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Cabinet
Supplementary Information

Date: Thursday, 25 February 2021
Time: 4.00 pm
Venue: Virtual Meeting - Zoom Committee Meeting with Public Access via YouTube

16. Improving Public Health - Bristol Clean Air Zone Update

FBC 27-48 (excluding 33,35,41) **(Pages 2 - 337)**

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Date: Thursday, 18 February 2021

Bristol City Council Clean Air Plan Final Business Case

Transport Modelling Forecasting Report (T4)

FBC-27 | 7

February 2021

Bristol City Council

Bristol City Council Clean Air Plan Final Business Case

Project No: 673846.ER.20
Document Title: Transport Model Forecast Report (T4)
Document No.: FBC-27
Revision: 7
Document Status: N/A
Date: February 2021
Client Name: Bristol City Council
Client No: N/A
Project Manager: HO
Author: JM/KW
File Name: N/A

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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
1	31/08/2018	Draft	KW	JB	CB	BL
2	29/01/2018	Draft	KW	JB	CB	HO
3	02/09/2019	Draft	KW	JB	CB	HO
4	25/10/2019	Draft OBC	KW	CB	CB	HO
5	05/04/2020	Draft FBC	KW	CB	CB	HO
6	05/02/2021	Updated draft FBC	JM/KW	CB	CB	HO
7	16/02/2021	Updated draft FBC	JM/KW	CB	CB	HO

Acronyms and Abbreviations

AADT	Annual average daily traffic
ANPR	Automatic Number Plate Recognition
ATC	Automatic traffic count
AQMA	Air Quality Management Area
BCC	Bristol City Council
CAP	Clean Air Plan
CAZ	Clean Air Zone
CO_2	Carbon Dioxide
Defra	Department for Environment, Food & Rural Affairs
DfT	Department for Transport
EFT	Emission Factor Toolkit
GBATS	Greater Bristol Area Transport Study
HGV	Heavy Goods Vehicle
IMD	Indices of Multiple Deprivation
JAQU	Joint Air Quality Unit
LGV	Light Goods Vehicle
NO_2	Nitrogen Dioxide
NTM	National Transport Model
NTEM	National Trip End Model
OBC	Outline Business Case
FBC	Final Business Case
PT	Public Transport
(Web)TAG	Transport Analysis Guidance
VDM	Variable Demand Model
VRN	Vehicle Registration Number
(Web)TAG	Transport Analysis Guidance

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). The Mayor of Bristol has often cited Bristol's 'moral and legal duty' to improve air quality in the city and the administration recognises that achieving improved air quality is not solely a transport issue. Notwithstanding the Council's work on a Clean Air Zone, efforts have been made to make citizens more aware of – and take personal responsibility for – various sources of air pollution, from traffic fumes to solid fuel burning. The Mayor has articulated a 'call to action' for local people, businesses and organisations to consider how small changes can make a significant difference in cutting toxic fumes across the city. BCC has monitored and endeavoured to address air quality in Bristol for decades and declared its first Air Quality Management Area in 2001. Despite this, Bristol has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO_2) and these are predicted to continue until around 2027 without intervention.

The added context is that of the COVID-19 pandemic. Recent research suggests that poor air quality may be correlated with higher death / infection rates from COVID-19. This is further compounded by growing evidence that suggests that those from black, Asian and minority ethnic communities are more at risk of catching and dying from the virus and the fact that individuals from these communities are more likely to live in areas where air quality is poor. The challenge of maintaining public health and supporting economic recovery while also achieving legal air quality levels after lockdown restrictions are lifted will remain live and intersecting issues for the foreseeable future.

The UK Government continue to transpose European Union law into its Environment Bill[2] , to ensure that certain standards of air quality continue to be met, by setting air quality assessment levels (AQALs) on the concentrations of specific air pollutants. It's very unlikely that these AQALs will differ to EU Limit Values prescribed by the European Union's Air Quality Directive and transcribed in the UK's Air Quality Standards Regulation 2010. Therefore, these Limit Values will remain in enforcement post-Brexit. In common with many EU member states, the EU Limit Value for annual mean nitrogen dioxide (NO_2) is breached in the UK and there are on-going breaches of the NO_2 limit value in Bristol. The UK government is taking steps to remedy this breach in as short a time as possible, with the aim of reducing the harmful impacts on public health. Within this objective, the Government has published a UK Air Quality Plan and a Clean Air Zone Framework, both originally published in 2017 (noting there have been subsequent revisions). The latter document provides the expected approach for local authorities when implementing and operating a Clean Air Zone (CAZ). The following business cases have been submitted to JAQU for the Clean Air Plan; Strategic Outline Case (April 2018), and an Outline Business Case (November 2019 and updated between April and June 2020).

Following the submission of the OBC, further work was undertaken to develop the scheme, which resulted in the development of a new option - the Small area CAZ D. This work, and the option development work undertaken as part of the OBC, is presented in an updated Option Assessment Report (Appendix C FBC-16). The OBC version of this report is appended to the updated Option Assessment Report.

1.2 Purpose of this Report

This report presents the methodology and results for the transport modelling forecasting undertaken to assess the baseline and Small CAZ D option. This report has previously been submitted as part of the OBC and the draft FBC (April 2020). Previous options presented in previous versions of the T4 report are no longer being considered.

[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] Environment Bill 2019-21 https://services.parliament.uk/bills/2019-21/environment.html

2. Scope of Assessment

2.1 Model extent

The SATURN highway model covers the city of Bristol, South Gloucestershire, North Somerset and Bath and North East Somerset within the limits of the Greater Bristol area in the simulation network, with the remaining parts of these authorities included within the buffer network. The Bristol SATURN highway model extent is shown in Figure 2-1.

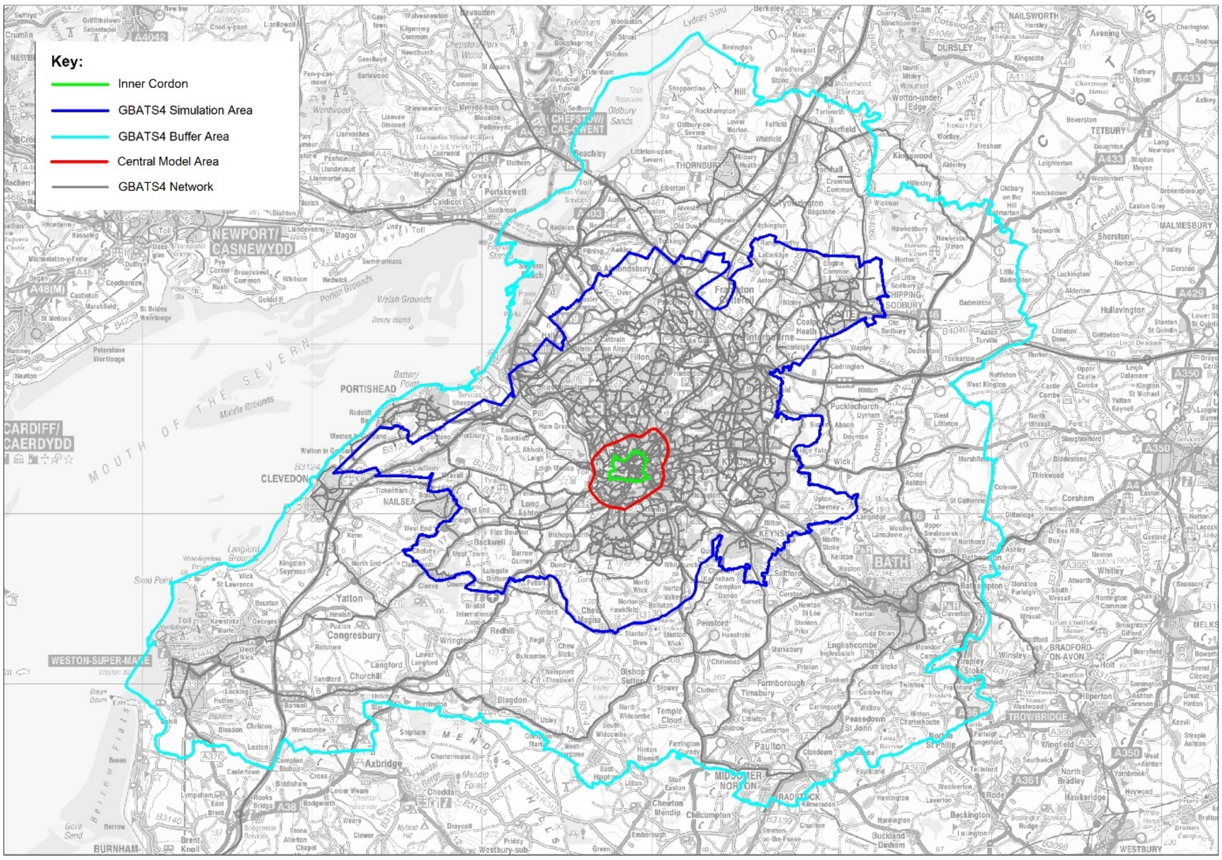


Figure 2-1: Bristol Model Extent

2.2 Time periods

The GBATS4M Demand Model represents trip-based movements across Bristol and the surrounding area for a weekday 12-hour period (07:00-19:00). The GBATS4M SATURN Highway model represents vehicle-based movements across the city for the 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 2015 since the 2017 data was not available at the time the model was developed, and in 2016 there was a significant amount of disruption from roadworks in the city (related to the Metrobus scheme) which prevented some monitoring data from being collected and altered the typical travel patterns across the city.

The target compliance year was estimated 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 2021. Hence the modelled opening year is 2021.

A 2031 model has also been developed, to assess the impact of the CAZ 10 years after the initial modelled forecast year.

Based on use of the above models, the OBC transport and air quality modelling work has identified an earliest compliance year of 2027, assuming a linear interpolation of air quality results between 2021 and 2031. However, since various modelled factors such as improvements in fleet composition are not linear, it was agreed that 2023 should be modelled for the baseline and the CAZ options to provide a more accurate assessment.

2.4 CAZ Boundary

Figure 2-2 shows the CAZ boundary for the Small CAZ D option.

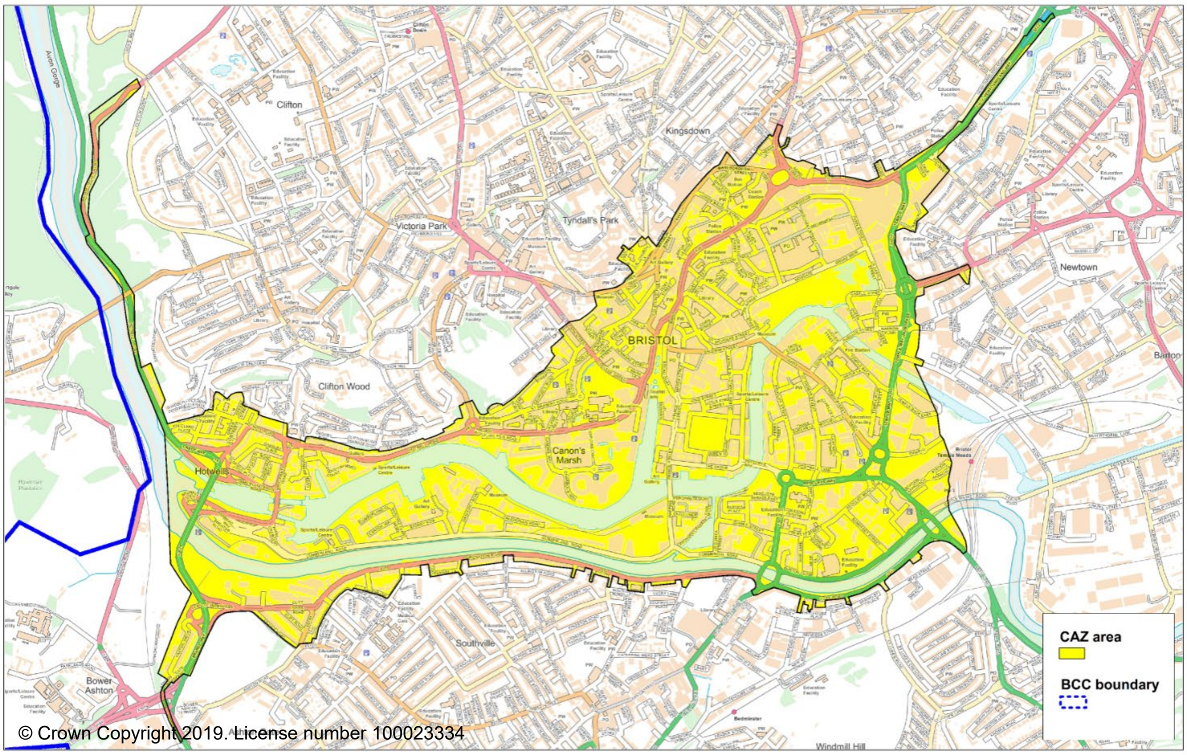


Figure 2-2: Bristol Small CAZ geography

3. Modelling methodology

This section provides a summary of the modelling methodology, the detailed methodology found in FBC-23 Transport Modelling Methodology Report (T3) in Appendix E of the FBC, and its appended technical notes, bringing together an overview of all the components of how the baseline and option testing has been carried out using the GBATS4M Transport Model.

3.1 Base and Baseline

3.1.1 Model Development

The Transport Modelling Methodology Report (T3), chapters 3, 4, 6 and 7, outlines the modelling methodology for the Base and Baseline models. It states that the GBATS4M variable demand model has been used to develop the 2021 baseline models, based on the inputs from the updated Uncertainty Log.

The Uncertainty Log was developed in 2015 therefore details for an up-to-date Uncertainty Log have been collated. This covers both development and scheme assumptions. The Baseline model (2021) has the most recent scheme assumptions for the assessment year modelled within it based on the Near Certain and More than Likely entries in the Uncertainty Log. In addition to those highway schemes in the Uncertainty Log, the Street Space Schemes have also been included in the Baseline model.

A growth model has been developed within the Demand Model which creates highway and public transport future year demand matrices using the production and attraction trip end totals for the new development, a gravity model to distribute these new developments using base year travel costs and then converting to origin and destination format. These new trips are then added to the base year matrices. Three-dimensional matrix balancing to build full reference case matrices is undertaken, retaining the base year trip length distribution and control to the National Trip End model (NTEM, Tempro V7.2) growth for West of England and external zones.

These matrices are then run through the variable demand model until convergence is achieved within the limits specified by the DfT.

Light and heavy goods vehicle growth is based on forecasts produced by the National Transport Model (NTM) as advised by TAG. Goods vehicles are not subject to change via the demand model.

Joint Spatial Plan growth has not been included in the development of the 2021, 2023 and 2031 baseline models as it is not sufficiently certain, in terms of the TAG criteria, to be included.

The 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 Street Space Schemes

The Street Space schemes have been included in the Baseline scenario. The Street Space schemes have been implemented in Bristol to open up road space usually occupied by vehicles to public transport, cyclists and pedestrians. The schemes are expected to be made permanent by BCC and therefore have been included in the Baseline models.

Further information on the Street Space schemes is provided in FBC-23 Transport Modelling Methodology Report (T3), Chapter 4, in Appendix E of the FBC.

3.1.3 ANPR Data

The 2017 ANPR surveys were undertaken in July and the analysis (including tabulated data) and use are discussed fully in FBC-24 ANPR Data Analysis and Application technical note in Appendix E of the FBC. A summary is provided here.

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 and fuel type splits. 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.

The base year compliance splits by vehicle type (Car, Taxi, LGVs, Coaches and HGVs) have been determined from the 2017 ANPR data worked back to 2015 using the Emission Factor Toolkit national euro standard splits. The 2021, 2023 and 2031 baseline compliance splits by vehicle type (Car, Taxi, LGVs, Coaches and HGVs) and Euro standard fleet mix have been determined from the 2017 ANPR data adjusted to the future year using the fleet projection tool within the Emission Factor Toolkit (EFT). Fuel splits for each year have been taken from the EFT (v9.1b).

3.1.4 Matrix Compliance / Fuel Type Splits

The highway model has 6 user classes: Car Non-business (Low Income), Car Non-business (Medium Income), Car Non-business (High Income), Car Business, LGV and HGV. These have been split into 12 user classes using the following methodology:

- Split the Car user classes into Car and Taxi user classes;
- Split the HGV user class into HGV and Coach user classes; and
- Split Car, Taxi, LGV, HGV and Coach matrices into compliant and non-compliant using the time period splits.

3.1.5 Post-Processing

The ANPR data collected has also been used to determine the HGV rigid/artic split by compliance. The EFT v9.1b has been used for the fuel splits. This has been used to add more detail, where needed, to the modelled outputs via post processing, to produce inputs into the EFT.

An additional adjustment has been made to car fuel splits due to identification by BCC of an increase in petrol taxis replacing diesel. These were applied to the traffic link data extracted from the model runs via post-processing before input to the EFT.

First Bus and BCC provided information regarding the 2021, 2023 and 2031 fleet composition by service. The bus fleet composition has been handled outside the transport model, before input to the EFT. This has enabled vehicle details for particular routes to be accounted for in both the current and future fleet.

Adjustments have been made to traffic flows to improve the accuracy of the Air Quality Modelling along Church Road near St George's Park prior to inputting the data into the EFT. Additional adjustments have also been made to traffic flows and speeds at three locations on the network which critical to Air Quality compliance. These locations are:

- Marlborough St (B4051)
- Rupert St (A38)
- Baldwin St (B4053)

Details of the adjustments applied are given in FBC-23 Transport Modelling Methodology Report (T3), Chapter 7, in Appendix E of the FBC. Adjustments to these links were made prior to inputting data into the EFT.

3.1.6 Euro Standard Splits

The EFT has national Euro Standard splits within it. These have been overwritten with splits calculated from the 2017 ANPR data, projected forward to the future modelled years, using the EFT.

3.1.7 2015 Base Compliance Splits

The base year compliance splits have been determined from the 2017 ANPR data worked back to 2015 using the EFT national euro standard splits. Chapter 3 of the FBC-24 ANPR Data Analysis and Application technical note, in Appendix E of the FBC, details this process and the outputs. Table 3-1 shows the projected 2015 compliance data by time period.

Table 3-1: 2015 Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	36.1%	63.9%	34.7%	65.3%	35.3%	64.7%
LGV	0.2%	99.8%	0.2%	99.8%	0.2%	99.8%
HGV rigid	20.2%	79.8%	19.0%	81.0%	15.2%	84.8%
HGV artic	35.0%	65.0%	36.3%	63.7%	34.0%	66.0%
HGV	22.7%	77.3%	21.7%	78.3%	19.2%	80.8%
Taxi	11.5%	88.5%	9.1%	90.9%	10.7%	89.3%
Bus	7.6%	92.4%	7.9%	92.1%	7.7%	92.3%
Coach	14.7%	85.3%	15.1%	84.9%	15.8%	84.2%
Total	28.4%	74.8%	27.1%	76.6%	30.0%	71.3%

3.1.8 Baseline Compliance Splits

The fleet projection tool within the EFT v9.1b has been used to project the euro standard splits from the 2017 ANPR data to the Baseline compliance splits. The forecast compliance splits by vehicle type for 2021, 2023 and 2031 are summarised in Table 3-2, Table 3-3 and Table 3-4 respectively. It should be note that the EFT does not go beyond 2030, therefore 2030 was used as a proxy for 2031.

Table 3-2: 2021 Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	72.7%	27.3%	71.4%	28.6%	72.0%	28.0%
LGV	58.0%	42.0%	63.1%	36.9%	58.2%	41.8%
HGV rigid	73.9%	26.1%	72.5%	27.5%	66.7%	33.3%
HGV artic	85.7%	14.3%	86.4%	13.6%	85.2%	14.8%
HGV	76.6%	23.4%	75.6%	24.4%	72.6%	27.4%
Taxi	66.0%	34.0%	66.0%	34.0%	66.0%	34.0%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	68.8%	31.2%	69.6%	30.4%	70.6%	29.4%
Total	70.6%	29.4%	70.7%	29.3%	70.9%	29.1%

Table 3-3: 2023 Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	82.9%	17.1%	82.1%	17.9%	82.5%	17.5%
LGV	73.3%	26.7%	77.3%	22.7%	73.5%	26.5%
HGV rigid	85.1%	14.9%	84.1%	15.9%	80.1%	19.9%
HGV artic	92.4%	7.6%	92.8%	7.2%	92.0%	8.0%
HGV	86.8%	13.2%	86.2%	13.8%	84.2%	15.8%
Taxi	74.5%	25.5%	74.5%	25.5%	74.5%	25.5%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	81.1%	18.9%	81.7%	18.3%	82.4%	17.6%
Total	81.5%	18.5%	81.6%	18.4%	81.6%	18.4%

Table 3-4: 2031 Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	98.2%	1.8%	98.1%	1.9%	98.2%	1.8%
LGV	97.0%	3.0%	97.6%	2.4%	97.0%	3.0%
HGV rigid	98.8%	1.2%	98.7%	1.3%	98.3%	1.7%
HGV artic	99.4%	0.6%	99.5%	0.5%	99.4%	0.6%
HGV	99.0%	1.0%	98.9%	1.1%	98.7%	1.3%
Taxi	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Total	98.1%	1.9%	98.2%	1.8%	98.2%	1.8%

It should be noted that the taxi and bus compliance splits for 2021, 2023 and 2031 are based on data obtained by BCC and First Bus.

3.1.9 Fuel Type Splits

The 2017 ANPR fuel splits for cars and LGVs have been adjusted to 2015 using the change over time in the TAG databook (May 2019) fuel split table. These were applied to the traffic link data extracted from the model runs during post-processing. Table 3-5 shows the fuel type splits obtained from the 2015 calculations.

Table 3-5: Fuel Type Splits (2015)

Vehicle Category	2015		
	Petrol	Diesel	Electric
Cars	55.21%	44.74%	0.04%
LGVs	0.80%	99.15%	0.05%

The EFT v9.1b has been used for the fuel splits for 2021, 2023 and 2031. An additional adjustment has been made to car fuel splits due to identification by BCC of an increase in petrol taxis replacing diesel. These were applied to the traffic link data extracted from the model runs via post-processing before input to the EFT. Table 3-6 shows the fuel type splits from the 2021, 2023 and 2031 EFT v9.1b with taxi adjustment.

Table 3-6: Fuel Type Splits (2021, 2023 and 2031)

Vehicle Category	2021			2023			2031		
	Petrol	Diesel	Electric	Petrol	Diesel	Electric	Petrol	Diesel	Electric
Cars	60.46%	38.71%	0.83%	61.42%	37.18%	1.40%	61.92%	28.88%	9.20%
LGVs	0.47%	99.38%	0.15%	0.44%	99.21%	0.35%	0.31%	95.91%	3.78%

3.2 Clean Air Zone Option Testing

3.2.1 Assessment Scenarios

The Small CAZ D option has been tested in the Transport Model. The Small CAZ D option includes:

- Small Area Class D (charging non-compliant cars, buses, coaches, taxis, HGVs and LGVs);
- Fast Track Measures:
    - Closure of Cumberland Road inbound to general traffic; and
    - Holding back traffic to the city centre through the use of existing signals.

The response rates modelled for the Small CAZ D are outlined below and have been modelled within the GBATS SATURN highway model using the methodology outlined below. The boundary of the Small CAZ D is shown in Figure 2-2.

3.2.2 Primary Behavioural Responses

The primary charging CAZ responses have been modelled using the GBATS4M highway model using the following methodology, as described in FBC-23 Transport Modelling Methodology Report (T3) in Appendix E of the FBC, Chapter 5:

- Pay Charge – no change to the model;
- Avoid Zone (diversion) – 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 / change destination– 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 link flows to the compliant link flows.

3.2.3 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 Guidance. 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.

3.2.4 Stated Preference Surveys

Stated preference survey of BCC / South Gloucestershire Council (SGC) / North Somerset Council (NSC)/ Bath and North East Somerset (B&NES) residents were undertaken in 2018. The work targeted owners of non-compliant cars / LGVs who drive in central Bristol, and 1,100 online surveys completed Feb / March 2018.

The questionnaires asked how owners would respond to a small and medium size charging CAZ using structured 'multiple choice' exercises and then the results were analysed using logistical regression statistical techniques.

The structure, implementation and outcomes of the survey are provided fully in FBC-28 Stated Preference Survey Report, in Appendix F of the FBC.

3.2.5 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 for cars. The LGVs methodology for determining response rates also requires an estimation of an upgrade cost. The upgrade costs of other vehicle types (HGVs, 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.

The methodology for calculating the upgrade costs for all vehicle type is discussed fully in FBC-26 Primary Behavioural Response Calculation Methodology in Appendix E of the FBC.

3.2.6 Proposed Charge Rates

The methodology for determining the proposed charge rates for all vehicle type is discussed fully in FBC-26 Primary Behavioural Response Calculation Methodology in Appendix E of the FBC and Table 3-7 shows the final proposed charges for the small sized charging zone. The charges were initially set for Cars, Taxis and LGVs so that the responses, from the Stated Preference survey, of avoid zone, change mode / cancel journey and replace vehicle combined roughly equated to the combined JAQU CAZ responses. These charges were found to be insufficient to bring about compliance during early model testing and so testing with higher charges was undertaken. Above a certain level there are diminishing returns to further increases and so the final proposed charges arrived at were at this point. Modelling also suggests that lowering the charges would lead to diminished air quality benefits.

Table 3-7: Bristol CAZ Proposed Changes

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

3.2.7 Calculated Response Rates

The methodology for calculating the primary response rates for each Option is discussed fully in FBC-26 Bristol Clean Air Plan: Primary Behavioural Response Calculation Methodology in Appendix E of the FBC and is summarised in FBC-23 Transport Modelling Methodology Report (T3).

Table 3-8 shows the final primary behavioural response rates by vehicle type for the Small CAZ D.

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

Response	Cars Low Income	Cars Medium Income	Cars High Income	Cars Employers Business	Taxis	LGVs	HGVs	Buses	Coaches
Pay Charge	4.3%	10.4%	5.4%	6.8%	4.1%	15.9%	8.8%	0.0%	17.8%
Avoid Zone	15.6%	19.0%	15.7%	7.7%	0.0%	19.2%	4.3%	0.0%	0.0%
Cancel Journey / Change Mode	39.8%	20.4%	14.2%	30.7%	0.0%	2.6%	4.3%	6.4%	11.4%
Replace Vehicle	40.4%	50.3%	64.6%	54.8%	95.9%	62.2%	82.6%	93.6%	70.8%

3.3 Traffic Management Measures

The identified traffic management measures to improve air quality have been modelled where included within Small CAZ D. This section discusses the methodology used to model these, which are covered by the Fast Track measures.

3.3.1 Cumberland Road

The closure of Cumberland Road inbound to general traffic was modelled within the SATURN highway model and run through the VDM to allow the demand model to determine the traffic response to this physical measure of removing highway capacity. This scheme component is a Fast Track measure.

3.3.2 Holding Back Traffic from City Centre

The modelling of holding back traffic to the city centre was achieved through the use of adjusting existing signal timings to reduce the capacity to that of the baseline flows at each entry point. This restricted the re-routing of trips from Cumberland Road, therefore ensuring overall trips into the city centre remain at the reduced level.

3.4 Links to Air Quality Model

The links from the transport model to the air quality model are outlined in FBC-23 Transport Modelling Methodology Report (T3), Chapter 10. Link-based traffic flows, by compliance / fuel type 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 6-user class and 16-user class matrix totals have been compared for each year, to maintain the same level of trips within the model. This check showed that the process was done correctly;
- The post-processing final compliance splits have been compared to the target splits; and
- Base year validation / calibration has been checked to ensure it has not been affected by the compliance splitting process.

After the matrices were split out (from 6 to 16 user classes) as described in the preceding chapter, the 16 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. The vehicle compliance splits across both the original small and medium model cordons were checked against the target values from the ANPR data. Table 4-1 and Table 4-2 show the target and modelled compliance rates as well as differences for each user class and time period (AM, IP (inter-peak) and PM) for the Small and Medium cordons respectively. These results show only very minor differences and hence are deemed acceptable.

Table 4-1: 2015 Small Cordon Compliance Splits

Vehicle Category	AM					IP					PM				
	Target		Model		Diff.	Target		Model		Diff.	Target		Model		Diff.
	%	Value	%	Value		%	Value	%	Value		%	Value	%	Value	
Cars	36%	6756	36%	6756	0	35%	4583	35%	4,578	-5	35%	6,972	36%	6,982	10
LGV	1%	23	1%	24	1	1%	30	1%	29	-1	1%	18	1%	19	1
HGV	26%	341	26%	341	0	25%	424	25%	424	0	23%	168	22%	167	0
Taxi	14%	97	14%	97	0	11%	94	11%	95	0	13%	139	13%	139	1
Coach	20%	17	20%	17	0	21%	30	21%	30	0	22%	41	21%	41	0
Total		7234		7236	2		5162		5,157	-5		7,338		7,349	11

Table 4-2: 2015 Medium Cordon Compliance Splits

Vehicle Category	AM					IP					PM				
	Target		Model		Diff.	Target		Model		Diff.	Target		Model		Diff.
	%	Value	%	Value		%	Value	%	Value		%	Value	%	Value	
Cars	36%	10,934	36%	10,934	0	35%	7,609	35%	7,600	-9	35%	11,755	35%	11,772	17
LGV	1%	37	1%	39	2	1%	50	1%	49	-1	1%	32	1%	34	2
HGV	26%	753	26%	753	0	25%	844	25%	845	1	23%	258	23%	258	0
Taxi	14%	158	14%	158	0	11%	158	11%	158	0	13%	229	13%	229	1
Coach	20%	39	20%	39	0	21%	61	21%	61	0	22%	63	22%	63	0
Total		11,920		11,923	3		8,722		8,713	-9		12,336		12,355	19

This the assignment of the 6-user class model was compared against the assignment of the 16-user class model, to ensure that the model had not been adversely affected. Table 4-3 shows the validation / calibration summary results for the AM, IP and PM highway assignments for the 6-user class and 16-user class user class models.

Table 4-3: Calibration/Validation Summary Results (UC6 is original model, UC16 is revised model)

Time Period	% Links GEH <5%			DMRB Link Criteria		
	UC6	UC16	Diff	UC6	UC16	Diff
AM	90%	90%	0%	88%	88%	0%
IP	88%	89%	1%	89%	90%	1%
PM	87%	86%	-1%	89%	87%	-3%

The results show that overall there are no significant differences between the UC6 and UC16 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 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 6-user class and 16-user class matrix totals have been compared for each year, to maintain the same level of trips within the model. This check showed that the process was done correctly;

- The 2015 to 2021, 2021-2023 and 2023-2031 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 2015 and 2021, Table 5-2 shows the changes by user class for 2021 and 2023, while Table 5-3 shows the changes by user class for 2023 and 2031; and

- The post-processing final compliance splits have been compared to the 'target' splits from the projected ANPR data. Table 5-4, Table 5-5 and Table 5-6 show the daily target and modelled proportions of compliant vehicles for 2021, 2023 and 2031 respectively.

Table 5-1: Matrix Totals by User Class (2015-2021)

User Class	Description	2015			2021			2021 - 2015 % Difference		
		AM	IP	PM	AM	IP	PM	AM	IP	PM
Total	Total	**144,727**	**126,810**	**135,991**	**150,080**	**132,728**	**140,810**	**3.7%**	**4.7%**	**3.5%**
UC1	Car Low Income Compliant	8,880	6,134	9,717	18,541	13,203	20,618	108.8%	115.2%	112.2%
UC2	Car Low Income Non-Compliant	15,718	11,544	17,811	6,514	4,933	7,472	-58.6%	-57.3%	-58.0%
UC3	Car Medium Income Compliant	12,986	8,938	14,182	27,141	19,271	30,150	109.0%	115.6%	112.6%
UC4	Car Medium Income Non-Compliant	22,986	16,821	25,994	9,536	7,200	10,926	-58.5%	-57.2%	-58.0%
UC5	Car High Income Compliant	9,064	6,038	9,707	18,914	13,011	20,593	108.7%	115.5%	112.1%
UC6	Car High Income Non-Compliant	16,043	11,363	17,792	6,646	4,861	7,463	-58.6%	-57.2%	-58.1%
UC7	Car Employers Business Compliant	3,390	3,923	2,028	7,128	8,475	4,334	110.3%	116.1%	113.7%
UC8	Car Employers Business Non-Compliant	6,000	7,382	3,717	2,504	3,167	1,571	-58.3%	-57.1%	-57.7%
	Car total	**95,065**	**72,142**	**100,949**	**96,924**	**74,121**	**103,127**	**2.0%**	**2.7%**	**2.2%**
UC9	Taxi Compliant	420	434	592	2,458	3,233	3,733	485.2%	645.1%	530.1%
UC10	Taxi Non-Compliant	3,233	4,335	4,945	1,266	1,666	1,923	-60.8%	-61.6%	-61.1%
	Taxi total	**3,653**	**4,768**	**5,537**	**3,724**	**4,899**	**5,656**	**2.0%**	**2.7%**	**2.1%**
UC11	LGV Compliant	30	34	25	10,040	12,451	8,385	33289%	36221%	33400%
UC12	LGV Non-Compliant	15,007	17,107	12,490	7,270	7,281	6,022	-51.6%	-57.4%	-51.8%
	LGV total	**15,037**	**17,142**	**12,515**	**17,310**	**19,732**	**14,407**	**15.1%**	**15.1%**	**15.1%**
UC13	HGV Compliant	6,602	6,547	2,600	23,104	23,656	10,196	250.0%	261.3%	292.2%
UC14	HGV Non-Compliant	22,481	23,623	10,941	7,059	7,636	3,848	-68.6%	-67.7%	-64.8%
	HGV total	**29,083**	**30,170**	**13,541**	**30,162**	**31,292**	**14,044**	**3.7%**	**3.7%**	**3.7%**
UC15	Coach Compliant	278	391	545	1,348	1,868	2,525	385.3%	377.9%	363.4%
UC16	Coach Non-Compliant	1,612	2,197	2,904	612	817	1,051	-62.0%	-62.8%	-63.8%

User Class	Description	2015			2021			2021 - 2015 % Difference		
		AM	IP	PM	AM	IP	PM	AM	IP	PM
	Coach total	**1,889**	**2,588**	**3,449**	**1,960**	**2,684**	**3,577**	**3.7%**	**3.7%**	**3.7%**

Overall, the total trips increase in 2021 compared to 2015. 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: Matrix Totals by User Class (2021-2023)

User Class	Description	2021			2023			2023 - 2015 % Difference		
		AM	IP	PM	AM	IP	PM	AM	IP	PM
Total	Total	**150,080**	**132,728**	**140,810**	**152,452**	**134,995**	**142,996**	**1.6%**	**1.7%**	**1.6%**
UC1	Car Low Income Compliant	18,541	13,203	20,618	21,147	15,189	23,579	14.1%	15.0%	14.4%
UC2	Car Low Income Non-Compliant	6,514	4,933	7,472	4,362	3,312	5,002	-33.0%	-32.9%	-33.1%
UC3	Car Medium Income Compliant	27,141	19,271	30,150	30,926	22,162	34,397	13.9%	15.0%	14.1%
UC4	Car Medium Income Non-Compliant	9,536	7,200	10,926	6,379	4,832	7,296	-33.1%	-32.9%	-33.2%
UC5	Car High Income Compliant	18,914	13,011	20,593	21,539	14,962	23,490	13.9%	15.0%	14.1%
UC6	Car High Income Non-Compliant	6,646	4,861	7,463	4,443	3,262	4,983	-33.1%	-32.9%	-33.2%
UC7	Car Employers Business Compliant	7,128	8,475	4,334	8,119	9,734	4,943	13.9%	14.9%	14.1%
UC8	Car Employers Business Non-Compliant	2,504	3,167	1,571	1,675	2,122	1,049	-33.1%	-33.0%	-33.2%
	Car total	**96,924**	**74,121**	**103,127**	**98,590**	**75,575**	**104,739**	**1.7%**	**2.0%**	**1.6%**
UC9	Taxi Compliant	2,458	3,233	3,733	2,822	3,722	4,280	14.8%	15.1%	14.7%
UC10	Taxi Non-Compliant	1,266	1,666	1,923	966	1,274	1,465	-23.7%	-23.5%	-23.8%
	Taxi total	**3,724**	**4,899**	**5,656**	**3,788**	**4,996**	**5,745**	**1.7%**	**2.0%**	**1.6%**
UC11	LGV Compliant	10,040	12,451	8,385	13,031	15,666	10,875	30%	26%	30%
UC12	LGV Non-Compliant	7,270	7,281	6,022	4,747	4,600	3,921	-34.7%	-36.8%	-34.9%
	LGV total	**17,310**	**19,732**	**14,407**	**17,778**	**20,266**	**14,796**	**2.7%**	**2.7%**	**2.7%**
UC13	HGV Compliant	23,104	23,656	10,196	26,323	27,118	11,889	13.9%	14.6%	16.6%
UC14	HGV Non-Compliant	7,059	7,636	3,848	4,003	4,341	2,231	-43.3%	-43.1%	-42.0%
	HGV total	**30,162**	**31,292**	**14,044**	**30,326**	**31,460**	**14,120**	**0.5%**	**0.5%**	**0.5%**
UC15	Coach Compliant	1,348	1,868	2,525	1,598	2,205	2,963	18.5%	18.0%	17.3%
UC16	Coach Non-Compliant	612	817	1,051	372	494	633	-39.1%	-39.5%	-39.8%
	Coach total	**1,960**	**2,684**	**3,577**	**1,970**	**2,698**	**3,596**	**0.5%**	**0.5%**	**0.6%**

Overall, the total trips increase in 2023 compared to 2021. 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 5-3: Matrix Totals by User Class (2023-2031)

User Class	Description	2023			2031			2031 - 2015 % Difference		
		AM	IP	PM	AM	IP	PM	AM	IP	PM
Total	Total	**150,080**	**132,728**	**140,810**	**160,593**	**143,788**	**150,955**	**7.0%**	**8.3%**	**7.2%**
UC1	Car Low Income Compliant	18,541	13,203	20,618	26,449	19,495	29,662	42.7%	47.7%	43.9%
UC2	Car Low Income Non-Compliant	6,514	4,933	7,472	485	378	544	-92.6%	-92.3%	-92.7%
UC3	Car Medium Income Compliant	27,141	19,271	30,150	38,636	28,457	43,131	42.4%	47.7%	43.1%
UC4	Car Medium Income Non-Compliant	9,536	7,200	10,926	708	551	791	-92.6%	-92.3%	-92.8%
UC5	Car High Income Compliant	18,914	13,011	20,593	26,849	19,199	29,435	42.0%	47.6%	42.9%
UC6	Car High Income Non-Compliant	6,646	4,861	7,463	492	372	540	-92.6%	-92.3%	-92.8%
UC7	Car Employers Business Compliant	7,128	8,475	4,334	10,155	12,439	6,228	42.5%	46.8%	43.7%
UC8	Car Employers Business Non-Compliant	2,504	3,167	1,571	186	241	114	-92.6%	-92.4%	-92.7%
	Car total	**96,924**	**74,121**	**103,127**	**103,960**	**81,132**	**110,445**	**7.3%**	**9.5%**	**7.1%**
UC9	Taxi Compliant	2,458	3,233	3,733	3,994	5,363	6,058	62.5%	65.9%	62.3%
UC10	Taxi Non-Compliant	1,266	1,666	1,923	0	0	0	-100.0%	-100.0%	-100.0%
	Taxi total	**3,724**	**4,899**	**5,656**	**3,994**	**5,363**	**6,058**	**7.3%**	**9.5%**	**7.1%**
UC11	LGV Compliant	10,040	12,451	8,385	19,060	21,862	15,864	90%	76%	89%
UC12	LGV Non-Compliant	7,270	7,281	6,022	589	538	491	-91.9%	-92.6%	-91.8%
	LGV total	**17,310**	**19,732**	**14,407**	**19,649**	**22,400**	**16,355**	**13.5%**	**13.5%**	**13.5%**
UC13	HGV Compliant	23,104	23,656	10,196	30,668	31,783	14,236	32.7%	34.4%	39.6%
UC14	HGV Non-Compliant	7,059	7,636	3,848	310	353	187	-95.6%	-95.4%	-95.1%
	HGV total	**30,162**	**31,292**	**14,044**	**30,978**	**32,136**	**14,423**	**2.7%**	**2.7%**	**2.7%**
UC15	Coach Compliant	1,348	1,868	2,525	2,012	2,757	3,674	49.3%	47.6%	45.5%
UC16	Coach Non-Compliant	612	817	1,051	0	0	0	-100.0%	-100.0%	-100.0%
	Coach total	**1,960**	**2,684**	**3,577**	**2,012**	**2,757**	**3,674**	**2.7%**	**2.7%**	**2.7%**

Overall, the total trips increase in 2031 compared to 2023. 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 5-4: 2021 Target and Modelled Average Compliance

Vehicle Type	Target Compliance	Modelled Compliance
Car / Taxi	72%	73%
LGV	60%	61%
HGV	75%	76%
Coach	70%	71%

Table 5-5: 2023 Target and Modelled Average Compliance

Vehicle Type	Target Compliance	Modelled Compliance
Car / Taxi	82%	82%
LGV	75%	76%
HGV	86%	86%
Coach	82%	82%

Table 5-6: 2031 Target and Modelled Average Compliance

Vehicle Type	Target Compliance	Modelled Compliance
Car / Taxi	98%	98%
LGV	97%	97%
HGV	99%	99%
Coach	100%	100%

5.2 Highway Network Statistics

The highway model network statistics have been extracted for the base year, and the three forecast years. Table 5-7 shows a comparison between 2015 and 2021. Table 5-8 shows a comparison between 2021 and 2023. The highway model network statistics comparing 2023 and 2031 are shown in Table 5-9.

