traffic model. The response rates are applied to 'non-compliant' vehicles under each scenario.

Table 3-8: CAZ D Final Primary Behavioural Response Rates

Response	Cars	Taxis	LGVs	HGVs	Buses	Coaches
Pay Charge	4.9%	4.1%	18.4%	11.9%	0.0%	20.1%
Avoid Zone	19.6%	0.0%	11.7%	4.4%	0.0%	0.0%
Cancel Journey / Change Mode	18.3%	0.0%	3.6%	1.1%	6.4%	11.5%
Replace Vehicle	57.2%	95.9%	66.3%	82.7%	93.6%	68.4%

Table 3-9: Alternative CAZ D Final Primary Behavioural Response Rates*

Response	Cars	Taxis	LGVs	HGVs	Buses	Coaches
Pay Charge	3.8%	4.1%	18.4%	11.9%	0.0%	20.1%
Avoid Zone	14.2%	0.0%	11.7%	4.4%	0.0%	0.0%
Cancel Journey / Change Mode	13.8%	0.0%	3.6%	1.1%	6.4%	11.5%
Replace Vehicle	68.2%	95.9%	66.3%	82.7%	93.6%	68.4%

* Note: only applied to 2021 Alternative CAZ D as the grant will not be available in 2031 (see Section 6).

Table 3-10: CAZ C with TM Final Primary Behavioural Response Rates

Response	Cars	Taxis	LGVs	HGVs	Buses	Coaches
Pay Charge	0.0%	4.1%	18.4%	11.9%	0.0%	20.1%
Avoid Zone	0.0%	0.0%	11.7%	4.4%	0.0%	0.0%
Cancel Journey / Change Mode	0.0%	0.0%	3.6%	1.1%	6.4%	11.5%
Replace Vehicle	0.0%	95.9%	66.3%	82.7%	93.6%	68.4%

3.2.7 Non-charging measures

For the CAZ Class D scenario, no non-charging measures have been identified that will have a significant impact on the level of traffic within B&NES. As such, no further traffic modelling of these schemes has been undertaken for this scenario.

For the Alternative CAZ Class D scenario, the non-charging options include a £2000 grant available for owners of pre-Euro 4 cars for the first year of the CAZ and the Queens Square traffic management scheme. The grant would effectively reduce car owners upgrade cost; therefore, this has been reflected in the upgrade costs used to determine the car response rates used for the opening year (2021) of a CAZ. The Queens Square traffic management scheme has been modelled explicitly within the G-BATH SATURN Highway Model.

For the CAZ Class C with TM scenario, the non-charging option includes the Queens Square traffic management scheme. The Queens Square traffic management scheme has been modelled explicitly within the G-BATH SATURN Highway Model.

3.3 Links to Air Quality Model

The links from the transport model to the air quality model are outlined in FBC-13 Local Plan Transport Modelling Methodology Report (T3) in Appendix E of the FBC, Chapter 9. Link-based traffic flows, by compliance from the highway model are fed through to the air quality model in a format compatible with the EFT, after undergoing post-processing of the model outputs.

4. Base Year Outputs

4.1 Model Checks

The highway model outputs were checked for the following:

- The 4-user class and 12-user class matrix totals have been compared for each year, to maintain the same level of trips within the model. This check helped confirm that the matrix-splitting process was applied correctly;
- Target ANPR verses modelled HGV compliance splits by corridor. Table 4-1 to Table 4-3 show the HGV compliance splits by corridor for the AM, Inter and PM peaks respectively;
- The post-processing final compliance splits have been compared to the target splits. Table 4-4 shows the daily target and modelled proportions of compliant vehicles for 2017; and
- Base year validation / calibration has been checked to ensure it has not been affected by the compliance splitting process; the results of which are shown in Section 4.2.

Table 4-1: HGV Compliance Splits by Corridor: AM Peak

Corridor	ANPR Values		Model Values		Difference	
	Comp %	Comp Abs	Comp %	Comp Abs	Comp %	Comp Abs
NW	38.4%	170	39.4%	175	3%	5
NE	50.5%	245	44.6%	217	-12%	-29
SE	30.4%	23	72.0%	54	137%	31
SW	43.3%	72	41.5%	69	-4%	-3
TOTALS		**510**		**514**	**1%**	**4**

Table 4-2: HGV Compliance Splits by Corridor: Inter Peak

Corridor	ANPR Values		Model Values		Difference	
	Comp %	Comp Abs	Comp %	Comp Abs	Comp %	Comp Abs
NW	38.2%	149	36.1%	141	-5%	-8
NE	48.5%	232	40.4%	194	-17%	-39
SE	30.4%	15	30.5%	15	0%	0
SW	39.2%	61	35.3%	55	-10%	-6
TOTAL		**457**		**404**	**-12%**	**-53**

Table 4-3: HGV Compliance Splits by Corridor: PM Peak

Corridor	ANPR Values		Model Values		Difference	
	Comp %	Comp Abs	Comp %	Comp Abs	Comp %	Comp Abs
NW	37.7%	61	36.4%	59	-4%	-2
NE	48.1%	103	48.9%	104	2%	2
SE	23.3%	8	30.6%	10	32%	2
SW	31.1%	19	22.5%	14	-28%	-5
TOTAL		**190**		**187**	**-2%**	**-3**

The results of the HGV compliance splitting process using matrix estimation show that while the percentage splits are not matched exactly, the absolute difference on most of the corridors is small and the ANPR data is well matched.

Table 4-4: 2017 Target and Modelled Average Compliance

Veh Type	Target Compliance	Modelled Compliance
Car	55%	54%
LGV	14%	15%
HGV	44%	43%
Bus/Coach	29%	26%

The results of the average compliance show that the modelled percentages are close to the target values.

4.2 Base Year Validation

After the matrices were split out (from 4 to 12 user classes) as described in the preceding chapter, the 12 revised highway matrices were re-assigned within the SATURN model. Following this, a check was carried out on the base year model, to ensure that the ANPR data had been applied within the model as intended. This compared the validation of the 4 user-class model against the validation of the 12 user-class model, to ensure that the validation had not been adversely affected.

Further investigations have been undertaken into the validation of both the LGV and HGV flows, as set out in FBC-15 G-BATH Highway Model Local Model Validation Report: Addendum: LGV and HGV Validation in Appendix E of the FBC. This assessment found that the HGV model validation is weak in places and it was proposed that an adjustment to the HGV traffic volumes would be required outside of the model runs to improve the fit between observed and modelled HGV flows. This process was agreed by JAQU via Huddle on 22nd March 2018.

Table 4-5 shows the validation / calibration summary results for the AM, IP and PM assignments, incorporating the HGV adjustment in the 12 user-class models, which improved the model fit.

Table 4-5: Calibration / Validation Summary Results (UC4 is original model, UC12 is revised model)

Time Period	% Links GEH <5			DMRB Link Criteria		
	UC4	UC12	Diff	UC4	UC12	Diff
AM	84%	84%	0%	90%	90%	0%
IP	91%	91%	0%	98%	98%	0%
PM	86%	86%	0%	90%	89%	-1%

The results show that overall there are no significant differences between the levels of validation of the UC4 and UC12 models. In a few cases there are more significant differences on particular links which have been investigated. These are not critical to the CAZ scheme so are deemed acceptable.

5. Baseline Forecast Outputs

5.1 Model Checks

The 2021 and 2031 Baseline outputs have been checked to ensure that the input compliance splits are carried through to the outturn results provided for the air quality modelling. The following have been checked:

- The 4-user class and 12-user class matrix totals have been compared for each year, to maintain the same level of trips within the model. This check helped confirm that the process was applied correctly;
- The 2017 to 2021 and 2021 to 2031 matrix totals have been compared to check growth has been applied correctly and compliance changes over time. Table 5-1 shows the changes by user class for 2017, 2021 and 2031; and
- The post-processing final compliance splits have been compared to the target. Table 5-2 and Table 5-3 show the daily target and modelled proportions of compliant vehicles for 2021 and 2031 respectively.

Table 5-1: Matrix Totals by User Class

User Class	Description	2017			2021			2031			2021-2017 Difference %			2031-2021 Difference %		
		AM	IP	PM	AM	IP	PM	AM	IP	PM	AM	IP	PM	AM	IP	PM
Total	**Total**	**39452**	**28928**	**37079**	**41837**	**30980**	**39195**	**45116**	**33979**	**42154**	**6.0%**	**7.1%**	**5.7%**	**7.8%**	**9.7%**	**7.5%**
UC1	Car Non Emp Compliant	15192	9452	14526	22975	14524	22001	30302	19689	29108	51.2%	53.7%	51.5%	31.9%	35.6%	32.3%
UC2	Car Non Emp Non-Compliant	12581	7891	12127	5961	3791	5743	214	139	205	-52.6%	-52.0%	-52.6%	-96.4%	-96.3%	-96.4%
UC3	Car Emp Compliant	751	1276	1470	1155	1952	2256	1509	2554	2952	53.8%	53.0%	53.5%	30.7%	30.9%	30.8%
UC4	Car Emp Non-Compliant	622	1065	1227	300	509	589	11	18	21	-51.8%	-52.2%	-52.0%	-96.5%	-96.5%	-96.5%
Car Total		**29146**	**19683**	**29351**	**30391**	**20777**	**30589**	**32035**	**22400**	**32285**	**4.3%**	**5.6%**	**4.2%**	**5.4%**	**7.8%**	**5.5%**
UC5	Taxi Compliant	214	191	229	440	396	497	803	748	1005	104.9%	107.8%	117.0%	82.8%	88.6%	102.2%
UC6	Taxi Non-Compliant	533	481	710	340	313	482	18	17	28	-36.2%	-35.0%	-32.2%	-94.7%	-94.6%	-94.2%
Taxi Total		**747**	**672**	**939**	**779**	**709**	**979**	**821**	**764**	**1033**	**4.3%**	**5.6%**	**4.2%**	**5.4%**	**7.8%**	**5.5%**
UC7	LGV Compliant	716	640	542	3538	2999	2710	7336	5930	5675	394.1%	368.9%	399.8%	107.4%	97.7%	109.4%
UC8	LGV Non-Compliant	4472	3541	3474	2615	1958	2053	227	165	182	-41.5%	-44.7%	-40.9%	-91.3%	-91.6%	-91.2%
LGV Total		**5188**	**4180**	**4017**	**6152**	**4958**	**4764**	**7563**	**6095**	**5856**	**18.6%**	**18.6%**	**18.6%**	**22.9%**	**22.9%**	**22.9%**
UC9	HGV Compliant	1892	1758	965	3302	3158	1694	4228	4142	2221	74.5%	79.6%	75.7%	28.0%	31.2%	31.1%
UC10	HGV Non-Compliant	2252	2314	1279	978	1047	622	224	232	189	-56.6%	-54.7%	-51.3%	-77.1%	-77.8%	-69.6%
HGV Total		**4144**	**4072**	**2243**	**4279**	**4205**	**2317**	**4452**	**4375**	**2410**	**3.3%**	**3.3%**	**3.3%**	**4.0%**	**4.0%**	**4.0%**
UC11	Coach Compliant	96	147	263	171	251	429	244	344	569	78.8%	70.9%	63.1%	42.7%	37.2%	32.5%
UC12	Coach Non-Compliant	132	174	266	64	80	118	0	0	0	-51.7%	-53.9%	-55.9%	-100.0%	-100.0%	-100.0%
Coach Total		**227**	**321**	**530**	**235**	**331**	**547**	**244**	**344**	**569**	**3.2%**	**3.3%**	**3.3%**	**4.0%**	**4.0%**	**4.0%**

Overall, the total trips increase for 2021 compared to 2017. It also shows that the number of compliant vehicles increases over time and the number of non-compliant vehicles decreases, which is the pattern expected.

Table 5-2: 2021 Target and Modelled Average Compliance

Veh Type	Target Compliance	Modelled Compliance
Car	79%	79%
LGV	58%	59%
HGV	78%	72%
Bus/Coach	54%	51%

Table 5-3: 2031 Target and Modelled Average Compliance

Veh Type	Target Compliance	Modelled Compliance
Car	99%	99%
LGV	97%	97%
HGV	99%	89%
Bus/Coach	97%	96%

5.1.1 Highway Network Statistics

The highway model network statistics have been extracted for 2017, 2021 and 2031, covering the whole model, including buffer network. Table 5-4 shows the statistics for 2017 and 2021 and Table 5-5 shows the statistics for 2021 and 2031.