Table 5-7: 2015 and 2021 Highway Network Statistics

Measure	2015			2021			2021 - 2015		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
TRANSIENT QUEUES	7,534	4,679	7,597	7,831	4,941	7,734	3.9%	5.6%	1.8%
OVER-CAPACITY QUEUES	1,417	34	1,510	1,520	63	1,109	7.3%	83.0%	-26.6%
LINK CRUISE TIME	18,586	14,577	18,736	19,519	15,363	19,713	5.0%	5.4%	5.2%
FREE FLOW TIME	17,861	14,224	18,194	18,815	14,975	19,039	5.3%	5.3%	4.6%
DELAYS	724	354	542	704	388	674	-2.8%	9.7%	24.3%
TOTAL TRAVEL TIME	27,536	19,291	27,843	28,870	20,367	28,556	4.8%	5.6%	2.6%
TRAVEL DISTANCE	1,157,050	931,628	1,186,111	1,210,852	981,083	1,241,787	4.6%	5.3%	4.7%
OVERALL AVERAGE SPEED	42.00	48.30	42.60	41.90	48.20	43.50	-0.2%	-0.2%	2.1%
MONETARY TOLLS	442.70	326.30	559.00	524.40	417.90	581.00	18.5%	28.1%	3.9%
TOTAL TRIPS LOADED	127,221	108,295	126,388	131,925	113,524	130,871	3.7%	4.8%	3.5%

Table 5-8: 2021 and 2023 Highway Network Statistics

Measure	2021			2023			2023 - 2021		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Transient queues	7,831	4,941	7,734	8,043	5,068	7,950	2.7%	2.6%	2.8%
Over-capacity queues	1,520	63	1,109	1,633	68	1,207	7.4%	9.3%	8.8%
Link cruise time	19,519	15,363	19,713	19,874	15,682	20,053	1.8%	2.1%	1.7%
Free flow time	18,815	14,975	19,039	19,133	15,267	19,338	1.7%	1.9%	1.6%
Delays	704	388	674	741	416	715	5.2%	7.1%	6.2%
Total travel time	28,870	20,367	28,556	29,550	20,819	29,210	2.4%	2.2%	2.3%
Travel distance	1,210,852	981,083	1,241,787	1,233,191	1,002,090	1,263,336	1.8%	2.1%	1.7%
Overall average speed	41.90	48.20	43.50	41.70	48.10	43.30	-0.5%	-0.2%	-0.5%
Monetary tolls	524.40	417.90	581.00	534.20	424.60	596.80	1.9%	1.6%	2.7%
Total trips loaded	131,925	113,524	130,871	134,197	115,687	132,981	1.7%	1.9%	1.6%

Table 5-9: 2023 and 2031 Highway Network Statistics

Measure	2023			2031			2031 - 2023		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Transient queues	8,043	5,068	7,950	8,748	5,612	8,698	8.8%	10.7%	9.4%
Over-capacity queues	1,633	68	1,207	2,159	106	1,689	32.2%	55.6%	40.0%
Link cruise time	19,874	15,682	20,053	21,048	17,016	21,300	5.9%	8.5%	6.2%
Free flow time	19,133	15,267	19,338	20,165	16,459	20,396	5.4%	7.8%	5.5%
Delays	741	416	715	883	556	903	19.3%	33.8%	26.3%
Total travel time	29,550	20,819	29,210	31,955	22,734	31,687	8.1%	9.2%	8.5%
Travel distance	1,233,191	1,002,090	1,263,336	1,307,286	1,090,321	1,342,476	6.0%	8.8%	6.3%
Overall average speed	41.70	48.10	43.30	40.90	48.00	42.40	-1.9%	-0.2%	-2.1%
Monetary tolls	534.20	424.60	596.80	606.10	470.00	634.40	13.5%	10.7%	6.3%
Total trips loaded	134,197	115,687	132,981	141,947	124,064	140,724	5.8%	7.2%	5.8%

Tables 5-7 to 5-9 show that over time speeds decrease, while queues and delays increase. This is due to the introduction highway schemes around Bristol, some of which increase capacity, i.e. the South Bristol Link Road but other schemes decrease capacity, particularly in the city centre, i.e. the Street Space Schemes. Also, as time goes on the traffic demand increases, leading to increased congestion.

6. Option Assessment Forecasts

6.1 Compliance Splits

The compliance splits at the Small CAZ cordon level for the Small CAZ D option for 2021, 2023 and 2031 are shown in Table 6-1, Table 6-2 and Table 6-3 respectively.

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

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	97.9%	2.1%	97.9%	2.1%	97.9%	2.1%
LGV	92.7%	7.3%	93.7%	6.3%	92.8%	7.2%
HGV	97.9%	2.1%	97.8%	2.2%	97.6%	2.4%
Taxi	98.6%	1.4%	98.6%	1.4%	98.6%	1.4%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	94.3%	5.7%	94.3%	5.7%	94.7%	5.3%

The compliance splits results for 2021 show that the percentage of compliant cars increases from 73% in the Baseline to 98% in the Small CAZ D options. This is due to non-compliant cars being charged in the Small CAZ area, which results in non-compliant cars either replacing their vehicle with a compliant one, avoiding the CAZ area (re-routing), changing mode or cancelling their trip. The compliance split for the other vehicle types also increases with this option, compared to the Baseline, due to the charging of non-compliant vehicles for the same reasons as the non-complaint cars.

Table 6-2: 2023 Small CAZ D - Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	98.6%	1.4%	98.6%	1.4%	98.6%	1.4%
LGV	95.5%	4.5%	96.3%	3.7%	95.6%	4.4%
HGV	98.8%	1.2%	98.8%	1.2%	98.6%	1.4%
Taxi	99.0%	1.0%	99.0%	1.0%	99.0%	1.0%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	96.6%	3.4%	96.6%	3.4%	96.9%	3.1%

The compliance splits for 2023 show that the percentage of compliant cars increases from 83% in the Baseline to 99% in the Small CAZ D option. Similar to 2021, this is due to non-compliant cars being charged within the Small CAZ area. The compliance split for other vehicle types have also increased due to non-compliant vehicles being charged.

Table 6-3: 2031 Small CAZ D - Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	99.9%	0.1%	99.9%	0.1%	99.9%	0.1%
LGV	99.5%	0.5%	99.6%	0.4%	99.5%	0.5%
HGV	99.9%	0.1%	99.9%	0.1%	99.9%	0.1%
Taxi	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%

The effect of the CAZ in 2031 is minor, with small increases in the percentage of compliant vehicles compared to the Baseline. This is because the majority of vehicles are compliant by 2031.

6.2 Euro Standard Splits

The Euro Standard splits for the Baseline and Small CAZ D option for 2021, 2023 and 2031 are shown in the Table 6-4.

Table 6-4: 2021, 2023 and 2031 Euro Standard Splits

Vehicle Type/Fuel Type/Euro Standard	2021		2023		2031	
	Baseline	Small CAZD	Baseline	Small CAZD	Baseline	Small CAZD
Petrol Car						
1Pre-Euro 1	-	-	-	-	-	-
2Euro 1	-	-	-	-	-	-
3Euro 2	0.01	0.00	-	-	-	-
4Euro 3	0.08	0.01	0.03	0.00	-	-
5Euro 4	0.13	0.14	0.06	0.03	0.00	0.00
6Euro 5	0.34	0.37	0.27	0.20	0.05	0.05
7Euro 6*	0.18	0.20	0.14	0.12	0.04	0.04
7Euro 6c*	0.26	0.29	0.49	0.65	0.91	0.91
Diesel Car						
1Pre-Euro 1	-	-	-	-	-	-
2Euro 1	-	-	-	-	-	-
3Euro 2	0.00	0.00	-	-	-	-
4Euro 3	0.04	0.00	0.02	0.00	-	-
5Euro 4	0.11	0.01	0.05	0.00	0.00	0.00
6Euro 5	0.37	0.05	0.29	0.03	0.04	0.00
7Euro 6	0.19	0.37	0.15	0.16	0.04	0.04
7Euro 6c*	0.28	0.56	0.36	0.38	0.19	0.20
7Euro 6d*	-	-	0.12	0.43	0.73	0.76
Petrol LGV						
1Pre-Euro 1	-	-	-	-	-	-
2Euro 1	0.00	0.00	-	-	-	-
3Euro 2	0.03	0.03	0.01	0.02	-	-
4Euro 3	0.07	0.06	0.03	0.05	-	-
5Euro 4	0.06	0.06	0.02	0.00	0.00	0.00
6Euro 5	0.36	0.37	0.29	0.17	0.02	0.02
7Euro 6*	0.33	0.34	0.22	0.13	0.02	0.02
7Euro 6c*	0.14	0.14	0.42	0.63	0.96	0.96
Diesel LGV						
1Pre-Euro 1	-	-	-	-	-	-
2Euro 1	-	-	-	-	-	-
3Euro 2	0.01	0.00	-	-	-	-
4Euro 3	0.03	0.00	0.01	0.00	-	-
5Euro 4	0.10	0.02	0.05	0.00	0.00	0.00
6Euro 5	0.27	0.04	0.19	0.02	0.03	0.00
7Euro 6*	0.20	0.31	0.15	0.12	0.04	0.04
7Euro 6c*	0.39	0.62	0.40	0.30	0.12	0.13
7Euro 6d*	-	-	0.19	0.54	0.81	0.83

Vehicle Type/Fuel Type/Euro Standard	2021		2023		2031	
	Baseline	Small CAZD	Baseline	Small CAZD	Baseline	Small CAZD
Rigid HGV						
1Pre-Euro I	-	-	-	-	-	-
2Euro I	-	-	-	-	-	-
3Euro II	0.00	0.00	-	-	-	-
4Euro III	0.02	0.00	0.01	0.00	-	-
5Euro IV	0.05	0.00	0.02	0.00	0.00	0.00
6Euro V_EGR	0.05	0.00	0.03	0.00	0.00	0.00
7Euro V_SCR	0.15	0.01	0.09	0.01	0.01	0.00
8Euro VI	0.73	0.97	0.84	0.99	0.99	1.00
9Euro II SCRRF	-	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-	-
11Euro IV SCRRF	-	0.00	-	-	-	-
12Euro V EGR + SCRRF	-	0.00	-	0.00	-	-
Artic HGV						
1Pre-Euro I	-	-	-	-	-	-
2Euro I	-	-	-	-	-	-
3Euro II	0.00	0.00	-	-	-	-
4Euro III	0.01	0.00	-	0.00	-	-
5Euro IV	0.01	0.00	-	0.00	-	-
6Euro V_EGR	0.02	0.00	0.01	0.00	0.00	0.00
7Euro V_SCR	0.07	0.01	0.03	0.00	0.00	0.00
8Euro VI	0.89	0.99	0.96	1.00	1.00	1.00
9Euro II SCRRF	-	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-	-
11Euro IV SCRRF	-	0.00	-	-	-	-
12Euro V EGR + SCRRF	-	0.01	-	0.00	-	-
Buses						
1Pre-Euro I	-	-	-	-	-	-
2Euro I	-	-	-	-	-	-
3Euro II	0.04	-	0.02	-	-	-
4Euro III	0.16	-	0.09	-	0.00	-
5Euro IV	0.04	-	0.02	-	-	-
6Euro V_EGR	0.02	-	0.01	-	0.00	-
7Euro V_SCR	0.05	-	0.03	-	0.01	-
8Euro VI	0.70	1.00	0.84	1.00	0.98	1.00
9Euro II SCRRF	-	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	-	-
12Euro V EGR + SCRRF	-	-	-	-	-	-
Coaches						
1Pre-Euro I	-	-	-	-	-	-
2Euro I	-	-	-	-	-	-
3Euro II	0.02	0.00	-	-	-	-
4Euro III	0.07	0.02	0.04	0.01	-	-
5Euro IV	0.03	0.01	0.02	0.01	-	-
6Euro V_EGR	0.02	0.01	0.01	0.00	0.00	-
7Euro V_SCR	0.07	0.02	0.04	0.01	0.01	-
8Euro VI	0.79	0.94	0.88	0.98	0.98	1.00
9Euro II SCRRF	-	-	-	-	-	-
10Euro III SCRRF	-	-	-	-	-	-
11Euro IV SCRRF	-	-	-	-	-	-
12Euro V EGR + SCRRF	-	-	-	-	-	-

6.3 Highway Network Statistics

The highway model network statistics have been extracted for 2021, 2023 and 2031 for the Baseline and Small CAZ D models. Table 6-5, Table 6-6 and Table 6-7 show the statistics for 2021, 2023 and 2031 respectively.

Table 6-5: 2021 Baseline and Small CAZ D Highway Network Statistics

Measure	2021 Baseline			2021 Small CAZ D			2021 Small CAZ D - Baseline		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Transient Queues	7,831	4,941	7,734	7,554	4,843	7,436	-3.5%	-2.0%	-3.9%
Over-Capacity Queues	1,520	63	1,109	1,327	52	902	-12.7%	-17.4%	-18.6%
Link Cruise Time	19,519	15,363	19,713	19,267	15,231	19,483	-1.3%	-0.9%	-1.2%
Free Flow Time	18,815	14,975	19,039	18,579	14,850	18,830	-1.3%	-0.8%	-1.1%
Delays	704	388	674	689	381	653	-2.2%	-1.7%	-3.1%
Total Travel Time	28,870	20,367	28,556	28,148	20,126	27,821	-2.5%	-1.2%	-2.6%
Travel Distance	1,210,852	981,083	1,241,787	1,198,212	974,658	1,230,405	-1.0%	-0.7%	-0.9%
Overall Average Speed	41.90	48.20	43.50	42.60	48.40	44.20	1.7%	0.4%	1.6%
Total Trips Loaded	131,925	113,524	130,871	130,781	112,593	129,723	-0.9%	-0.8%	-0.9%

Table 6-5 shows that there is a small decrease in the number of trips within the network due to the cancel trip / change mode primary response. Table 6-5 also shows that the Small CAZ D causes an increase in the average speed and decreases in queues and delays across the model area.

Table 6-6: 2023 Baseline and Small CAZ D Highway Network Statistics

Measure	2023 Baseline			2023 Small CAZ D			2023 Small CAZ D - Baseline		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Transient Queues	8,043	5,068	7,950	7,894	5,023	7,728	-1.9%	-0.9%	-2.8%
Over-Capacity Queues	1,633	68	1,207	1,539	61	1,064	-5.8%	-11.5%	-11.9%
Link Cruise Time	19,874	15,682	20,053	19,699	15,593	19,905	-0.9%	-0.6%	-0.7%
Free Flow Time	19,133	15,267	19,338	18,971	15,182	19,201	-0.8%	-0.6%	-0.7%
Delays	741	416	715	728	412	703	-1.7%	-1.0%	-1.7%
Total Travel Time	29,550	20,819	29,210	29,132	20,677	28,696	-1.4%	-0.7%	-1.8%
Travel Distance	1,233,191	1,002,090	1,263,336	1,224,209	997,770	1,256,254	-0.7%	-0.4%	-0.6%
Overall Average Speed	41.70	48.10	43.30	42.00	48.30	43.80	0.7%	0.4%	1.2%
Total Trips Loaded	134,197	115,687	132,981	133,427	115,055	132,209	-0.6%	-0.5%	-0.6%

The results for 2023 show a similar pattern to the results for 2021, with the average speed increasing and decreases in queues and delays. The changes in 2023 are to a smaller compared to 2021 due to there being fewer non-compliant vehicles in 2023 Baseline.

Table 6-7: 2031 Baseline and Small CAZ D Highway Network Statistics

Measure	2031 Baseline			2031 Small CAZ D			2031 Small CAZ D - Baseline		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Transient Queues	8,748	5,612	8,698	8,758	5,623	8,630	0.1%	0.2%	-0.8%
Over-Capacity Queues	2,159	106	1,689	2,290	134	1,760	6.1%	26.1%	4.1%
Link Cruise Time	21,048	17,016	21,300	20,976	16,988	21,265	-0.3%	-0.2%	-0.2%
Free Flow Time	20,165	16,459	20,396	20,099	16,431	20,361	-0.3%	-0.2%	-0.2%
Delays	883	556	903	877	557	904	-0.7%	0.1%	0.0%
Total Travel Time	31,955	22,734	31,687	32,024	22,746	31,654	0.2%	0.1%	-0.1%
Travel Distance	1,307,286	1,090,321	1,342,476	1,303,723	1,089,263	1,341,145	-0.3%	-0.1%	-0.1%
Overall Average Speed	40.90	48.00	42.40	40.70	47.90	42.40	-0.5%	-0.2%	0.0%
Total Trips Loaded	141,947	124,064	140,724	141,828	123,974	140,572	-0.1%	-0.1%	-0.1%

Table 6-7 shows that in 2031, the effect of the CAZ in minor. The average speed and delays are similar in the Baseline and the Small CAZ D option, and the queues increase. This is because there are very few non-compliant vehicles in 2031.

6.4 Cordon Flows

Small CAZ area cordon flows have been extracted for 2021, 2023 and 2031, for each time period, for the Baseline and Small CAZ D models, to show the change in flows that cross the cordon as a result of the Small CAZ D. The flows are shown by user class to also show the change in non-complaint vehicles to compliant vehicles. Table 6-8, Table 6-9 and Table 6-10 show the cordon flows for 2021, 2023 and 2031 respectively.

Table 6-8: 2021 Baseline and Small CAZ D Cordon Flows

Description	2021 Baseline			2021 Small CAZ D			% Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Cars Low Inc Comp	3264	2325	3396	3819	2757	4097	17%	19%	21%
Cars Low Inc NonComp	1147	869	1231	52	40	59	-95%	-95%	-95%
Cars Med Inc Comp	4708	3457	5124	5711	4197	6305	21%	21%	23%
Cars Med Inc NonComp	1654	1292	1857	178	137	202	-89%	-89%	-89%
Cars High Inc Comp	3049	2293	3469	3877	2897	4436	27%	26%	28%
Cars High Inc NonComp	1071	857	1257	59	47	70	-95%	-95%	-94%
Cars EMP Comp	1152	1457	694	1437	1792	869	25%	23%	25%
Cars EMP NonComp	405	544	251	29	38	18	-93%	-93%	-93%
Taxis Comp	405	565	647	631	863	957	56%	53%	48%
Taxis NonComp	209	291	315	9	12	13	-96%	-96%	-96%
LGV Comp	1748	2237	1430	2630	3132	2168	50%	40%	52%
LGV NonComp	1266	1308	1027	206	211	167	-84%	-84%	-84%
HGV Comp	1248	1483	414	1609	1912	561	29%	29%	35%
HGV NonComp	381	479	156	35	42	14	-91%	-91%	-91%
Coach Comp	73	117	103	99	157	137	35%	34%	34%
Coach NonComp	33	51	43	6	9	8	-82%	-82%	-82%
TOTAL	**21813**	**19623**	**21415**	**20385**	**18245**	**20082**	**-7%**	**-7%**	**-6%**

Table 6-8 shows that there is a 6-7% decrease in the number of trips crossing and within the Small CAZ area in 2021. Table 6-5 also shows that the Small CAZ D causes a decrease of between 82-96% in non-compliant vehicles.

Table 6-9: 2023 Baseline and Small CAZ D Cordon Flows

Description	2023 Baseline			2023 Small CAZ D			% Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Cars Low Inc Comp	3677	2657	3841	4036	2939	4292	10%	11%	12%
Cars Low Inc NonComp	758	579	815	35	26	39	-95%	-95%	-95%
Cars Med Inc Comp	5290	3937	5793	5945	4424	6578	12%	12%	14%
Cars Med Inc NonComp	1091	858	1229	115	91	133	-89%	-89%	-89%
Cars High Inc Comp	3417	2609	3906	3952	3013	4565	16%	15%	17%
Cars High Inc NonComp	705	569	829	38	31	46	-95%	-95%	-94%
Cars EMP Comp	1291	1655	784	1473	1879	900	14%	14%	15%
Cars EMP NonComp	266	361	166	18	25	12	-93%	-93%	-93%
Taxis Comp	459	644	696	625	868	949	36%	35%	36%
Taxis NonComp	157	220	238	7	9	10	-96%	-96%	-96%
LGV Comp	2259	2803	1855	2849	3390	2346	26%	21%	26%
LGV NonComp	823	823	669	135	132	109	-84%	-84%	-84%
HGV Comp	1408	1696	482	1613	1938	565	15%	14%	17%
HGV NonComp	214	272	91	19	24	8	-91%	-91%	-91%
Coach Comp	85	138	120	102	161	140	19%	17%	17%
Coach NonComp	20	31	26	4	6	5	-82%	-82%	-82%
TOTAL	**21922**	**19853**	**21539**	**20964**	**18958**	**20697**	**-4%**	**-5%**	**-4%**

Table 6-9 shows that there is a 4-5% decrease in the number of trips crossing and within the Small CAZ area in 2023. Table 6-9 also shows that the Small CAZ D causes a decrease of between 82-96% in non-compliant vehicles.

Table 6-10: 2031 Baseline and Small CAZ D Cordon Flows

Description	2031 Baseline			2031 Small CAZ D			% Difference		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Cars Low Inc Comp	4314	3254	4601	4419	3347	4672	2%	3%	2%
Cars Low Inc NonComp	79	63	84	4	3	4	-95%	-95%	-95%
Cars Med Inc Comp	6200	4862	6921	6362	4960	7047	3%	2%	2%
Cars Med Inc NonComp	114	94	127	12	10	13	-90%	-89%	-89%
Cars High Inc Comp	3978	3207	4699	4057	3278	4776	2%	2%	2%
Cars High Inc NonComp	73	62	86	4	3	5	-95%	-94%	-95%
Cars EMP Comp	1515	2008	936	1526	2044	946	1%	2%	1%
Cars EMP NonComp	28	39	17	2	3	1	-94%	-93%	-93%
Taxis Comp	614	889	948	617	898	953	0%	1%	1%
Taxis NonComp	0	0	0	0	0	0	0%	0%	0%
LGV Comp	3481	4089	2855	3328	3912	2734	-4%	-4%	-4%
LGV NonComp	108	101	88	16	15	13	-85%	-85%	-85%
HGV Comp	1614	2009	597	1584	1987	587	-2%	-1%	-2%
HGV NonComp	16	22	8	1	2	1	-92%	-91%	-91%
Coach Comp	106	174	154	103	171	150	-3%	-2%	-3%
Coach NonComp	0	0	0	0	0	0	0%	0%	0%
TOTAL	**22239**	**20874**	**22120**	**22034**	**20635**	**21900**	**-1%**	**-1%**	**-1%**

Table 6-10 shows that there is a 1% decrease in the number of trips crossing and within the Small CAZ area in 2031. Table 6-10 also shows that the Small CAZ D causes a decrease of between 85-95% in non-compliant vehicles.

6.5 Upgraded Vehicle Trips

The forecast number of trips made by vehicles that have upgraded to complaint vehicles, on a daily basis, as a result of the Small CAZ D has been calculated at a Small CAZ area cordon level. The numbers have been extracted for 2021, 2023 and 2031, for each time period by vehicle type. Table 6-11 shows the daily upgraded trips for 2021, 2023 and 2031.

Table 6-11: Upgrade Vehicle Totals

Description	2021			2023			2031		
	AM	IP	PM	AM	IP	PM	AM	IP	PM
Cars	2280	1898	2500	1479	1261	1655	153	141	166
Taxis	209	286	317	155	215	235	0	0	0
LGVs	803	822	653	526	515	424	61	60	50
HGVs	328	398	131	176	227	75	13	18	6
Coaches	24	38	31	14	22	18	0	0	0
TOTAL	3644	3442	3630	2350	2241	2407	227	219	223

The results show that over time, the number of non-compliant vehicles that upgrade decreases, as the number of non-compliant vehicles naturally decreases over time.

6.6 Flow Difference Plots

To show the impact of the CAZ on traffic flows around the Bristol area, flow difference plots have been produced representing the AADT traffic flow change (veh) between the 2021 and 2023 Small CAZ D option and Baseline. The change in AADT flows for 2021 are shown in Figure 6-1 and for 2023 in Figure 6-2. Appendix A shows additional traffic flow plots for the Baseline scenario and changes in traffic flows at a greater Bristol area level. In all difference plots, Blue represents a decrease in flows and Red represents an increase in flows.

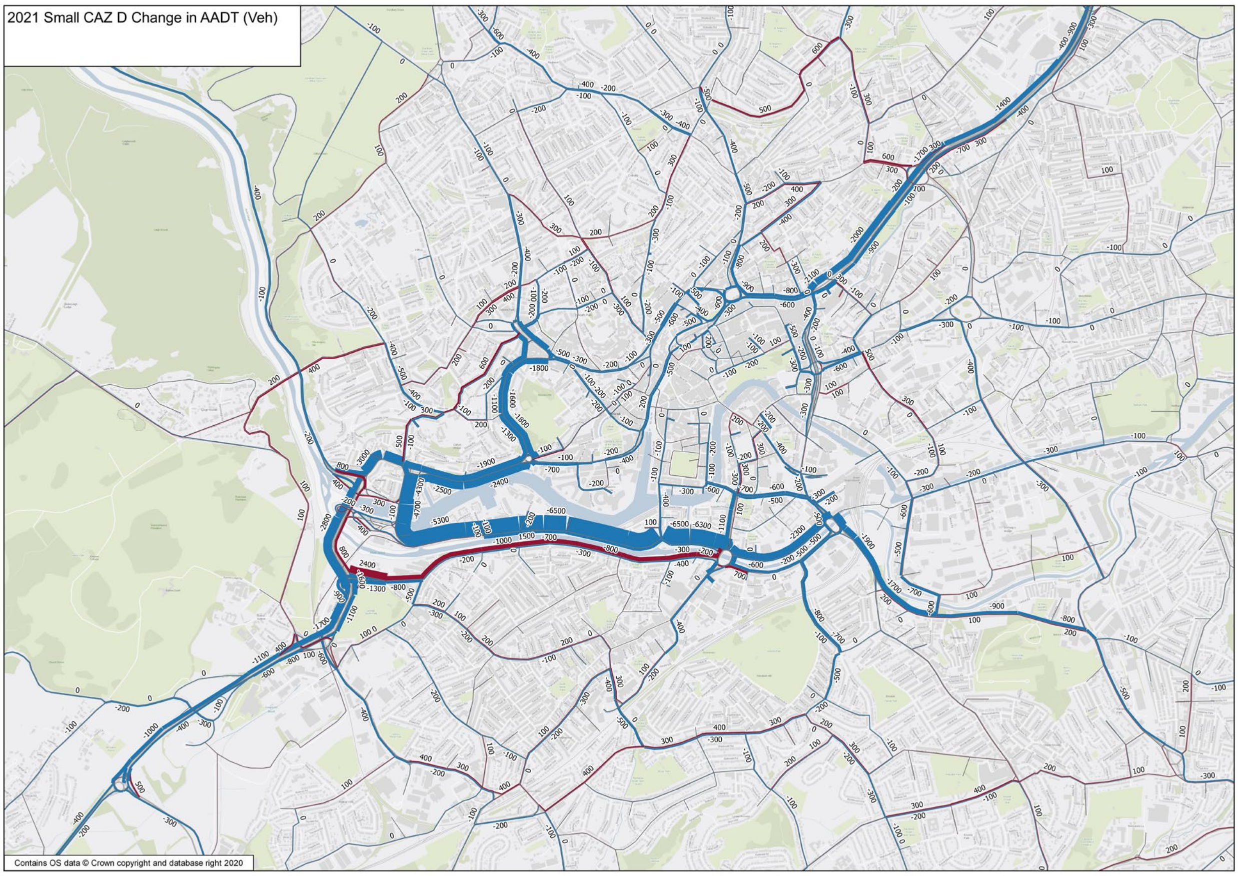


Figure 6-1: 2021 Small CAZ D - Baseline: AADT (veh) (Note: Street Space schemes are included in the Baseline model)

Figure 6-1 indicates that the Small CAZ D significantly reduces the traffic along Cumberland Road in 2021 compared to the Baseline due to the closure to inbound traffic along Cumberland Road. The introduction of a charge fee over the Small CAZ area reduces the amount of vehicle traffic accessing the City Centre, by approximately 2,000 vehicles per day, and through traffic using roads in the CAZ area.

However, this does result in some increases in traffic on roads mainly outside the CAZ boundary as non-compliant drivers attempt to avoid the charge by routing around the CAZ area. The scale of these potential impacts on other routes is considered to be modest, as almost all the changes on links showing increases can be considered as well within normal day-to-day variation in traffic volumes. A sample of the key roads with AADT increases outside the CAZ area are as follows:

- Clifton Suspension Bridge 4.5% AADT 2-way increase;
- St. Pauls Roads 5% AADT 2-way increase;
- Cotham Hill 2% AADT 2-way increase;
- Lower Ashley Road 2.5% AADT 2-way increase;

- Midland Road 5% AADT 2-way increase; and
- Bedminster Road 4% AADT 2-way increase.

Within the CAZ boundary, Coronation Road, 5% AADT 2-way increase in flows, due to the closure of Cumberland Road in the inbound direction.

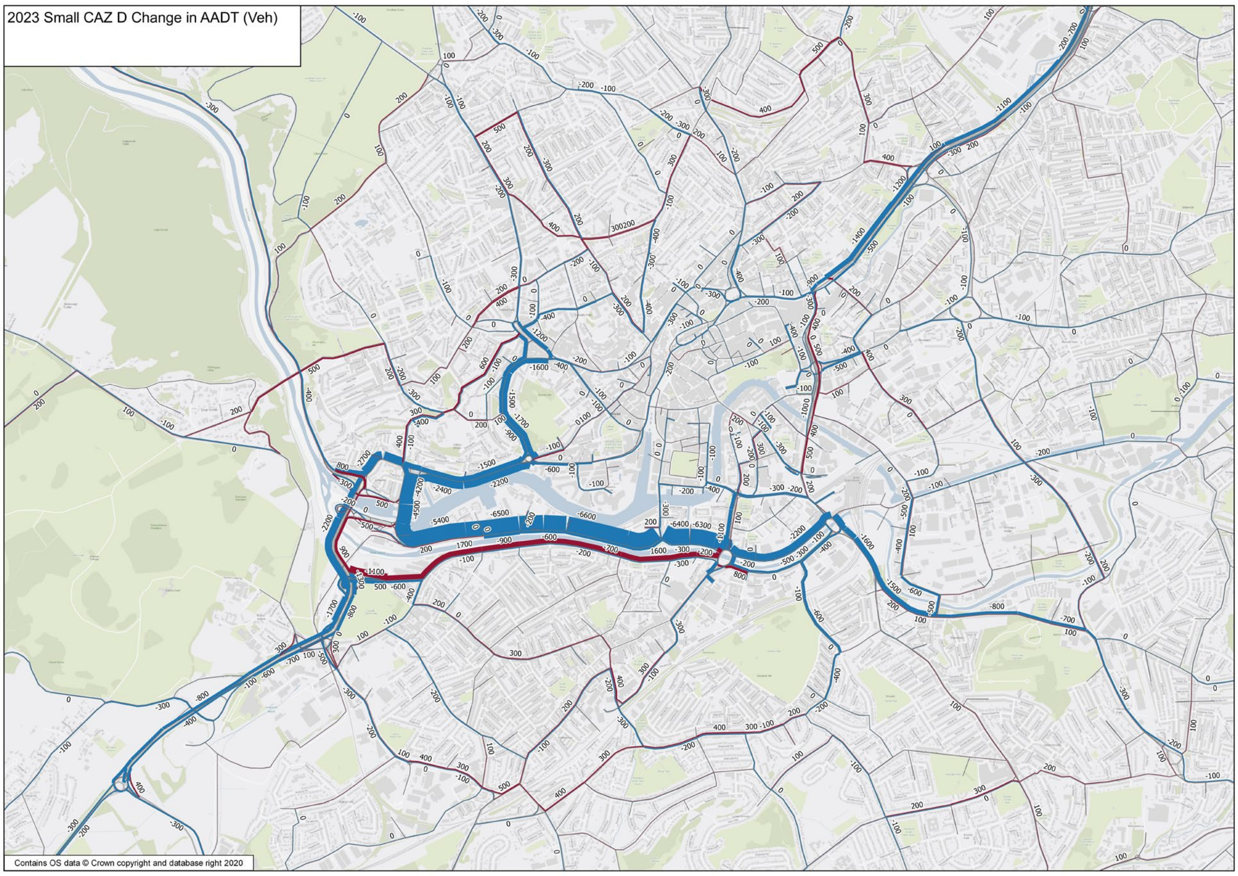


Figure 6-2: 2023 Small CAZ D - Baseline: AADT (veh) (Note: Street Space schemes are included in the Baseline model)

Figure 6-2 indicates that the impacts of the Small CAZ D in 2023, compared to the Baseline, would have a similar trend to 2021 but to a slightly lesser extent. The reduction in vehicles accessing the City Centre, due to the introduction of charge fee, would be approximately 1,500 vehicles per day, which is 500 fewer than in 2021. Furthermore, the slight increases in traffic on roads outside the CAZ boundary are lower in 2023 compared to 2021. All of this is because there are fewer non-compliant vehicles in the 2023 Baseline scenario compared to 2021. The scale of the impact from increases on some roads in 2023 is considered to be modest as almost all the changes on these links can be considered well within normal day-to-day variation in traffic volumes.

7. Links to Air Quality Model

7.1 Base/Baseline Data Use

Link based data from the base and baseline highway assignment model has been output for Cars, Taxis, LGVs, Coaches and HGVs split by Euro standards compliance and / or fuel type as required into a spreadsheet. The highway model outputs also include buses (not split by compliance) and net speeds by link. Buses are split into compliant / non-compliant during post processing of highway model outputs before being input to the EFT.

The peak hourly flows (AM, IP and PM) have been converted into AADT using global factors derived from local ATC data. Percentages of cars (by fuel type), taxis, LGVs, HGVs (rigid and artic) and buses and coaches have been calculated from the flow data for each link from the highway model.

The disaggregation of the link-based data has been undertaken via post processing before input into the Air Quality model. This has been achieved using the following methodology:

- Buses split using information provided by First Bus, using Euro Standard of vehicle by service, which can then be applied to links;
- Cars and LGVs split by fuel type derived from the ANPR data;
- HGVs split by rigid and artic from the ANPR data;
- Motor cycles excluded due to limited information;
- Two separate EFT's used, split by compliance populated from the transport model; and
- Within each EFT, Euro Standard splits for the assessment year are overwritten with values derived from ANPR data projected to the modelled year.

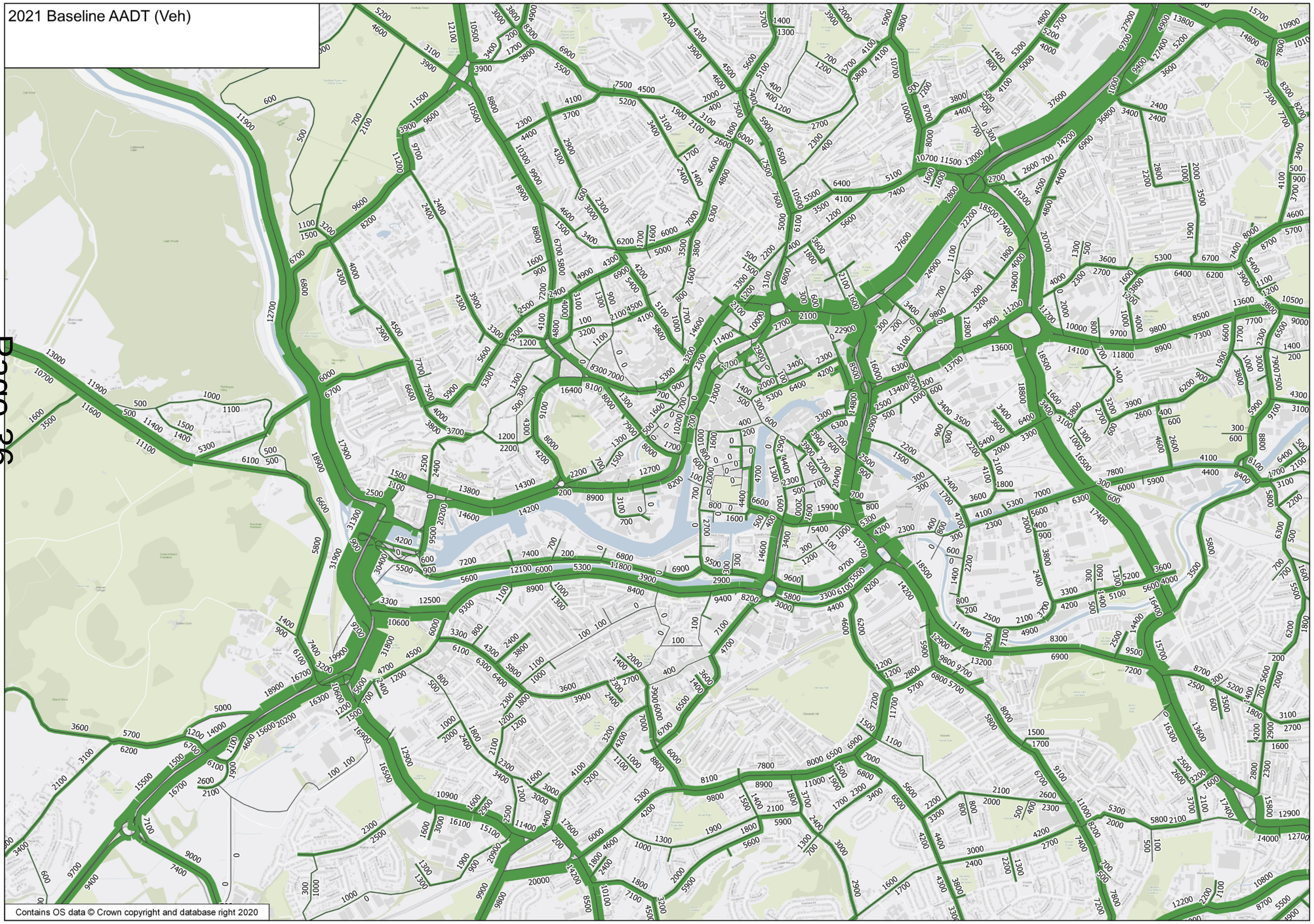
The base and baseline year splits have been derived from the 2017 ANPR data, adjusted to the assessment years. For full details please refer to FBC-24 ANPR Analysis and Application technical note in Appendix E of the FBC.

7.2 Option Data Use

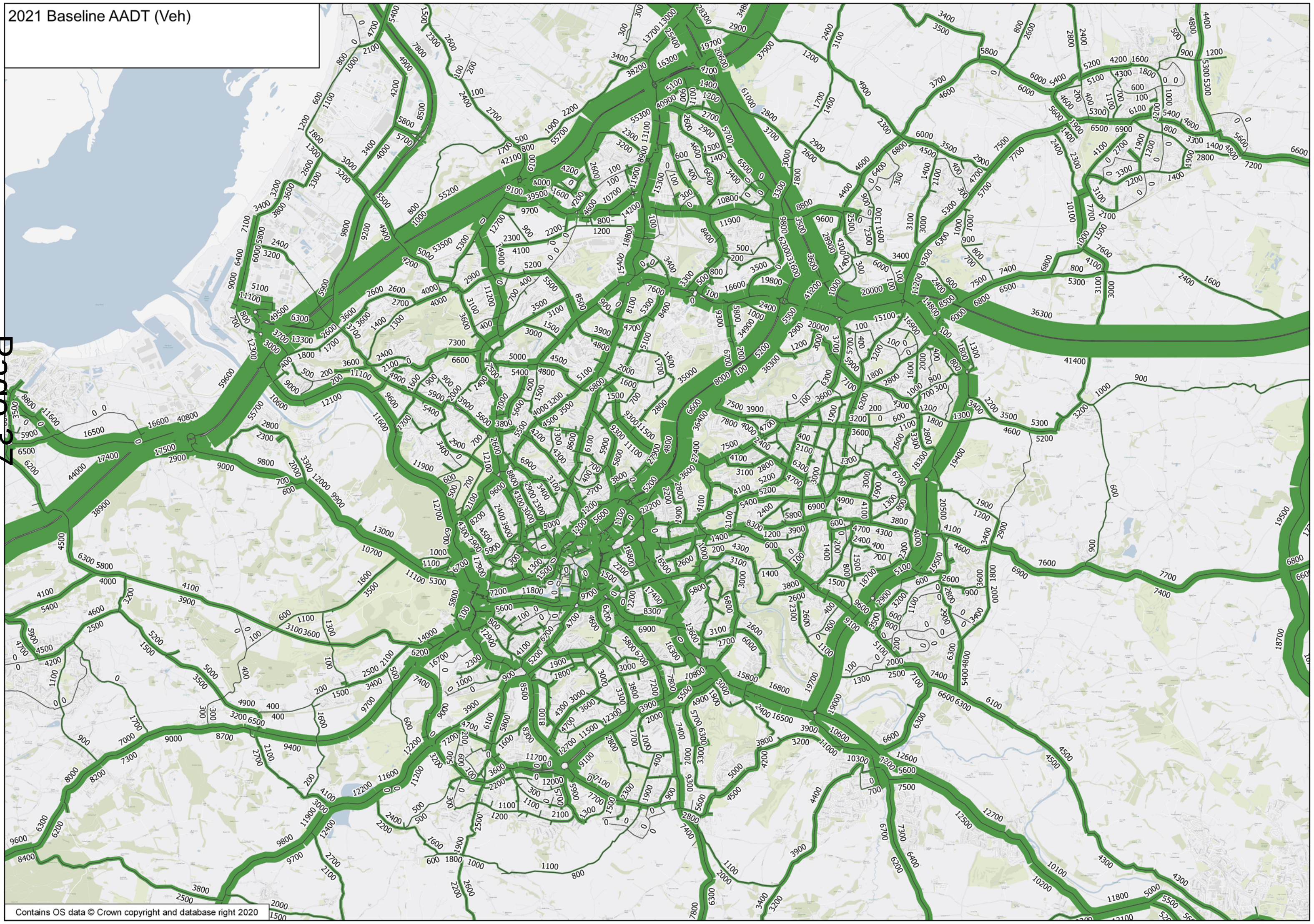
After the primary behavioural responses were modelled for each option and the secondary behavioural responses of what type of car the replacement will be in accordance with the methodology outlined in Chapter 3, a similar approach to above for processing the options transport model data was used. There are separate EFT input tables split by compliance containing the required link-based data. Separate spreadsheets for compliant and non-compliant vehicles were produced and run through separate EFT's so that varying proportions of compliant / non-compliant vehicles could be reflected spatially across the modelled area by link.

Appendix A. AADT Difference Plots

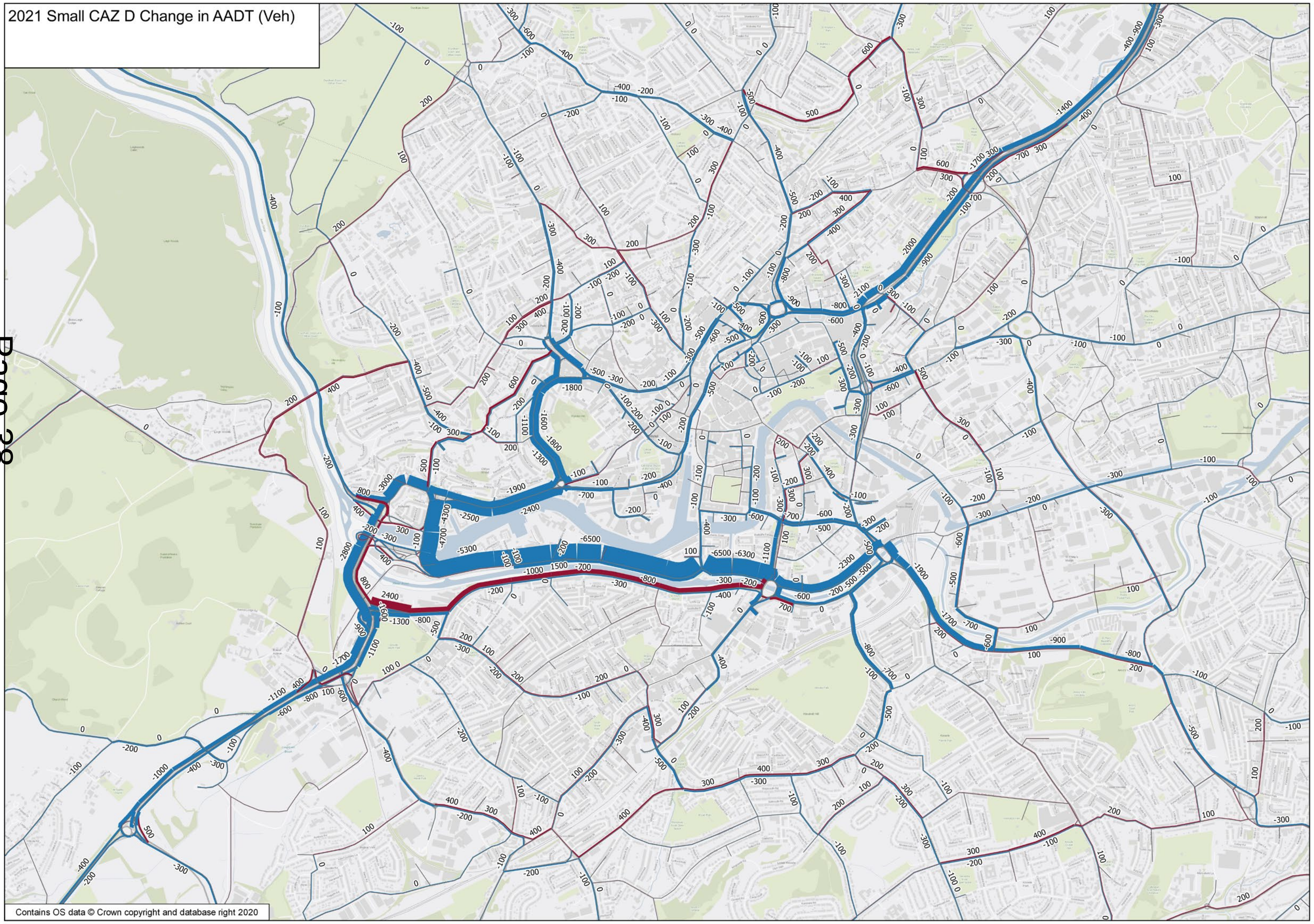
A.1 2021 Baseline: AADT – Central Bristol Area



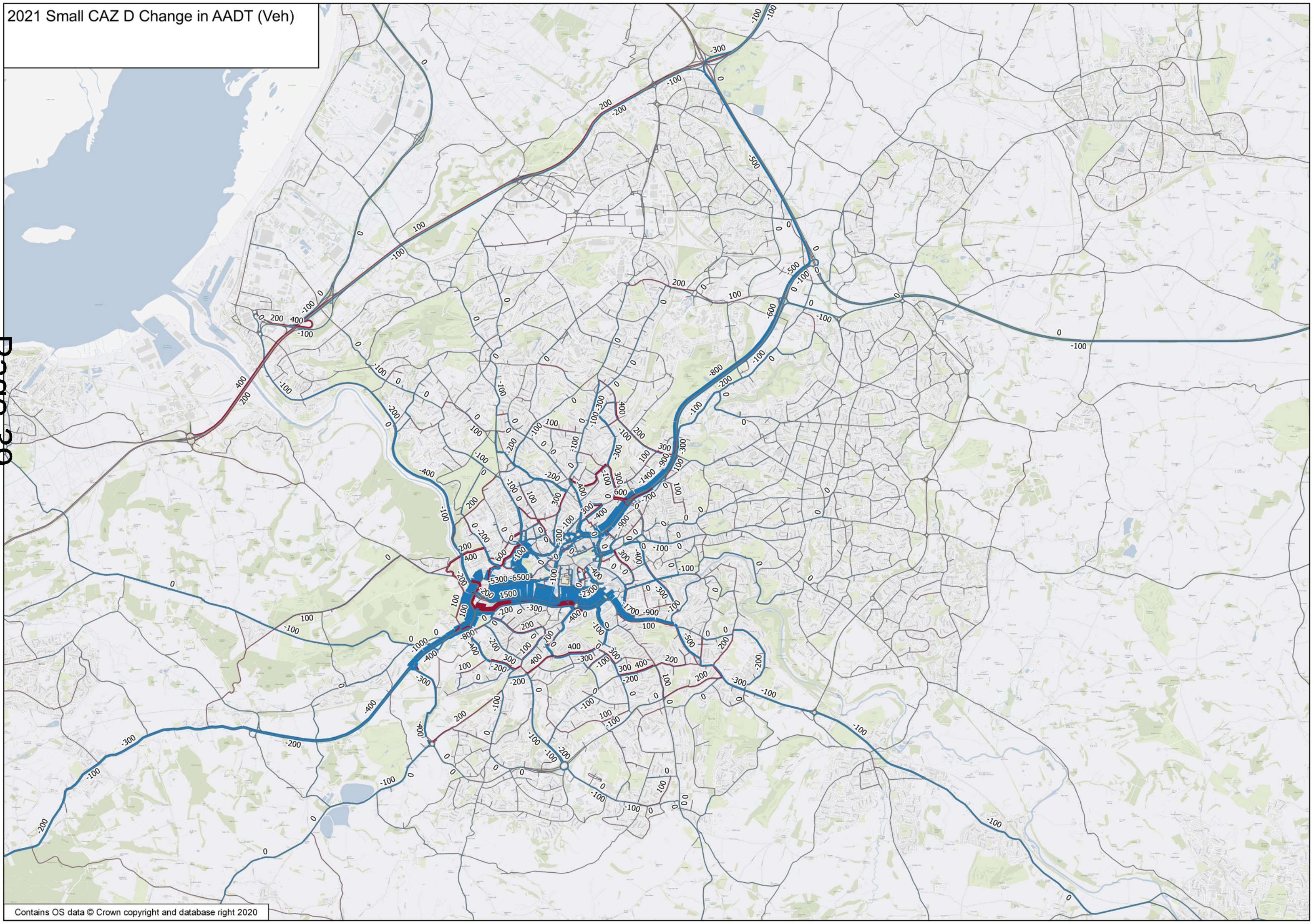
A.2 2021 Baseline: AADT – Greater Bristol Area



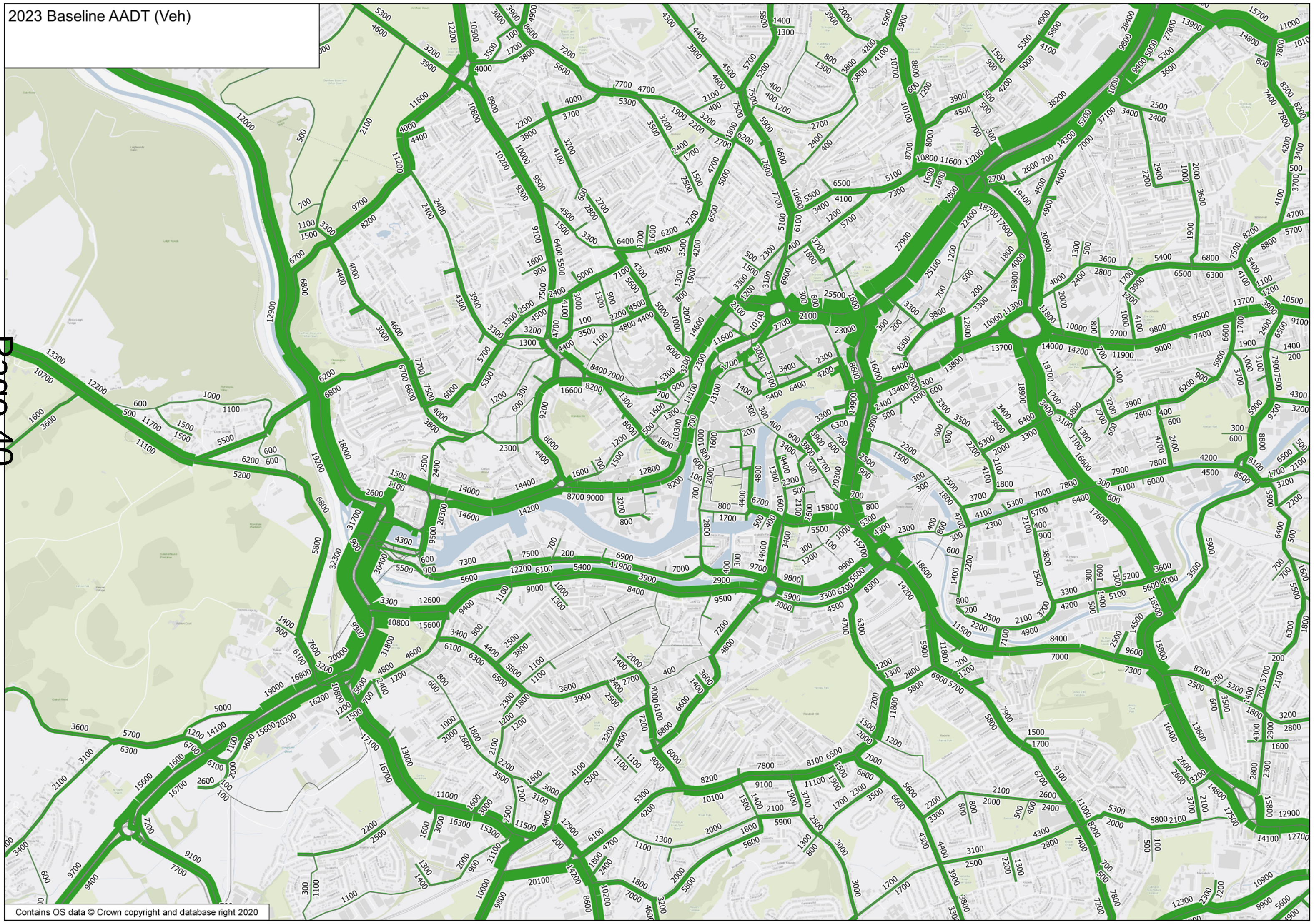
A.3 2021 Small CAZ D - Baseline: AADT – Central Bristol Area



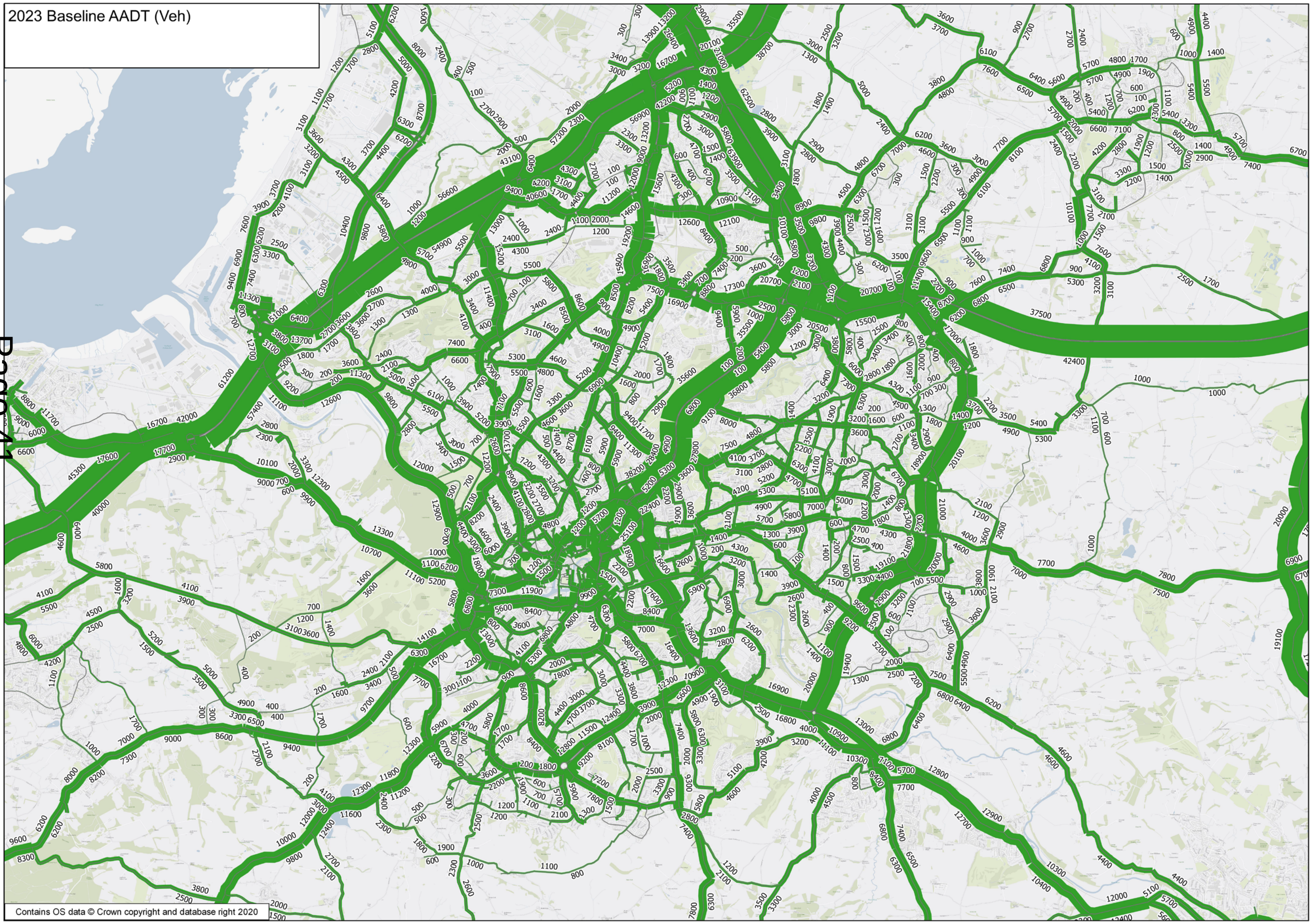
A.4 2021 Small CAZ D - Baseline: AADT – Greater Bristol Area



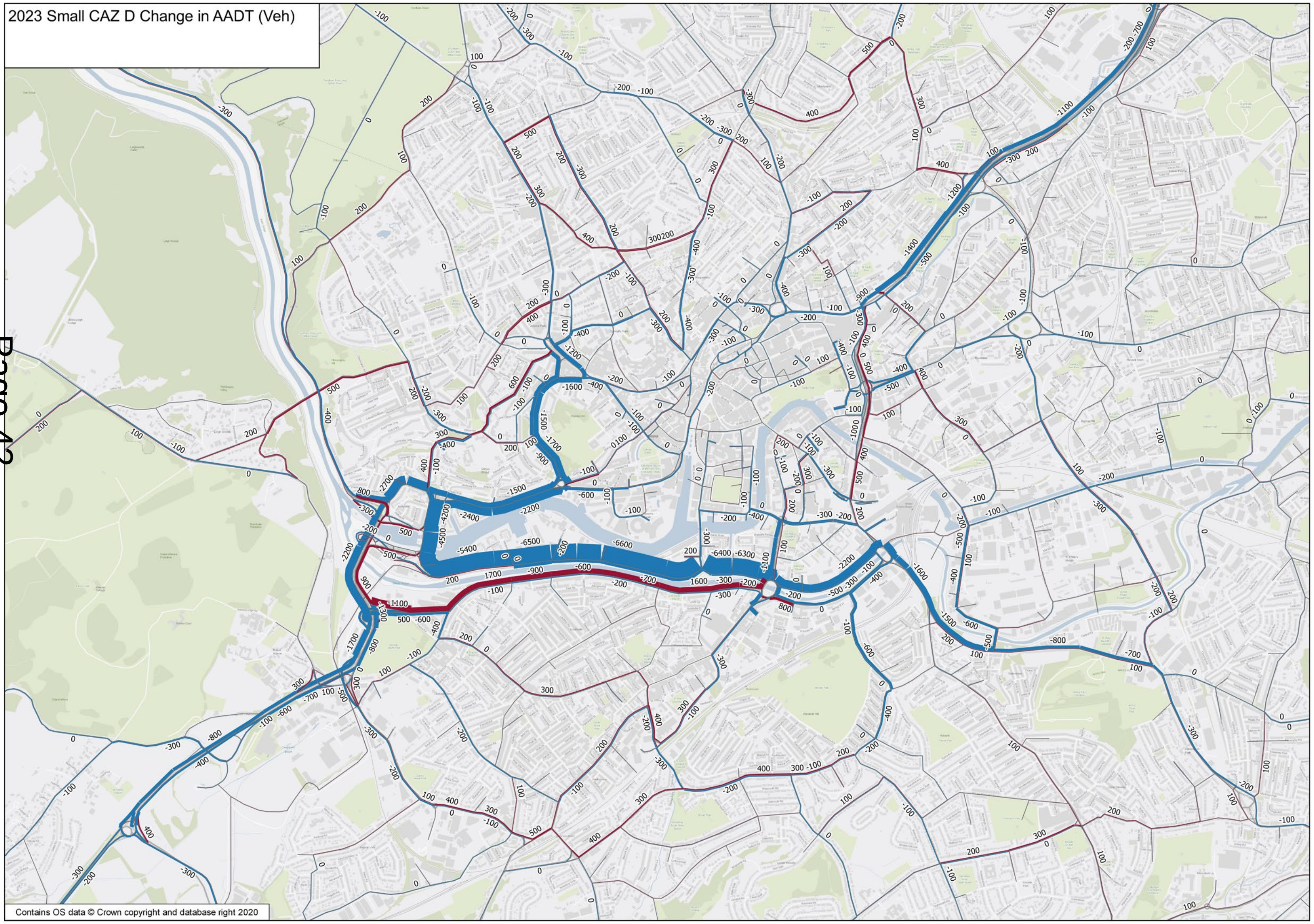
A.5 2023 Baseline: AADT – Central Bristol Area



A.6 2023 Baseline: AADT – Greater Bristol Area

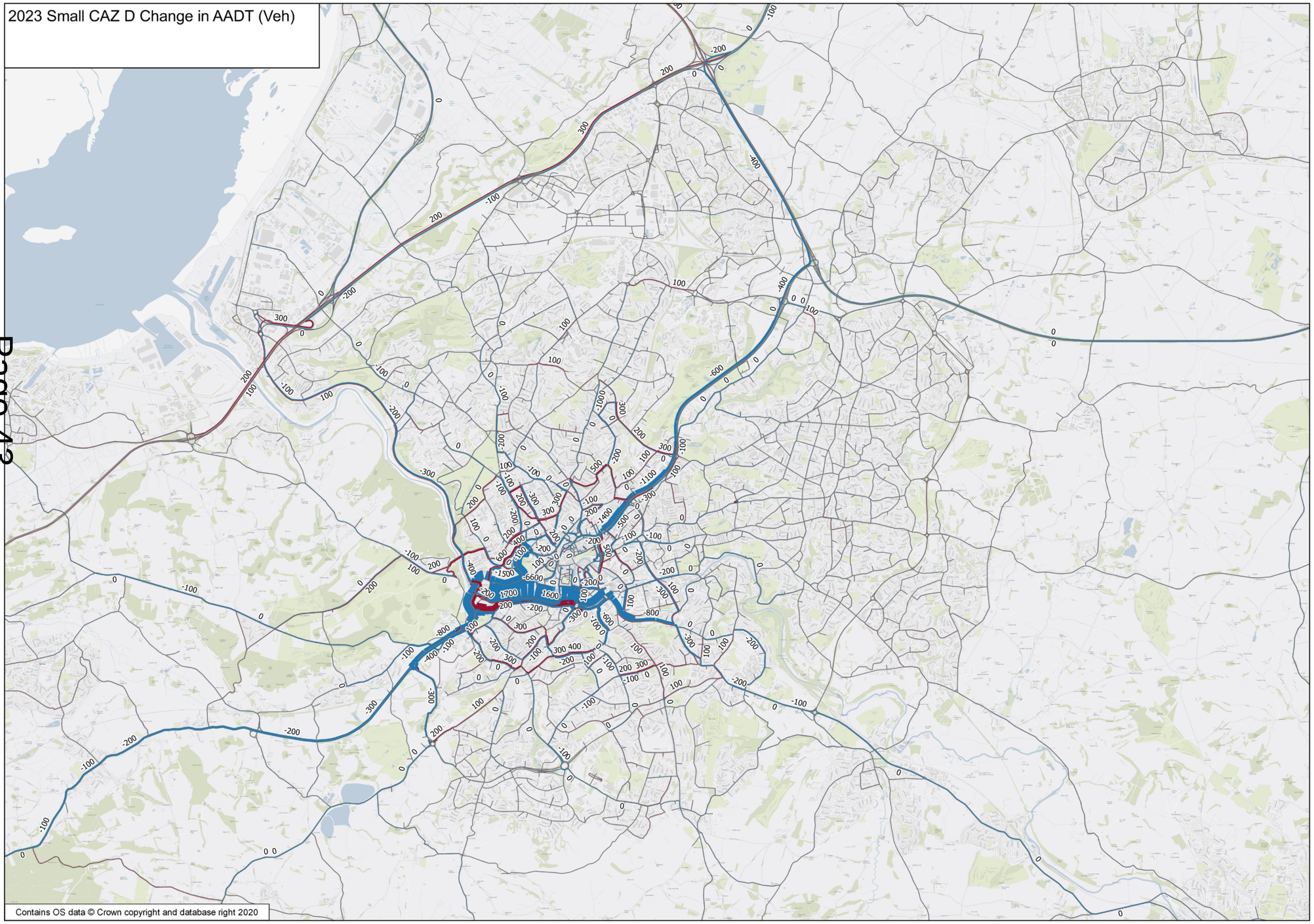


A.7 2023 Small CAZ D - Baseline: AADT – Central Bristol Area



Page 42

A.8 2023 Small CAZ D - Baseline: AADT – Greater Bristol Area



Bristol City Council Clean Air Plan Business Case

Stated Preference Survey Report

FBC-28 | 7

February 2021

Bristol City Council

Bristol City Council Clean Air Plan Business Case

Project No:	673846.CD.55.01
Document Title:	Primary Behavioural Response Calculation Methodology
Document No.:	FBC-28
Revision:	7
Document Status:	N/A
Date:	February 2021
Client Name:	Bristol City Council
Project Manager:	HO
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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
1	31-May-18	Draft Report issued	JB/HL/JG	CB	CB	BL
2	01-Jun-18	Draft Report reissued with minor corrections	JB	BL	BL	BL
3	29-Jan-19	Revised Draft Report for OBC	JB	CB	CB	HO
4	24 Oct-19	Revised Draft Report for OBC	JB	CB	CB	HO
5	28 Oct-19	Revised Draft Report for OBC	JB	CB	CB	HO
6	03-Feb-21	Revised Draft Report for FBC	JB	HO	HO	HO
7	17-Feb-21	Revised Draft Report for FBC	JB	HO	HO	HO

Contents

1. Introduction

1.1 Clean Air Zone context

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). The Mayor of Bristol has often cited Bristol's 'moral and legal duty' to improve air quality in the city and the administration recognises that achieving improved air quality is not solely a transport issue. Notwithstanding the Council's work on a Clean Air Zone, efforts have been made to make citizens more aware of – and take personal responsibility for – various sources of air pollution, from traffic fumes to solid fuel burning. The Mayor has articulated a 'call to action' for local people, businesses and organisations to consider how small changes can make a significant difference in cutting toxic fumes across the city. BCC has monitored and endeavoured to address air quality in Bristol for decades and declared its first Air Quality Management Area in 2001. Despite this, Bristol has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO_2) and these are predicted to continue until around 2027 without intervention.

The added context is that of the COVID-19 pandemic. Recent research suggests that poor air quality may be correlated with higher death / infection rates from COVID-19. This is further compounded by growing evidence that suggests that those from black, Asian and minority ethnic communities are more at risk of catching and dying from the virus and the fact that individuals from these communities are more likely to live in areas where air quality is poor. The challenge of maintaining public health and supporting economic recovery while also achieving legal air quality levels after lockdown restrictions are lifted will remain live and intersecting issues for the foreseeable future.