Table 5-4: 2017 and 2021 Highway Network Statistics

Measure	2017			2021			Difference %		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	1183.40	812.60	1074.50	1306.90	891.60	1162.70	10.4%	9.7%	8.2%
OVER-CAPACITY QUEUES	493.20	137.80	316.30	660.00	189.70	387.40	33.8%	37.7%	22.5%
LINK CRUISE TIME	5628.80	3988.50	5251.70	6011.10	4275.50	5566.80	6.8%	7.2%	6.0%
(FREE FLOW	5466.80	3854.60	5077.10	5832.50	4124.20	5373.20	6.7%	7.0%	5.8%
DELAYS	162.00	133.80	174.60	178.60	151.30	193.60	10.2%	13.1%	10.9%
TOTAL TRAVEL TIME	7305.40	4938.90	6642.50	7978.00	5356.80	7116.90	9.2%	8.5%	7.1%
TRAVEL DISTANCE	251052	189346	233800	266992	202679	247621	6.3%	7.0%	5.9%
OVERALL AVERAGE SPEED	34.40	38.30	35.20	33.50	37.80	34.80	-2.6%	-1.3%	-1.1%
TOTAL TRIPS LOADED	39487	28937	37092	41837	30980	39195	5.9%	7.1%	5.7%

Table 5-5: 2021 and 2031 Highway Network Statistics

Measure	2021			2031			Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	1306.90	891.60	1162.70	1401.10	985.10	1267.70	7.2%	10.5%	9.0%
OVER-CAPACITY QUEUES	660.00	189.70	387.40	771.70	212.30	392.30	16.9%	11.9%	1.3%
LINK CRUISE TIME	6011.10	4275.50	5566.80	6472.30	4687.40	5972.70	7.7%	9.6%	7.3%
(FREE FLOW	5832.50	4124.20	5373.20	6275.60	4521.10	5753.50	7.6%	9.6%	7.1%
DELAYS	178.60	151.30	193.60	196.70	166.20	219.30	10.1%	9.8%	13.3%
TOTAL TRAVEL TIME	7978.00	5356.80	7116.90	8645.20	5884.80	7632.80	8.4%	9.9%	7.2%
TRAVEL DISTANCE	266992	202679	247621	289454	222890	266520	8.4%	10.0%	7.6%
OVERALL AVERAGE SPEED	33.50	37.80	34.80	33.50	37.90	34.90	0.0%	0.3%	0.3%
TOTAL TRIPS LOADED	41837	30980	39195	45116	33978	42153	7.8%	9.7%	7.5%

6. FBC Option Assessment Forecasts

6.1.1 Assessment Scenarios

The final FBC CAZ options were determined through an iterative process of Transport Model / Air Quality Model scenario runs. The scenarios tested in the Transport Model were as follows:

- 2020 CAZ Class C, with a £7.50 charge for LGVs/Taxis and £100 for HGVs/Coaches/Buses;
- 2020 CAZ Class C, with a £9.00 charge for LGVs/Taxis and £100 for HGVs/Coaches/Buses;
- 2020 CAZ Class D, with a £7.50 charge for Cars/LGVs/Taxis and £100 for HGVs/Coaches/Buses;
- 2020 CAZ Class D, with a £9.00 charge for Cars/LGVs/Taxis and £100 for HGVs/Coaches/Buses;
- 2021 CAZ Class C, with a £7.50 charge for LGVs/Taxis and £100 for HGVs/Coaches/Buses;
- 2021 CAZ Class C, with a £9.00 charge for LGVs/Taxis and £100 for HGVs/Coaches/Buses;
- 2021 CAZ Class C plus TM, with a £9.00 charge for LGVs/Taxis and £100 for HGVs/Coaches/Buses and the Queens Square traffic management scheme. Further details of the scheme are provided in FBC-8 Option Assessment Report in Appendix C of the FBC.
- 2021 CAZ Class D, with a £7.50 charge for Cars/LGVs/Taxis and £100 for HGVs/Coaches/Buses;
- 2021 CAZ Class D, with a £9.00 charge for Cars/LGVs/Taxis and £100 for HGVs/Coaches/Buses; and
- 2021 Alternative CAZ Class D, with a £9.00 charge for Cars/LGVs/Taxis and £100 for HGVs/Coaches/Buses, a £2000 vehicle replacement grant available for owners of pre-Euro 4 cars and Euro 4/5 diesel exemption for the first year of the CAZ and the Queens Square traffic management scheme.

The 2021 CAZ Class D £9.00, Alternative CAZ D £9.00 and CAZ C £9.00 with TM options are forecast to bring about compliance within the EU Limit Value for annual mean NO_2, within Bath in the shortest timeframe. The response rates modelled for this CAZ option are shown in Tables 3-8 to 3-10 and have been modelled within the GBATH SATURN highway model using the methodology outlined in Chapter 3, section 3.2.1. The boundary of the CAZ is shown in Figure 2-2 and Figure 2-3.

Note, the CAZ Class D option was modelled without the loan / grant schemes since details of these schemes had not been identified at the time the option was modelled. This therefore presents a worst case assessment in this regard since the loan / grant schemes would be expected to improve the non-compliant vehicle replacements rates. The grant scheme was reflected in the modelling of the Alternative CAZ D option since the details were available at the time of the modelling and hence it was included to gauge the impacts. The inclusion of this scheme is expected to have a limited impact due to the relatively low numbers of (pre-Euro 4) vehicles that would be eligible. The loan / grant schemes are subject to funding at the time of writing. Further discussion is provided in FBC-08 Option Assessment Report in Appendix C of the FBC.

The results from this option are outlined below.

6.1.2 Compliance Splits

The 2021 compliance splits at the cordon of the CAZ Class D, Alternative CAZ D and CAZ C with TM options are shown in Table 6-1 to Table 6-3 respectively.

Table 6-1: 2021 CAZ D Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	98.35%	1.65%	99.45%	0.55%	99.07%	0.93%
LGV	91.45%	8.55%	92.58%	7.42%	91.11%	8.89%
HGV rigid	95.03%	4.97%	93.97%	6.03%	95.26%	4.74%
HGV artic	97.91%	2.09%	97.46%	2.54%	98.01%	1.99%
HGV	95.91%	4.09%	95.03%	4.97%	96.10%	3.90%
Taxi	97.41%	2.59%	97.84%	2.16%	97.35%	2.65%
Bus	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Coach	99.16%	0.84%	99.10%	0.90%	99.32%	0.68%
Total	**97.46%**	**2.54%**	**98.16%**	**1.84%**	**98.37%**	**1.63%**

Table 6-2: 2021 Alternative CAZ D Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	90.68%	9.32%	90.62%	9.38%	90.63%	9.37%
LGV	91.45%	8.55%	92.58%	7.42%	91.11%	8.89%
HGV rigid	95.03%	4.97%	93.97%	6.03%	95.26%	4.74%
HGV artic	97.91%	2.09%	97.46%	2.54%	98.01%	1.99%
HGV	95.91%	4.09%	95.03%	4.97%	96.10%	3.90%
Taxi	97.41%	2.59%	97.84%	2.16%	97.35%	2.65%
Bus	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Coach	99.16%	0.84%	99.10%	0.90%	99.32%	0.68%
Total	91.4%	8.6%	91.5%	8.5%	91.1%	8.9%

Table 6-3: 2021 CAZ C with TM Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	79.40%	20.60%	79.30%	20.70%	79.30%	20.70%
LGV	91.12%	8.88%	92.32%	7.68%	91.55%	8.45%
HGV rigid	95.03%	4.97%	93.97%	6.03%	95.26%	4.74%
HGV artic	97.91%	2.09%	97.46%	2.54%	98.01%	1.99%
HGV	96.84%	3.16%	96.00%	4.00%	95.94%	4.06%
Taxi	97.18%	2.82%	97.88%	2.12%	97.80%	2.20%
Bus	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Coach	99.25%	0.75%	99.50%	0.50%	99.36%	0.64%
Total	**82.38%**	**17.62%**	**83.01%**	**16.99%**	**81.45%**	**18.55%**

The compliance splits results show that the CAZ Class D scheme increases the average compliance from 75% in the 2021 Baseline to 98%. This figure accounts for switching of non-complaint vehicles to compliant, but also the infilling of compliant trips into the CAZ zone when non-compliant trips are removed as part of the cancel trip / change mode response.

The compliance splits results show that the Alternative CAZ Class D scheme increases the average compliance from 75% in the 2021 Baseline to 91%. Again, this figure accounts for switching of non-complaint vehicles to compliant, but also the infilling of compliant trips into the CAZ zone when non-compliant trips are removed as part of the cancel trip / change mode response. As Euro 4/5 diesel cars are exempt for the first year of opening of the CAZ the replacement to compliant cars is not as great as the CAZ Class D option, however the grant does lower the upgrade cost for pre-Euro 4 cars so replacement does occur.

The compliance splits results show that the CAZ Class C with TM scheme increases the average compliance from 75% in the 2021 Baseline to 82% compliant. This is lower than the other two options as cars are not charged under this option.

The 2031 compliance splits at the cordon of the CAZ Class D and Alternative CAZ D (one table as they are the same since the Euro 4/5 diesel car exemption only applies in 2021) and CAZ C with TM options for are shown in Table 6-4 and Table 6-5 respectively.

Table 6-4: 2031 CAZ D and Alternative CAZ D Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	99.95%	0.05%	99.97%	0.03%	99.97%	0.03%
LGV	99.96%	0.04%	99.99%	0.01%	99.97%	0.03%
HGV rigid	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
HGV artic	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
HGV	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Taxi	99.91%	0.09%	99.92%	0.08%	99.90%	0.10%
Bus	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Coach	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Total	**99.96%**	**0.04%**	**99.98%**	**0.02%**	**99.97%**	**0.03%**

Table 6-5: 2031 CAZ C with TM Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	99.30%	0.70%	99.30%	0.70%	99.30%	0.70%
LGV	99.91%	0.09%	99.99%	0.01%	99.95%	0.05%
HGV rigid	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
HGV artic	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
HGV	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Taxi	99.86%	0.14%	99.90%	0.10%	99.89%	0.11%
Bus	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Coach	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Total	**99.44%**	**0.56%**	**99.48%**	**0.52%**	**99.40%**	**0.60%**

The effect of the CAZ in 2031 is only marginal, where the average compliance changes from 99% in the Baseline to just under 100% with the CAZ Class D and Alternative CAZ Class D. The CAZ Class C with TM has a marginally lower average compliance than the other two options.

6.1.3 Euro Standard Splits

The 2021 Euro Standard splits at the cordon of the CAZ Class D, Alternative CAZ D and CAZ C with TM options for are shown in Table 6-6 to Table 6-8 respectively, together with the baseline (Calculated Bath Euro Proportions) splits for comparison.

Table 6-6: 2021 CAZ D Euro Standard Splits

Petrol Car	Calculated Bath Euro Proportions 2021	Modelled CAZ D Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.01	0.00
4Euro 3	0.05	0.01
5Euro 4	0.14	0.14
6Euro 5	0.36	0.38
7Euro 6*	0.17	0.18
7Euro 6c*	0.28	0.29

Diesel Car	Calculated Bath Euro Proportions 2021	Modelled CAZ D Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.00	0.00
4Euro 3	0.02	0.00
5Euro 4	0.09	0.00
6Euro 5	0.29	0.01
7Euro 6	0.18	0.32
7Euro 6c*	0.39	0.68
7Euro 6d*	-	-

Petrol LGV	Calculated Bath Euro Proportions 2021	Modelled CAZ D Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	0.00	0.00
3Euro 2	0.03	0.05
4Euro 3	0.07	0.10
5Euro 4	0.01	0.01
6Euro 5	0.34	0.32
7Euro 6*	0.25	0.24
7Euro 6c*	0.31	0.29

Diesel LGV	Calculated Bath Euro Proportions 2021	Modelled CAZ D Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.00	0.00
4Euro 3	0.03	0.01
5Euro 4	0.10	0.02
6Euro 5	0.28	0.05
7Euro 6*	0.18	0.28
7Euro 6c*	0.41	0.64
7Euro 6d*	-	-

Rigid HGV	Calculated Bath Euro Proportions 2021	Modelled CAZ D Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.00	0.00
4Euro III	0.02	0.00
5Euro IV	0.05	0.01
6Euro V_EGR	0.05	0.01
7Euro V_SCR	0.14	0.03
8Euro VI	0.74	0.94
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Artic HGV	Calculated Bath Euro Proportions 2021	Modelled CAZ D Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.00	0.00
4Euro III	0.00	0.00
5Euro IV	0.01	0.00
6Euro V_EGR	0.02	0.01
7Euro V_SCR	0.06	0.02
8Euro VI	0.90	0.98
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Buses	Calculated Bath Euro Proportions 2021	Modelled CAZ D Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.04	-
4Euro III	0.16	-
5Euro IV	0.12	-
6Euro V_EGR	0.03	-
7Euro V_SCR	0.08	-
8Euro VI	0.58	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Coaches	Calculated Bath Euro Proportions 2021	Modelled CAZ D Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.03	0.00
4Euro III	0.04	0.00
5Euro IV	0.05	0.00
6Euro V_EGR	0.02	0.00
7Euro V_SCR	0.06	0.00
8Euro VI	0.79	0.99
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Table 6-7: 2021 Alternative CAZ D Euro Standard Splits