The UK Government continue to transpose European Union law into its Environment Bill[2] , to ensure that certain standards of air quality continue to be met, by setting air quality assessment levels (AQALs) on the concentrations of specific air pollutants. It's very unlikely that these AQALs will differ to EU Limit Values prescribed by the European Union's Air Quality Directive and transcribed in the UK's Air Quality Standards Regulation 2010. Therefore, these Limit Values will remain in enforcement post-Brexit. In common with many EU member states, the EU Limit Value for annual mean nitrogen dioxide (NO_2) is breached in the UK and there are on-going breaches of the NO_2 limit value in Bristol. The UK government is taking steps to remedy this breach in as short a time as possible, with the aim of reducing the harmful impacts on public health. Within this objective, the Government has published a UK Air Quality Plan and a Clean Air Zone Framework, both originally published in 2017 (noting there have been subsequent revisions). The latter document provides the expected approach for local authorities when implementing and operating a Clean Air Zone (CAZ). The following business cases have been submitted to JAQU for the Clean Air Plan; Strategic Outline Case (April 2018), and an Outline Business Case (November 2019 and updated between April and June 2020).

Following the submission of the OBC, further work was undertaken to develop the scheme, which resulted in the development of a new option - the Small area CAZ D. This work, and the option development work undertaken as part of the OBC, is presented in an updated Option Assessment Report (Appendix C FBC-16). The OBC version of this report is appended to the updated Option Assessment Report.

1.2 Overview of the Study

In order to help understand travel behaviour within the zones and how this could change should charging be introduced, a survey of those who drive in the proposed zones was conducted using stated preference techniques. The survey also collected information on respondents' demographics and existing vehicle replacement plans.

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[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] Environment Bill 2019-21 https://services.parliament.uk/bills/2019-21/environment.html

The extent of the proposed CAZs presented in the survey are depicted in Figure 1-1 and Figure 1-2.

Figure 1-1: Small Clean Air Zone

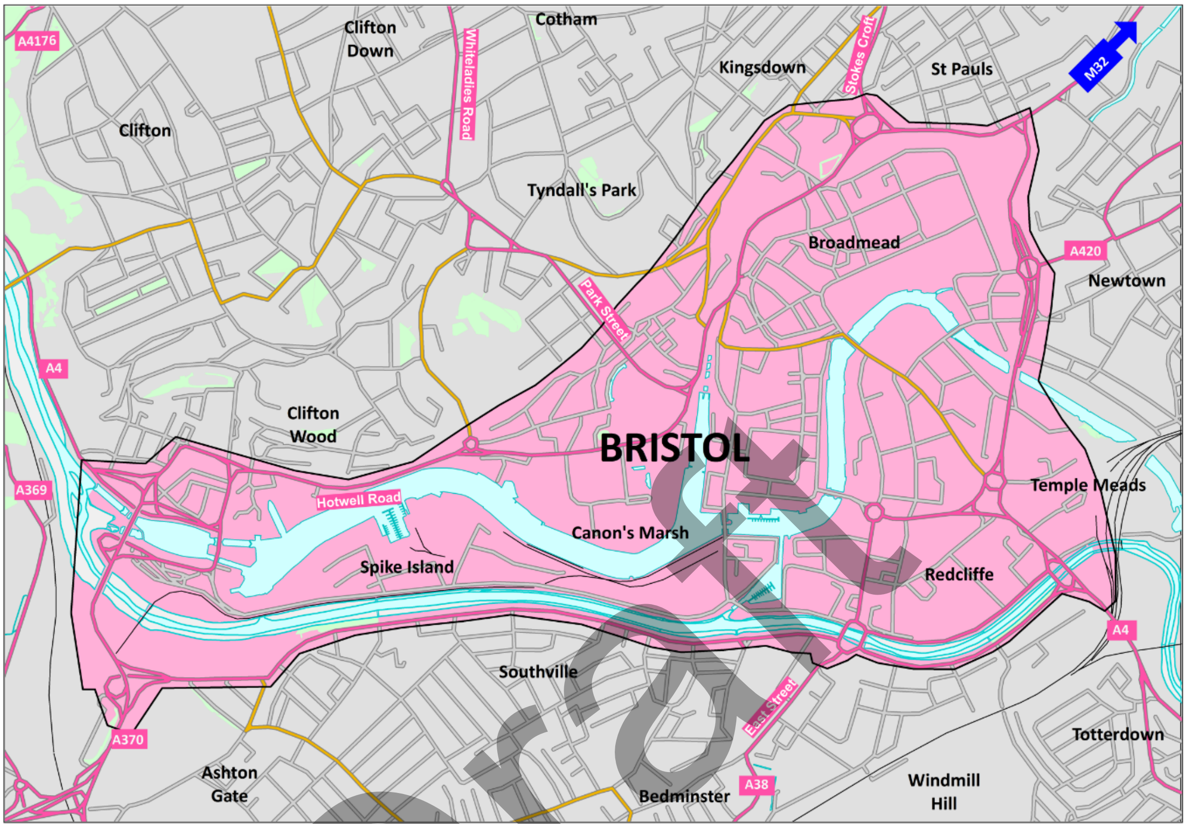
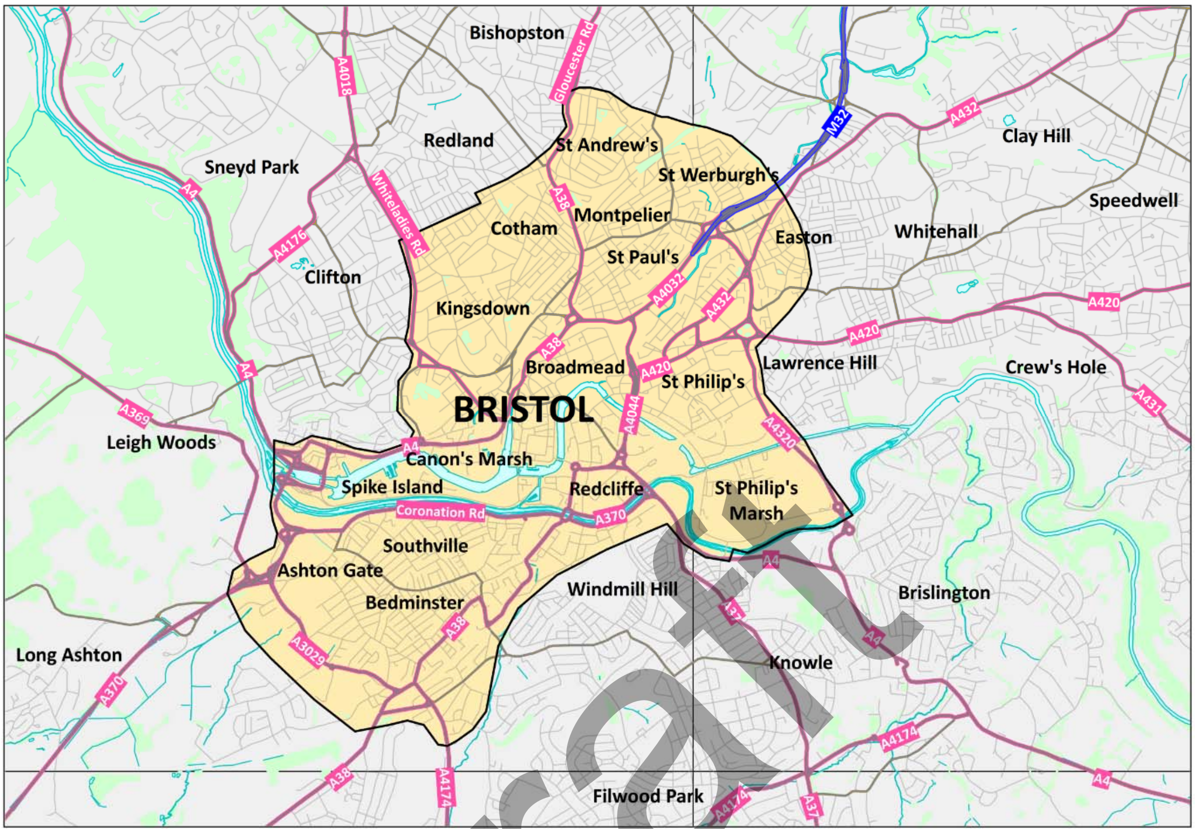


Figure 1-2: Medium Clean Air Zone



- **Survey Design:** provides an overview of the key stages in the development of the stated preference survey.
- **Implementation and Sampling**: describes the data collection and sampling methodologies.
- **Data Checks and Cleaning:** describes sense and logic checks, and the data cleaning process.
- **Stated Preference Analysis and Results:** describes the methods to analyse the stated preference exercises and an overview of the results from these.
- **Conclusion:** summary of the headline results and conclusions from the survey.

2. Survey Design

2.1 Overview

The survey was conducted among residents of Bristol City Council and the surrounding Local Authorities. Participants were obtained from an online market research panel allowing the survey to be targeted at a representative sample (age, gender) of the resident population.

Initial screening questions then limited the main survey to those who have recently driven within the proposed medium clean air zone boundary in a car or light van (under 3.5 tonnes) that does not comply with the standards, which are:

- Petrol vehicles with emissions standards at least Euro 4/IV (approx. registered 2006 or later); and
- Diesel vehicles with emissions standard Euro 6/VI (approx. registered pre-2015 or later).

Vehicles which meet the standards of the CAZ framework, and therefore would not be charged within a charging CAZ (barring potential exemptions), are referred to as 'compliant' vehicles within the remainder of this report, and vice versa for 'uncompliant' vehicles.

The questionnaire collected information on the most recent trips of drivers of non-compliant vehicles within the affected zone and how the drivers may respond to various levels of proposed charge. The questionnaire also collected information on the vehicle replacement plans in terms of timescales and likely type of vehicle.

To identify the behavioural changes, two exercises were included in the questionnaire, testing responses to possible charges. All of the data was collected using an online questionnaire.

Exercise 1 provided a number of possible actions the respondent might have taken if charging had been in place the last time they drove in the CAZ. One of the options was continuing to use their current vehicle to make the journey and pay the charge.

The purpose of Exercise 2 was to work out whether the respondent would replace the vehicle with a compliant one if CAZ charging is implemented. The respondent had a choice between two options: either continue to pay the charge or replace their vehicle.

The questionnaire used in the London Ultra Low Emission Zone stated preference survey, conducted for Transport for London by Steer Davies Gleave, was used as a basis to design the questionnaire used in Bristol study.

The purpose of the survey was specifically to determine the response of local travellers to a Charging Clean Air Zone and therefore questions did not cover other potential Clean Air Plan measures such as improved alternatives or full exclusions of certain vehicle types.

2.2 Questionnaire Structure

A summary of the questionnaire is provided in this section. The full survey can be found in Appendix A.

2.3 Screening Questions

The questionnaire started with a series of screening questions in order to exclude all non-eligible participants early in the process. The screening was based on the following criteria:

- Home postcode;
- Age of the respondent (to check whether he/she is eligible to drive);
- Vehicle type;

- Registration date;
- Decision making over vehicle replacement;
- Vehicle fuel type; and
- Frequency of travel to CAZ.

This was used to ensure that only people who drive a non-compliant car or LGV within the CAZ at least once every 6 months, make the decision about its replacement and live in either City of Bristol, South Gloucestershire, B&NES or North Somerset Local Authority (LA) areas were included in this survey.

2.4 Vehicle Questions

This section included questions about the respondent's current vehicle, including size and age of the vehicle, as well as the number of additional vehicles in the household (if any). The information about the additional vehicles in the household was required to work out if any of these were compliant and if the respondent is likely to use it to travel in/through the zone in light of the introduction of the charging scheme.

The section also collected information on the vehicle replacement plans, including planned timescales for replacing the vehicle, as well as expected age, size and fuel type of the replacement vehicle. These questions are all asked before any mention of the proposed clean air charge to avoid this information influencing these choices.

2.5 Frequency of driving to the centre of Bath

This question was asked to measure the overlap between driving in central Bristol and Bath, where a Clean Air Zone is also being considered.

2.6 Clean Air Zone: Introduction

This section started with an introduction to the Clean Air Zone and the proposed charging scheme. This is the first time within the survey that the concept of a Clean Air Zone is mentioned. The question about the compliancy of additional vehicles available in the household (if any) was also asked in this section.This section collected information on the purpose of the most recent journey the respondent had made to the study zone.

2.7 Clean Air Zone Exercise 1

The next section consisted of an exercise to help understand the possible short-term behaviour of the respondent assuming CAZ charging is introduced. For this exercise the respondent was asked to choose between several possible alternatives in relation to their most recent journey:

- Making the same journey using your own vehicle and paying the charge (varies by scenario);
- Making the same journey but using a different mode (e.g. public transport, cycle, walk);
- Not making the journey;
- Changing destination to avoid the charging area;
- Changing route to avoid the charge; and
- Making the same journey but using a compliant vehicle available in your household. (only included if respondent had indicated they had access to such a vehicle).

Asking specifically for the most recent journey is intended to obtain a split of different journey purposes rather than just asking about the most frequent trip the respondent makes in the zone.

The exercise consisted of four different scenarios where the only difference was the charge level. Half the sample were shown one set of 4 charges and the other half of the sample were shown another set of 4 charges; thus, across the survey, 8 charge levels were tested.

The different charge levels for Exercise 1 are summarised in Table 2-2.

Table 2-1: Exercise 1 Charge Levels

Charge (£)	
Subgroup 1	***Subgroup 2***
£5.00	£3.00
£7.00	£6.00
£9.50	£8.00
£12.50	£10.50

2.8 Clean Air Zone Exercise 2

The second exercise concerned the potential long-term behaviour assuming CAZ charging was in place.

The only options provided in this exercise were to either continue paying the charge when travelling in/through CAZ using the current vehicle, or to replace the vehicle with a compliant one at a given hypothetical cost. The respondents were asked to assume that this cost was sufficient to replace their vehicle with a compliant one and to set aside any considerations about their current vehicle type and replacement plans.

The purpose of this exercise was to establish whether the respondent is likely to switch to a compliant vehicle assuming a CAZ is in place, and how this decision would vary depending on the charge level/vehicle replacement cost.

For this exercise respondents had to complete six different scenarios. The difference between the scenarios was the combination of charge level and replacement cost. Across the survey 12 scenarios were assessed, 6 to each half of the sample, the combinations are shown in the following table:

Table 2-2: Exercise 1 Charge Levels

Subgroup 1		**Subgroup 2**	
Charge (£)	***Replace (£)***	***Charge (£)***	***Replace (£)***
£3.00	£9,000	£5.00	£10,000
£4.00	£3,000	£6.00	£1,000
£10.00	£10,000	£6.00	£6,000
£9.00	£2,000	£8.00	£5,000
£11.00	£6,000	£12.00	£8,000
£7.00	£8,000	£13.00	£4,000

2.9 Questionnaire Assessment

In the next section the respondent was asked to provide their assessment of the survey, covering topics such as:

- Complexity of the survey;
- Clarity of descriptions and explanations used in the questionnaire; and
- Practicality of the vehicle replacement costs.

It also allowed for the respondent to expand on why they had found the exercise difficult to complete or why the vehicle replacement costs seemed very unrealistic should they have selected these responses.

2.10 Demographic questions

The last section collected demographic information about the respondent, including employment status, occupation, household income, gender, ethnicity and disabilities.

This information is useful to analyse the demographic make-up of the sample and its representativeness, potential demographic related variances in response to the charge zone as well as assist in the segmentation of the results for use in the transport modelling.

The questionnaire finishes with an open-ended question which gives an opportunity for the respondent to provide any comments about the survey or the topic itself.

2.11 Questionnaire versions

There were 4 versions of the questionnaire which were the possible combinations of two sets of charge levels and two orders in which the Medium and Small Zones were presented. The version assigned was randomly selected so that each version was completed by approximately a quarter of the respondents.

To further avoid order bias, the order in which charge levels and charge levels/replacement costs were presented in Exercises 1 and 2 was randomised.

3. Implementation and Sampling

3.1 Implementation and Sampling

Crystal Market Research worked with Jacobs throughout the survey development and implementation process. The questionnaire used in the London Ultra Low Emission Zone stated preference survey conducted for Transport for London by Steer Davies Gleave was reviewed and adapted for the purposes of the study in Bristol. The online version of the questionnaire was programmed by Indiefield – to be usable on all types of device.

The survey participants were recruited using a market research panel held by Indiefield. A panel is a database of people who have 'signed up' to take part in market research studies and receive a small payment for doing so. They have provided contact, demographic, behavioural and ownership details about themselves that enables targeting of relevant types of people for a particular survey

For this survey a representative sample of the Indiefield panel living in the LA areas, based on quotas for gender and age (17-34, 35-54, 55+) using 2011 Census data, was contacted by email and invited to take part in the survey. Each participant was offered a small financial incentive to complete the survey. The panel sample was contacted in batches and email reminders were sent out to those who had not responded. Each invitation email contained a questionnaire link with a unique ID that was possible to open only once, thereby preventing an individual questionnaire from being completed multiple times.

Clicking on the survey link took invites to a series of 'screening' questions (as described in section 2.3) to establish whether or not they met the requirements for completing the main questionnaire. To be eligible to complete the main questionnaire the respondent had to:

- Live in City of Bristol, South Gloucestershire, North Somerset or B&NES LAs;
- Be aged 17+;
- Drive a car or LGV that is non-compliant under the Defra CAZ Framework;
- Be a joint or sole decision maker over the replacement of that vehicle;
- Drive in the proposed small and/or medium clean air zones in Bristol at least once every 6 months; and
- The target completion rate for respondents was 1,100 for the Medium CAZ and 700 for the Small CAZ.

Table 3-1 below summarises the target splits by Local Authority for the required questionnaire completion rate. Initial targets were calculated from 2011 travel to work Census data with minor adjustments during the survey based on the eligibility rates (i.e. the % of initial respondents passing the screening questions).

Table 3-1: Target Splits by Local Authority

Local Authority	Number of Respondents	Proportion
Bristol	550	50%
South Gloucestershire	275	25%
North Somerset	165	15%
B&NES	110	10%
Total	1100	-

The survey was targeted at a representative sample (of age and gender) to the population of panel members.

3.2 Testing Surveys

The questionnaire underwent internal testing prior being sent to the survey panel. The key focus of the tests was to check:

- The sequence and logic of the questions;
- That the screening out process worked correctly;
- The randomisation of scenarios worked for all of the exercises; and
- That no technical issues occur during the completion of the survey.

3.3 Survey Pilot

A pilot of the online survey was launched amongst CH2M and CMR associates who did not have a direct involvement in the study. 35 questionnaires were completed.

The purpose of the pilot was to collect broader feedback on the questionnaire prior to launching the final version online. Below are the key areas assessed:

- Overall length and completion time of the survey;
- Questionnaire design flaws/technical issues;
- Complexity of the terminology/wording used in the survey;
- Complexity and understanding of the exercises;
- Appropriateness of vehicle trade-in (upgrade costs);
- Overall feedback on the questionnaire.

This feedback helped to inform a number of amendments to the questionnaires including:

- Simplification of the wording of the introductory text and questions;
- Structure and presentation of the exercises simplified and clarified;
- Exercises changed from asking all participants all 8 options in both exercises to two subgroups of 4 and 6 for exercises 1 and 2 respectively, and;
- Maps amended for clarity and increase the distinction between the two zones.

Once amended, the post-pilot versions then underwent further checks and testing to ensure that all of the amendments were applied correctly to the final version of the questionnaires.

3.4 Quotas Achieved

The survey was conducted between the dates of 22 February and 12 March 2018 with a total of 1103 questionnaires completed from a target of 1100. Table 3-2 and Table 3-3 provide a summary of the target and achieved sample sizes.

Table 3-2: Target Splits by Local Authority

Zone	Target	Actual
Medium CAZ	1100	1103
Small CAZ	700	967

Table 3-3: Local Authority Targets and Achieved Sample

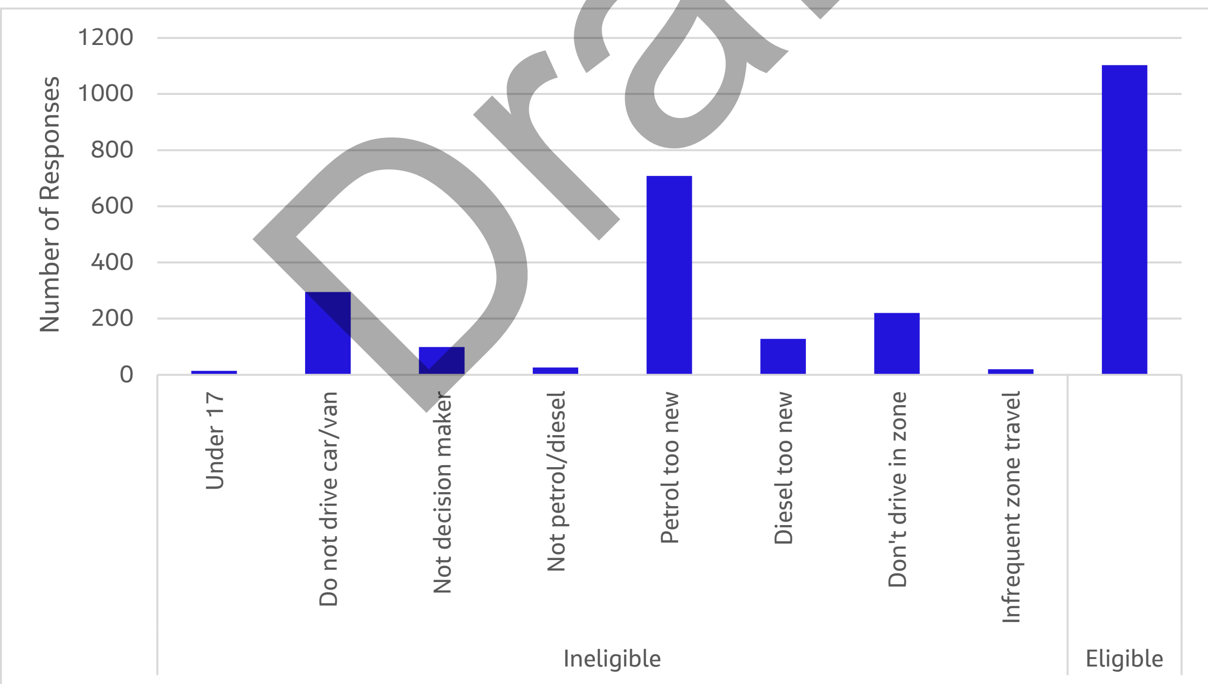
Local Authority	Target	%Target	Actual	%Actual
B&NES	110	10%	110	10%
Bristol	550	50%	554	50%
North Somerset	165	15%	176	16%
South Gloucestershire	275	25%	263	24%
Total	1100	-	1103	-

3.5 Ineligible respondents

Of the respondents who opened the link only 42% were eligible to complete the full questionnaire. Figure 3-1 shows the proportion that were eliminated at each of the screening questions.

Notable reasons for elimination were: not driving a car or van (11% of those starting the questionnaire), vehicle too new (32%) and not driving in the zone either at all, or within the last 6 months (9%). When interpreting these numbers, care should be taken to note that the questions were asked in order and only up until the point that the respondent was found to be ineligible. Thus, of those eliminated because their vehicle was already compliant, a number may have also not driven in the zone.

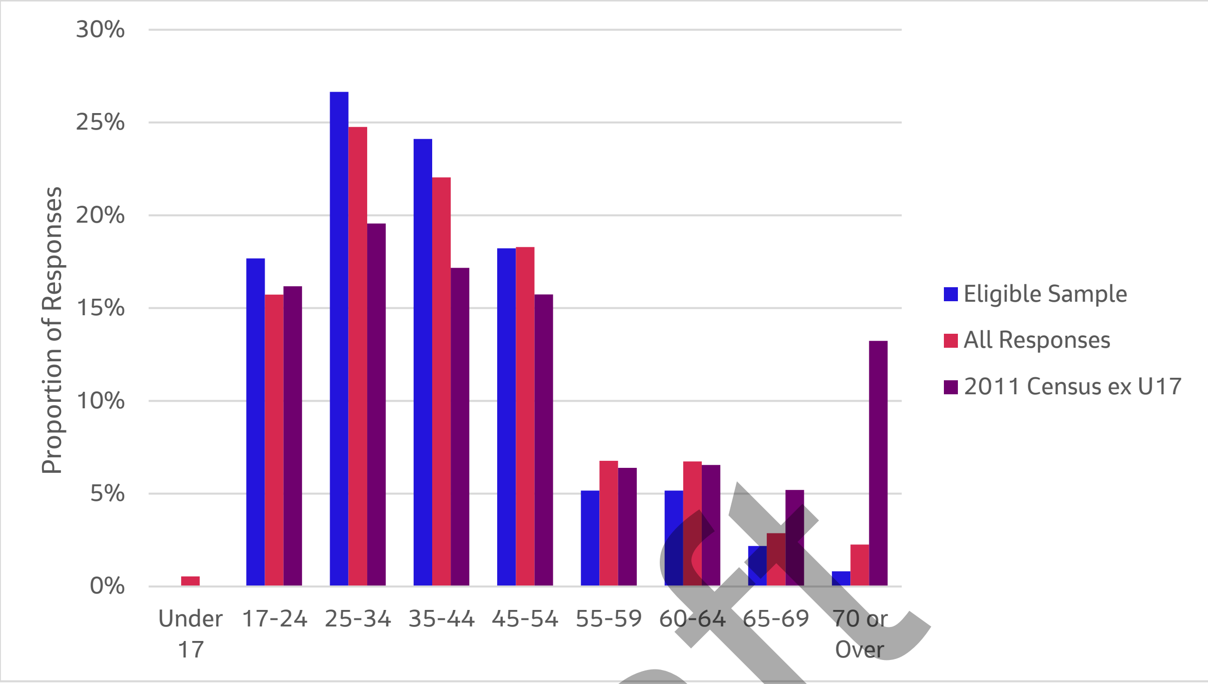
Figure 3-1: Ineligible Respondents



3.6 Sample profile

The split of respondents in each individual age group both before and after screening questions is presented in Figure 3-2. Approximately 90% of the eligible sample falls within the age range of 17 to 54, with the highest proportion of respondents in age group 35-44 followed closely by age group 25-34. The age profile of the sample is also compared with both age profile of the eligible area according to the 2011 Census (with under 17s excluded).

Figure 3-2: Respondents by Age Group



The screening process skews the sample slightly towards younger people. It is thought that there could be two main drivers behind this. First, younger people are more likely to be economically active and therefore travel within the zone more often. Secondly, older people have a number of potential reasons to be less likely to be eligible. The demographic tends to be wealthier and therefore may be more likely to already have a compliant vehicle and also have more attractive alternatives such as free bus travel.

Comparing the profile of pre-screening responses to the age profile of residents in 2011 shows a further skew towards ages 25-45 and away from those over 65. This is likely in part due to the online nature of the panel. Though emails were targeted at a representative sample, there is likely still a limitation in the response rate/engagement from older demographics.

Given the low eligibility rates amongst these ages noted, it is considered that the impact of this on the final results is limited with, at most, 70 more respondents in the younger age bands and correspondingly fewer in the eldest two.

Participants were asked about the fuel type of their vehicle and, as can be seen in Figure 3-3, a higher share of respondents had a petrol vehicle.

Figure 3-3: Respondent's Non-Compliant Vehicles by Fuel Type

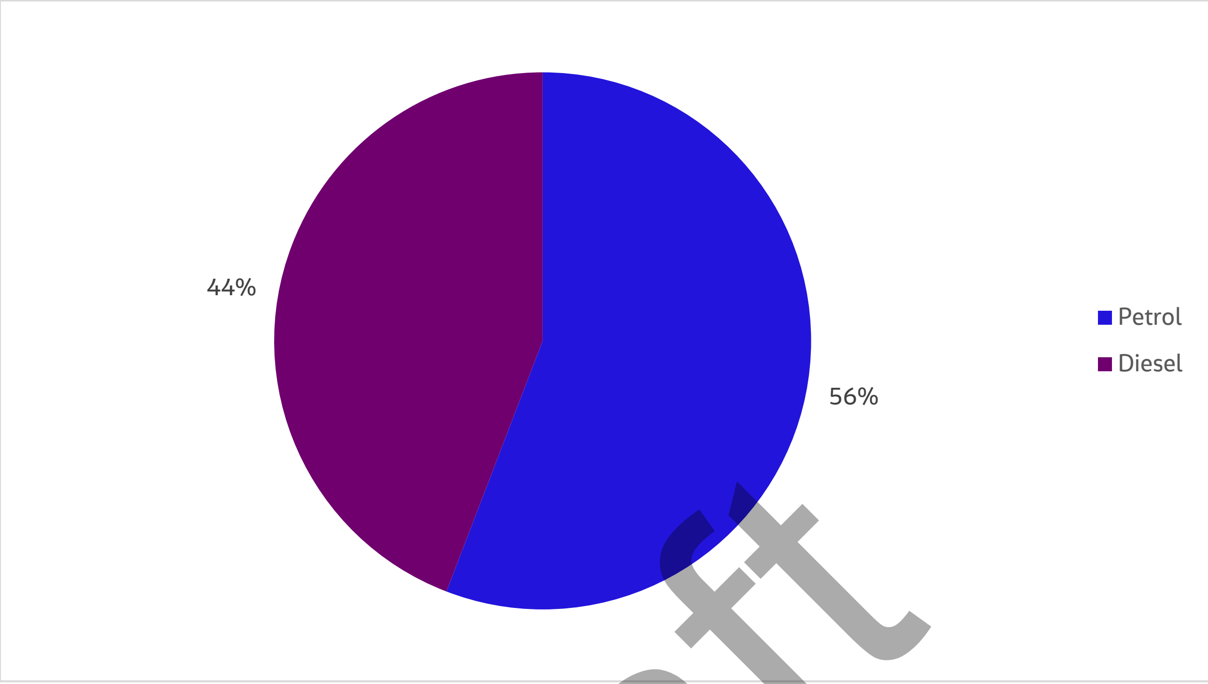


Figure 3-4 and Figure 3-5 show that majority of the respondents (70%) were in full-time employment in a range of different occupations.

Figure 3-4: Number of Respondents by Employment Status

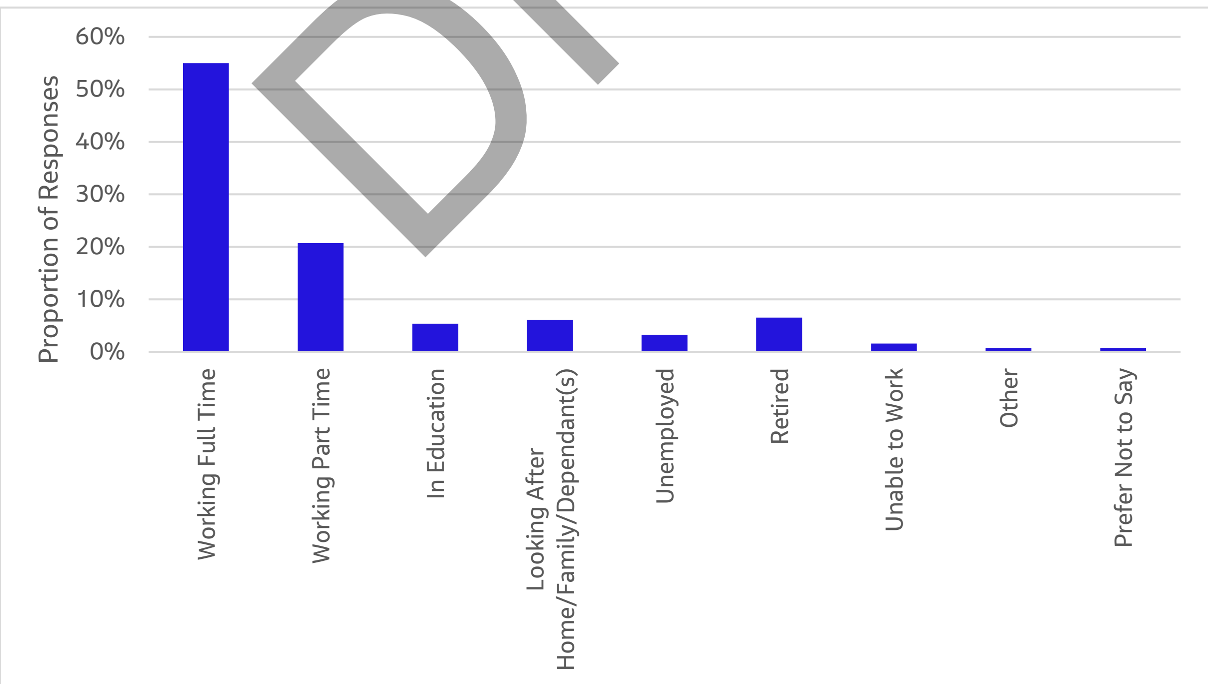
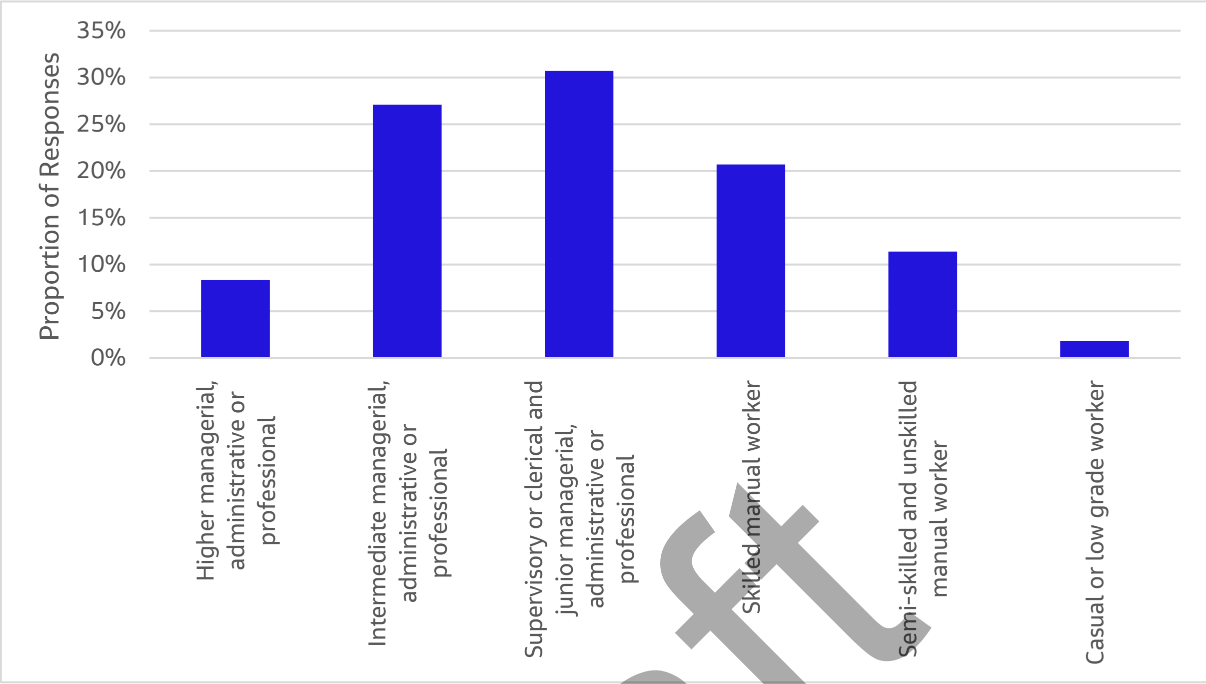


Figure 3-5: Number of Respondents by Occupation



The income profile of respondents is shown in Figure 3-6. The £35,000-£49,999 household income band has the highest number of respondents, with 36% between £25,000 and £49,999. A significant proportion declined to share their income.

Figure 3-6: Household Income Distribution

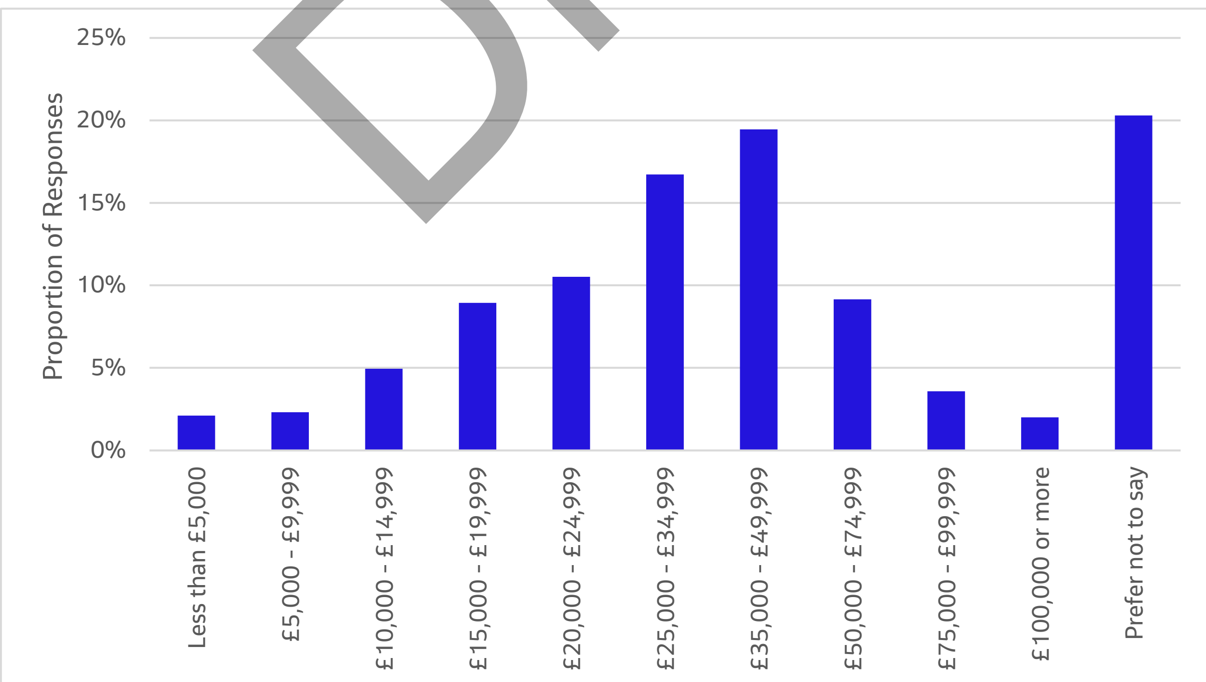
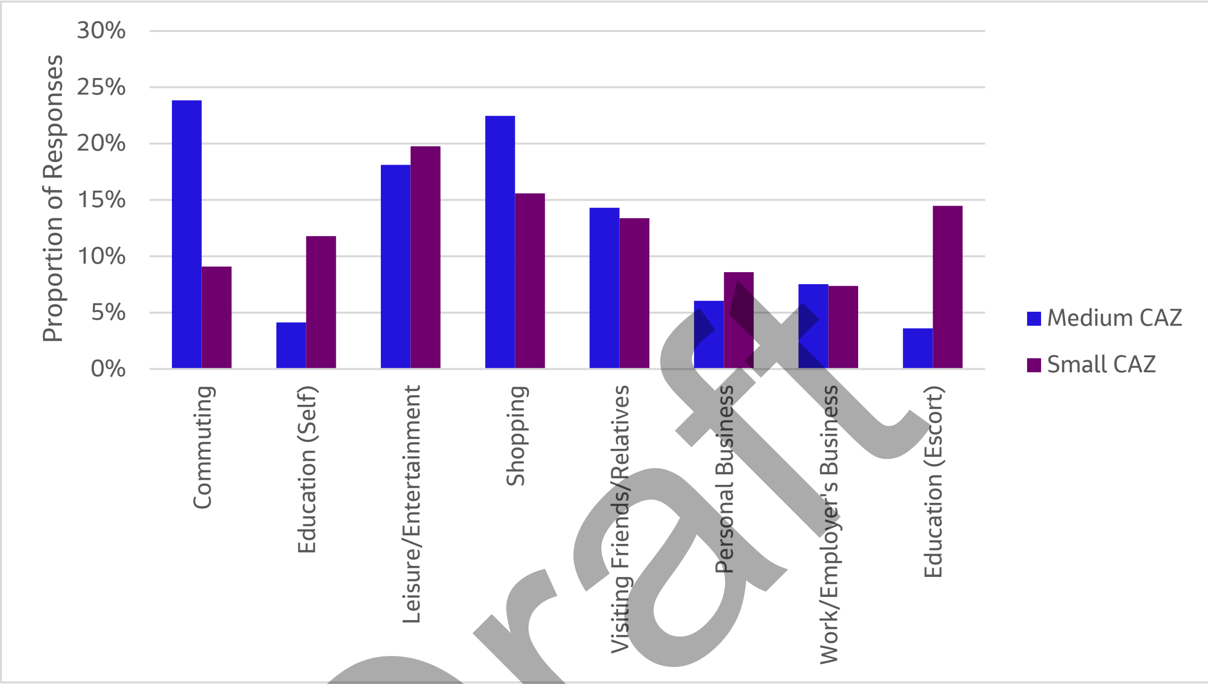


Figure 3-7 shows a relatively broad mix of trip purposes were sampled by the survey. The last trips undertaken in the small zone comprised a much lower proportion of commuting and higher proportion of education escort. This may reflect the lack of central parking availability and higher use of other modes to commute into this area. Meanwhile there are a number of primary schools close to the Small Zone boundary generating short distance pupil ferrying.

Figure 3-7: Trip Purposes Sampled



4. Data Checks and Cleaning

The data collected via the online survey underwent a number of sense and logic checks in order to discard any non-sensical data.

Rather than excluding a questionnaire on specific automated criteria, a series of checks were set up to flag a subset of the responses for further investigation. The internal consistency of each questionnaire was then manually assessed, and a decision made on whether to discard the record. This section discusses the aspects considered in this process.

4.1 Sense Checks.

The following aspects were considered in detail during the sense checks of questionnaires:

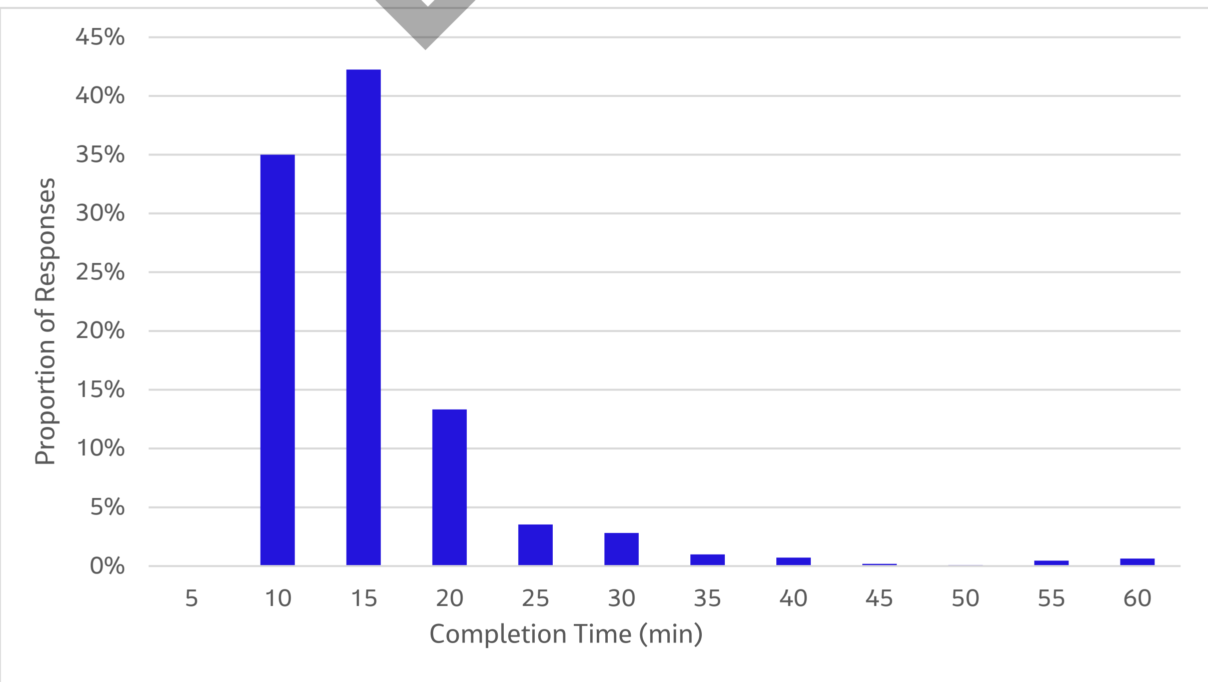
- Questionnaire completion time;
- Respondent's assessment of the survey;
- Overall logic of the responses; and
- Answers to open ended questions.

Questionnaire completion times were analysed in more detail to identify the amount of time considered to be sufficient to complete the questionnaire. The questionnaires completed outside the identified time range were checked in more detail for overall logic of the responses as these can indicate a questionnaire filled in without much thought or in a distracted manner. Out of 1103 questionnaires completed:

- 20 questionnaires were completed in 7 minutes or less;
- 23 were completed in 35 minutes or more.

Figure 4-1 below provides a summary of the completion times for all of the questionnaires collected as part of the study. Long completion times were likely due to a respondent completing part of the survey and then returning to it later.

Figure 4-1: Questionnaire Completion Time (min)



The design of the questionnaire allowed for the respondent's assessment of:

- Overall difficulty of the survey;
- Clarity of the definitions and explanations; and
- Practicality of vehicle trade-in (replacement) costs.

If the respondent found either of the exercises particularly difficult or the vehicle replacement costs very unreasonable, there was an option to provide reasoning in a comment box.

The questionnaires where the respondent found the stated preference exercise too difficult to complete, the definitions and explanations very unclear or the vehicle replacement too unrealistic, were analysed in more detail. It was considered that the responses provided in such questionnaires might not be sufficiently accurate.

From 1103 respondents that completed the stated preference questionnaire:

- 1 respondent found the exercise very difficult;
- 3 respondents found the survey explanations and definitions very unclear; and
- 57 respondents considered the replacement costs very unrealistic.

Figure 4-2 below provides the proportion of responses by the perceived difficulty of the questionnaire for the survey prior to any data cleaning or elimination.

Figure 4-2: Assessment of the Questionnaire Difficulty

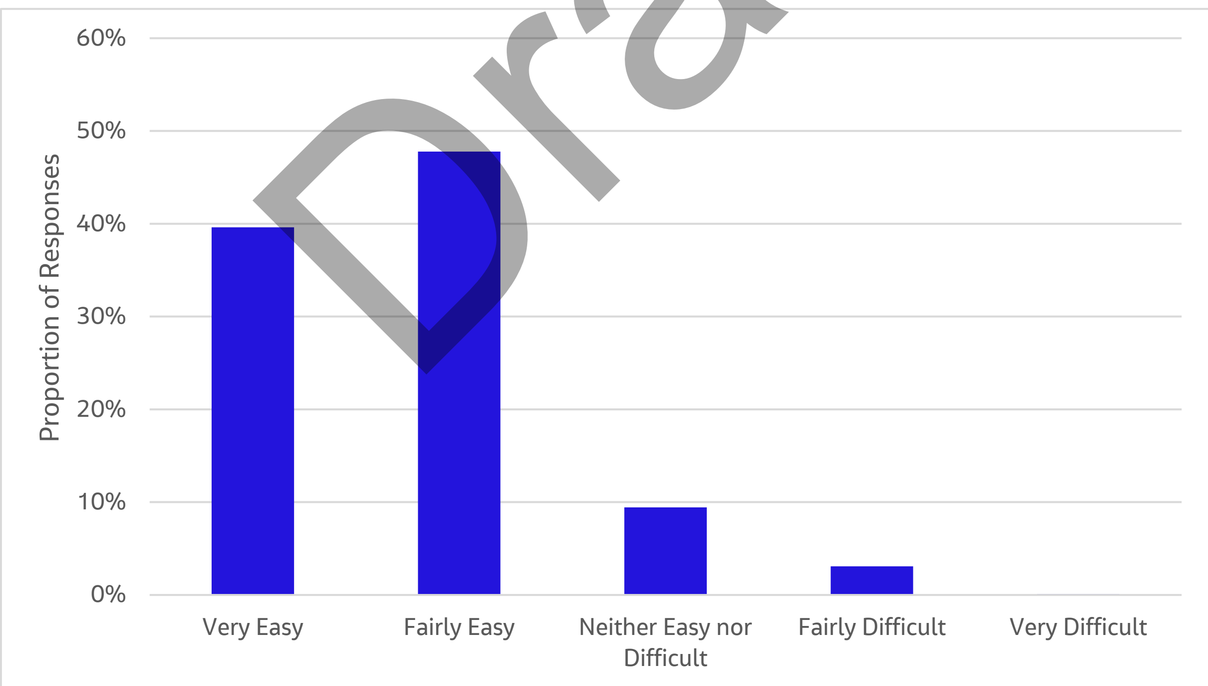


Figure 4-3 shows the number of responses by perceived clarity of the explanations and definitions used in the stated preference questionnaire for the survey prior to any data cleaning or elimination.

Figure 4-3: Assessment of the Clarity of the Explanations and Definitions

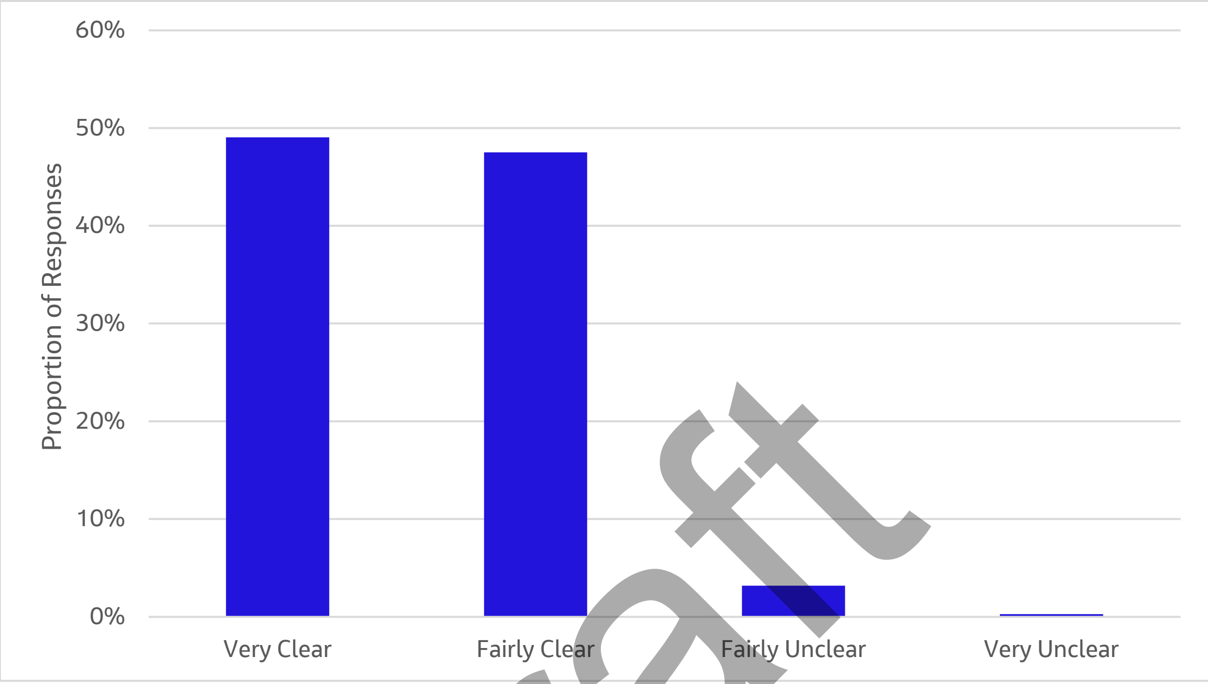
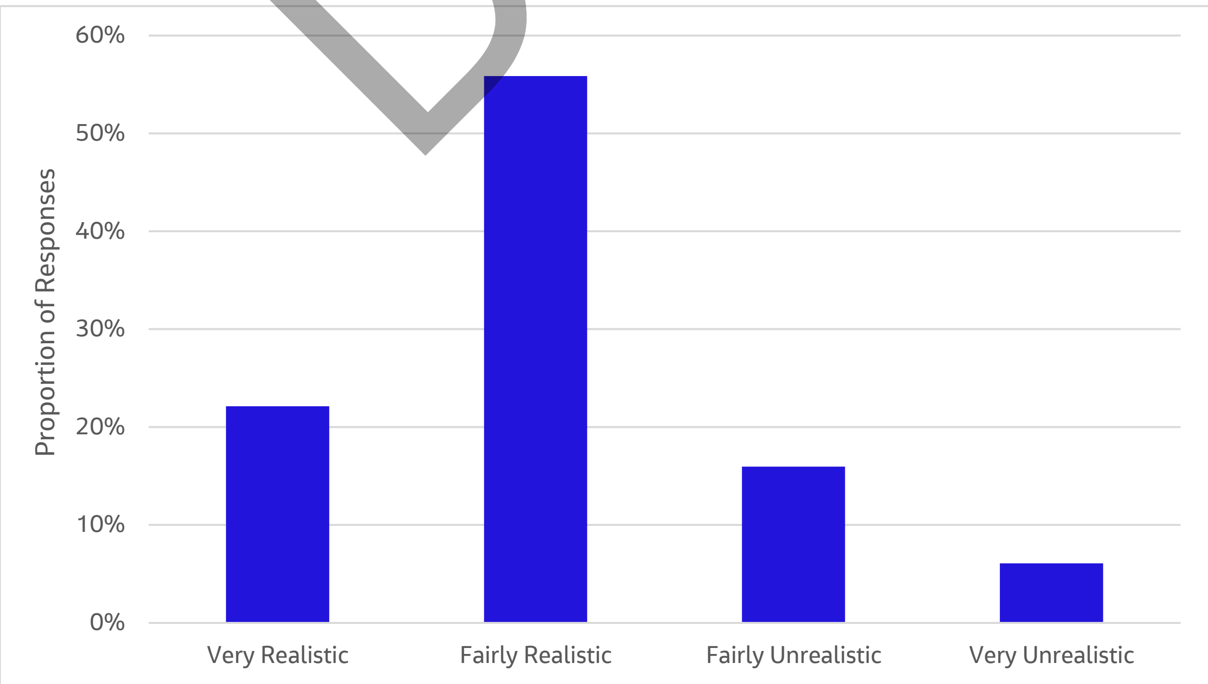


Figure 4-4 shows the perceived realism of vehicle replacement costs for the survey prior to any data cleaning or elimination.

Figure 4-4: Practicality of the Vehicle Trade-in (Replacement) Costs



If a respondent chose to pay the CAZ charge at all levels at Exercise 1 they were asked to explain why. Likewise, if, at Exercise 2, a respondent always chose to pay the charge or always chose to replace their vehicle, regardless of charge level/ replacement cost, they were asked to give an explanation.

At the end of the survey the respondents also had an option to provide general comments on the topic of the survey or the questionnaire itself. Any questionnaires containing non-sensical or highly emotional written answers or comments were investigated in more detail to assess the overall logic of the responses. In addition, further checks were done for the questionnaires where the respondent seemed particularly biased towards or against the CAZ scheme, to see if this might have had an impact on the responses to exercises.

The key factor in the sense checks was the internal consistency of each questionnaire. Some of these checks included the relation between:

- Respondent's occupation and household income;
- Residential postcode and frequency of travel to a particular zone;
- Travel purpose and frequency of travel; and
- Near-identical record data indicating duplicate submission.

4.2 Logic Checks

To review the responses to exercises 1 and 2 some logic checks were used to remove illogical responses that suggested the respondent either did not understand the questionnaire or was not thinking about the answers and selecting responses at random.

Exercise 1: Pay charge vs behaviour change

For the short-term response exercise, responses were flagged where the respondent had suggested they would pay a more expensive CAZ charge but change behaviour for a cheaper CAZ charge.

Exercise 2: Pay charge vs replace vehicle

For the second exercise, where the respondent had selected a mix of choices, (i.e. to pay the charge to some combinations of charge and cost but replace vehicle to others), the average replacement cost per charge was computed for both the 'pay charge' and 'replace vehicle' responses. If this average value was higher for the 'replace vehicle' responses, then the record was discarded from consideration as this suggests the respondent would be prepared to pay the charge for relatively high charges to low replacement costs and vice versa.

Consider the following two hypothetical responses to Subgroup 2:

Table 4-1: Example of Exercise 2 Logic Check

Charge (£)	5	6	6	8	12	13
Replacement Cost (£)	10,000	1,000	6,000	5,000	8,000	4,000
Average replacement cost per charge (£)	2,000	167	1,000	625	667	308
Respondent 1 decision	Pay charge	Replace	Pay charge	Replace	Replace	Replace
Respondent 2 decision	Pay charge	Pay charge	Replace	Pay charge	Pay charge	Pay charge

For respondent 1, the average 'replacement cost per charge' of the choices to pay the charge are 1,500 while for upgrading it is 442, the difference of 1058 is therefore positive, and the questionnaire is not discarded. This is reflected in the answers; respondent 1 has consistently chosen to pay the charge when it is relatively cheaper (e.g. first column) but replace the vehicle when the charge is relatively expensive (second column).

Respondent 2, meanwhile has an average of 753 for the selections to pay the charge and 1,000 for replacing the vehicle. The difference is therefore a negative, -247. This is reflected in the answers, particularly the second and third columns: for the same £6 charge respondent 2 has elected to replace the vehicle if it would cost them

£6,000 but not if it only cost £1,000. Data for this participant would not be included in the final analysis for exercise 2.

Surveys that were excluded in this manner were not excluded from other analysis providing the responses were otherwise logical. This is considered reasonable as the hypothetical and somewhat unintuitive nature of exercise 2 means a respondent may not understand fully what is being asked for but is still able to provide accurate answers to the rest of the survey.

4.3 Summary

As the result of the process, 153 (13.9%) questionnaires out of 1103 were removed entirely from the final dataset. A further 74 records were removed from consideration for Exercise 2 for the Medium CAZ and 50 records for the Small CAZ. This process has ensured that an potentially erroneous data is removed from the sample and is not relied upon when extracting results from the survey data.

5. Stated Preference Analysis and Results

This section presents an overview of the segmentation, factoring and weighting applied to the data. It then discusses the type of statistical model used for each of the exercises and then presents and discusses the final statistical models as used to inform in the transport modelling. As part of the factoring and weighting process, significance testing of a number of potential variables was undertaken. For brevity and clarity, the detail and outputs for this are not included in this section of the report and instead can be found in Appendix B.

5.1 Segmentation

To align with the transport modelling work being undertaken to forecast the impact of a charging clean air zone, the survey data was segmented to align with the GBATS transport model into the following purpose & income combinations:

- Commute/Other – Low Income (annual HH <£25,000);
- Commute/Other – Medium Income (annual HH £25,000 - £49,999);
- Commute/Other – High Income (annual HH >£49,999); and
- Employer's Business.

Further information on the GBATS transport model and its use can be found in the modelling reports OBC-22, OBC-23 and OBC-27.

5.2 Factoring

For the creation of statistical models from the results, responses were factored by the reported frequency of travel in the proposed zone. This serves as a method of transforming the units of the sample from that of unique users into non-compliant car trips into the zone.

This reflects that a 'typical' daytime 5 days a week commuter within the zone who chooses to change mode leads to a one vehicle reduction in flows in both the AM and PM peaks. Someone who only works one day a week, however, will only result in a reduction of 0.2 vehicles when considering an 'average weekday'.

Significance testing indicated that, without factoring, reported frequency is a significant predictor in response to the zone, particularly regarding the choice to replace the vehicle. This is unsurprising as a more frequent traveller will incur the charge more often and therefore replacing the vehicle becomes better value for money. With factoring the influence of reported frequency was considerably reduced though not eliminated.

5.3 Weighting

After factoring by reported frequency, the sample is weighted by trip purpose and fuel type when developing the statistical models. The purpose of this is to better fit the profile of trips in the zone as it is not possible to ensure the survey targets or returns a representative sample of fuel types or trip purposes in the zone.

Purpose

The proportion of Commute and Other purposes within the first three model user classes can be extracted from the GBATS demand model (which treats these separately) as weighting targets and these are shown in Table 5-1.

Table 5-1: Proportions and Weighting for Trip Purpose Medium CAZ

Purpose	2013 GBATS	Exercise 1 Sample	Exercise 1 Weighting	Exericse 2 Sample	Exercise 2 Weighting
Work (Commuting)	41%	49%	0.82	51%	0.77
Other	59%	51%	1.17	49%	1.21

Fuel

The target split of non-compliant petrol and diesel cars in the zone was taken from the ANPR survey conducted for the project. The outcome of this is shown in Table 5-2.

Table 5-2: Proportions and Weighting for Fuel Type

Fuel	ANPR	Sample	Weighting
Petrol	35%	56%	0.63
Diesel	65%	44%	1.47

Home Origin

The significance of Home Origin (considered as distance of the respondent's Post Code from the proposed zone) were also considered. Analysis indicated that Home Origin had some influence over the responses, however, there is little reliable data to serve as a basis for weighting, particularly when considered in the context of who actually travels in the zone (rather than the resident population). As such it was chosen to not attempt to use any weighting or segmentation for this variable. Details and outputs from this process can be found in Appendix B.

5.4 Exercise 2 Model and Results (Pay Charge or Replace Vehicle)

In the final combined statistical model, the choice made in Exercise 2 is considered first and also makes use of a more simple form of logistical regression as it considered just two choices. As such it is appropriate to consider it first in this report.

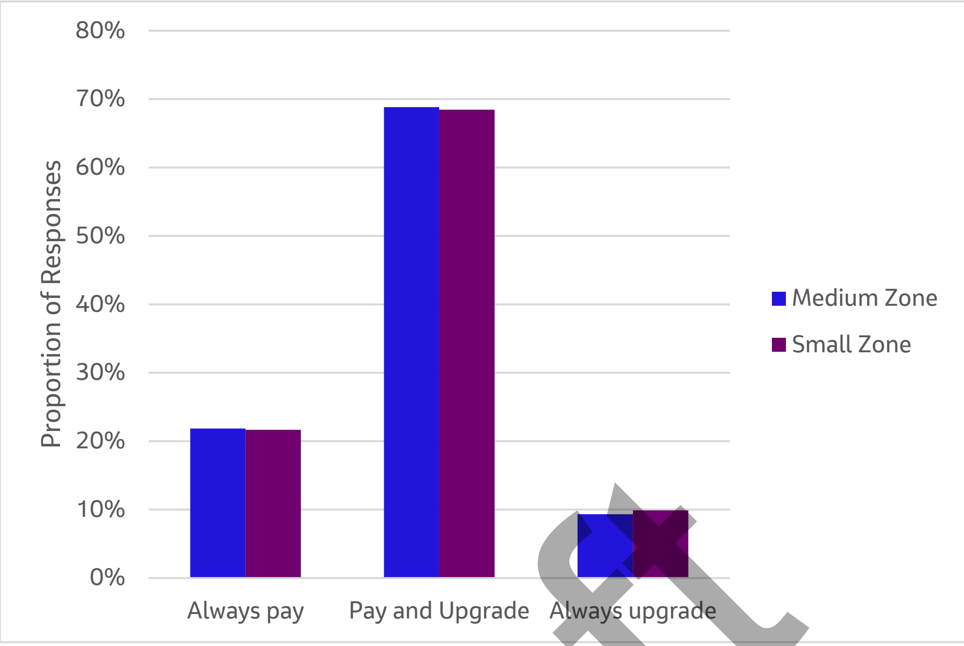
The second exercise presents a series of choices between paying the charge or upgrading the vehicle to a compliant one for a certain hypothetical cost. Each respondent was presented with one of two sets of six combinations of CAZ charge and replacement costs.

5.4.1 Trading – non-trading bias

As discussed in the survey design, the range of price options was developed with the intention that a majority of people would provide a mix of answers to their six sets of choices with relatively even minorities responding that they would either always replace vehicle or always pay the charge.

Figure 5-1 shows the proportion of traders and non-traders in the responses to Exercise 2.

Figure 5-1: Answer splits to Exercise 2



The sample shows that most respondents provide a mix of choices with only small proportions choosing to always replace the vehicle or to always pay. Over twice as many elected to always pay which indicates a somewhat lower willingness to replace the vehicle compared to the data gathered for the London ULEZ. A possible explanation for this is the comparatively lower wage levels in the region.

There is very little difference between responses for the two zones, this is reasonable as it is not expected.

5.4.2 Statistical Model Form and Fitting

Since Exercise 2 considers a binary choice of either paying the charge or replacing the vehicle, logistical regression was used to develop models of this choice. This will produce a best fit log function that will predict the likely split between paying the charge or replacing the vehicle for a given combination of charge and replacement cost.

5.4.3 Results

Model coefficients are reported for a model considering the probability of choosing to pay the charge of the following form:

$$P(charge) = \frac{1}{1 + e^{-(Const - coefC \times Charge - coefUp \times Upgrade \ldots etc)}}$$

Further it should be noted that the model coefficients are on the basis that the replacement cost is in units of £000's.

As an example Table 5-3 shows the derived model parameters for the Commute/Other Medium Income segment for the Medium CAZ area in Bristol.

Table 5-3: Exercise 2 Model Parameters for Medium CAZ

(CO Med Income, weighted by purpose & fuel type n=361)

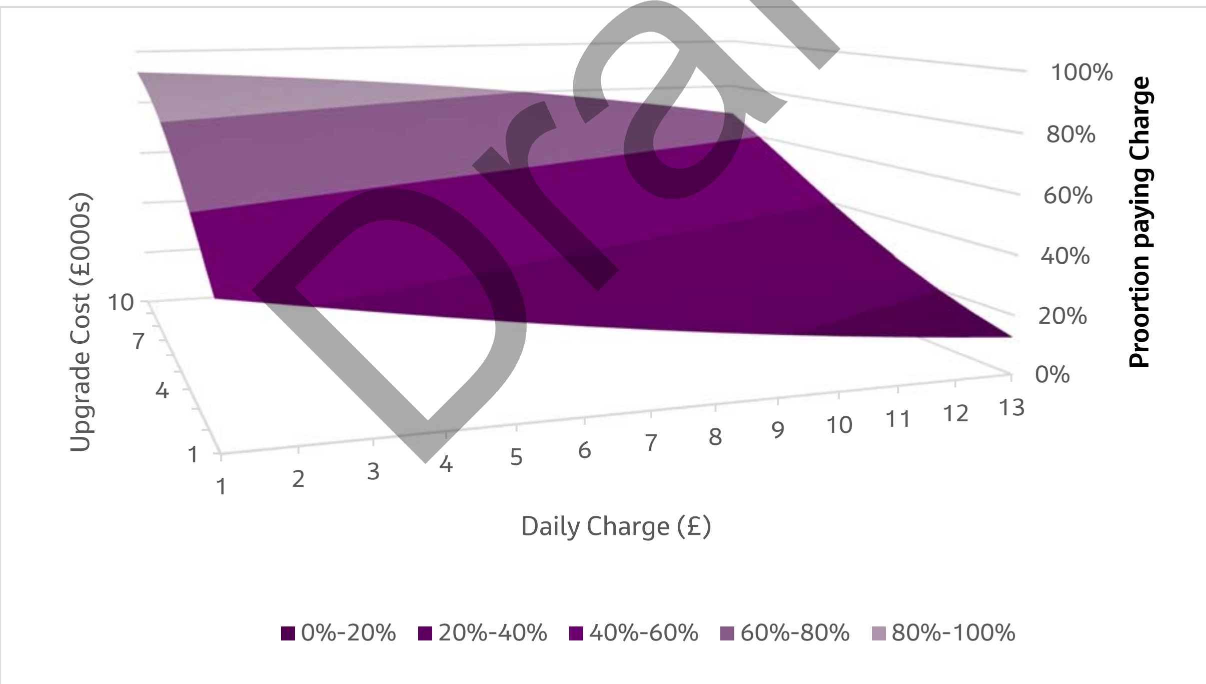
Choice	Coeff.	Std. Err.	Z	p-value	95% Conf. Int.	
Constant	-0.39736	0.189867	2.092828	0.036365		
Charge	-0.14124	0.018822	7.504117	6.18E-14	-0.17813	-0.10435
Replace	0.297453	0.020387	14.59049	3.23E-48	0.257495	0.33741

It can be seen that the coefficient for the charge is negative while for replacing the vehicle it is positive. This makes sense as both a lower charge and a higher replacement cost means it is more likely that someone will pay the charge.

In this case, with a £1 charge and £1000 replacement cost, the model predicts that 45% will pay the charge while at £10 charge and £10,000 replacement cost the model predicts that 64% will pay the charge.

Based on this model, a prediction of the compliance rate for any given charge and replacement cost assumption can be established. For example, the chart in Figure 5-2 shows the surface indicating the proportion who continue to pay the charge predicted by the model across the range of charges and replacement costs considered.

Figure 5-2: Exercise 2 Model (CO Med Income, weighted by purpose & fuel type n=361)



5.5 Exercise 1 Model and Results: (Pay Charge or Changing Travel Behaviour)

The first exercise asked respondents whether, for their most recent journey, if a CAZ was in place, they would have paid the charge or made a change in behaviour that would avoid the charge. Each respondent was presented with one of two sets of four charge levels for the proposed zone and for each charge the respondent was given 5 or 6 choices:

- Pay the charge and travel as before;
- Make the same journey but by a different mode;
- Not have made the journey;
- Made the same journey purpose but changed the destination (e.g. someone could shop elsewhere);

- Made the same journey but changed route to avoid the zone, and;
- Made the same journey but switched to another compliant vehicle in their household (this option was only shown if they had previously indicated such a vehicle existed).

5.5.1 Model Form and Fitting

As there is only a single variable here, the proposed daily charge, it is possible to use simple interpolation between the surveyed charge values. However, because participants were asked only half of the charge values, there are differences due to sampling error between the two sets of response that can cause unrealistic marginal changes between each 50p increase in charge.

For example, if those presented with the charges in Subgroup 1 (Table 2-1) had a somewhat higher willingness to pay the charge then simple interpolation may find the proportion paying the charge decreases more slowly between £5 and £6 than between £6 and £7 but then slower again above £7.

When looking at smaller sub samples (e.g. employer's business trips only), the random error can be sufficiently large that parts of the scale can show an increasing rate of payment with increasing daily charge which is clearly illogical.

Given this it is considered that undertaking a multinomial logistic regression will provide a more consistent statistical model for use in predicting the response to various charge levels.

Multinomial logistic regression is a generalisation of the binomial model used in Exercise 2 above to be able to consider more than two choices. It handles this by fitting and combining binomial models of one specific choice (or reference outcome) against each other choice in turn.

5.5.2 Results

The model has the following form:

$$P(Y) = \frac{e^{\beta_{0_Y}+\beta_{1_Y}C}}{\sum_{k=1}^{K} e^{\beta_{0_k}+\beta_{1_k}C}}$$

where $P(Y)$ is the probability of choice Y, C is the charge and β_{0_Y} and β_{1_Y} are the coefficients for choice Y. In the divisor, β_{0_k} and β_{1_k} are the coefficients for each possible choice k in turn.

Table 5-4 shows the coefficients for the fitted model for the Commuting/Other Medium Income segment. In this case, paying the charge is selected as the reference outcome and hence has coefficients of zero. The selection of which choice is the reference outcome has no impact on the final model.

Table 5-4: Exercise 1 Model Coefficients for Medium CAZ

(CO Med Income, weighted by purpose & fuel type n=396)

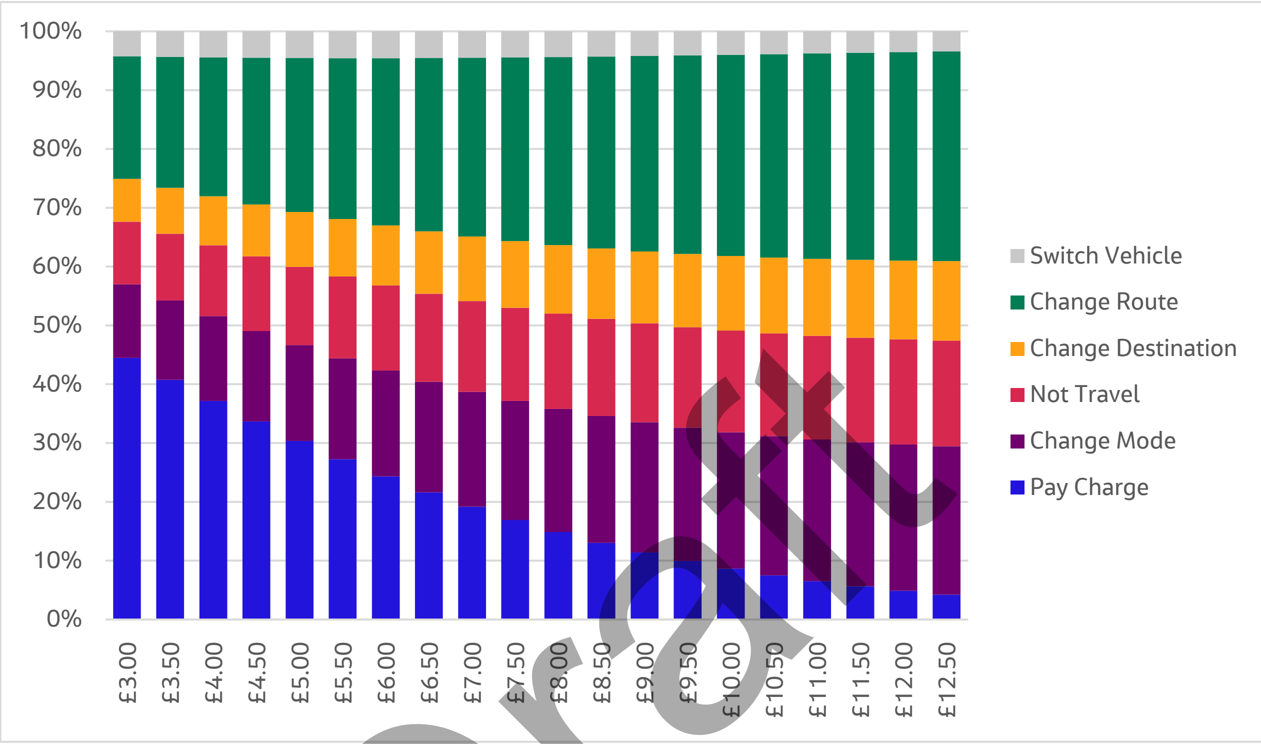
Outcome	Pay Charge	Change Mode	Not Travel	Change Destination	Change Route	Switch Vehicle
Constant	0	-2.23	-2.3396	-2.74744	-1.67103	-3.02627
Charge	0	0.32	0.303245	0.313131	0.304578	0.225364

Figure 5-3 shows the output of this model across the range of surveyed charges.