Petrol Car	Calculated Bath Euro Proportions 2021	Modelled Alt CAZ D Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.01	0.00
4Euro 3	0.05	0.01
5Euro 4	0.14	0.14
6Euro 5	0.36	0.38
7Euro 6*	0.17	0.18
7Euro 6c*	0.28	0.29

Diesel Car	Calculated Bath Euro Proportions 2021	Modelled Alt CAZ D Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.00	0.00
4Euro 3	0.02	0.01
5Euro 4	0.09	0.04
6Euro 5	0.29	0.15
7Euro 6	0.18	0.25
7Euro 6c*	0.39	0.54
7Euro 6d*	-	-

Petrol LGV	Calculated Bath Euro Proportions 2021	Modelled Alt CAZ D Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	0.00	0.00
3Euro 2	0.03	0.05
4Euro 3	0.07	0.10
5Euro 4	0.01	0.01
6Euro 5	0.34	0.32
7Euro 6*	0.25	0.24
7Euro 6c*	0.31	0.29

Diesel LGV	Calculated Bath Euro Proportions 2021	Modelled Alt CAZ D Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.00	0.00
4Euro 3	0.03	0.01
5Euro 4	0.10	0.02
6Euro 5	0.28	0.05
7Euro 6*	0.18	0.28
7Euro 6c*	0.41	0.64
7Euro 6d*	-	-

Rigid HGV	Calculated Bath Euro Proportions 2021	Modelled Alt CAZ D Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.00	0.00
4Euro III	0.02	0.00
5Euro IV	0.05	0.01
6Euro V_EGR	0.05	0.01
7Euro V_SCR	0.14	0.03
8Euro VI	0.74	0.95
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Artic HGV	Calculated Bath Euro Proportions 2021	Modelled Alt CAZ D Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.00	0.00
4Euro III	0.00	0.00
5Euro IV	0.01	0.00
6Euro V_EGR	0.02	0.01
7Euro V_SCR	0.06	0.02
8Euro VI	0.90	0.98
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Buses	Calculated Bath Euro Proportions 2021	Modelled Alt CAZ D Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.04	-
4Euro III	0.16	-
5Euro IV	0.12	-
6Euro V_EGR	0.03	-
7Euro V_SCR	0.08	-
8Euro VI	0.58	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Coaches	Calculated Bath Euro Proportions 2021	Modelled Alt CAZ D Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.03	0.00
4Euro III	0.04	0.00
5Euro IV	0.05	0.00
6Euro V_EGR	0.02	0.00
7Euro V_SCR	0.06	0.00
8Euro VI	0.79	0.99
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Table 6-8: 2021 CAZ C with TM Euro Standard Splits

Petrol Car	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.01	0.01
4Euro 3	0.05	0.05
5Euro 4	0.14	0.14
6Euro 5	0.36	0.36
7Euro 6*	0.17	0.17
7Euro 6c*	0.28	0.28

Diesel Car	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.00	0.00
4Euro 3	0.02	0.02
5Euro 4	0.09	0.09
6Euro 5	0.29	0.29
7Euro 6	0.18	0.18
7Euro 6c*	0.39	0.39
7Euro 6d*	-	-

Petrol LGV	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	0.00	0.00
3Euro 2	0.03	0.05
4Euro 3	0.07	0.10
5Euro 4	0.01	0.01
6Euro 5	0.34	0.32
7Euro 6*	0.25	0.24
7Euro 6c*	0.31	0.29

Diesel LGV	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.00	0.00
4Euro 3	0.03	0.01
5Euro 4	0.10	0.02
6Euro 5	0.28	0.05
7Euro 6*	0.18	0.28
7Euro 6c*	0.41	0.64
7Euro 6d*	-	-

Rigid HGV	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.00	0.00
4Euro III	0.02	0.00
5Euro IV	0.05	0.01
6Euro V_EGR	0.05	0.01
7Euro V_SCR	0.14	0.03
8Euro VI	0.74	0.94
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Artic HGV	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.00	0.00
4Euro III	0.00	0.00
5Euro IV	0.01	0.00
6Euro V_EGR	0.02	0.01
7Euro V_SCR	0.06	0.02
8Euro VI	0.90	0.98
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Buses	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.04	-
4Euro III	0.16	-
5Euro IV	0.12	-
6Euro V_EGR	0.03	-
7Euro V_SCR	0.08	-
8Euro VI	0.58	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Coaches	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.03	0.00
4Euro III	0.04	0.00
5Euro IV	0.05	0.00
6Euro V_EGR	0.02	0.00
7Euro V_SCR	0.06	0.00
8Euro VI	0.79	0.99
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

The 2031 Euro Standard at the cordon of the CAZ Class D and Alternative CAZ D (one table as they are the same since the Euro 4/5 diesel car exemption only applies in 2021) and CAZ C with TM options for are shown in Table 6-9 and Table 6-10 respectively, together with the baseline (Calculated Bath Euro Proportions) splits for comparison.

Table 6-9: 2031 CAZ D and Alternative CAZ D Euro Standard Splits

Petrol Car	Calculated Bath Euro Proportions 2031	Modelled CAZ D Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	0.00
5Euro 4	0.00	0.00
6Euro 5	0.05	0.05
7Euro 6*	0.03	0.03
7Euro 6c*	0.92	0.92

Diesel Car	Calculated Bath Euro Proportions 2031	Modelled CAZ D Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	-
5Euro 4	0.00	0.00
6Euro 5	0.02	0.00
7Euro 6	0.04	0.04
7Euro 6c*	0.16	0.16
7Euro 6d*	0.78	0.80

Petrol LGV	Calculated Bath Euro Proportions 2031	Modelled CAZ D Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	0.00
5Euro 4	0.00	0.00
6Euro 5	0.01	0.01
7Euro 6*	0.01	0.01
7Euro 6c*	0.98	0.98

Diesel LGV	Calculated Bath Euro Proportions 2031	Modelled CAZ D Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	-
5Euro 4	0.00	0.00
6Euro 5	0.03	0.00
7Euro 6*	0.03	0.03
7Euro 6c*	0.12	0.13
7Euro 6d*	0.82	0.84

Rigid HGV	Calculated Bath Euro Proportions 2031	Modelled CAZ D Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	-	-
5Euro IV	0.00	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.01	-
8Euro VI	0.99	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Artic HGV	Calculated Bath Euro Proportions 2031	Modelled CAZ D Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	-	-
5Euro IV	-	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.00	-
8Euro VI	1.00	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Buses	Calculated Bath Euro Proportions 2031	Modelled CAZ D Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	0.00	-
5Euro IV	0.01	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.01	-
8Euro VI	0.97	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Coaches	Calculated Bath Euro Proportions 2031	Modelled CAZ D Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	-	-
5Euro IV	-	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.01	-
8Euro VI	0.98	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Table 6-10: 2031 CAZ C with TM Euro Standard Splits

Petrol Car	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	-
5Euro 4	0.00	0.00
6Euro 5	0.05	0.05
7Euro 6*	0.03	0.03
7Euro 6c*	0.92	0.92

Diesel Car	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	-
5Euro 4	0.00	0.00
6Euro 5	0.02	0.02
7Euro 6	0.04	0.04
7Euro 6c*	0.16	0.16
7Euro 6d*	0.78	0.78

Petrol LGV	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	0.00
5Euro 4	0.00	0.00
6Euro 5	0.01	0.01
7Euro 6*	0.01	0.01
7Euro 6c*	0.98	0.98

Diesel LGV	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	-
5Euro 4	0.00	0.00
6Euro 5	0.03	0.00
7Euro 6*	0.03	0.03
7Euro 6c*	0.12	0.13
7Euro 6d*	0.82	0.84

Rigid HGV	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	-	-
5Euro IV	0.00	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.01	-
8Euro VI	0.99	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Artic HGV	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	-	-
5Euro IV	-	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.00	-
8Euro VI	1.00	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Buses	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	0.00	-
5Euro IV	0.01	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.01	-
8Euro VI	0.97	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Coaches	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	-	-
5Euro IV	-	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.01	-
8Euro VI	0.98	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

6.1.4 Highway Network Statistics

The highway model network statistics have been extracted for each option, for 2021 and 2031 and compared against the baseline network statistics. Table 6-11 to Table 6-13 show the statistics for 2021 and Table 6-14 to Table 6-16 show the statistics for 2031.

Table 6-11: 2021 Baseline and CAZ D Highway Network Statistics

Measure	2021 Baseline			2021 CAZ D			% Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	1306.90	891.60	1162.70	1256.30	851.30	1112.20	-3.9%	-4.5%	-4.3%
OVER-CAPACITY QUEUES	660.00	189.70	387.40	615.40	187.50	377.60	-6.8%	-1.2%	-2.5%
LINK CRUISE TIME	6011.10	4275.50	5566.80	5924.00	4207.00	5484.90	-1.4%	-1.6%	-1.5%
FREE FLOW	5832.50	4124.20	5373.20	5756.30	4069.70	5305.50	-1.3%	-1.3%	-1.3%
DELAYS	178.60	151.30	193.60	167.80	137.30	179.40	-6.0%	-9.3%	-7.3%
TOTAL TRAVEL TIME	7978.00	5356.80	7116.90	7795.70	5245.80	6974.70	-2.3%	-2.1%	-2.0%
TRAVEL DISTANCE	266992	202679	247621	264029	200313	245137	-1.1%	-1.2%	-1.0%
OVERALL AVERAGE SPEED	33.50	37.80	34.80	33.90	38.20	35.10	1.2%	1.1%	0.9%
TOTAL TRIPS LOADED	41837	30980	39195	41337	30515	38659	-1.2%	-1.5%	-1.4%

Table 6-12: 2021 Baseline and Alternative CAZ D Highway Network Statistics

Measure	2021 Baseline			2021 Alternative CAZ D			% Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	1306.90	891.60	1162.70	1298.90	886.10	1152.10	-0.6%	-0.6%	-0.9%
OVER-CAPACITY QUEUES	660.00	189.70	387.40	652.00	190.20	388.10	-1.2%	0.3%	0.2%
LINK CRUISE TIME	6011.10	4275.50	5566.80	5992.80	4267.60	5557.60	-0.3%	-0.2%	-0.2%
FREE FLOW	5832.50	4124.20	5373.20	5818.50	4121.70	5369.60	-0.2%	-0.1%	-0.1%
DELAYS	178.60	151.30	193.60	174.30	145.90	188.00	-2.4%	-3.6%	-2.9%
TOTAL TRAVEL TIME	7978.00	5356.80	7116.90	7943.70	5343.90	7097.80	-0.4%	-0.2%	-0.3%
TRAVEL DISTANCE	266992	202679	247621	266382	202401.7	247508.9	-0.2%	-0.1%	0.0%
OVERALL AVERAGE SPEED	33.50	37.80	34.80	33.50	37.90	34.90	0.0%	0.3%	0.3%
TOTAL TRIPS LOADED	41837	30980	39195	41768.6	30936.8	39147.8	-0.2%	-0.1%	-0.1%

Table 6-13: 2021 Baseline and CAZ C + TM Highway Network Statistics

Measure	2021 Baseline			2021 CAZ C + TM			% Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	1306.90	891.60	1162.70	1302.70	890.00	1157.50	-0.3%	-0.2%	-0.4%
OVER-CAPACITY QUEUES	660.00	189.70	387.40	658.10	190.70	389.50	-0.3%	0.5%	0.5%
LINK CRUISE TIME	6011.10	4275.50	5566.80	5998.70	4267.80	5560.90	-0.2%	-0.2%	-0.1%
FREE FLOW	5832.50	4124.20	5373.20	5823.40	4120.60	5371.70	-0.2%	-0.1%	0.0%
DELAYS	178.60	151.30	193.60	175.30	147.20	189.20	-1.8%	-2.7%	-2.3%
TOTAL TRAVEL TIME	7978.00	5356.80	7116.90	7959.60	5348.50	7107.90	-0.2%	-0.2%	-0.1%
TRAVEL DISTANCE	266992	202679	247621	266542	202300	247530	-0.2%	-0.2%	0.0%
OVERALL AVERAGE SPEED	33.50	37.80	34.80	33.50	37.80	34.80	0.0%	0.0%	0.0%
TOTAL TRIPS LOADED	41837	30980	39195	41803	30946	39169.9	-0.1%	-0.1%	-0.1%

Table 6-14: 2031 Baseline and CAZ D Highway Network Statistics

Measure	2031 Baseline			2031 CAZ D			% Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	1401.10	985.10	1267.70	1398.10	982.70	1274.80	-0.2%	-0.2%	0.6%
OVER-CAPACITY QUEUES	771.70	212.30	392.30	759.60	210.70	402.00	-1.6%	-0.8%	2.5%
LINK CRUISE TIME	6472.30	4687.40	5972.70	6467.40	4680.80	5967.20	-0.1%	-0.1%	-0.1%
FREE FLOW	6275.60	4521.10	5753.50	6272.90	4516.00	5750.40	0.0%	-0.1%	-0.1%
DELAYS	196.70	166.20	219.30	194.50	164.90	216.80	-1.1%	-0.8%	-1.1%
TOTAL TRAVEL TIME	8645.20	5884.80	7632.80	8625.10	5874.10	7643.90	-0.2%	-0.2%	0.1%
TRAVEL DISTANCE	289454	222890	266520	288689	222359	265824	-0.3%	-0.2%	-0.3%
OVERALL AVERAGE SPEED	33.50	37.90	34.90	33.50	37.90	34.80	0.0%	0.0%	-0.3%
TOTAL TRIPS LOADED	45116	33978	42153	45030	33908	42088	-0.2%	-0.2%	-0.2%

Table 6-15: 2031 Baseline and Alternative CAZ D Highway Network Statistics

Measure	2031 Baseline			2031 CAZ D			% Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	1401.10	985.10	1267.70	1395.30	979.30	1260.60	-0.4%	-0.6%	-0.6%
OVER-CAPACITY QUEUES	771.70	212.30	392.30	757.10	213.60	391.10	-1.9%	0.6%	-0.3%
LINK CRUISE TIME	6472.30	4687.40	5972.70	6456.90	4672.80	5959.00	-0.2%	-0.3%	-0.2%
FREE FLOW	6275.60	4521.10	5753.50	6263.70	4511.30	5745.80	-0.2%	-0.2%	-0.1%
DELAYS	196.70	166.20	219.30	193.30	161.50	213.20	-1.7%	-2.8%	-2.8%
TOTAL TRAVEL TIME	8645.20	5884.80	7632.80	8609.30	5865.80	7610.70	-0.4%	-0.3%	-0.3%
TRAVEL DISTANCE	289454	222890	266520	288937	222343	266217	-0.2%	-0.2%	-0.1%
OVERALL AVERAGE SPEED	33.50	37.90	34.90	33.60	37.90	35.00	0.3%	0.0%	0.3%
TOTAL TRIPS LOADED	45116	33978	42153	45030.3	33907.8	42087.9	-0.2%	-0.2%	-0.2%

Table 6-16: 2031 Baseline and CAZ C + TM Highway Network Statistics

Measure	2031 Baseline			2031 CAZ C + TM			% Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	1401.10	985.10	1267.70	1395.60	980.20	1262.60	-0.4%	-0.5%	-0.4%
OVER-CAPACITY QUEUES	771.70	212.30	392.30	761.80	214.70	392.40	-1.3%	1.1%	0.0%
LINK CRUISE TIME	6472.30	4687.40	5972.70	6457.10	4674.60	5961.30	-0.2%	-0.3%	-0.2%
FREE FLOW	6275.60	4521.10	5753.50	6263.90	4512.90	5747.70	-0.2%	-0.2%	-0.1%
DELAYS	196.70	166.20	219.30	193.30	161.60	213.60	-1.7%	-2.8%	-2.6%
TOTAL TRAVEL TIME	8645.20	5884.80	7632.80	8614.50	5869.40	7616.30	-0.4%	-0.3%	-0.2%
TRAVEL DISTANCE	289454	222890	266520	288903	222392	266289	-0.2%	-0.2%	-0.1%
OVERALL AVERAGE SPEED	33.50	37.90	34.90	33.50	37.90	35.00	0.0%	0.0%	0.3%
TOTAL TRIPS LOADED	45116	33978	42153	45045.9	33922.6	42105.2	-0.2%	-0.2%	-0.1%

The 2021 results show that with the introduction of a CAZ Class D the number of trips within the network decreases the most due to this scheme impacting the most vehicles. As a result, the average speed increases, with moderate decreases in queues and delays across the model area. However, the average distance increases slightly due to some non-compliant vehicles avoiding the CAZ charge.

The 2031 results show that each option has very little effect on the traffic in Bath, as the Baseline compliance across all vehicle types is approximately 99%.

6.1.5 Flow Difference Plots

To show the impact of the CAZ on traffic flows around the Bath area, flow difference plots representing the 1-way traffic flow change (in PCUs) between the 2021 CAZ and Baseline scenarios across all modelled time periods are presented below. Similar plots for 2031 have been omitted, as the scheme impact magnitude at this time in the future is significantly smaller because of the majority of vehicle fleet being compliant with CAZ entry policy, leaving smaller number of users with non-compliant vehicles.

Figure 6-1 to Figure 6-3 show the expected changes in the weekday AM peak hour (8:00-9:00 am), an average weekday inter-peak hour and the weekday PM peak hour (5:00-6:00 pm), respectively for the CAZ D option.

Figure 6-1: Traffic flow difference between '2021 CAZ D' and '2021 Baseline' scenarios in the AM Peak Hour

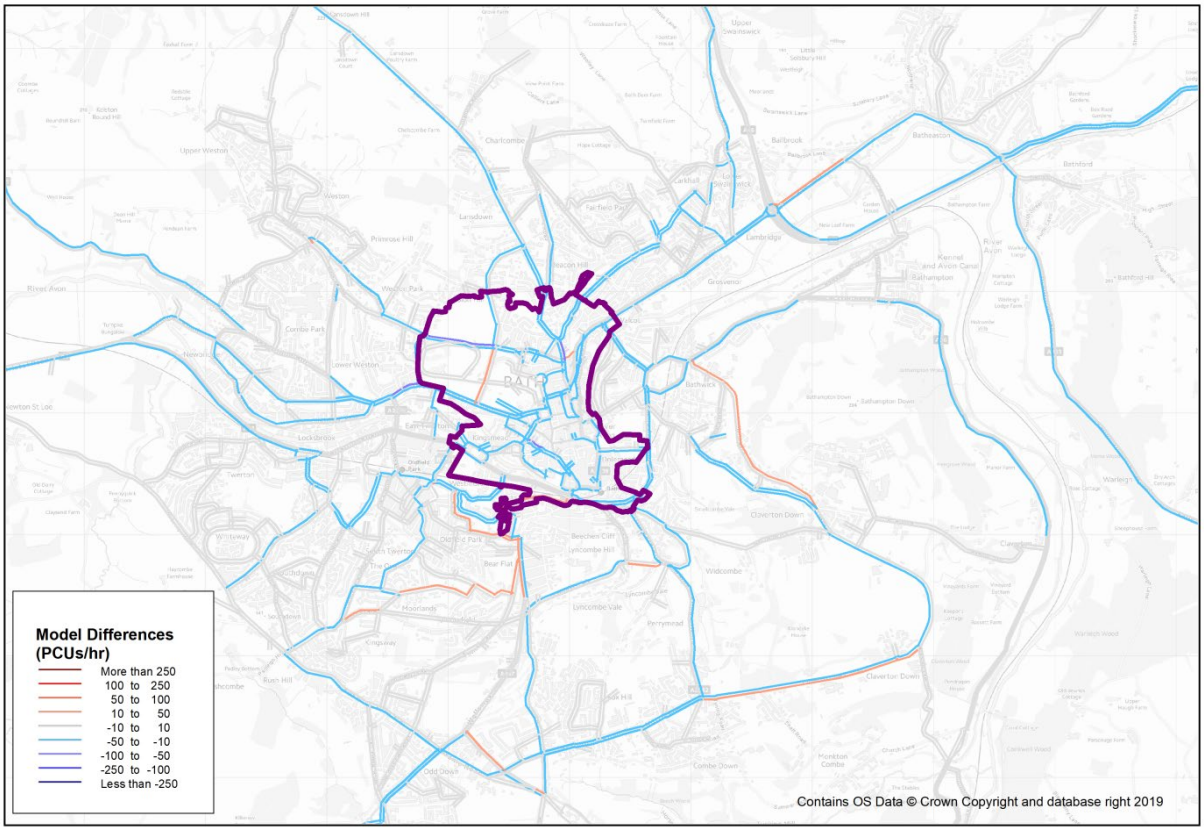


Figure 6-2: Traffic flow difference between '2021 CAZ D' and '2021 Baseline' scenarios in the Interpeak Period

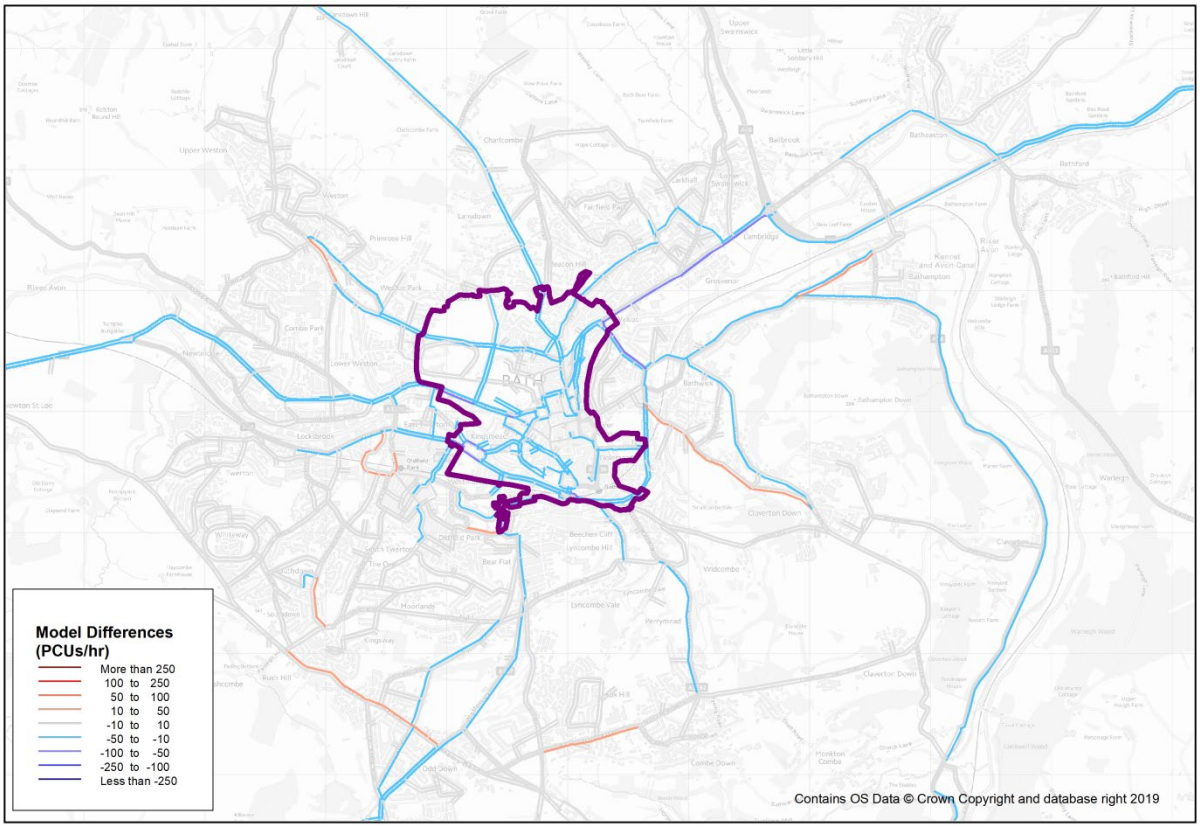
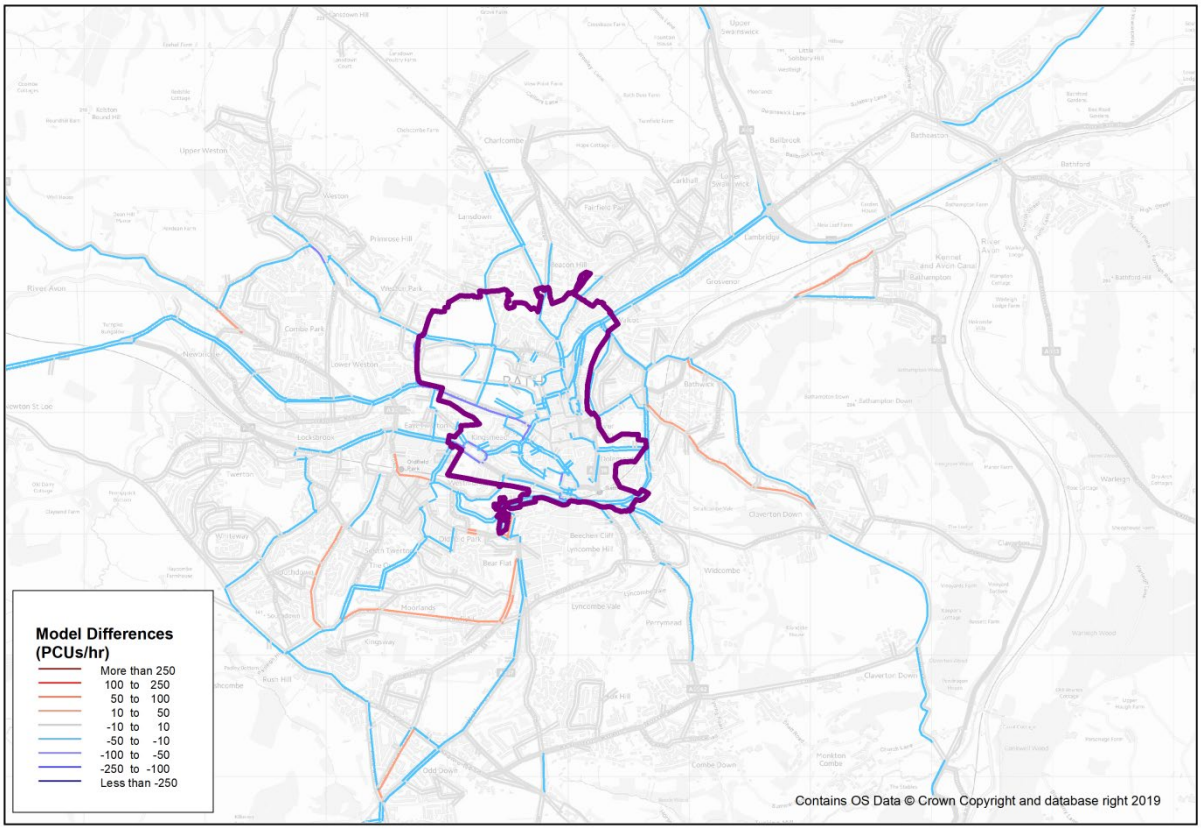