The graph shows a notable decrease in the propensity to pay the charge as the charge increases. The alternative response to the introduction of charging for the majority of the respondents was either to use a different mode or change the destination to avoid the charging area.

It can be noted how the propensity to use a different mode, to change route/destination or to not travel increases with the increase in charge level. The proportion switching vehicle shows a notably lower sensitivity. This seems reasonable as for those for which this is an option it is generally a low cost choice to make.

Figure 5-3: Exercise 1 Responses for Medium CAZ (CO Med Income, weighted by purpose & fuel type n=396)



5.6 Combined Model

To estimate the overall response to different levels of charge the models can be combined as follows:

The choice from Exercise 2 is applied first on the basis that people who can afford or choose to replace their vehicle are assumed to do so.

The remaining proportion that are predicted by Exercise 2 to pay the charge are then split by the Exercise 1 results, with splits between the charge levels asked in Exercise 1 estimated by interpolation.

Plots of the outputs from the combined models are shown in Figure 5-4 to Figure 5-7 for the four car user classes in GBATS for the Medium CAZ area for a replacement cost of £4,884 that has been used in the modelling as the typical car replacement cost. This cost is based on a combination of industry data on the most common car purchases, ANPR data and current market prices of vehicles. Derivation of these costs are discussed in more detail in OBC-26, Response Rates Technical Note.

Figure 5-4: Combined Model for CO Low Income Medium CAZ (weighted by purpose & fuel type, n=164/140)

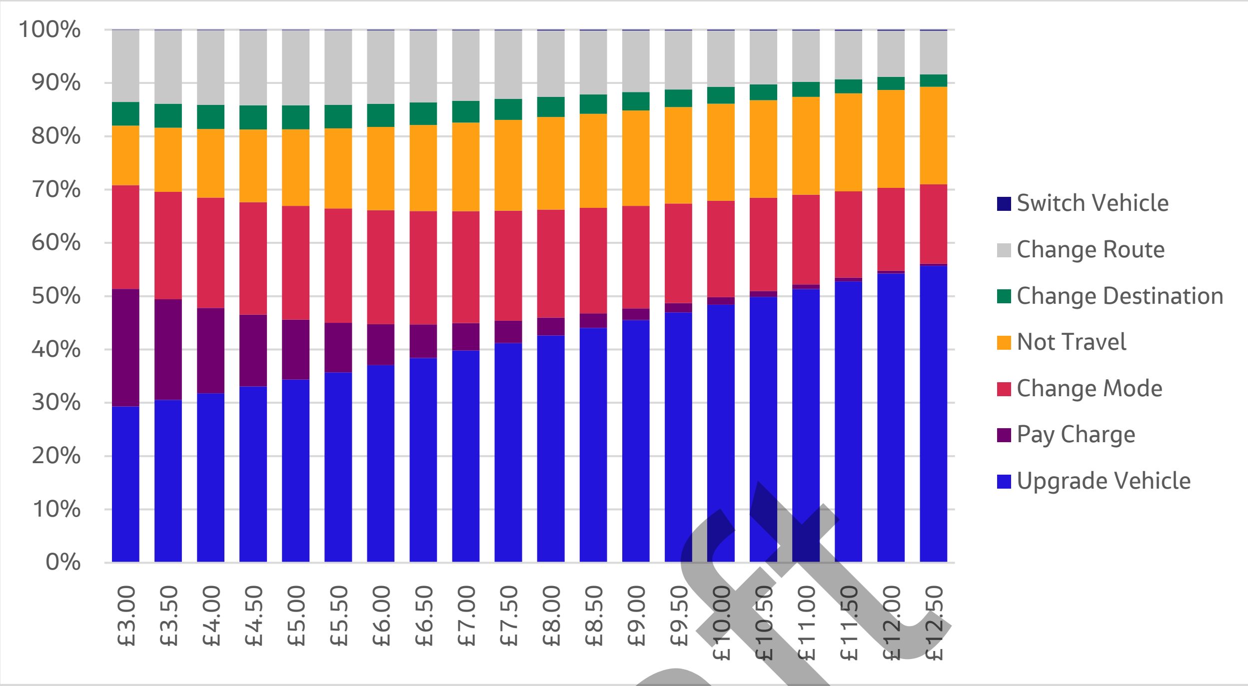


Figure 5-5: Combined Model for CO Medium Income Medium CAZ (weighted by purpose & fuel type, n=396/361)

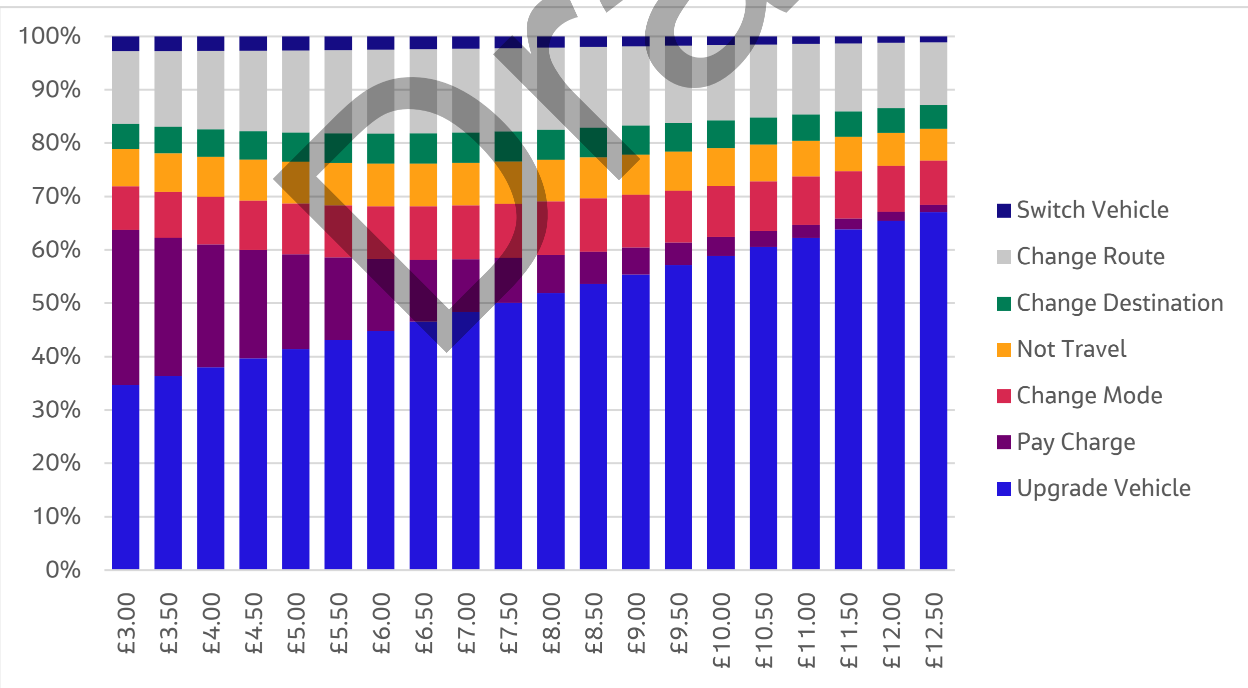


Figure 5-6: Combined Model for CO High Income Medium CAZ (weighted by purpose & fuel type, n=122/113)

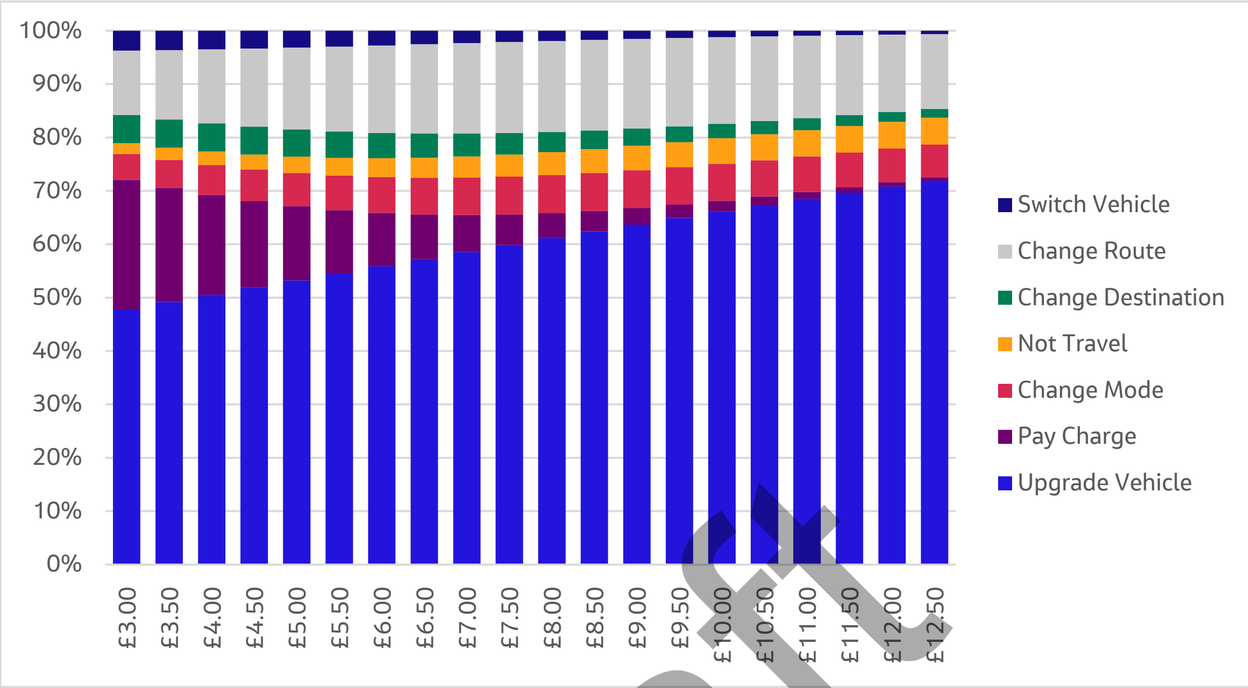
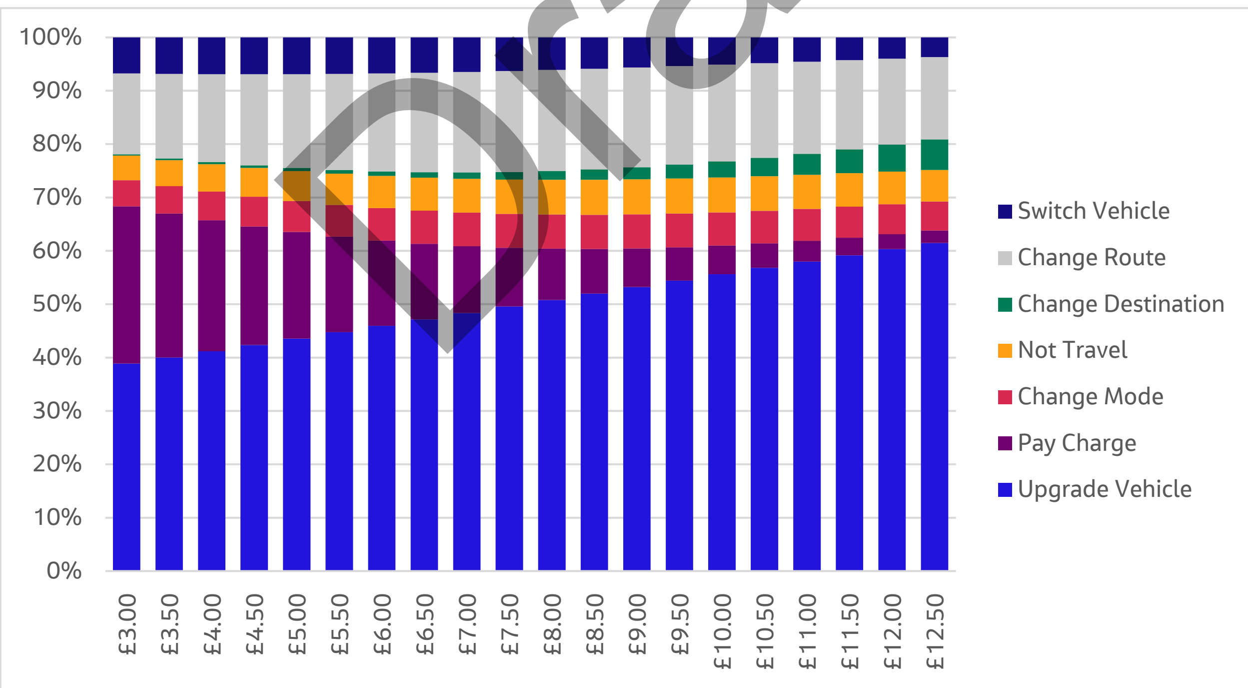


Figure 5-7: Combined Model for Employer's Business Medium CAZ (weighted by purpose & fuel type, n=71/68)



There are some clear trends with rising household income. Willingness to replace the vehicle increases with income. This is expected as higher income households are more likely to have the disposable income required to afford the replacement. This increase largely comes from a reduction in those changing mode or not travelling at all. The switch vehicle response is also not present in the lowest income band reflecting the lower level of car ownership in poorer households. The proportion changing route is similar across income levels and for different level of charge indicating that for those where diverting around the zone is an option, a £3 charge is sufficient to cause this.

With the employer's business group there is a greater willingness to pay the charge which is likely a result that a proportion of those travelling on employer's business are able to pass the charge onto their employer so do not perceive the cost as much as if it were coming from their own pocket. It may also reflect the nature of a number of employer's business trips meaning that changing mode or destination are not practical alternatives. It should be noted though that some drivers on employer's business will incur the charge themselves and, combined with the relatively small sample size, these figures should be taken with some caution.

6. Summary

A survey was undertaken between 22 February and 12 March 2018 of 1103 residents of Bristol and the surrounding Local Authorities who had recently driven within the proposed CAZ in a car or light van considered non-compliant under the Defra Framework. The survey responses went through a cleaning and checking process leaving 950 responses for analysis.

Along with a number of demographic and other relevant questions, the survey consisted of stated preference exercises where the participant was asked to consider their last trip within the CAZ and if they would have made a different choice as a result. The first exercise asked whether they would have made the same trip again and paid the charge or have taken one of five alternative actions to avoid the charge such as travel by a different mode or change route.

The second exercise asked whether, if a CAZ was in place, the user would either pay the charge whenever they travelled in the zone, or to spend money upgrading their vehicle to a compliant one that would not incur the charge. The exercises asked about a range charge levels and assumed replacement costs. The two exercises were asked for two difference sizes of CAZ making four exercises in total.

Statistical models were fitted to the data from each exercise and were then combined into a series of models representing the user classes used in the traffic modelling. These models are then used with average replacement costs to extract response rates to inform the traffic modelling of the proposed Clean Air Zone. This process is discussed in OBC-26 Response Rates Technical Note.

Appendix A. Survey Questionnaire

Driving in Bristol Survey

WELCOME

Good (morning/afternoon/evening). Thank you for your interest in our project.

This is an online survey that will take a maximum of 20 minutes to complete. It's an interesting topic concerning an important local issue that could be very relevant to you.

Please note that all personal data will be processed in accordance with the principles of good information handling contained in the Data Protection Act 1998 and the EU General Data Protection Regulation when it comes into force in May 2018. We will not sell this information to any other persons or organisations, and you will receive no marketing material as a result of completing this questionnaire.

START SURVEY >

Q1 What is your **FULL** home postcode?

CONTINUE >

If invalid postcode then: Unfortunately, you are not eligible to complete the questionnaire. Thank you for your time. *Close*

Thank you.
Your reference is 15936-1136.
If you experience any problems completing the survey and wish to contact us please quote this reference.

CONTINUE >

QUESTIONNAIRE A1

Before we start the survey, we need to ask you a few screening questions to make sure you are eligible to complete the survey.

Q2 Which age group do you fall into?
Under 17
17-24
25-34
35-44
45-54
55-59
60-64
65-69
70 or over

PREV NEXT

If under 17 then: Unfortunately, only people aged 17 or over are eligible to complete the questionnaire. Thank you for your time**.** *Close.*

Q3 Are you …?
Male
Female
Transgender
Prefer not to say

Q4a Do you drive a car or light van (including camper van, pick-up truck)? If you drive more than one vehicle, please answer in relation to the vehicle you **normally** drive.
Car
Light van (under 3.5 tonnes)
No

PREV NEXT

If 'no' then: This survey is for people who drive a car or van so unfortunately you are not eligible to complete the questionnaire. Thank you for your time**.** *Close*.

Q4b Are you the person who would solely or jointly makes decisions concerning the replacement of your vehicle?
PREV NEXT

If 'no' then: This survey is for people who take the decision about replacing their vehicle so unfortunately you are not eligible to complete the questionnaire. Thank you for your time**.** *Close.*

Q5 What type of fuel does the vehicle you normally drive use?

Petrol
Diesel
Electric/plug-in
Hybrid
Gas/LPG
Other

PREV NEXT
If not petrol or diesel then: This survey is focussed on petrol and diesel vehicles, so unfortunately you are not eligible to complete the questionnaire. Thank you for your time. *Close.*

Q6a/b How old is your vehicle?

For petrol:
Pre 2006
2006 or more recent

If 2006 or more recent, then: This survey is focussed on older vehicles, so unfortunately you are not eligible to complete the questionnaire. Thank you for your time. *Close.*

For diesel:
Pre 2015
2015 or more recent

PREV NEXT

If 2015 or more recent, then: **This survey is focussed on older vehicles, so unfortunately you are not eligible to complete the questionnaire. Thank you for your time.** *Close*

SCREENING A

Q7 In the past 6 months have you used this vehicle to drive within, through, or in/out of the area of Bristol shown in yellow on the map below?

Yes
No

Map of Zone A (yellow)

PREV NEXT

If 'no' for Zone A then: This survey is focussed on trips in, through or in/out of this area, so unfortunately you are not eligible to complete the questionnaire. Thank you for your time. Close.

Q8a In general, how often do you use your vehicle in this area of Bristol?
6-7 days a week
5 days a week
3-4 days a week
2 days a week
1 day a week
About once a fortnight
About once a month
About once every 2 months
About once every 4-5 months
About once every 6 months
Less often

PREV NEXT

If 'less often' then: This survey is focussed on people who have used a vehicle in this area in the last 6 months, so unfortunately you are not eligible to complete the questionnaire. Thank you for your time. *Close.*

Q8b In general, how often do you use your vehicle **in Bath city centre**?
6-7 days a week
5 days a week
3-4 days a week

2 days a week
1 day a week
About once a fortnight
About once a month
About once every 2 months
About once every 4-5 months
About once every 6 months
Less often/never

PREV NEXT

YOUR VEHICLE

Q9 What type of vehicle do you drive?

Mini car (e.g. Peugeot 108, Skoda Citigo, Citroen C1)
Small car (e.g. Ford Fiesta, Opel Corsa, Nissan Micra, Renault Clio, Toyota Yaris)
Medium car (e.g. Volkswagen Golf, Skoda Octavia, Toyota Corolla, Ford Focus, BMW 1 Se ries)
Large car (e.g. Mazda 6, Kia Optima, Audi A5, Toyota Avensis)
Executive (e.g. Audi S7, Mercedes-Benz E-Class, Toyota Avalon, BMW 5-series)
People carrier (MPV) (e.g. Kia Carens, Citroen C4 Picasso, SEAT Alhambra)
Sports utility vehicle (SUV) (e.g. Volkswagen Tiguan, BMW X6, Kia Sorento, Land Rover)
Sports car (e.g. Audi TT, BMW i8, Aston Martin Vanquish)
Other (please state)

PREV NEXT

Q10a Are there any other vehicles in this household that you can use?

Yes
No

PREV NEXT

Q10b How many other vehicles could you use? ________

PREV NEXT

Q11 How many years old is the vehicle you normally drive? _____ (years)

Q12 When do you expect to replace this vehicle?

Within the next 2 years (by 2020)
Within the next 3 years (by 2021)
Within the next 4 years (by 2022)
Within the next 5 years (by 2023)
I have no specific plans right now – *skip to Zone A Preparation Questions*

PREV NEXT

Q13 How old do you expect your replacement vehicle will be?
It will be a new vehicle
1-2 years old
3-4 years old
5+ years old
Don't know

Q14 What type of fuel do you expect your replacement vehicle will use?

Petrol

Diesel
Electric/plug-in
Hybrid
Gas/LPG
Other
Don't know

Q15 What do you expect will be the type of your replacement vehicle?

Mini car (e.g. Peugeot 108, Skoda Citigo, Citroen C1)
Small car (e.g. Ford Fiesta, Opel Corsa, Nissan Micra, Renault Clio, Toyota Yaris)
Medium car (e.g. Volkswagen Golf, Skoda Octavia, Toyota Corolla, Ford Focus, BMW 1 Series)
Large car (e.g. Mazda 6, Kia Optima, Audi A5, Toyota Avensis)
Executive (e.g. Audi S7, Mercedes-Benz E-Class, Toyota Avalon, BMW 5-series)
People carrier (MPV) (e.g. Kia Carens, Citroen C4 Picasso, SEAT Alhambra)
Sports utility vehicle (SUV) (e.g. Volkswagen Tiguan, BMW X6, Kia Sorento, Land Rover)
Sports car (e.g. Audi TT, BMW i8, Aston Martin Vanquish)
Other (please state)
Don't know

PREV NEXT

CLEAN AIR ZONE A

Bristol City Council has been tasked by Central Government to improve air quality in Bristol in the shortest time possible. In response to this, the introduction of a charging Clean Air Zone covering the yellow area of Bristol shown in the map below is currently being considered. Within this zone any trip made by a petrol vehicle registered before 2006 or a diesel vehicle registered before 2015 would be required to pay a daily charge. Newer vehicles would be considered 'compliant' with the emissions standards and would not have to pay. For the purposes of this survey it should be assumed there would be no exemptions for non-compliant vehicles (e.g. for local residents). The daily charge would cover multiple journeys in one day.

Map of Zone A (yellow)

PREV NEXT

If yes at Q10
Q16 You mentioned that there were other vehicles in your household that you could use for the journeys you make in or into the zone shown on the map. Are any of those vehicles compliant with the emissions standards described in the previous screen?

Yes
No
Don't know

PREV NEXT

Q17 You mentioned that you have made a journey in/through the yellow area shown in the map below in the last 6 months. Thinking about the most recent journey you made here, what was the main reason for this journey?

Travel to/from work (commuting)
Travel to/from college
Travel for leisure /entertainment
Shopping
Travel to visit friends or relatives
Travel for personal business (e.g. doctor's, bank appointment)
Travel for business reasons (but not commuting)
Taking children to/from education or activity

Map of Zone A (yellow)

PREV NEXT

CLEAN AIR ZONE A EXERCISE 1

In this section we would like you to think about what you would have done if a Clean Air Zone was in place in the yellow area. We will show you 4 different Clean Air Zone charging prices and, for each, you will be asked which travel option you would have chosen for your most recent journey in or through the area, which you said was ... ***(answer at Q17).***

Map of Zone A (yellow)

Q18 Thinking about your most recent journey driving in or through the area, what would you have done, assuming a Clean Air Zone was in place?

*Clean Air Zone daily charge £5

1. Made the same journey using your own vehicle and paid a **£5** charge
2. Made the same journey but using a different mode (e.g. public transport, cycle, walk)
3. Would not have made this journey
4. Changed your destination to avoid the charging area
5. Changed your route to avoid the charge
6. Made the same journey but using a compliant vehicle available in your household

*Clean Air Zone daily charge £7

1. Made the same journey using your own vehicle and paid a **£7** charge
2. Made the same journey but using a different mode (e.g. public transport, cycle, walk)
3. Would not have made this journey
4. Changed your destination to avoid the charging area
5. Changed your route to avoid the charge
6. Made the same journey but using a compliant vehicle available in your household

*Clean Air Zone daily charge £9.50

1. Made the same journey using your own vehicle and paid a **£9.50** charge
2. Made the same journey but using a different mode (e.g. public transport, cycle, walk)

3. Would not have made this journey
4. Changed your destination to avoid the charging area
5. Changed your route to avoid the charge
6. Made the same journey but using a compliant vehicle available in your household

*Clean Air Zone daily charge £12.50

1. Made the same journey using your own vehicle and paid a **£12.50** charge
2. Made the same journey but using a different mode (e.g. public transport, cycle, walk)
3. Would not have made this journey
4. Changed your destination to avoid the charging area
5. Changed your route to avoid the charge
6. Made the same journey but using a compliant vehicle available in your household

Note: on screen the options appear horizontally not vertically. The 4 price points should be shown in a random order.

Only show option 6 if Q16 = yes

PREV NEXT

If say will pay for all 4 price points ask:
Q19 You selected to pay the charge for each of the price points. Could you please tell us why?

PREV NEXT

CLEAN AIR ZONE A EXERCISE 2

In this section, we would like you to again think about what you might do assuming a Clean Air Zone was in place in the yellow area.

We will show you 6 scenarios where you will be asked to choose between continuing to use your current vehicle and paying a Clean Air Zone charge, or replacing it with a compliant vehicle (these are petrol vehicles registered in or after 2006 or diesel vehicles registered in or after 2015).

In each scenario there is a different combination of daily charge and vehicle upgrade cost to choose between. The upgrade cost is the amount you would have to pay for a compliant vehicle, <u>over and above</u> the amount you sold your current vehicle for.

Map of Zone A (yellow)

For each question please assume that the two choices shown are the only options available to you.

For example, you may want to consider this in terms of costs per year such as:

- with a daily charge of £5, 4 journeys per week for 46 weeks would cost £920 per year
- a vehicle upgrade cost of £5,000 over five years would be £1,000 per year.

For your convenience, there is an on-line calculator that you can use here (the link will open a new tab).

Q20 If the Clean Air Zone was in place which option would you choose in the following 6 scenarios?

* **£3 charge v £9,000 upgrade:**

Use current vehicle and pay a daily charge of **£3**

when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£9,000**

and pay **no** charge when you drive in/through the zone O

* **£4 charge v £3,000 upgrade:**

Use current vehicle and pay a daily charge of **£4**

when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£3,000**

and pay **no** charge when you drive in/through the zone O

* **£10 charge v £10,000 upgrade:**

Use current vehicle and pay a daily charge of **£10**

when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£10,000**

and pay **no** charge when you drive in/through the zone O

* **£9 charge v £2,000 upgrade:**

Use current vehicle and pay a daily charge of **£9**
when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£2,000**
and pay **no** charge when you drive in/through the zone O

* **£11 charge v £6,000 upgrade:**

Use current vehicle and pay a daily charge of **£11**
when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£6,000**
and pay **no** charge when you drive in/through the zone O

* **£7 charge v £8,000 upgrade:**

Use current vehicle and pay a daily charge of **£7**
when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£8,000**
and pay **no** charge when you drive in/through the zone O

Note: the six scenarios should be in random order

PREV NEXT

If say will pay for all 6 options ask:
Q22 You selected to pay the charge in each of the scenarios. Could you please tell us why?

PREV NEXT

If say will change to a compliant vehicle for all 6 options ask:
Q23 You selected to change to a compliant vehicle in each of the scenarios. Could you please tell us why?

PREV NEXT

SCREENING B

Q24 In the past 6 months have you used your current vehicle to drive within, through, or in/out of the area of Bristol shown in pink on the map below?

Yes
No

Map of Zone B (pink)

PREV NEXT

If 'no' skip to questionnaire assessment - Q33

Q25 In general, how often do you use your vehicle in this area?
6-7 days a week
5 days a week
3-4 days a week
2 days a week
1 day a week
About once a fortnight
About once a month
About once every 2 months
About once every 4-5 months
About once every 6 months
Less often

PREV NEXT

If 'less often' skip to questionnaire assessment – Q33

CLEAN AIR ZONE B

The introduction of a charging Clean Air Zone covering **a different** area of Bristol is also currently being considered, as shown by the pink area on the map below. Within this zone any trip made by a petrol vehicle registered before 2006, or a diesel vehicle registered before 2015 would be required to pay a daily charge. Newer vehicles would be considered 'compliant' with the emissions standards and would not have to pay. For the purposes of this survey it should be assumed there would be no exemptions for non-compliant vehicles (e.g. for local residents). The daily charge would cover multiple journeys in one day.

Map of Zone B (pink)

PREV NEXT

Q26 Thinking about the most recent journey you made in/through this pink area, what was the main reason for this journey?

Travel to/from work (commuting)
Travel to/from college
Travel for leisure /entertainment
Shopping
Travel to visit friends or relatives
Travel for personal business (e.g. doctor's, bank appointment)
Travel for business reasons (but not commuting)
Taking children to/from education or activity

Map of Zone B (pink)

PREV NEXT

CLEAN AIR ZONE B EXERCISE 1

In this section we would like you to think about what you would have done if a Clean Air Zone was in place in the pink area. You will notice the following questions are similar to those previously asked. However, **it is very important that you answer these questions as well, for each charging price, as we need to understand how people would react if this area were chosen to be the Clean Air Zone rather than the other area.**

Map of Zone B (pink)

Q27 Thinking about your most recent journey driving in or through the pink area, which you said was **…(answer at Q26)**, what would you have done, assuming a Clean Air Zone was in place?

*Clean Air Zone daily charge £5

1. Made the same journey using your own vehicle and paid a **£5** charge
2. Made the same journey but using a different mode (e.g. public transport, cycle, walk)
3. Would not have made this journey
4. Changed your destination to avoid the charging area

5. Changed your route to avoid the charge
6. Make the same journey but using a compliant vehicle available in your household

*Clean Air Zone daily charge £7

1. Made the same journey using your own vehicle and paid a **£7** charge
2. Made the same journey but using a different mode (e.g. public transport, cycle, walk)
3. Would not have made this journey
4. Changed your destination to avoid the charging area
5. Changed your route to avoid the charge
6. Made the same journey but using a compliant vehicle available in your household

*Clean Air Zone daily charge £9.50

1. Made the same journey using your own vehicle and paid a **£9.50** charge
2. Made the same journey but using a different mode (e.g. public transport, cycle, walk)
3. Would not have made this journey
4. Changed your destination to avoid the charging area
5. Changed your route to avoid the charge
6. Made the same journey but using a compliant vehicle available in your household

*Clean Air Zone daily charge £12.50

1. Made the same journey using your own vehicle and paid a **£12.50** charge
2. Made the same journey but using a different mode (e.g. public transport, cycle, walk)
3. Would not have made this journey
4. Changed your destination to avoid the charging area
5. Changed your route to avoid the charge
6. Made the same journey but using a compliant vehicle available in your household

Note: on screen the options appear horizontally not vertically. The 4 price points should be shown in a random order.

Only show option 6 if Q16 = yes

PREV NEXT

If say will pay for all 4 price points ask:

Q28 You selected to pay the charge for each of the price points. Could you please tell us why?

CLEAN AIR ZONE B EXERCISE 2

In this section, we would like you to again think about what you might do assuming a Clean Air Zone was in place in the pink area.

We will show you 6 scenarios where you will be asked to choose between continuing to use your current vehicle and paying a Clean Air Zone charge, or replacing it with a compliant vehicle (these are petrol vehicles registered in or after 2006 or diesel vehicles registered in or after 2015).

In each scenario there is a different combination of daily charge and vehicle upgrade cost to choose between. The upgrade cost is the amount you would have to pay for a compliant vehicle, over and above the amount you sold your current vehicle for.

Map of Zone B (pink)

For each question please assume that the two choices shown are the only options available to you.

For example, you may want to consider this in terms of costs per year such as:

- with a daily charge of £5, 4 journeys per week for 46 weeks would cost £920 per year
- a vehicle upgrade cost of £5,000 over five years would be £1,000 per year.

For your convenience, there is an on-line calculator that you can use here (the link will open a new tab).

Q29 If the Clean Air Zone was in place which option would you choose in the following 6 scenarios?

* **£3 charge v £9,000 upgrade:**

Use current vehicle and pay a daily charge of **£3**

when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£9,000**

and pay **no** charge when you drive in/through the zone O

* **£4 charge v £3,000 upgrade:**

Use current vehicle and pay a daily charge of **£4**

when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£3,000**

and pay **no** charge when you drive in/through the zone O

* **£10 charge v £10,000 upgrade:**

Use current vehicle and pay a daily charge of **£10**

when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£10,000**

and pay **no** charge when you drive in/through the zone O

* **£9 charge v £2,000 upgrade:**

Use current vehicle and pay a daily charge of **£9**

when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£2,000**

and pay **no** charge when you drive in/through the zone O

* **£11 charge v £6,000 upgrade:**

Use current vehicle and pay a daily charge of **£11**

when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£6,000**

and pay **no** charge when you drive in/through the zone O

* **£7 charge v £8,000 upgrade:**

Use current vehicle and pay a daily charge of **£7**

when you drive in/through the zone O

Change to a compliant vehicle for an upgrade cost of **£8,000**

and pay **no** charge when you drive in/through the zone O

Note: the six scenarios should be in random order

PREV NEXT

If say will pay for all 6 options ask:
Q31 You selected to pay the charge in each of the scenarios. Could you please tell us why?

PREV NEXT

If say will change to a compliant vehicle for all 6 options ask:
Q32 You selected to change to a compliant vehicle in each of the scenarios. Could you please tell us why?

PREV NEXT

YOUR ASSESSMENT OF THE SURVEY

Q33 Please tell us what you thought of this survey. How easy or difficult did you find it?

Very easy
Fairly easy
Neither easy nor difficult
Fairly difficult
Very difficult

PREV NEXT

If Q33 is 'Very difficult'
Q36 You said you found the exercise very difficult. Could you please tell us why?
Blank response allowed

PREV NEXT

Q34 Were the descriptions and explanations clear to you?
Very clear
Fairly clear
Fairly unclear
Very unclear

Q35 How realistic were the upgrade costs?
Very realistic
Fairly realistic
Fairly unrealistic
Very unrealistic

PREV NEXT

If Q35 is or 'Very unrealistic'
Q37 You said you found the upgrade costs very unrealistic. Could you please tell us why?
Allow blank response

PREV NEXT

About You

Q38 Please indicate your employment status.
Working full time
Working part time
In education
Looking after home/family/dependent(s)
Unemployed
Retired
Unable to work
Other
Prefer not to say

PREV NEXT

If working full or part time then ask Q39, else skip to Q40
Q39 Which of the following best describes your occupation?

Higher managerial, administrative or professional
Intermediate managerial, administrative or professional
Supervisory or clerical and junior managerial, administrative or professional
Skilled manual worker
Semi-skilled and unskilled manual worker
Casual or low grade worker

Q40 Which category corresponds to your annual HOUSEHOLD income? (before tax)
i. Less than £5,000
ii. £5,000 - £9,999
iii. £10,000 - £14,999
iv. £15,000 - £19,999
v. £20,000 - £24,999
vi. £25,000 - £34,999
vii. £35,000 - £49,999
viii. £50,000 - £74,999
ix. £75,000 - £99,999
x. £100,000 or more
xi. Prefer not to say

PREV NEXT

Q41 Which ethnic group do you consider you belong to?
i. White - English/Welsh/Scottish/Northern Irish
ii. White - Other British
iii. White - Irish
iv. Other white
v. Mixed or multiple ethnic groups - White and Black Caribbean
vi. Mixed or multiple ethnic groups - White and Black African
vii. Mixed or multiple ethnic groups - White and Asian

viii. Other Mixed or multiple ethnic background
ix. Asian or Asian British – Indian
x. Asian or Asian British - Pakistani
xi. Asian or Asian British - Bangladeshi
xii. Asian or Asian British - Chinese
xiii. Asian or Asian British - Other Asian background
xiv. Black or Black British - Caribbean
xv. Black or Black British - African
xvi. Black or Black British - Other Black background
xvii. Other Ethnic Group
xviii. Prefer not to say

PREV NEXT

Q42 Do you have a long-term physical or mental disability or health issue that limits your ability to travel and get about? Include any issues due to old age.
i. Yes
ii. No

PREV NEXT

If ii, then skip to Q44

Q43 Are you a Blue Badge holder?
i. Yes
ii. No

PREV NEXT

Q44 Do you have any further comments about this topic or the survey itself? If you have no further comments, please select 'No comments'. *This question is limited to 400 characters*
No comments
Yes

PREV NEXT

Q996 And finally, if we need to, can we contact you again?
Yes
No

PREV NEXT

At what email address would you like to be contacted?