Figure 6-3: Traffic flow difference between '2021 CAZ D' and '2021 Baseline' scenarios in the PM Peak Hour



The flow difference plots for the CAZ D option indicate an overall traffic flow reduction within the impacted area across all modelled time periods. This is because the introduction of the charge fee reduces vehicle traffic accessing the City Centre, approximately 900 vehicles per hour, as well as through traffic using roads in the CAZ. However, it does result in some increases on roads mainly outside of the CAZ boundary, as non-compliant drivers attempt to avoid the charge by using routes around it. Examples of these include:

- Bathwick Hill: Rosemount Lane: Predicted flow increases in all time periods;
- Bathampton Lane: Predicted flow increase in the inter-peak and PM peak hours;
- B3111: Predicted flow increase in the AM peak hour;
- Rush Hill and North Road: Predicted flow increase in the inter-peak; and
- Englishcombe Lane and Southdown Road: Predicted flow increase in PM peak hour.

However, the scale of these potential impacts is considered to be negligible, as almost all the links highlighted in mid-orange fall into the “50 to 100 PCU increment in traffic flow in an hour” category, which can be considered as within normal day-to-day variation in traffic volumes.

Figure 6-4 to Figure 6-6 show the expected changes in the weekday AM peak hour (8:00-9:00 am), an average weekday inter-peak hour and the weekday PM peak hour (5:00-6:00 pm), respectively for the Alternative CAZ D option.

Figure 6-4: Traffic flow difference between ‘2021 Alternative CAZ D’ and ‘2021 Baseline’ scenarios in the AM Peak Hour

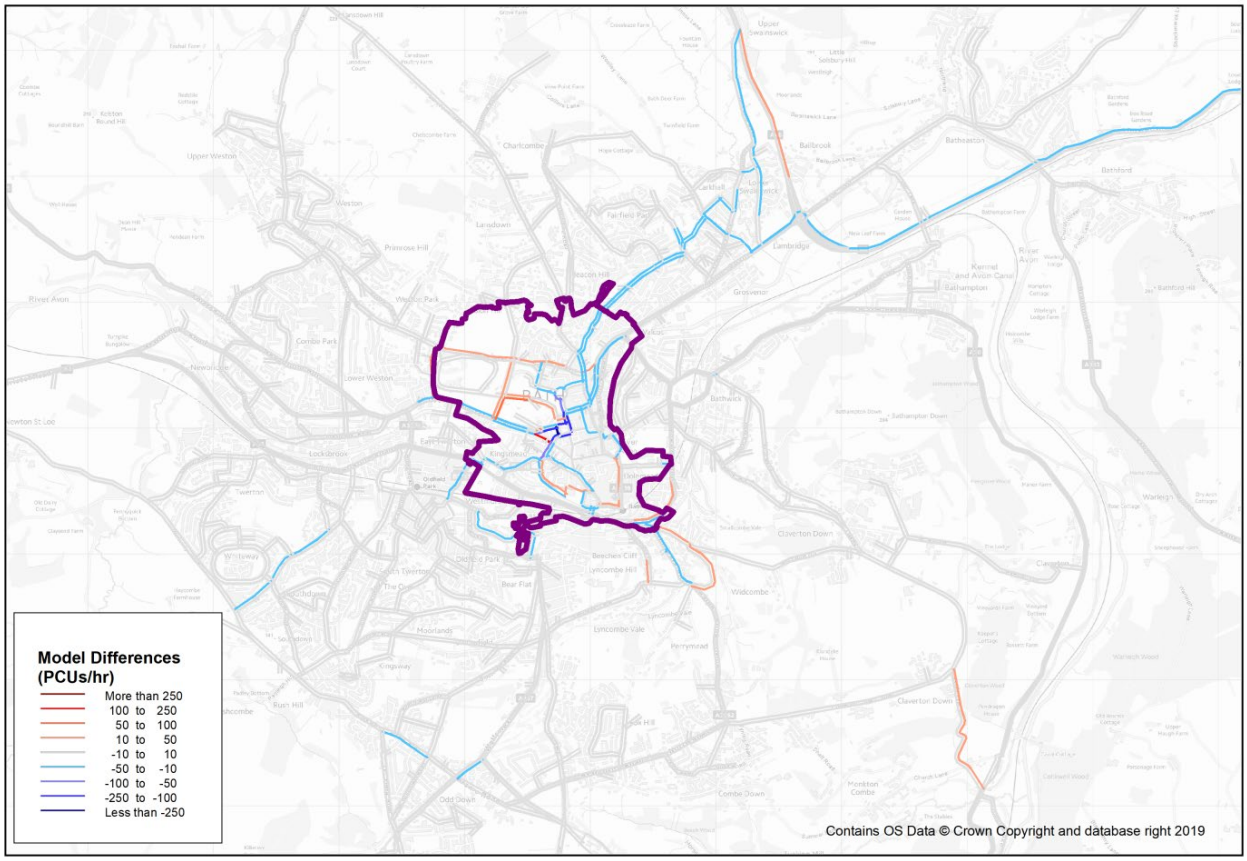


Figure 6-5: Traffic flow difference between '2021 Alternative CAZ D' and '2021 Baseline' scenarios in the Interpeak Period

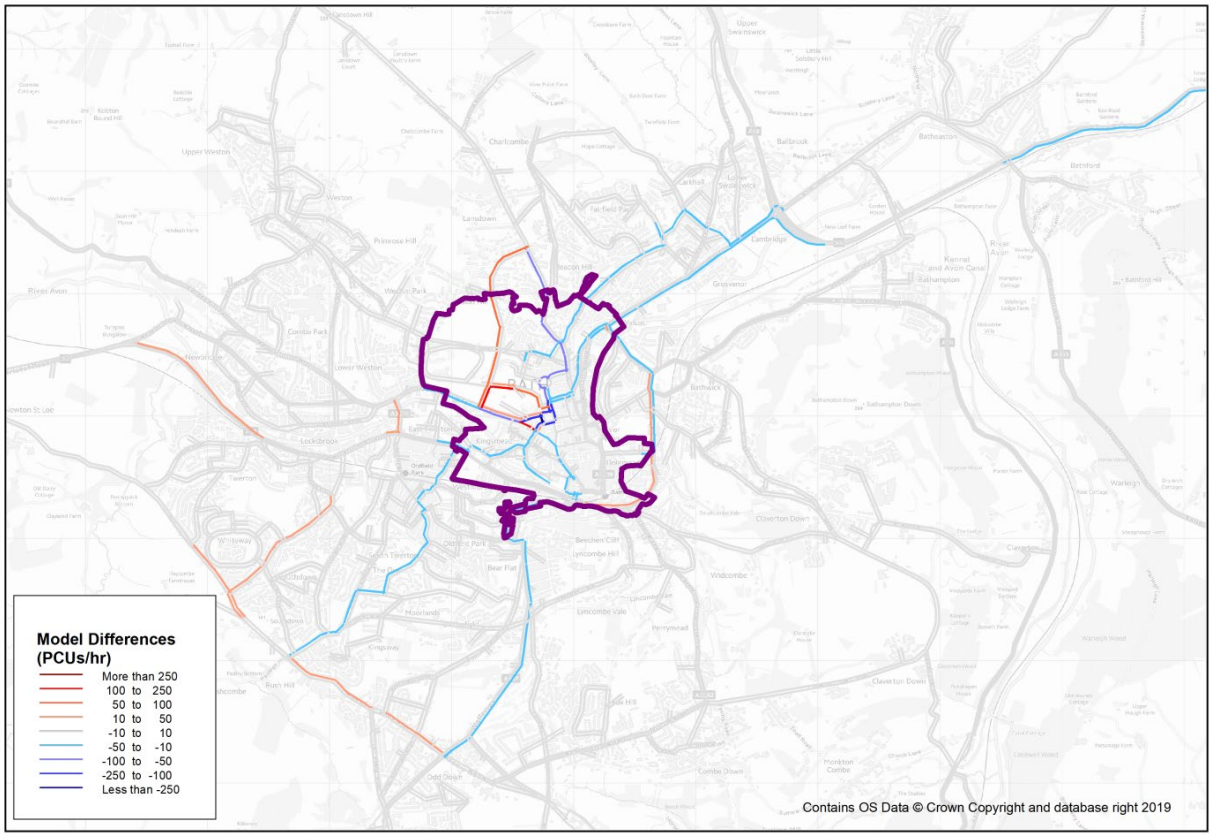
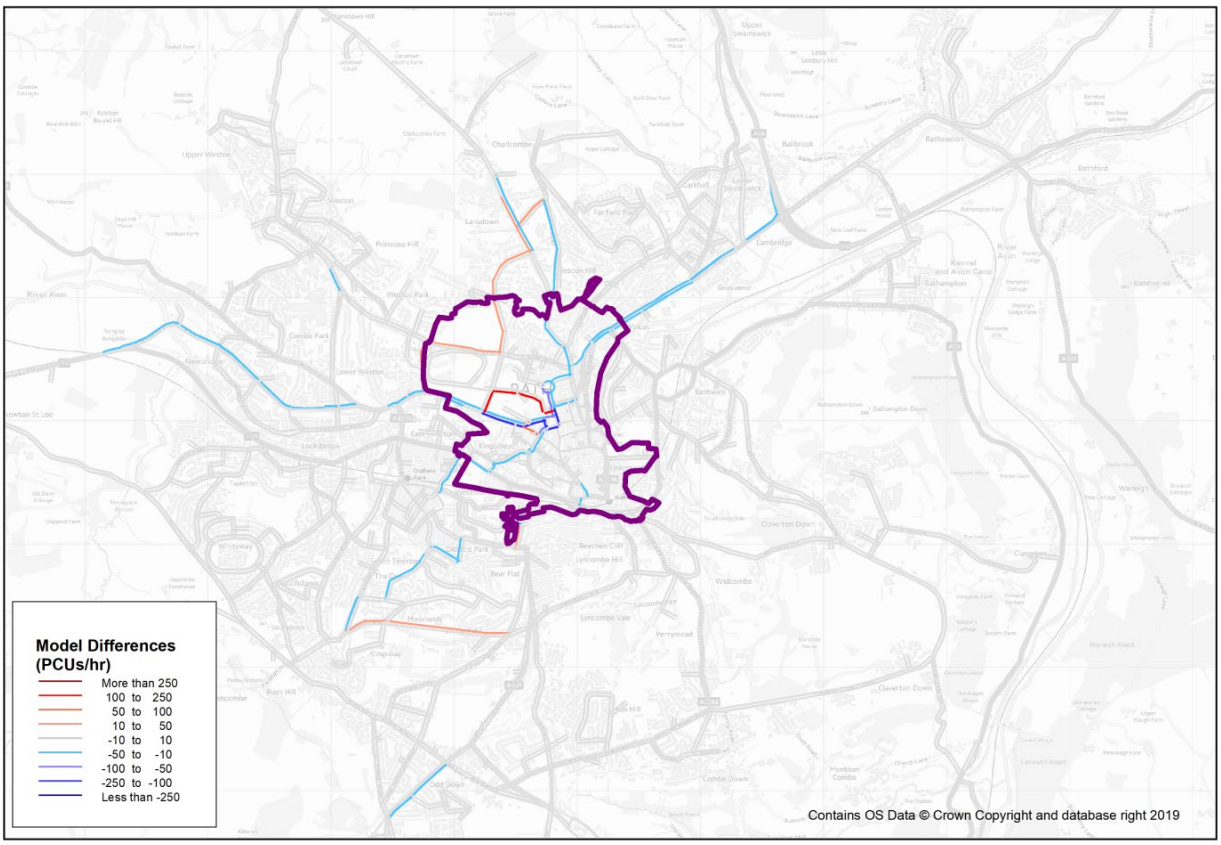


Figure 6-6: Traffic flow difference between '2021 Alternative CAZ D' and '2021 Baseline' scenarios in the PM Peak Hour



The flow difference plots for the Alternative CAZ D option indicate an overall traffic flow reduction within the impacted area across all modelled time periods. This is because the introduction of the charge fee reduces vehicle traffic accessing the City Centre, approximately 600 vehicles per hour, as well as through traffic using roads in the CAZ. However, it does result in some increases on roads mainly outside of the CAZ boundary, as non-compliant drivers attempt to avoid the charge by using routes around it. Examples of these include:

- Brassknocker Hill: Predicted flow increase in the AM peak hour;
- A4 north of London Road: Predicted flow increase in the AM peak hour;
- Widcombe Hill: Predicted flow increase in the AM peak hour;
- Pulteney Road (South): Predicted flow increase in the AM and inter peak hours;
- Whiteway Road – Rush Hill: Predicted flow increases in inter-peak hour;
- A36 Bristol Road: Predicted flow increases in inter-peak hour;
- The Hollow: Predicted flow increases in inter-peak hour; and
- Englishcombe Lane: Predicted flow increase in the PM peak hour.

However, the scale of these potential impacts is considered to be negligible, as almost all the links highlighted in light-orange fall into the “10 to 50 PCU increment in traffic flow in an hour” category, which can be considered as well within normal day-to-day variation in traffic volumes.

The is also a re-routing effect from the Queen Square Traffic Management non-charging measure, which reduces traffic along Queens Square, Charlotte Street, Monmouth Place, Gay Street, George Street and Lansdown Road while traffic increases along Marlborough Lane, Royal Avenue, Park Lane and Weston Road.

Figure 6-7 to 6-9 show the expected changes in the weekday AM peak hour (8:00-9:00 am), an average weekday inter-peak hour and the weekday PM peak hour (5:00-6:00 pm), respectively for the CAZ C plus TM option.

Figure 6-7: Traffic flow difference between '2021 CAZ C + TM' and '2021 Baseline' scenarios in the AM Peak Hour

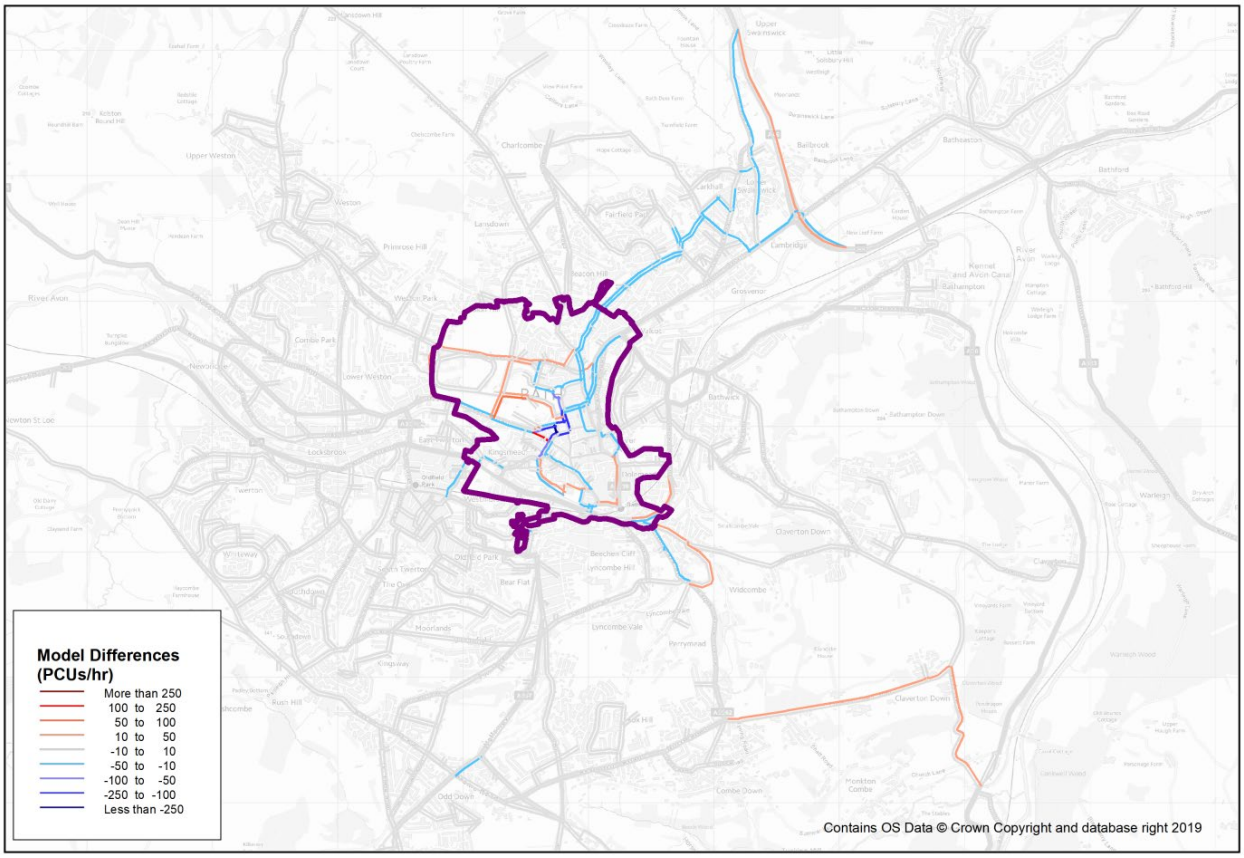


Figure 6-8: Traffic flow difference between '2021 CAZ C + TM' and '2021 Baseline' scenarios in the Interpeak Period

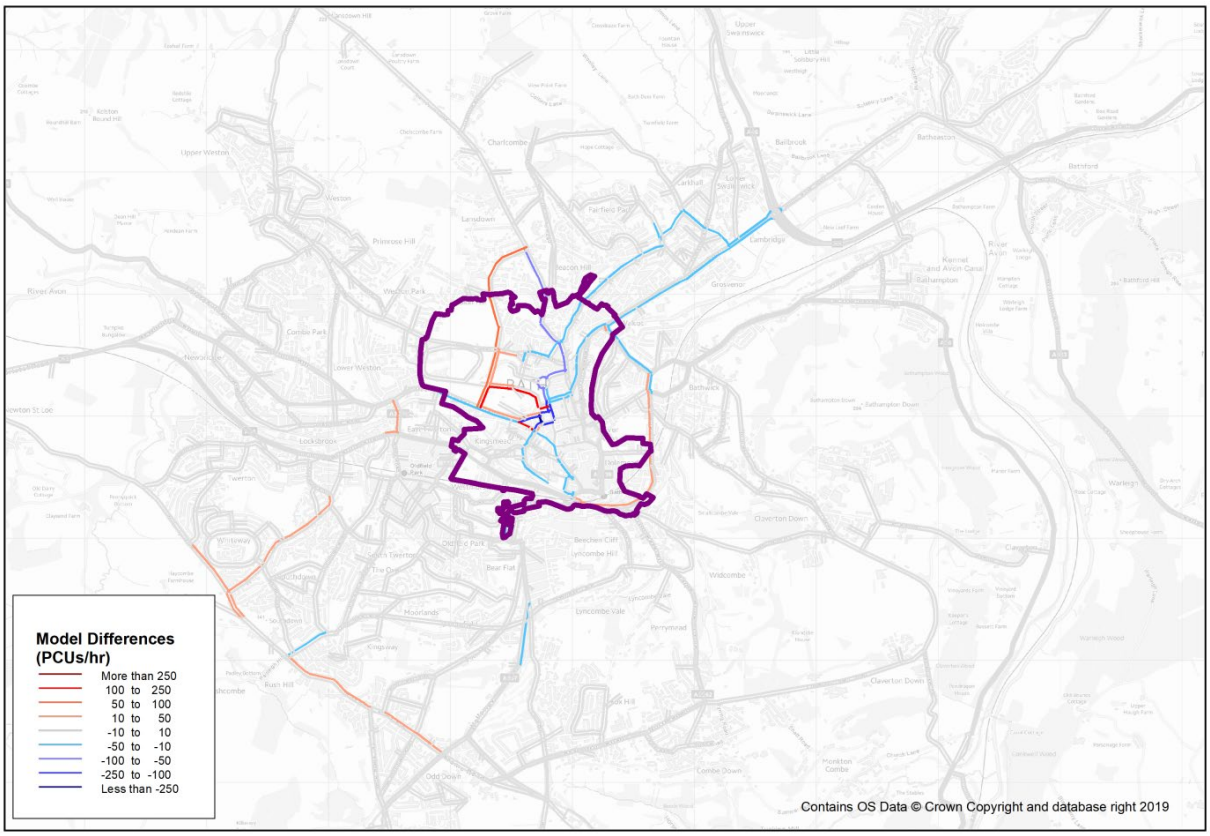
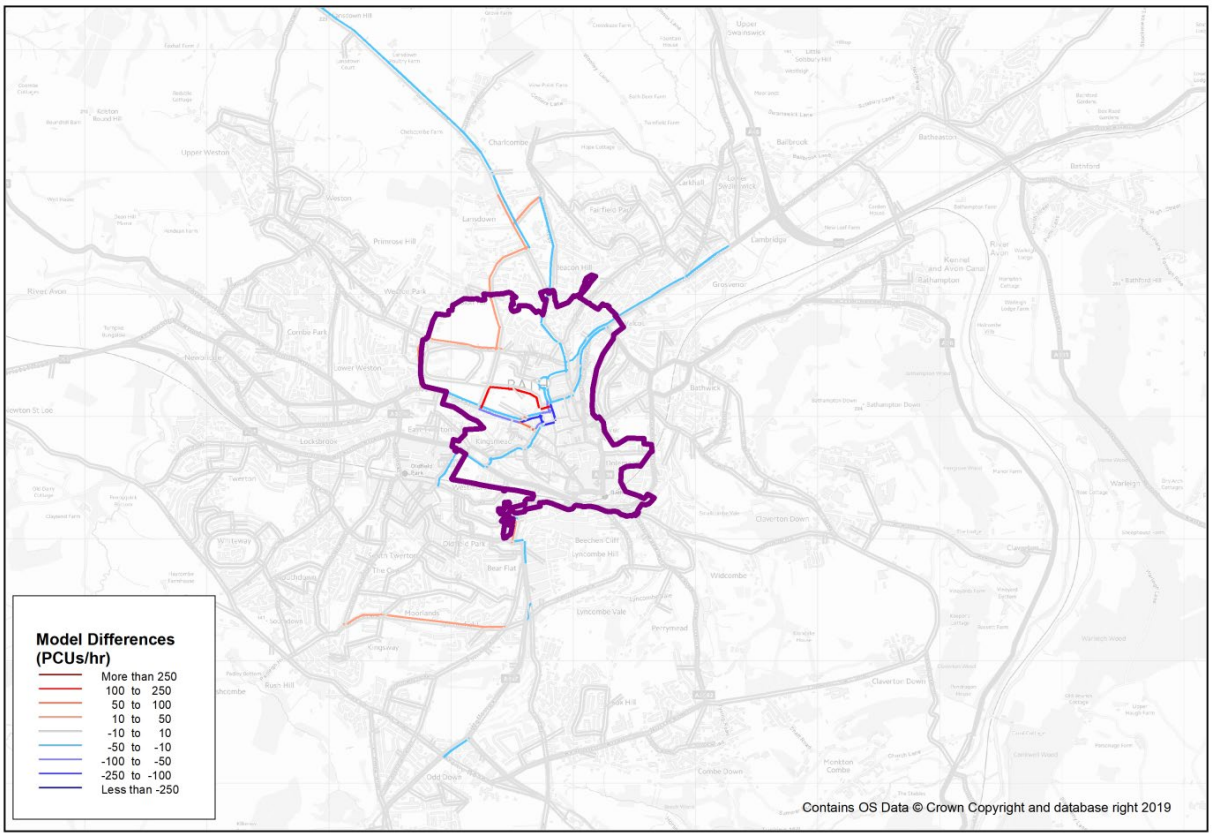