PREV NEXT

Thank you very much for completing this questionnaire. We appreciate your time and effort.

DONE

This survey has been completed successfully. Thank you once again.

Appendix B. Model Detailed Analysis

B.1 Small CAZ Models

Figure B-1 to Figure B-4 show the statistical models for the 4 small zones.

Figure B-1: Combined Model for CO Low Income Small CAZ (weighted by purpose & fuel type, n=135/122)

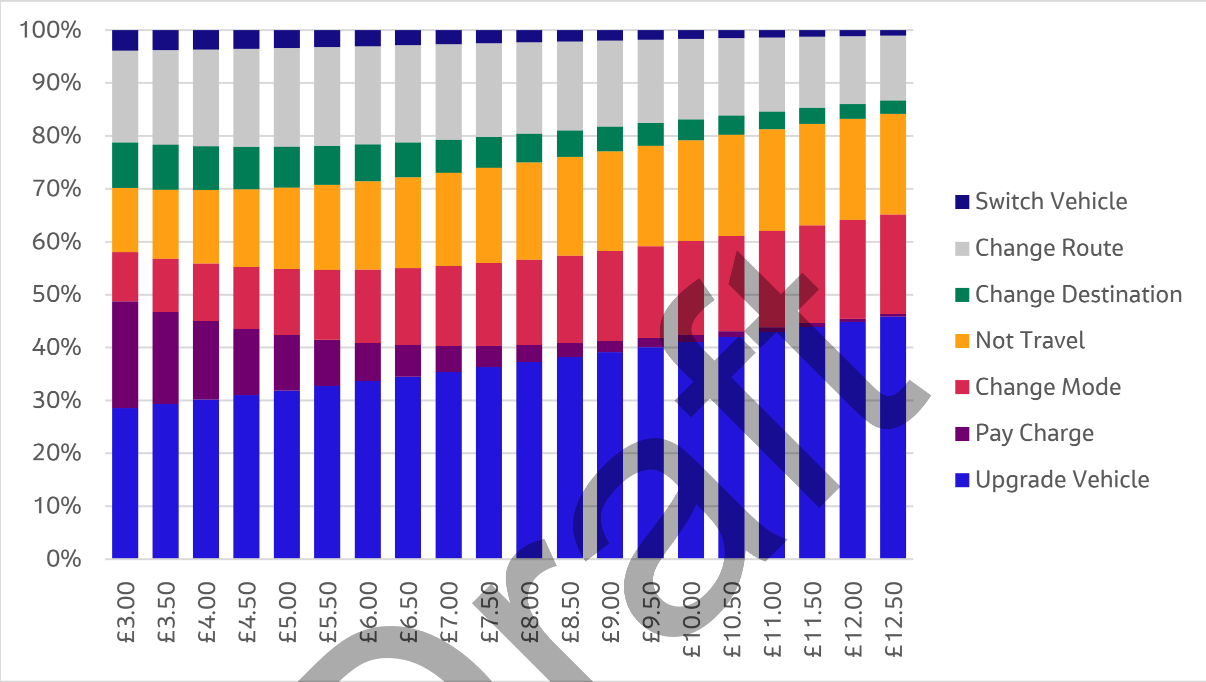


Figure B-2: Combined Model for CO Medium Income Small CAZ (weighted by purpose & fuel type, n=345/322)

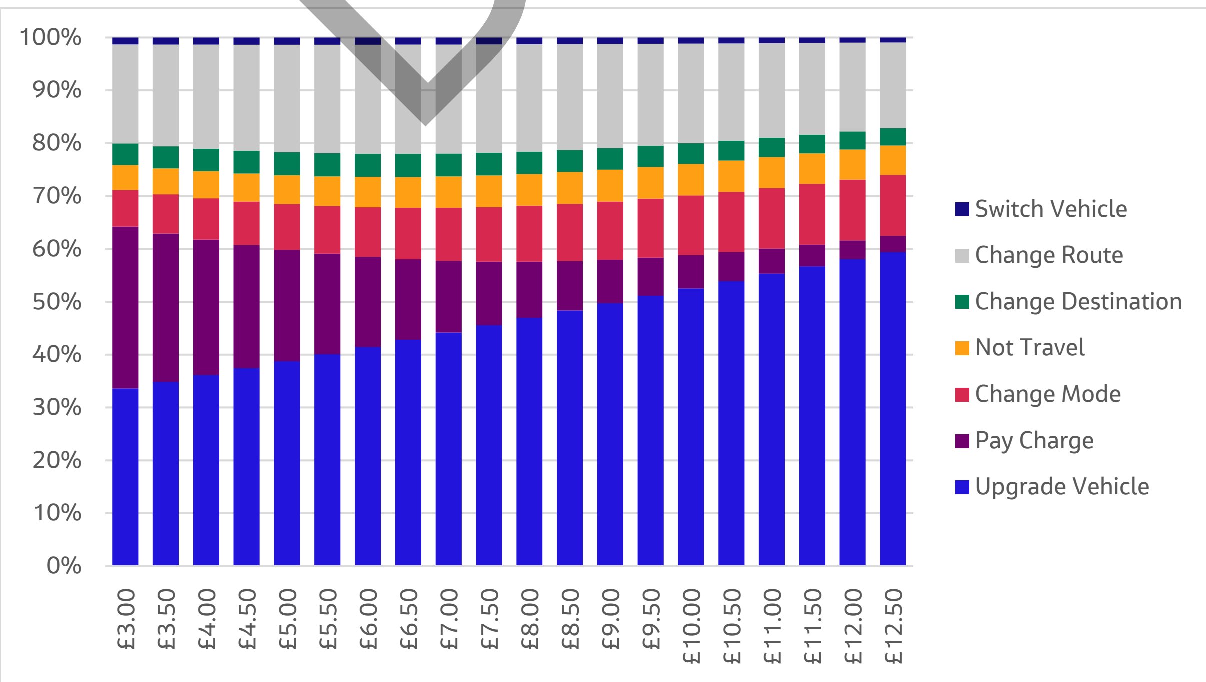


Figure B-3: Combined Model for CO High Income Small CAZ (weighted by purpose & fuel type, n=109/100)

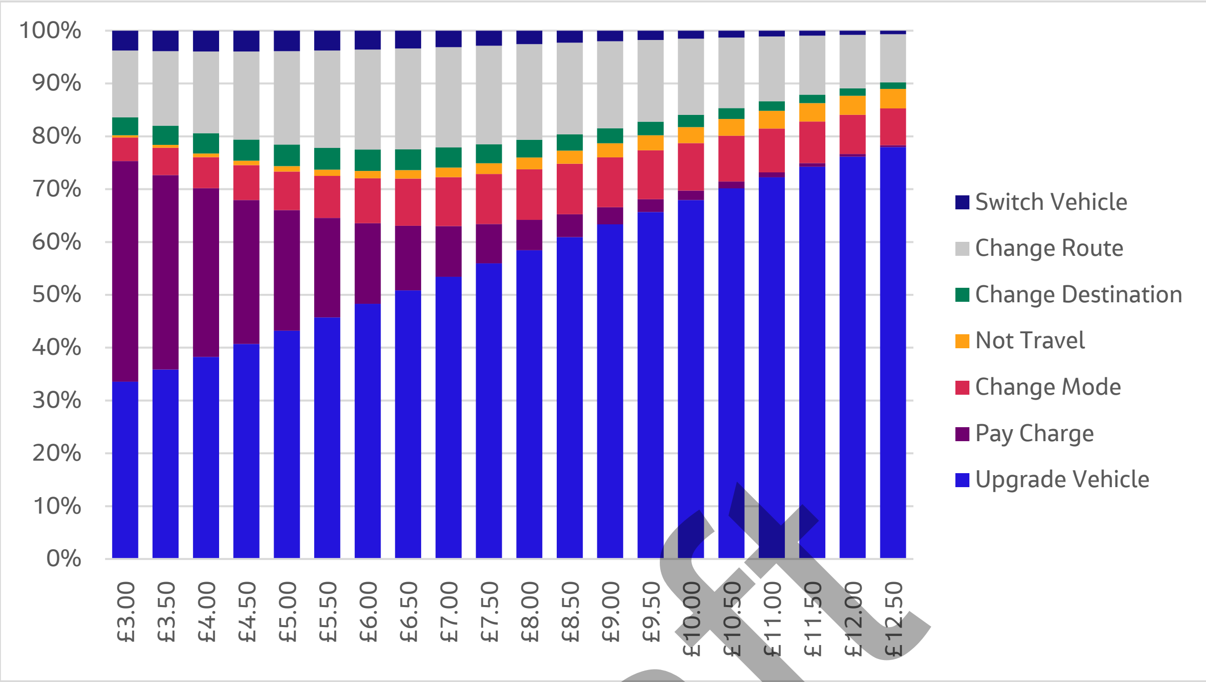
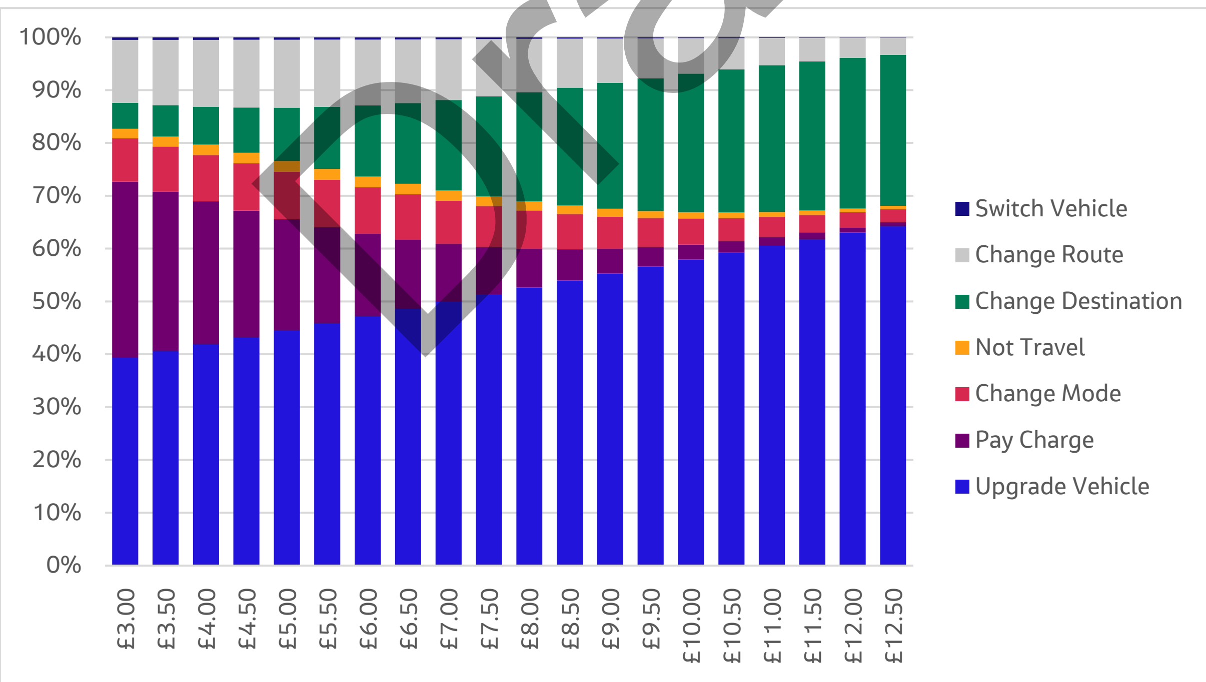


Figure B-4: Combined Model for Employer's Business Small CAZ (weighted by purpose & fuel type, n=51/47)



Results for the small zone are broadly similar to that found for the Medium Zone. Of note is the somewhat higher propensity to change mode, even amongst higher income groups, which may reflect the relatively better provision of non-car transport options into the central area and the reduced response to not travel at all which may reflect that trips into this smaller area are less discretionary.

B.2 Significance of Variables

In the process of creating the statistical models, the significance of a number of variables was considered to establish their potential impact upon the responses. Each variable considered is discussed in the following section.

B.2.1 Trip Frequency

Participants were asked to set out how frequently they drive within the zone, in order to assess whether trip frequency alters the responses to the CAZ. To test the significance of trip frequency, responses were split into 3 bands: 3 or more days a week, 1 or 2 days a week and less often than weekly and were given values of 1 to 3 accordingly.

Logistic regression models (of the same type used for the analysis presented within the main report) were then fitted for both exercises and the parameters are shown in Table B-1 and Table B-2 for the medium zone and Table B-3 and Table B-4 for the small zone.

Table B-1: Exercise 1 Model Parameters Medium CAZ

(All sample, weighted by purpose & fuel type)

Response		Coeff.	Z	p-value
Change Mode	*Intercept*	-1.675	7.7	
	Charge	0.316	13.1	
	Frequency	-0.220	3.1	0.001642797
Not Travel	*Intercept*	-2.769	12.1	
	Charge	0.379	15.6	
	Frequency	0.093	1.3	0.182801606
Change Destination	*Intercept*	-2.965	10.8	
	Charge	0.307	10.8	
	Frequency	0.116	1.4	0.168406238
Change Route	*Intercept*	-1.376	6.9	
	Charge	0.318	14.2	
	Frequency	-0.158	2.5	0.013304244
Switch Vehicle	*Intercept*	-4.086	10.7	
	Charge	0.299	8.1	
	Frequency	0.289	2.5	0.011232653

Table B-2: Exercise 2 Model Parameters Medium CAZ

(All sample, weighted by purpose & fuel type)

Choice	Coeff.	Std. Err.	Z	p-value	95% Conf. Int.	
Const	-0.39748	0.145309	7.482348	0.006231	0.672014	
Charge	-0.1213	0.011963	102.8106	3.69E-24	0.885765	0.865237
Replace	0.222495	0.012634	310.1642	2.01E-69	1.249189	1.218638
Frequency	0.22775	0.040274	31.97907	1.56E-08	1.255772	1.160458

Table B-3: Exercise 1 Model Parameters Small CAZ

(All sample, weighted by purpose & fuel type)

Response		Coeff.	Z	p-value
Change Mode	*Intercept*	-2.056	8.7	
	Charge	0.355	13.6	
	Frequency	-0.234	2.9	0.003248804
Not Travel	*Intercept*	-2.799	10.8	
	Charge	0.345	12.6	
	Frequency	0.081	1.0	0.322241838
Change Destination	*Intercept*	-2.674	9.2	
	Charge	0.249	8.1	
	Frequency	0.156	1.7	0.096038913
Change Route	*Intercept*	-0.961	4.7	
	Charge	0.308	13.1	
	Frequency	-0.314	4.5	8.45847E-06
Switch Vehicle	*Intercept*	-4.197	11.1	
	Charge	0.289	8.0	
	Frequency	0.486	4.2	2.49218E-05

Table B-4: Exercise 2 Model Parameters Small CAZ

(All sample, weighted by purpose & fuel type)

Choice	Coeff.	Std. Err.	Z	p-value	95% Conf. Int.	
Const	-0.34736	0.155897	4.964743	0.025869	0.706548	
Charge	-0.13538	0.013053	107.5736	3.33E-25	0.873384	0.851324
Replace	0.2241	0.013767	264.9694	1.42E-59	1.251196	1.217886
Frequency	0.272278	0.045557	35.72073	2.28E-09	1.312952	1.200801

From the exercise 2 results it is clear that, as would be expected, reported frequency of travel is a significant predictor of the choice between upgrading the vehicle and paying the charge. For a more frequent traveller into the zone it is relatively better value to replace the vehicle.

There is no reliable data available for weighting frequency of trip, however it was considered that, to accurately assess the impact upon the zone that the survey should be weighted or factored by the reported frequency of travel within the zone. The response of someone who travels daily in the zone will have a much larger impact that someone who travels weekly.

After factoring by frequency, the significance of the reported frequency was re-checked and this is shown in Table B-5 to Table B-8.

Table B-5: Exercise 1 Model Parameters Medium CAZ

(All sample, factored by frequency, weighted by purpose & fuel type)

Response		Coeff.	Z	p-value
Change Mode	*Intercept*	-1.607	7.5	
	Charge	0.326	13.7	
	Frequency	-0.261	2.5	0.011082144
Not Travel	*Intercept*	-2.598	11.3	
	Charge	0.364	14.5	
	Frequency	0.084	0.8	0.404998246
Change Destination	*Intercept*	-3.034	11.1	

	Charge	0.307	10.5	
	Frequency	0.214	1.9	0.06398069
Change Route	*Intercept*	-1.407	7.0	
	Charge	0.327	14.4	
	Frequency	-0.174	1.8	0.06483828
Switch Vehicle	*Intercept*	-2.695	7.5	
	Charge	0.235	6.2	
	Frequency	-0.200	1.1	0.254273109

Table B-6: Exercise 2 Model Parameters Medium CAZ

(All sample, factored by frequency, weighted by purpose & fuel type)

Choice	Coeff.	Std. Err.	Z	p-value	95% Conf. Int.	
Const	-0.60219	0.135763	19.67479	9.18E-06	0.547609	
Charge	-0.11756	0.011146	111.2486	5.22E-26	0.889088	0.869877
Replace	0.224496	0.011807	361.542	1.3E-80	1.251691	1.223059
Frequency	0.28295	0.0536	27.86718	1.3E-07	1.327039	1.194702

Table B-7: Exercise 1 Model Parameters Small CAZ

(All sample, factored by frequency, weighted by purpose & fuel type)

Response		Coeff.	Z	p-value
Change Mode	*Intercept*	-2.230	9.0	
	Charge	0.373	14.5	
	Frequency	-0.233	1.8	0.077271949
Not Travel	*Intercept*	-2.961	10.9	
	Charge	0.361	12.9	
	Frequency	0.105	0.8	0.43122352
Change Destination	*Intercept*	-2.961	9.7	
	Charge	0.254	7.9	
	Frequency	0.314	2.2	0.029930043
Change Route	*Intercept*	-1.219	5.7	
	Charge	0.312	13.4	
	Frequency	-0.218	1.9	0.060052466
Switch Vehicle	*Intercept*	-3.771	9.5	
	Charge	0.229	5.5	
	Frequency	0.495	2.8	0.004720958

Table B-8: Exercise 2 Model Parameters Small CAZ

(All sample, factored by frequency, weighted by purpose & fuel type)

Choice	Coeff.	Std. Err.	Z	p-value	95% Conf. Int.	
Const	-0.24156	0.150087	2.590455	0.107509	0.785399	
Charge	-0.12156	0.012094	101.033	9.05E-24	0.885538	0.864795
Replace	0.232825	0.012889	326.2785	6.21E-73	1.26216	1.230674
Frequency	0.139492	0.06872	4.120347	0.04237	1.14969	1.004815

With this factoring the significance of frequency, while not eliminated, is reduced in both exercises. This drop-in significance is reflected in the lower Z value and large spread in the confidence interval.

It is therefore considered that the decision to factor by reported frequency is justified and though, not perfect, is sufficient without an additional source of data for weighting.

B.2.2 Home Origin

To test the significance of home origin, processing in GIS was undertaken into order to calculate the crow fly distance between the centroid of the reported home postcode and the closest point on the boundary of the proposed zone (this value is treated as 0 for those living in the zone).

As for the trip frequency test, responses were split into 3 bands, those within 2km of the zone, those between 2 and 7km and those further than 7km. The distance values were chosen such that numbers of responses in each band were similar.

Logistic regression modelling was again undertaken and the results are shown in Table B-9 to Table B-12.

Table B-9: Exercise 1 Home Origin Test Medium CAZ

(All sample, factored by frequency, weighted by purpose & fuel type)

Response		**Coeff.**	**Z**	**p-value**
Change Mode	*Intercept*	-1.423	6.6	
	Charge	0.328	13.7	
	Distance	-0.288	3.8	0.000126102
Not Travel	*Intercept*	-2.061	8.8	
	Charge	0.366	14.6	
	Distance	-0.231	2.9	0.003487601
Change Destination	*Intercept*	-2.936	10.2	
	Charge	0.306	10.4	
	Distance	0.102	1.1	0.28148277
Change Route	*Intercept*	-1.479	7.2	
	Charge	0.327	14.4	
	Distance	-0.083	1.2	0.238457327
Switch Vehicle	*Intercept*	-3.949	9.9	
	Charge	0.231	6.1	
	Distance	0.479	3.7	0.000195221

Table B-10: Exercise 2 Home Origin Test Medium CAZ

(All sample, factored by frequency, weighted by purpose & fuel type)

Choice	**Coeff.**	**Std. Err.**	**Z**	**p-value**	**95% Conf. Int.**	
Const	0.003078	0.138034	0.000497	0.98221	1.003083	
Charge	-0.11712	0.011116	111.0231	5.85E-26	0.889474	0.870305
Replace	0.223447	0.011769	360.4584	2.24E-80	1.250379	1.221867
Distance	-0.11566	0.041007	7.955445	0.004794	0.890777	0.821985

Table B-11: Exercise 1 Home Origin Test Small CAZ

(All sample, factored by frequency, weighted by purpose & fuel type)

Response		Coeff.	Z	p-value
Change Mode	*Intercept*	-1.532	6.1	
	Charge	0.382	14.7	
	Distance	-0.502	5.9	3.09802E-09
Not Travel	*Intercept*	-1.883	6.8	
	Charge	0.370	13.1	
	Distance	-0.483	5.2	1.95856E-07
Change Destination	*Intercept*	-2.622	7.8	
	Charge	0.254	7.9	
	Distance	0.029	0.3	0.793965051
Change Route	*Intercept*	-0.752	3.4	
	Charge	0.318	13.5	
	Distance	-0.367	4.8	1.28181E-06
Switch Vehicle	*Intercept*	-5.320	9.1	
	Charge	0.218	5.2	
	Distance	0.922	4.8	1.37065E-06

Table B-12: Exercise 2 Home Origin Test Small CAZ

(All sample, factored by frequency, weighted by purpose & fuel type)

Choice	Coeff.	Std. Err.	Z	p-value	95% Conf. Int.	
Const	0.324978	0.15455	4.421514	0.035489	1.384	
Charge	-0.12281	0.012121	102.6584	3.98E-24	0.884432	0.863668
Replace	0.234316	0.012928	328.5021	2.04E-73	1.264044	1.232418
Distance	-0.18798	0.044757	17.64006	2.67E-05	0.828631	0.759038

In Exercise 1 the distance from the zone has some weaker significance for some choices for the medium zone but stronger significant with the smaller zone. This may be because the extent of the medium zone limits options available for the smaller zone. Responses to changing mode and changing route are significantly stronger with the small zone, this matches up with these responses featuring more strongly generally for the smaller zone.

In Exercise 2 some significance is shown with both zones although this is fairly weak with the medium zone. This suggests that not all respondents were considering this exercise in an entirely hypothetical manner.

It was decided not to use any weighting for distance in the statistical model due to the lack of reliable information to weight to. Further the traffic modelling process will already account for the difference of distances from the zone for some of the responses such as trips rerouting around the zone.

Bristol City Council Clean Air Plan

Economic Assessment Methodology Report E1

FBC-29 | 2

17 February 2021

Bristol City Council

Bristol City Council Clean Air Plan

Project No:	673846.ER.20
Document Title:	Economic Assessment Methodology Report E1
Document No.:	FBC-29
Revision:	2
Document Status:	Draft
Date:	17 February 2021
Client Name:	Bristol City Council
Project Manager:	HO
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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
1	05/02/21	Draft	GW	GW	HO	HO
2	17/02/21	Draft	GW	GW	HO	HO

Contents

1. Introduction

1.1 Clean Air Zone Context

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). The Mayor of Bristol has often cited Bristol's 'moral and legal duty' to improve air quality in the city and the administration recognises that achieving improved air quality is not solely a transport issue. Notwithstanding the Council's work on a Clean Air Zone, efforts have been made to make citizens more aware of – and take personal responsibility for – various sources of air pollution, from traffic fumes to solid fuel burning. The Mayor has articulated a 'call to action' for local people, businesses and organisations to consider how small changes can make a significant difference in cutting toxic fumes across the city. BCC has monitored and endeavoured to address air quality in Bristol for decades and declared its first Air Quality Management Area in 2001. Despite this, Bristol has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO_2) and these are predicted to continue until around 2027 without intervention.

The added context is that of the COVID-19 pandemic. Recent research suggests that poor air quality may be correlated with higher death / infection rates from COVID-19. This is further compounded by growing evidence that suggests that those from black, Asian and minority ethnic communities are more at risk of catching and dying from the virus and the fact that individuals from these communities are more likely to live in areas where air quality is poor. The challenge of maintaining public health and supporting economic recovery while also achieving legal air quality levels after lockdown restrictions are lifted will remain live and intersecting issues for the foreseeable future.

The UK Government continue to transpose European Union law into its Environment Bill[2] , to ensure that certain standards of air quality continue to be met, by setting air quality assessment levels (AQALs) on the concentrations of specific air pollutants. It's very unlikely that these AQALs will differ to EU Limit Values prescribed by the European Union's Air Quality Directive and transcribed in the UK's Air Quality Standards Regulation 2010. Therefore, these Limit Values will remain in enforcement post-Brexit. In common with many EU member states, the EU Limit Value for annual mean nitrogen dioxide (NO_2) is breached in the UK and there are on-going breaches of the NO_2 limit value in Bristol. The UK government is taking steps to remedy this breach in as short a time as possible, with the aim of reducing the harmful impacts on public health. Within this objective, the Government has published a UK Air Quality Plan and a Clean Air Zone Framework, both originally published in 2017 (noting there have been subsequent revisions). The latter document provides the expected approach for local authorities when implementing and operating a Clean Air Zone (CAZ). The following business cases have been submitted to JAQU for the Clean Air Plan; Strategic Outline Case (April 2018), and an Outline Business Case (November 2019 and updated between April and June 2020).

1.2 Purpose of this Report

This Economic Appraisal Methodology Report (EAMR) is written to support the FBC and outlines the overarching framework and detailed analysis that underpins the economic appraisal of the preferred option for the Bristol Clean Air Plan, i.e. Small CAZ D. It presents the key assumptions, approach and structure of the economic modelling that drives the cost-benefit analysis presented in the Economic Case of the Full Business Case (FBC).

Within this context, the EAMR should be reviewed alongside the Economic Case presented in the main FBC document. The Economic Case itself outlines the results of the economic appraisal, whilst this appendix presents the methodological underpinnings of the analyses.

[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] Environment Bill 2019-21 https://services.parliament.uk/bills/2019-21/environment.html

Earlier versions of this report were published in January 2019, October 2019 and June 2020 in support of the developing economic case published as part of the Strategic Outline Case, Outline Business Case and Revised Outline Business Case.

This document reflects the updated Bristol Clean Air Zone modelling, including the modelled impacts of the Bristol Street Space Schemes on the Bristol highway network and Small CAZ D.

The Street Space Schemes have been incorporated in an updated Baseline model which has helped refine the Bristol Clean Air Zone scheme presented in the Outline Business Case submission, prior to the Full Business Case submission.

Note in addition to the transport and air quality modelling presented in this Technical Note, there is further work being undertaken to consider the effects of COVID 19, further behaviour change, on ground traffic volumes and any additional schemes that could be viable in the required timescales.

2. Analytical Framework

2.1 Overarching Framework

The overarching framework for assessing the economic impacts of the preferred intervention for Bristol's Clean Air Plan is outlined in Figure 2.1 (at end of report). The flowchart presents a complex and interlinked series of inputs, processes and calculations that drive the economic model. Key inputs into the economic model can be split into three broad categories that are summarised as follows:

- Jacobs technical modelling processes (blue) and their outputs (purple), as required by JAQU's Evidence Package and pivoting from:
  - Stated preference surveys – commissioned specifically for this study, which determine behavioural responses to implementation of the Clean Air Zone;
  - Transport modelling – utilising local traffic survey data which, building on the stated preference surveys, provides data on traffic patterns with and without implementation of the Clean Air Plan;
  - Air quality modelling – utilising local air quality monitoring data which, building on the transport modelling, provides emissions data with and without implementation of the Clean Air Plan;
- Benchmark data recommended by JAQU (green), including:
  - Carbon prices, sourced from BEIS Carbon Tables;
  - Depreciation rates, informed by JAQU's National Data Inputs for Local Economic Models;
  - Vehicle prices, informed by ANPR data to identify the most common car types in Bristol, www.parkers.co.uk, www.Which.com and discussion with local bus and fleet operators;
  - Transaction costs by vehicle type and Euro Standard, informed by JAQU's National Data Inputs for Local Economic Models;
  - Damage costs, sourced from DEFRA's Air Quality Damage Cost Appraisal Toolkit;
- Jacobs economic modelling processes (yellow) that sit outside, but provide inputs to, the core Local Economic Model:
  - Transport user benefits assessment – which estimates the transport economic impacts associated with implementing the Clean Air Plan (based on Transport Economic Efficiency tables);
  - Cost modelling – which provides capital and operational cost data associated with implementing the Clean Air Plan;
  - Active Mode Appraisal Toolkit – which estimates the economic impacts associated with changes in the number of walking and cycling trips as a result of implementing the Clean Air Plan; and
  - CoBALT analysis – which estimates the economic impacts associated with changes in the frequency and severity of accidents as a result of implementing the Clean Air Plan.

The various inputs listed above feed into the calculation of the economic impacts (black) for the intervention, split into a range of categories that are consistent with the impact categories listed in JAQU's Option Appraisal Guidance. The economic impacts are monetised at this stage, before being aggregated into a holistic Net Present Value (NPV), which act as the key output of the economic model (orange).

2.2 Guidance, Data Sources and Key Assumptions

The economic analysis is underpinned by the following JAQU and cross-governmental guidance documents:

- JAQU Options Appraisal Guidance (2017)
- JAQU UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations (2017)
- HMT Green Book (updated 2020)
- DfT Transport Analysis Guidance (TAG) framework (updated October 2019)

The following data sources were also utilised within the economic model to derive key assumptions:

- Transport model outputs (Jacobs internal analysis)
- Air Quality model outputs (Jacobs internal analysis)
- JAQU National Data Inputs for Local Economic Models (2017)
- Bristol ANPR data (2017)
- Bristol taxi licensing data (2018)
- Bristol public transport data on fleet size, age and value based on discussion with local bus operators (2018)
- Department for Business, Energy and Industrial Strategy's Carbon Tables (2019)
- Vehicle prices, informed by ANPR data on most common car types in Bristol, www.parkers.co.uk, www.Which.com and discussion with local bus and fleet operators.
- DEFRA's Air Quality Damage Cost Appraisal Toolkit

Other key assumptions adopted within the model include:

- Opening year of 2021 to reflect assumed scheme opening
- Appraisal period of ten years (2021-2030), in line with JAQU guidance
- Presentation of monetised impacts in 2018 prices and values in line with JAQU guidance
- Adoption of a 3.5% discount rate per annum over the appraisal period, in line with HM Treasury Green Book Guidance
- Inflation adjustments in line with the HM Treasury's GDP Deflator (2020)

Additional impact-specific assumptions and parameters are presented in the relevant sections below. However, note that whilst this report provides a brief summary of the key behavioural, transport and air quality assumptions that drive the economic analysis, it does not attempt to re-state the methodological foundations or key outputs of any technical modelling. The following reports submitted as part of the FBC should be consulted for further details on these key data sources and assumptions:

- Behavioural Responses – FBC-28 'Stated Preference Survey', Appendix F and FBC-26 'Response Rates' within Appendix E of the FBC.
- Air Quality Technical Workstream – FBC-18 'AQ2 Methodology Report' and FBC-19 'AQ3 Modelling Report' within Appendix D of the FBC.
- Traffic Modelling Technical Workstream – FBC-22 'T2 Model Validation Report', FBC-23 'T3 Methodology Report ', FBC-24 'ANPR Summary TN', FBC-25 'LGV and HGV Validation TN', FBC-26 'Response Rates' and FBC-27 'T4 Model Forecast Report' within Appendix E of the FBC.

2.3 Structure of this Report

This report provides a step-by-step guide to the approach adopted to assess each of the economic impact categories defined in Figure 2.1 and listed below:

- Health and Environmental Impacts
  - Greenhouse Gas Emissions – an assessment of the change in CO_2 emissions resulting from implementation of the intervention scheme.
  - PM/NOx Emissions – an assessment of the change in PM and NO_2 emissions resulting from implementation of the intervention scheme.
- Impacts on Transport Users
  - Transaction Costs - an assessment of time costs associated with looking for and purchasing new/replacement vehicles as a result of implementation of the intervention scheme.
  - Consumer Welfare Loss – an assessment of reduction in consumer surplus resulting from the earlier purchase of new/replacement vehicles or the decision to change travel behaviour in response to implementation of the intervention scheme.
  - Scrappage Costs – an assessment of the loss in asset value for vehicles that are scrapped earlier as a result of implementation of the intervention scheme.
  - Journey Time/Vehicle Operating Costs – an assessment of the change in travel times and vehicle-use costs as a result of implementation of the intervention scheme. The vehicle operating cost element is assumed to implicitly include fuel switch costs.
  - Accident Impacts – an assessment of the change in frequency and severity of accidents as a result of implementation of the intervention scheme.
  - Walking/Cycling Impacts – an assessment of the change in number of individuals travelling by active modes as a result of implementation of the intervention scheme.
- Costs to Local/Central Government – an analysis of the cost to set-up and operate the intervention scheme.
  - Set-Up (Implementation) Costs – an assessment of the capital expenditure required to deliver the intervention scheme.
  - Running (Operational) Costs – an assessment of the ongoing operational expenditure required to deliver the intervention scheme.
- Note that financial impacts associated with CAZ charging have an overall net neutral impact from an economic perspective. This is because the CAZ charge acts an economic benefit to local/central government (in the form of revenue generation), but an economic cost to non-compliant vehicle users. The scale of the respective costs and benefits are equal therefore the impacts cancel each other out within the net present value analysis and are therefore discounted from consideration.

The following sections detail the analytical approach to each economic impact category in turn, supported by targeted versions of Figure 2.1 that isolate the methodology utilised for each type of impact.

2.4 Options Assessed

The economic analysis presented in this report considers the following scenarios:

- Baseline case – 2021-2030 scenario without a Clean Air Plan
- Preferred intervention scheme – 2021-2030 scenario with the following measures in place:
  - Small Area Class D CAZ charging non-compliant cars, buses, coaches, taxis, HGVs and LGVs;
  - Holding back traffic to the city centre through the use of existing signals; and

- o Changes to the boundary at Cabot Circus so vehicles can enter / exit Cabot Circus car park via Houlton St access without going through the CAZ.

This intervention scheme also includes Fast Track measures, some of which have been included in the revised Baseline (e.g closure of Cumberland Rd inbound and other measures such as additional cycle provision in the zone, additional air quality monitors etc). The M32 P&R and bus lane are not included as it cannot be delivered within the study programme, so do not form part of this option.

Note that the assessment is predicated on a 1st October 2021 switch-on date for the intervention option. As such, the economic analysis presented in the economic case reflects intervention impacts in 2021 accruing for a portion of the year only, rather than the full year. A pro-rata approach was adopted to account for the scheme being partially in place in 2021, based on numbers of days per month from start of October through to end of December compared to total days per year. This resulted in an adjustment factor of 25.2% being applied to 2021 economic analysis. This factor was validated against historic annual count data for BCC and more up to date 2019 count data at M32 (25.2% and 25.1% respectively), which demonstrates excellent alignment with the pro-rata factor.

3. Vehicle Fleet Composition

3.1 Base and Baseline Vehicle Fleet

The compositional split of the 2020 baseline vehicle fleet between compliant and non-compliant vehicles is outlined in Table 3.1. The 2020 baseline composition is derived by adjusting 2021 baseline modelled fleet data according to the forecast change in vehicle compliance between 2021 and 2022 under the baseline. Effectively, trends in vehicle turnover estimated for 2021 to 2022 are assumed to apply for 2020 to 2021 also. This approach is considered appropriate in the absence of a traffic model for 2020. For the purposes of the Table 3.1, vehicle compliance is defined as follows:

- Petrol vehicle compliance based on Euro 4+ for all vehicles;
- Diesel vehicle compliance (including all HGVs, buses/coaches) based on Euro 6+ for all vehicles.