Figure 6-9: Traffic flow difference between '2021 CAZ C + TM' and '2021 Baseline' scenarios in the PM Peak Hour



The flow difference plots for the CAZ C + TM option indicate an overall traffic flow reduction within the impacted area across all modelled time periods. This is because the introduction of the charge fee reduces vehicle traffic accessing the City Centre, approximately 500 vehicles per hour, as well as through traffic using roads in the CAZ. However, it does result in some increases on roads mainly outside of the CAZ boundary, as non-compliant drivers attempt to avoid the charge by using routes around it. Examples of these include:

- Brassknocker Hill: Predicted flow increase in the AM peak hour;
- A4 north of London Road: Predicted flow increase in the AM peak hour;
- Widcombe Hill: Predicted flow increase in the AM peak hour
- Claverton Down Road: Predicted flow increase in the AM peak hour;
- Pulteney Road (South): Predicted flow increase in the AM and inter peak hours;
- Whiteway Road – Rush Hill: Predicted flow increases in inter-peak hour;
- The Hollow: Predicted flow increases in inter-peak hour; and
- Englishcombe Lane: Predicted increases in the PM peak hour.

However, the scale of these potential impacts is considered to be negligible, as almost all the links highlighted in light-orange fall into the “10 to 50 PCU increment in traffic flow in an hour” category, which can be considered as well within normal day-to-day variation in traffic volumes.

The is also a re-routing effect from the Queen Square Traffic Management non-charging measure, which reduces traffic along Queens Square, Charlotte Street, Monmouth Place, Gay Street, George Street and Lansdown Road while traffic increases along Marlborough Lane, Royal Avenue, Park Lane and Weston Road.

6.1.6 Links to Air Quality Model

The link from the transport model to the air quality model are outlined in FBC-13 Local Plan Transport Modelling Methodology Report (T3) in Appendix E of the FBC, Chapter 9. Link-based traffic flows, by compliance from the highway model are fed through to the air quality model in a format compatible with the EFT, after undergoing post-processing of the model outputs. FBC-11 Air Quality Modelling Report (AQ3) in Appendix D of the FBC provides details of the air quality modelling.

7. FBC Option Forecasts with Revised Boundary

7.1.1 Assessment Scenarios

The final CAZ option was determined through an iterative process of Transport Model / Air Quality Model scenario runs as outlined in Chapter 6. The CAZ Class C plus TM was identified as the preferred option.

The boundary of the CAZ has extended slightly since the FBC, resulting in a FBC boundary being identified, therefore the preferred option has been tested with this boundary. The results from this option are outlined below.

7.1.2 Compliance Splits

The 2021 and 2031 compliance splits at the boundary for the CAZ C with TM option are shown in Table 6-1 and 7.2 respectively.

Table 7-1: 2021 CAZ C with TM Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	79.40%	20.60%	79.30%	20.70%	79.30%	20.70%
LGV	91.68%	8.32%	92.46%	7.54%	91.84%	8.16%
HGV rigid	95.03%	4.97%	93.97%	6.03%	95.26%	4.74%
HGV artic	97.91%	2.09%	97.46%	2.54%	98.01%	1.99%
HGV	96.62%	3.38%	95.54%	4.46%	95.42%	4.58%
Taxi	98.16%	1.84%	98.23%	1.77%	98.10%	1.90%
Bus	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Coach	98.95%	1.05%	98.53%	1.47%	99.11%	0.89%
Total	**82.24%**	**17.76%**	**82.84%**	**17.16%**	**81.38%**	**18.62%**

Table 7-2: 2031 CAZ C with TM Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	99.30%	0.70%	99.30%	0.70%	99.30%	0.70%
LGV	99.33%	0.67%	99.37%	0.63%	99.27%	0.73%
HGV rigid	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
HGV artic	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
HGV	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Taxi	99.91%	0.09%	99.92%	0.08%	99.90%	0.10%
Bus	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Coach	100.00%	0.00%	100.00%	0.00%	100.00%	0.00%
Total	**99.37%**	**0.63%**	**99.39%**	**0.61%**	**99.35%**	**0.65%**

The compliance splits results show that the CAZ Class C with TM scheme increases the average compliance from 75% in the 2021 Baseline to 82% compliant, which is the same as the CAZ Class C with TM scheme results from the FBC boundary model runs.

The effect of the CAZ Class C with TM in 2031 is only marginal, with the average compliance increasing very slightly, as the baseline is 99% in 2031. This is the same as the CAZ Class C with TM scheme results from the FBC boundary model runs.

7.1.3 Euro Standard Splits

The 2021 and 2031 Euro Standard splits at the cordon of the CAZ C with TM option for are shown in Table 6-63 and Table 6-94 together with the baseline (calculated Bath Euro Proportions) splits for comparison.

Table 7-3: 2021 CAZ C with TM Euro Standard Splits

Petrol Car	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.01	0.01
4Euro 3	0.05	0.05
5Euro 4	0.14	0.14
6Euro 5	0.36	0.36
7Euro 6*	0.17	0.17
7Euro 6c*	0.28	0.28

Diesel Car	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.00	0.00
4Euro 3	0.02	0.02
5Euro 4	0.09	0.09
6Euro 5	0.29	0.29
7Euro 6	0.18	0.18
7Euro 6c*	0.39	0.39
7Euro 6d*	-	-

Petrol LGV	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	0.00	0.00
3Euro 2	0.03	0.05
4Euro 3	0.07	0.10
5Euro 4	0.01	0.01
6Euro 5	0.34	0.32
7Euro 6*	0.25	0.24
7Euro 6c*	0.31	0.29

Diesel LGV	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	0.00	0.00
4Euro 3	0.03	0.00
5Euro 4	0.10	0.02
6Euro 5	0.28	0.05
7Euro 6*	0.18	0.28
7Euro 6c*	0.41	0.64
7Euro 6d*	-	-

Rigid HGV	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.00	0.00
4Euro III	0.02	0.00
5Euro IV	0.05	0.01
6Euro V_EGR	0.05	0.01
7Euro V_SCR	0.14	0.03
8Euro VI	0.74	0.95
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Artic HGV	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.00	0.00
4Euro III	0.00	0.00
5Euro IV	0.01	0.00
6Euro V_EGR	0.02	0.00
7Euro V_SCR	0.06	0.01
8Euro VI	0.90	0.98
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Buses	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.04	-
4Euro III	0.16	-
5Euro IV	0.12	-
6Euro V_EGR	0.03	-
7Euro V_SCR	0.08	-
8Euro VI	0.58	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Coaches	Calculated Bath Euro Proportions 2021	Modelled CAZ C + TM Euro Proprotions 2021
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	0.03	0.00
4Euro III	0.04	0.00
5Euro IV	0.05	0.00
6Euro V_EGR	0.02	0.00
7Euro V_SCR	0.06	0.00
8Euro VI	0.79	0.99
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Table 7-4: 2031 CAZ C with TM Euro Standard Splits

Petrol Car	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	-
5Euro 4	0.00	0.00
6Euro 5	0.05	0.05
7Euro 6*	0.03	0.03
7Euro 6c*	0.92	0.92

Diesel Car	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	-
5Euro 4	0.00	0.00
6Euro 5	0.02	0.02
7Euro 6	0.04	0.04
7Euro 6c*	0.16	0.16
7Euro 6d*	0.78	0.78

Petrol LGV	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	0.01
5Euro 4	0.00	0.00
6Euro 5	0.01	0.01
7Euro 6*	0.01	0.01
7Euro 6c*	0.98	0.97

Diesel LGV	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro 1	-	-
2Euro 1	-	-
3Euro 2	-	-
4Euro 3	-	-
5Euro 4	0.00	0.00
6Euro 5	0.03	0.01
7Euro 6*	0.03	0.03
7Euro 6c*	0.12	0.13
7Euro 6d*	0.82	0.83

Rigid HGV	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	-	-
5Euro IV	0.00	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.01	-
8Euro VI	0.99	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Artic HGV	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	-	-
5Euro IV	-	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.00	-
8Euro VI	1.00	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Buses	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	0.00	-
5Euro IV	0.01	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.01	-
8Euro VI	0.97	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

Coaches	Calculated Bath Euro Proportions 2031	Modelled CAZ C + TM Euro Proprotions 2031
1Pre-Euro I	-	-
2Euro I	-	-
3Euro II	-	-
4Euro III	-	-
5Euro IV	-	-
6Euro V_EGR	0.00	-
7Euro V_SCR	0.01	-
8Euro VI	0.98	1.00
9Euro II SCRRF	-	-
10Euro III SCRR	-	-
11Euro IV SCRR	-	-
12Euro V EGR +	-	-

7.1.4 Highway Network Statistics

The highway model network statistics have been extracted for the final option, for 2021 and 2031 and compared against the baseline network statistics. Table 6-115 and Table 6-136 show the statistics for 2021 and 2031 respectively.

Table 7-5: 2021 Baseline and CAZ C + TM Highway Network Statistics

Measure	2021 Baseline			2021 CAZ C + TM			% Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	1306.90	891.60	1162.70	1302.70	890.10	1156.80	-0.3%	-0.2%	-0.5%
OVER-CAPACITY QUEUES	660.00	189.70	387.40	656.60	190.60	389.70	-0.5%	0.5%	0.6%
LINK CRUISE TIME	6011.10	4275.50	5566.80	5998.90	4269.30	5560.70	-0.2%	-0.1%	-0.1%
FREE FLOW	5832.50	4124.20	5373.20	5823.80	4121.80	5371.60	-0.1%	-0.1%	0.0%
DELAYS	178.60	151.30	193.60	175.20	147.60	189.10	-1.9%	-2.4%	-2.3%
TOTAL TRAVEL TIME	7978.00	5356.80	7116.90	7958.10	5350.00	7107.20	-0.2%	-0.1%	-0.1%
TRAVEL DISTANCE	266992	202679	247621	266520	202351	247512	-0.2%	-0.2%	0.0%
OVERALL AVERAGE SPEED	33.50	37.80	34.80	33.50	37.80	34.80	0.0%	0.0%	0.0%
TOTAL TRIPS LOADED	41837	30980	39195	41804	30950	39171	-0.1%	-0.1%	-0.1%

Table 7-1: 2031 Baseline and CAZ C + TM Highway Network Statistics

Measure	2031 Baseline			2031 CAZ C + TM			% Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	1401.10	985.10	1267.70	1401.50	984.40	1267.60	0.0%	-0.1%	0.0%
OVER-CAPACITY QUEUES	771.70	212.30	392.30	771.30	213.60	394.50	-0.1%	0.6%	0.6%
LINK CRUISE TIME	6472.30	4687.40	5972.70	6469.80	4683.70	5970.60	0.0%	-0.1%	0.0%
FREE FLOW	6275.60	4521.10	5753.50	6275.30	4521.80	5755.70	0.0%	0.0%	0.0%
DELAYS	196.70	166.20	219.30	194.50	161.90	214.90	-1.1%	-2.6%	-2.0%
TOTAL TRAVEL TIME	8645.20	5884.80	7632.80	8642.60	5881.80	7632.70	0.0%	-0.1%	0.0%
TRAVEL DISTANCE	289454	222890	266520	289327	222713	266514	0.0%	-0.1%	0.0%
OVERALL AVERAGE SPEED	33.50	37.90	34.90	33.50	37.90	34.90	0.0%	0.0%	0.0%
TOTAL TRIPS LOADED	45116	33978	42153	45105	33971	42146	0.0%	0.0%	0.0%

The 2021 results show that with the introduction of a CAZ Class C with TM the number of trips within the network decreases. As a result, there are moderate decreases in queues and delays across the model area.

The 2031 results show that each option has very little effect on the traffic in Bath, as the Baseline compliance across all vehicle types is approximately 99%.

7.1.5 Flow Difference Plots

To show the impact of the CAZ on traffic flows around the Bath area, flow difference plots representing the 1-way traffic flow change (in PCUs) between the 2021 CAZ Class C with TM and Baseline scenarios across all

modelled time periods are presented below. Similar plots for 2031 have been omitted, as the scheme impact magnitude at this time in the future is significantly smaller because of the majority of vehicle fleet being compliant with CAZ entry policy, leaving smaller number of users with non-compliant vehicles.

Figure 6-71 to 7-3 show the expected changes in the weekday AM peak hour (8:00-9:00 am), an average weekday inter-peak hour and the weekday PM peak hour (5:00-6:00 pm), respectively for the CAZ C plus TM option with the FBC boundary.

Figure 7-1: Traffic flow difference between '2021 CAZ C + TM' and '2021 Baseline' scenarios in the AM Peak Hour

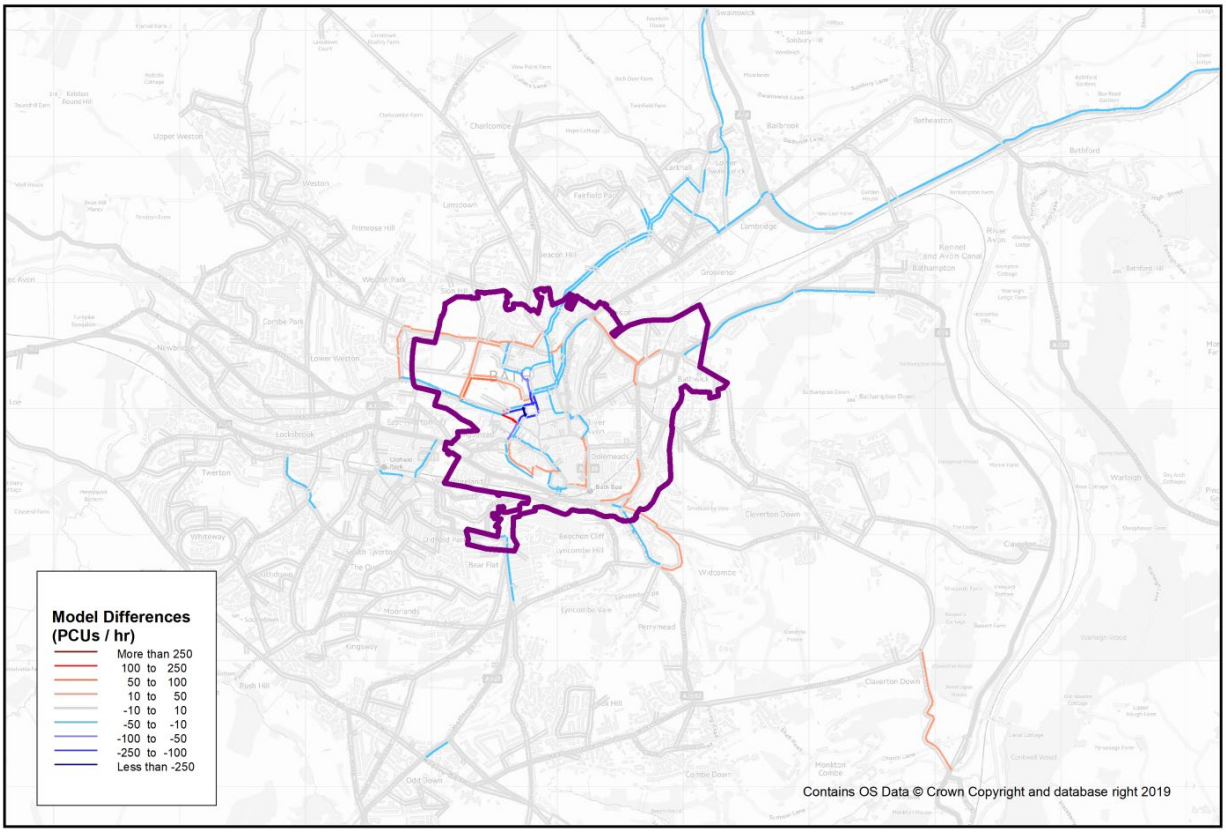


Figure 7-2: Traffic flow difference between '2021 CAZ C + TM' and '2021 Baseline' scenarios in the Interpeak Period

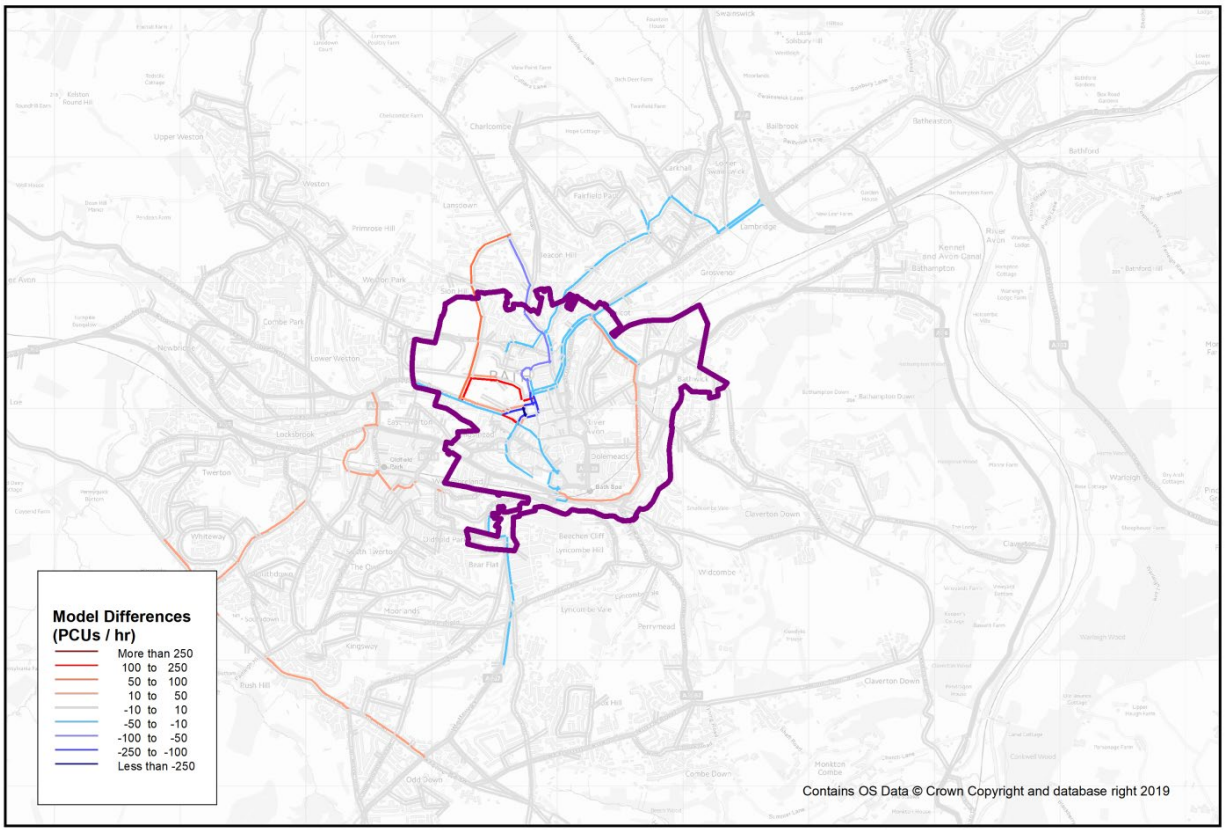
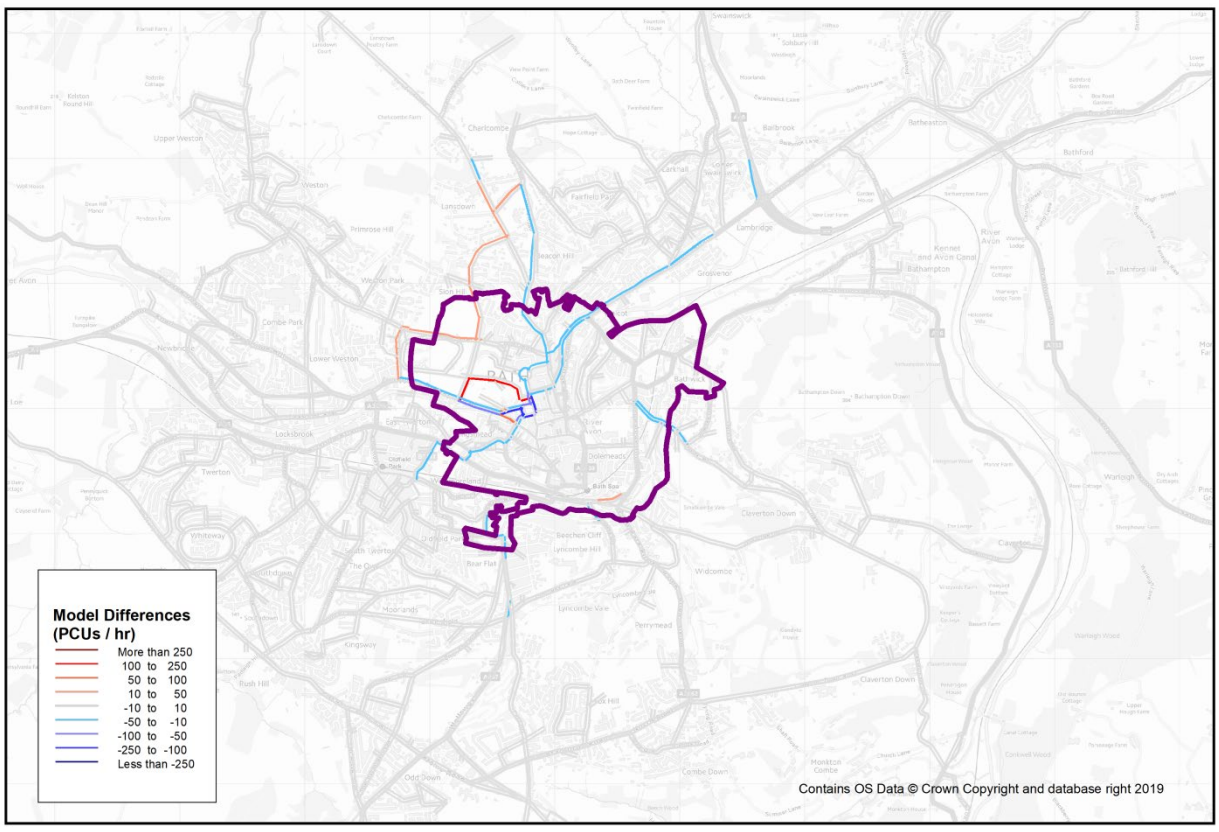


Figure 7-3: Traffic flow difference between '2021 CAZ C + TM' and '2021 Baseline' scenarios in the PM Peak Hour



The flow difference plots for the CAZ C + TM option indicate an overall traffic flow reduction within the impacted area across all modelled time periods. This is because the introduction of the charge fee reduces vehicle traffic accessing the City Centre, approximately 500 vehicles per hour, as well as through traffic using roads in the CAZ. However, it does result in some increases on roads mainly outside of the CAZ boundary, as non-compliant drivers attempt to avoid the charge by using routes around it. Examples of these include:

- Brassknocker Hill: Predicted flow increase in the AM peak hour;
- Widcombe Hill: Predicted flow increase in the AM peak hour
- Pulteney Road (South): Predicted flow increase in the AM and inter peak hours;
- Whiteway Road – Rush Hill: Predicted flow increases in inter-peak hour; and
- The Hollow: Predicted flow increases in inter-peak hour.

However, the scale of these potential impacts is considered to be negligible, as almost all the links highlighted in light-orange fall into the “10 to 50 PCU increment in traffic flow in an hour” category, which can be considered as well within normal day-to-day variation in traffic volumes.

The is also a re-routing effect from the Queen Square Traffic Management non-charging measure, which reduces traffic along Queens Square, Charlotte Street, Monmouth Place, Gay Street, George Street and Lansdown Road while traffic increases along Marlborough Lane, Royal Avenue, Park Lane and Weston Road.