Table 3.1: Base Vehicle Trips (AADT) in 2020

Euro Standard	Cars/Taxis (Petrol)	Cars/Taxis (Diesel)	LGV (Petrol)	LGV (Diesel)	HGV Rigid	HGV Artic	Buses/ Coaches
Compliant	107,054	35,914	84	21,790	4,657	1,562	619
Non-Compliant	17,141	44,153	103	19,010	2,316	314	354

Source: Jacobs Transport Modelling

The 2020 baseline vehicle fleet composition (pivoting from the 2021 baseline vehicle fleet data) is adopted as the key starting point for determining the change in vehicle fleet composition over the appraisal period.

3.2 Behavioural Response

The behavioural responses to the proposed scheme were derived through a stated preference survey undertaken in Spring 2018 (see FBC-28 'Stated Preference Survey Report' Appendix F of this FBC for more detail). The key primary behavioural response rates derived from the survey are replicated in Table 3.2.

Table 3.2: Primary Behavioural Response Rates

Response	Cars	LGV	HGV rigid	HGV artic	Buses	Coaches	Taxis
Pay Charge/ Excluded	10.4%	15.9%	8.8%	8.8%	0.0%	17.8%	4.1%
Avoid Zone	19.0%	19.2%	4.3%	4.3%	0.0%	0.0%	0.0%
Cancel Journey/ Change Mode	20.4%	2.6%	4.3%	4.3%	6.4%	11.4%	0.0%
Replace Vehicle/ Upgrade	50.3%	62.2%	82.6%	82.6%	93.6%	70.8%	95.9%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Source: Jacobs Transport Modelling

Note that the bus response rates listed in Table 3.2 were artificially adjusted within the model to reflect feedback received by local bus operators in Bristol, which demonstrated that all buses would be compliant by 2021 in the baseline. Hence, the intervention scheme is assumed to have no effect on buses.

In relation to the replace vehicle/upgrade behavioural choice, a secondary behavioural response assumption was adopted in line with JAQU guidance. Table 3.3 outlines the standard proportion of people replacing existing vehicles with new vehicles versus people replacing with used (same fuel) and used (switched fuel) vehicles.

Table 3.3: Secondary Behavioural Response Rates (Source JAQU Guidance)

Response	Fuel Type		Upgrade Type	
	Keep Same	Switch	Used	New
Car (Petrol)	100%	0%	75%	25%
Car (Diesel)	25%	75%	75%	25%
LGVs	100%	0%	100%	0%
Buses	100%	0%	0%	100%
HGV Rigid	100%	0%	100%	0%
HGV artic	100%	0%	100%	0%
Coaches	100%	0%	100%	0%
Taxis (Petrol)	100%	0%	75%	25%
Taxis (Diesel)	25%	75%	75%	25%

3.3 Upgrade in Vehicle Fleet

Future composition of the vehicle fleet was determined by applying the behavioural responses to the 2020 baseline vehicle fleet composition. Based on the behavioural responses outlined above, the vehicle fleet is expected to upgrade at an accelerated rate in the intervention case relative to the baseline.

These behavioural responses were incorporated into the traffic modelling to forecast the scale of vehicle movements across the cordons in 2021 (opening year), 2023 (interim/compliance year) and 2031 (future year) under the intervention scenario. The rate of upgrading and consequent forecast for the scale of vehicle movement in the baseline across the same horizon years was estimated according to the EFT Toolkit outputs. The composition of the vehicle fleet in these years is presented in Tables 3.4 to 3.7. Note that cars and taxis have been separated into discrete vehicle types within the analysis below based on the proportion of the car fleet that are taxis according to the traffic modelling analysis. Private hire vehicles are not differentiated from taxis or cars in the quantitative economic analysis below because there is no differentiation between charge rates for these vehicle types. Also note that there is no information on buses in the tables below, because bus operators in Bristol have confirmed that the bus fleet will be fully compliant by 2021 in the baseline.

Table 3.4: Vehicle Fleet (AADT) in 2021, Baseline

Euro Standard	Cars (Petrol)	Cars (Diesel)	LGV (Petrol)	LGV (Diesel)	HGV Rigid	HGV Artic	Taxis (Petrol)	Taxis (Diesel)	Coaches
1	0	0	2	0	0	0	0	0	0
2	1,388	96	27	267	21	1	101	7	24
3	9,634	2,742	60	1,011	156	26	703	200	95
4	15,156	7,039	8	4,034	340	15	226	514	48
5	39,600	29,107	44	10,789	1,393	211	590	2,125	128
6	51,792	37,828	56	25,186	5,067	1,626	771	5,611	679
Compliant	106,548	37,828	107	25,186	5,067	1,626	1,586	5,611	679
Non-Compliant	11,022	38,984	89	16,100	1,910	253	805	2,846	295

Source: Jacobs Transport Modelling

Table 3.5: Vehicle Fleet (AADT) in 2021, Intervention Case

Euro Standard	Cars (Petrol)	Cars (Diesel)	LGV (Petrol)	LGV (Diesel)	HGV Rigid	HGV Artic	Taxis (Petrol)	Taxis (Diesel)	Coaches
1	0	0	0	0	0	0	0	0	0
2	103	7	4	43	2	0	4	0	4
3	716	204	10	164	14	2	30	8	17
4	18,578	523	11	652	30	1	343	22	9
5	48,541	2,163	63	1,745	125	19	896	89	23
6	63,485	43,647	81	36,351	6,558	2,105	1,172	8,529	912
Compliant	130,604	43,647	155	36,351	6,558	2,105	2,411	8,529	912
Non-Compliant	819	2,896	14	2,604	171	23	34	120	54

Source: Jacobs Transport Modelling

Table 3.6: Vehicle Fleet (AADT) in 2031 Baseline

Euro Standard	Cars (Petrol)	Cars (Diesel)	LGV (Petrol)	LGV (Diesel)	HGV Rigid	HGV Artic	Taxis (Petrol)	Taxis (Diesel)	Coaches
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	149	81	0	107	6	0	3	0	0
5	6,028	3,585	2	1,170	83	10	119	0	0
6	116,705	54,759	119	46,010	7,094	1,918	2,310	8,602	1,009
Compliant	122,883	54,759	121	46,010	7,094	1,918	2,432	8,602	1,009
Non-Compliant	0	3,666	0	1,277	90	10	0	0	0

Source: Jacobs Transport Modelling

Table 3.7: Vehicle Fleet (AADT) in 2031, Intervention Case

Euro Standard	Cars (Petrol)	Cars (Diesel)	LGV (Petrol)	LGV (Diesel)	HGV Rigid	HGV Artic	Taxis (Petrol)	Taxis (Diesel)	Coaches
1	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0
4	152	6	0	16	1	0	3	0	0
5	6,153	266	2	175	7	1	120	0	0
6	119,122	55,873	114	44,027	6,999	1,892	2,328	8,671	985
Compliant	125,427	55,873	116	44,027	6,999	1,892	2,452	8,671	985
Non-Compliant	0	272	0	191	8	1	0	0	0

Source: Jacobs Transport Modelling

For the intervening years between 2021, 2023 and 2031, interpolation was undertaken to estimate the annual change in the vehicle fleet. Traffic flows for years between 2021, 2023 and 2031 were calculated using interpolation factors derived from traffic growth forecasts from TemPRO. To calculate the required vehicle and fuel types and euro standards the flows were split by a series of factors. Car and LGV compliant and non-compliant fuel splits were derived by adjusting WebTAG databook forecasts to account for locally observed ANPR data, the fuel splits for the intermediate years between 2021, 2023 and 2031 were taken directly from this process. Intermediate year splits between rigid and articulated for compliant and non-compliant HGVs were assumed to be a linear progression between the established 2021, 2023 and 2031 values. Euro standard splits were taken by utilising the fleet projection from observed ANPR data mechanism in the EFT for each year from 2021 to 2023 and from 2023 to 2031.

Prior to 2021, a simplifying assumption is that the vehicle fleet composition is identical in both the baseline and intervention cases.

Based on this approach, the percentage reduction in non-compliant vehicle trips in the baseline and intervention scenarios is outlined in Table 3.8. The table clearly demonstrates that the number of non-compliant trips reduces at much quicker rate in the intervention case relative to the baseline.

Table 3.8: Percentage Reduction in Non-Compliant Trips in the Baseline (Relative to 2020)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Baseline	13%	27%	40%	47%	54%	61%	68%	74%	81%	88%
Intervention	92%	93%	95%	95%	96%	96%	97%	98%	98%	99%

Source: Jacobs Transport Modelling

4. Health and Environmental Impacts

4.1 Greenhouse Gas Emissions

By changing travel behaviours (including number of trips, trip mode and vehicle type), the Plan may influence the quantum of Greenhouse Gas (GHG) emissions generated by road transport. A change in GHG emissions, and CO_2 emissions in particular, could generate variable effects on climate change processes.

The approach to estimating the economic impact of GHG emissions utilised the following data:

- Vehicle kilometres output from the traffic model.
- Euro splits as estimated by ANPR.
- Behavioural responses estimated in the traffic model.
- CO_2 emissions per kilometre, by vehicle class, as provided by JAQU.

This data was processed as part of the air quality modelling technical workstream to estimate the change in CO_2 emissions across the appraisal period for both the baseline and intervention scenarios (Table 4.1). Model data was made available for the opening year (2021), interim/compliance year (2023) and future year (2031). Linear interpolation was undertaken for intervening years, for both the baseline and intervention scenarios.

The difference in emissions under the two scenarios was then calculated to determine the change in CO_2 emissions attributable to the interventions across the appraisal period.

Table 4.1: Temporal Change in CO_2 Emissions (tonnes)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Baseline	287,225	286,209	285,193	282,917	282,659	282,401	282,142	281,884	281,626	281,368
Intervention	282,283	282,216	282,149	282,379	282,743	283,106	283,470	283,834	284,197	284,561
Difference	4,942	3,993	3,044	539	-83	-706	-1,328	-1,950	-2,572	-3,194

Source: Jacobs Air Quality Modelling

The difference in emissions was then multiplied by relevant carbon prices across the appraisal period (see Table 4.2, replicated from £/tCO_2e values in BEIS' Carbon Tables.

Table 4.2: Carbon Prices (£ per Tonne of CO_2 Emissions)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
£/tCO2e	£70.43	£71.59	£72.74	£73.90	£75.05	£76.21	£77.36	£78.52	£79.67	£80.83

Source: BEIS Carbon Tables (2018 prices)

The approach to analysis of GHG emissions is outlined in Figure 4.1 (see end of report).

4.2 Air Quality (PM/NO_2) Emissions

Poor air quality can have significant negative health impacts on human health. Specific impacts relating to NO_2 include[3]:

- High concentrations can lead to inflammation of the airways.
- Long-term exposure can increase symptoms of bronchitis in asthmatic children and reduced lung development and function.

[3] Ambient (Outdoor) Air Quality and Health Fact Sheet. World Health Organisation (2016). Accessed February 2018.

More generally, a range of other public health issues are linked to poor air quality, as detailed below. These issues are believed to disproportionately affect 'at-risk' groups such as older people, children and people with pre-existing respiratory and cardiovascular conditions[4].

- Long-term exposure to air pollution is linked to increases in premature death, associated with lung, heart and circulatory conditions.
- Short term exposure can contribute to adverse health effects including exacerbation of asthma, effects on lung function and increases in hospital admissions.
- Other adverse health effects including diabetes, cognitive decline and dementia, and effects on the unborn child[5] are also linked to air pollution exposure.
- Exposure can exacerbate lung and heart disease in older people[6].
- Approximately 40,000 deaths can be attributed to NO_2 and fine particulate matter pollution in England every year[7].

In light of the causal link between poor air quality and poor public health, health experts believe that improvements in air quality can lead to a range of public health benefits, including:

- Reduced morbidity, leading to a reduction in public health expenditure (associated with hospital admissions and health care) and increased productivity through reduced work absenteeism; and
- Reduced mortality, leading to a reduction in lost output and human costs.

In addition, an improvement in air quality can also lead to positive externalities associated with the natural and built environment, including:

- Reduced impact on ecosystems (nature conservation and green spaces in Bristol) through a reduction in emissions of NO_2;
- Reduced impact on climate change through a reduction in NOx; and
- Reduced damage to townscape and the built environment, leading to a reduction in surface cleaning costs and amenity costs for residential, historical and cultural assets.

Within this context, the health and environmental impact associated with changes in PM/NO_2 emissions were estimated using the Damage Cost approach. The Damage Cost approach estimates the average societal costs associated with marginal changes in pollution emissions based on the range of potential impacts highlighted above. By changing travel behaviours (including number of trips, trip mode and vehicle type), the Plan may alter the scale of PM/NO_2 emissions generated by road transport.

The approach to estimating the economic impact of PM/NO_2 emissions utilised the following data:

- Vehicle fleet data and vehicle kilometres outputs from the traffic model.
- Euro splits as estimated by ANPR.
- Behavioural responses estimated in the traffic model.
- PM and NO_2 emissions per kilometre, by vehicle class, as provided by JAQU.

This data was processed as part of the air quality modelling technical workstream to estimate the change in PM/NO_2 emissions across the appraisal period for both the baseline and intervention scenarios as shown in Table 4.3. Model data was made available for the opening year (2021), interim/compliance year (2023) and future year (2031). Linear interpolation was undertaken for intervening years for both the baseline and intervention scenarios.

[4] World Health Organization (2013) *Review of evidence on health aspects of air pollution – REVIHAAP Project.* http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollution-revihaap-project-final-technical-report

[5] Royal College of Physicians (2016) '*Every breath we take: the lifelong impact of air pollution*', 2016 www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution

[6] Simoni et al., Adverse effects of outdoor pollution in the elderly, Journal of Thoracic Disease, January 2015 (URL:https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4311079/)

[7] *Royal College of Physicians (2016) 'Every breath we take: the lifelong impact of air pollution'. 2016*

The difference in emissions under the two scenarios was then calculated to determine the change in PM/NO_2 emissions attributable to the interventions across the appraisal period

Table 4.3: Temporal Change in PM/NO_2 Emissions (tonnes)

NO_2	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Baseline	571.5	524.0	476.4	379.5	361.9	344.3	326.7	309.0	291.4	273.8
Intervention	507.3	469.9	432.5	355.4	342.1	328.7	315.4	302.1	288.8	275.4
Difference	64.2	54.0	43.9	24.1	19.8	15.5	11.2	7.0	2.7	-1.6
PM	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Baseline	32.00	31.50	31.00	30.14	30.25	30.36	30.47	30.57	30.68	30.79
Intervention	30.80	30.55	30.30	29.94	30.08	30.22	30.35	30.49	30.63	30.76
Difference	1.20	0.95	0.70	0.20	0.17	0.14	0.11	0.08	0.06	0.03

Source: Jacobs Air Quality Modelling

The difference in emissions was then multiplied by relevant damage costs across the appraisal period (see Table 4.4, replicated from DEFRA's Air Quality Damage Cost Appraisal Toolkit). Bristol falls within the 'Urban Big' area type according to DfT's classification system, therefore the damage cost relevant to 'Urban Big' setting was utilised.

Table 4.4: Damage Costs (£ per Tonne)

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
NO_2	£17,013	£17,353	£17,700	£18,054	£18,415	£18,783	£19,159	£19,542	£19,933	£20,332
PM	£324,500	£330,990	£337,610	£344,362	£351,249	£358,274	£365,440	£372,749	£380,204	£387,808

Source: DEFRA's Air Quality Damage Cost Appraisal Toolkit

The approach to analysis of PM/NO_2 emissions is outlined in Figure 4.2 (see end of report).

5. Impacts on Transport Users

5.1 Fuel Switch Costs

As road users upgrade to compliant vehicles and switch fuel types between petrol and diesel, individuals could face varying fuel costs in the intervention case relative to the baseline scenario. The change in fuel switch costs is reflected in the change in vehicle operating costs to the user, captured as part of the DfT's Transport User Benefits Assessment (TUBA) presented in Section 5.4. No additional or separate analysis is provided here.

5.2 Consumer Welfare Loss

The intervention option will change consumers behaviour by inducing a change in travel behaviours (e.g. through upgrading vehicles, using alternative modes, cancelling journeys etc). However, because consumers would have preferred their original action in the baseline, this change in behaviour leads to a consumer welfare impact. Two elements of analysis have been identified to estimate aggregate consumer welfare loss as a result of intervention:

- Welfare loss associated with individuals upgrading or replacing their vehicles earlier; and
- Welfare loss associated with changing travel patterns or behaviours (i.e. mode shift, cancelled journeys, diverted journeys).

5.2.1 Replacing Vehicles

As noted above, the intervention case leads to accelerated reduction in non-compliant trips which is indicative of an acceleration of vehicle replacement (see Table 3.8). By accelerating the vehicle replacement process, the proposed scheme will impose a financial cost on vehicle owners driven by the impact of depreciation on replacement and replaced vehicles. Depreciation affects two components of the vehicle replacement process in the intervention case:

- Additional cost of compliant vehicles bought earlier than otherwise intended; and
- Additional value of non-compliant vehicle sold.

The difference between these two values and the extent to which this difference diminishes over time, act as a proxy for consumer welfare change as a result of the proposed scheme. The net difference is driven by changes in depreciation rates over time, as highlighted in Table 5.1.

Table 5.1: Depreciation Rates by Year

Vehicle type	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Petrol cars	37%	18%	16%	16%	16%	16%	16%	16%	16%	16%
Diesel cars	37%	18%	16%	16%	16%	16%	16%	16%	16%	16%
Petrol vans	37%	18%	16%	16%	16%	16%	16%	16%	16%	16%
Diesel vans	37%	18%	16%	16%	16%	16%	16%	16%	16%	16%
Rigid HGVs	35%	18%	18%	18%	18%	18%	18%	18%	18%	18%
Articulated HGVs	35%	18%	18%	18%	18%	18%	18%	18%	18%	18%
Buses	35%	18%	18%	18%	18%	18%	18%	18%	18%	18%
Taxis	37%	18%	16%	16%	16%	16%	16%	16%	16%	16%
Coaches	35%	18%	18%	18%	18%	18%	18%	18%	18%	18%

Source: JAQU's National Data Inputs for Local Economic Models

As depreciation rates are higher in earlier years, depreciation acts to narrow the gap between the value of compliant vehicles purchased and non-compliant vehicles sold over time. This means vehicle owners induced to replace their vehicle earlier experience greater welfare loss as the net difference in value of replacement and replaced vehicles is higher, thus implying a higher cost of upgrading. As a result, the cost of upgrading is expected to be greater in the intervention scenario, as vehicle owners upgrade sooner than in the bassline.

The total number of vehicle owners who replace their vehicle in response to intervention is a function of the frequency of trips made by each vehicle owner. Vehicles that make regular trips into the CAZ zone are more likely to be replaced than vehicles who rarely enter the zone, as the cumulative cost of CAZ charges resulting from frequent trips into the CAZ becomes more expensive than the average cost to upgrade to a compliant vehicle.

For the intervention case, in order to determine the number of vehicles that upgrade, the daily frequency of non-compliant vehicle entries into the CAZ or exclusion zone in 2021 under the baseline scenario was estimated by adjusting 2017 ANPR data. The frequency data was converted to number of trips by multiplying the number of vehicles by their frequency of entry according to ANPR data. The analysis, pivoting from ANPR data captured over a two-month period, was assumed to be representative of annual trip patterns.

Based on the response rates noted in Table 3.2, the number of trips upgrading was converted to a number of vehicles that upgrade by assuming that those vehicles that enter the CAZ or exclusion zone with the highest frequency (i.e. those vehicles that make the most trips on separate days over the two month period) are the first to upgrade. The first vehicles to upgrade are those entering the CAZ or exclusion zone with the highest frequency because these vehicles would incur the CAZ charge most regularly or most disruption to day-to-day activities. As such, from a financial and utilitarian perspective, regular entrants would rationally upgrade earlier than irregular entrants. This approach estimated the number of vehicles that upgrade, relative to the number of vehicle trips that upgrade, as outlined in Table 5.2.

Table 5.2: Vehicle Upgrade Response Rate Estimates

Vehicle Type	Small CAZ D	
	Trips	Vehicles
Car	50%	9%
LGV	62%	15%
Rigid HGV	83%	32%
Artic HGV	83%	47%
Taxi	96%	74%
Coach	71%	18%

Source: Jacobs Economic Modelling

Based on the 'vehicles' response rates outlined in Table 5.2 and the interpolation approach described in Section 3.3, the number and timing of vehicle upgrades that are directly attributable to the intervention scenario is outlined in Table 5.3.

Table 5.3: Rate of Vehicle Upgrading

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car Petrol	1,384	34	25	4	3	3	2	2	3	0
Car Diesel	3,497	16	27	23	24	24	24	25	25	25
Taxi Petrol	834	11	8	1	1	1	1	1	1	0
Taxi Diesel	2,096	3	6	10	10	10	10	10	10	10

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
LGV petrol	13	0	0	0	0	0	0	2	0	0
LGV diesel	2,429	70	70	28	28	28	27	27	27	26
Rigid HGV	682	12	12	4	4	4	3	3	4	4
Artic HGV	138	3	2	1	1	1	1	1	1	1
Coaches	54	2	2	1	1	1	1	1	1	1
Total	11,127	150	153	71	71	71	69	70	69	67

Source: Jacobs Economic Modelling

The average cost of replacing a vehicle by vehicle type and year is estimated by calculating the cost differential between upgrading in 2021 and all other years in the appraisal period, based on the residual value of replacement and replaced vehicles in each year (informed by the depreciation rates presented in Table 5.3). Values for the replacement and replaced vehicles reflect 2018 market prices sourced at that time from industry databases, weighted by:

- The popularity of certain brands/models in Bristol (based on ANPR data); and,
- JAQU-defined depreciation rates to capture the reduction in value over time.

These values were assumed to remain consistent in 2021, with all residual values for older cars pivoting from the value of the new vehicles listed in Table 5.4 and the appropriate depreciation rate.

Table 5.4: Market Value of New Vehicles

	Market Value of New Vehicle	Source
Cars (Petrol)	19,818	ANPR data on most popular models combined with https://www.which.co.uk/reviews/new-and-used-cars/article/petrol-vs-diesel-cars-which-is-better
Cars (Diesel)	17,588	ANPR data on most popular models combined with https://www.which.co.uk/reviews/new-and-used-cars/article/petrol-vs-diesel-cars-which-is-better
PHV Petrol	£19,818	Taxi and PHV costs in line with car prices
PHV Diesel	£17,588	Taxi and PHV costs in line with car prices
Taxi Petrol	£19,818	Taxi and PHV costs in line with car prices
Taxi Diesel	£17,588	Taxi and PHV costs in line with car prices
LGV petrol	20,215	Road Haulage Association on the LGV and HGV operating costs, 2018
LGV diesel	20,215	Road Haulage Association on the LGV and HGV operating costs, 2018
Rigid HGV	67,774	Road Haulage Association on the LGV and HGV operating costs, 2018
Artic HGV	81,495	Road Haulage Association on the LGV and HGV operating costs, 2018
Buses/Coaches	186,667	Cost for new bus vehicle averaged across single-deck, double deck and midi types (source: Table 4 – Rudimentary funding costs (Early Measures Fund for Local NO2 Compliance Report)

Source: Jacobs Transport Modelling

This cost differential for upgrading was then multiplied by the differential proportion of vehicles assumed to upgrade in each year (taken from Table 3.8). A factor of 50%[8] was also applied to arrive at a cost differential for upgrading for each vehicle type and Euro Standard for every year of the appraisal period. The annual values were then summed. The summed values for each Euro Standard were then converted to a weighted average upgrade cost differential covering all Euro Standards, using the Euro Standard mix of the non-compliant component of the vehicle fleet (as set out in Table 5.5).

Table 5.5: Euro Standard of Non-Compliant Components of Fleet

	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6
Car Petrol	0%	13%	87%			
Car Diesel	0%	0%	7%	18%	75%	
LGV petrol	2%	31%	67%			
LGV diesel	0%	2%	6%	25%	67%	
Rigid HGV	0%	12%	88%			
Artic HGV	0%	0%	10%	6%	83%	
Buses	0%	8%	32%	16%	43%	
Taxis Petrol	0%	13%	87%			
Taxis Diesel	0%	0%	7%	18%	75%	

[8] The factor reflects half of the difference between the market value of the replaced and replacement vehicle, assuming a linear demand curve for upgraders and no more detailed knowledge on the value specific individuals place on new or replacement vehicles

	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6
Coaches	0%	8%	32%	16%	43%	

Source: Jacobs Transport Modelling

NB: some rows may not sum to 100% due to rounding

Three weighted average upgrade cost differentials were derived, reflecting the three types of vehicular upgrades noted in Table 3.3. Following JAQU's Guidance, 25% of vehicle owners upgrading were assumed to upgrade to new vehicles.

For the 75% of vehicle owners upgrading to second-hand vehicles, these individuals were expected to replace their vehicles with the cheapest (i.e. lowest Euro Standard) compliant vehicle that is at least one Euro Standard higher than their current vehicle. Of the 75% of vehicle owners replacing their vehicles with second-hand vehicles, 25% are expected to switch fuel from diesel to petrol with the remaining 75% expected to retain the same fuel.

In light of the above, the weighted average replacement vehicle differential value for vehicle owners upgrading to new and used (same fuel/switch fuel) vehicles are listed in Table 5.6:

Table 5.6: Weighted Replace Vehicle Value Differential (£)

	New	Used (Same Fuel)	Used (Switch Fuel)
Car Petrol	£3,364	£150	£0
Car Diesel	£3,032	£635	£591
Taxi Petrol	£3,502	£156	£0
Taxi Diesel	£2,669	£583	£543
LGV petrol	£2,424	£116	£0
LGV diesel	£3,083	£688	£0
Rigid HGV	£12,131	£3,364	£0
Artic HGV	£13,065	£2,606	£0
Coaches	£35,357	£8,434	£0

Source: Jacobs Economic Modelling

The weighted average upgrade cost differentials were combined with the number of vehicles upgrading in each year in the intervention scenario to generate aggregate consumer welfare loss from upgrading.

5.2.2 Changing Travel Patterns and Behaviours

A loss of consumer welfare resulting from changing travel patterns and behaviours was captured by noting the number of trips in the baseline that would be cancelled, subjected to changing modes or that would avoid the CAZ or exclusion zone in response to the proposed scheme. Diverted trips were not included in the consumer welfare analysis as any economic impact was assumed to be captured within the journey time savings/vehicle operating cost analysis below.

Table 3.4 highlights the number of non-compliant vehicle trips in AADT terms in the 2021 baseline and Table 3.8 highlights the reduction in non-compliant vehicles in the baseline. Meanwhile Table 3.2 demonstrates the proportion of trips that would be cancelled, change mode or avoid the zone. In light of these assumptions, the annualised number of trips cancelled/changed mode/avoiding the zone as a result of the scheme are outlined in Table 5.7.

Table 5.7: Trips with Changed Travel Patterns/Behaviours

	2021[9]	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car Petrol	399,229	870,616	338,448	261,105	193,746	136,370	90,813	54,398	0	0
Car Diesel	1,411,999	5,281,390	4,715,458	4,215,799	3,702,064	3,185,633	2,664,360	2,137,907	1,605,967	1,069,322
Taxi Petrol	0	0	0	0	0	0	0	0	0	0
Taxi Diesel	0	0	0	0	0	0	0	0	0	0
LGV petrol	1,785	5,929	4,721	5,719	6,330	6,555	6,409	0	0	0
LGV diesel	323,424	1,051,275	819,457	725,958	632,845	540,119	451,749	363,733	276,071	188,762
Rigid HGV	15,108	47,176	34,296	30,286	26,266	22,237	18,371	14,496	10,612	6,719
Artic HGV	2,000	6,006	4,196	3,663	3,140	2,627	2,146	1,674	1,211	758
Coaches	3,101	9,861	7,419	6,466	5,513	4,560	3,648	2,736	1,824	912
Total	2,156,645	7,272,253	5,923,993	5,248,996	4,569,904	3,898,100	3,237,496	2,574,943	1,895,684	1,266,472

Source: Jacobs Economic Modelling

The approach to monetising consumer welfare loss relating to changing travel patterns and behaviours assumes that a change is made where the cost of the action is less than the cost of the respective charge for entering the boundary, otherwise the rational economic choice would be to pay the charge. Whilst consumers often consider factors beyond financial cost, this qualifying assumption is adopted for simplicity, as per JAQU's option appraisal guidance. As the incurred consumer welfare loss could fall anywhere between zero and the CAZ charge, the average mid-point CAZ charge[10] is adopted as the consumer welfare loss value. Effectively, the overall cost of changing travel patterns and behaviours is equal to the total number of trips that are changed, multiplied by half of the CAZ charge.

However, it should be noted that not all trips are assumed to experience a consumer welfare loss in the intervention scenario relative to the baseline scenario. The ANPR survey in 2017 revealed that only approximately 31% of daily non-compliant vehicle trips into the CAZ were made by unique non-compliant vehicles. Hence only 31% of non-compliant vehicle trips would be charged for entering the boundary as all other trips would be repeat trips by vehicles that had already entered the boundary. Applying consumer welfare loss to multiple trips by the same vehicle on a single day would overestimate the aggregate welfare loss as the charge is only incurred once.

The approach to analysis of consumer welfare loss is outlined in Figure 5.2 (see end of report).

5.3 Scrappage Costs

Pivoting from JAQU Guidance, the number of vehicles being scrapped is assumed to be equal to the number of new vehicles being purchased through the upgrading process (i.e. 25% of all upgraded vehicles). The intervention case is assumed to bring forward the replacement (and therefore scrappage) of vehicles, meaning that vehicles

[9] Note that the traffic flows for 2021 reflect an October 2021 switch-on date for the CAZ and broadly reflect 25% of annual trips estimated for this year, based on the approach outlined in Section 2.4

[10] £4.50 for cars and LGVs (all fuel types), £50 for HGV (all types) and buses/coaches

are scrapped earlier and with higher residual values than they would have been under the baseline scenario. As a result, the intervention case leads to a greater loss of residual asset value.

The value of scrapped vehicles is estimated by identifying the age of scrapped vehicles (inferred from Euro Standards) and estimating their residual value taking into account JAQU's recommended depreciation rates, in line with the vehicle upgrading analysis described above. As the intervention case is assumed to accelerate scrappage, scrapped vehicles in the intervention case have a higher residual value than in the baseline case where vehicles are scrapped later. This is because additional depreciation can occur where scrappage occurs at a later date (i.e. in the baseline).

The methodology for calculating the differential between residual asset value in the baseline and intervention case was aligned with the approach adopted in the vehicle upgrading analysis described above, i.e.:

- Established the asset value of vehicles to be scrapped based on age and depreciation rates
- Subtracted the asset value of vehicles to be scrapped in each year of the appraisal period from the 2021 value to establish an asset value differential per vehicle scrapped earlier than intended, across all years
- Used the interpolation rates to determine the proportion of vehicles scrapped each year in the intervention case, and applied the proportion to the asset value differential per vehicle identified above
- Summed the asset value differential across all years and Euro Standards to arrive at a weighted average asset value differential to act as a proxy for scrappage cost change between the baseline and intervention case (Table 5.8)

Table 5.8: Weighted Average Scrappage Costs (£)

Vehicle Type	Small CAZ D
Car Petrol	£193
Car Diesel	£903
Taxi Petrol	£201
Taxi Diesel	£829
LGV petrol	£124
LGV diesel	£887
Rigid HGV	£415
Artic HGV	£3,383
Coach	£5,502

Source: Jacobs Economic Modelling

The values above were then applied to the profile of vehicle upgrades in the intervention case. The profile is outlined in Table 5.9, based on Table 5.3 above and pivoting from the relevant behaviour response rates and interpolation data presented above.

Table 5.9: Rate of Vehicle Upgrading to New Vehicles

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Car Petrol	346	8	6	1	1	1	1	0	1	0
Car Diesel	874	4	7	6	6	6	6	6	6	6
Taxi Petrol	208	3	2	0	0	0	0	0	0	0
Taxi Diesel	524	1	2	2	2	2	2	2	2	3

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
LGV petrol	0	0	0	0	0	0	0	0	0	0
LGV diesel	0	0	0	0	0	0	0	0	0	0
Rigid HGV	0	0	0	0	0	0	0	0	0	0
Artic HGV	0	0	0	0	0	0	0	0	0	0
Coach	0	0	0	0	0	0	0	0	0	0
Total	1,953	16	17	10	10	9	9	9	9	9

Source: Jacobs Economic Modelling

The approach to analysis of scrappage costs is outlined in Figure 5.3 (see end of report).

5.4 Journey Time/Vehicle Operating Costs

The proposed scheme could also have an impact on transport economic efficiency (TEE), measured in terms of changes to journey time savings and vehicle operating costs. Transport user benefits were assessed using TUBA 1.9.14.4. The key assumptions adopted include:

- Model outputs from the transport modelling workstream;
- Modelled years: 2021, 2023 and 2031;
- Appraisal period: 10 years;
- Price base year for discounting: 2010;
- Discount rate as per Green book guidance of 3.5% for first 10 years;
- Vehicle Classes: Bus/Coach, HGV, LGV and Car;
- Annualisation factors: AM 682, PM 701, Inter-Peak 1518;
- Value of Time: TAG Databook v1.13.1 July 2020; and
- A TUBA v1.9.14.4 sensitivity test with *Economics_TAG_db1_14_0* as economics file was undertaken.

In addition to the key assumptions outlined above, the key TUBA Inputs are:

- a standard economics file which includes the latest transport economics values in accordance with TAG guidance (July 2020 parameters were used);
- trip and skim matrices from the GBATS4 model; and
- scheme file detailing all aspects of the scheme including input matrices and annualisation factors.

Trip matrices, distance and time skims and cost matrices for the opening and design years of the scheme options have been obtained from the SATURN GBATS4 models for the baseline and intervention scenarios.

The annualisation factors applied to TUBA have been calculated based on the one-hour period as modelled in each defined period, therefore the skims have been multiplied by the standard annual TUBA figure of 253 and the period factor to give the annualisation factors as detailed in Table 5.10 below.

Table 5.10: TUBA Annualisation Factors Applied to Model Outputs

Period	Modelled Duration (minutes)	Annual Factor	Period Factor	Overall Annualisation Factor
Morning peak	60	253	2.7	682
Inter peak	60	253	6	1,518
Evening peak	60	253	2.77	701

Source: Jacobs Economic Modelling

Outputs from the two peak periods and the inter-peak period models have been used for the TUBA assessment. It is considered that these models do not constitute an appropriate base for assessing either the weekend or off-peak periods and their relative level of benefits. Therefore, the benefits for these periods will not be assessed.

The TEE benefits were calculated from changes in travel time and distance for the affected vehicles. Reduced travel time is usually associated with a reduction in congestion leading to increased speeds. The speed of the vehicle affects the vehicle operating costs associated with that journey.

The following adjustments have been applied to the GBATS model output files, to assure compliance with standard TUBA process:

- TAG advice that the economic assessment should be performed over ten-year period. Hence, the outputs have been adjusted to apply to 2021 to 2030.
- Do Something origin-destination matrices have been applied to both the Do Minimum and the Do Something scenarios.
- GBATS model matrices are split between compliant and non-compliant vehicles and the TUBA assessment has been performed separately and added at a final stage of the assessment.
- HGV and Buses are coded as PCUs in the GBATS model. Hence, the relevant factors (1/2.3 and 1/2.5) have been applied to HGV and Bus matrices to convert to vehicles.
- The Clifton Suspension Bridge Toll is modelled as 50 p in GBATS. Since the current toll on the bridge is £1, the cost has been factored by 2.
- Buses were split into two user classes, Bus (driver) and Bus (passenger). TUBA default occupancy levels (12.2 passengers/bus) was applied to the Bus (passenger) user class to capture benefits from coach users.
- The GBATS model does not have purpose defined user classes, so a default factor of typical purpose distribution has been applied to the user classes in TUBA.
- As the opening date for BCC CAZ is planned for October 2021, a seasonality factor of 0.252 was applied to 2021 benefits in order to exclude the nine first months of 2021 (as per discussion in Section 2.4).

See table 5.11 for further detail of the user classes applied.

Table 5.11 User Classes in TUBA

User Class	Description	Vehicle/Sub mode	Purpose	Person type
1	Cars Low Income	Car	Default split	Default split
2	Cars Medium Income	Car	Default split	Default split
3	Cars High Income	Car	Default split	Default split
4	Cars EMP	Car	Default split	Default split
5	Taxis	Car	Default split	Default split

User Class	Description	Vehicle/Sub mode	Purpose	Person type
6	LGV	LGV freight	Business	Default split
7	HGV	OGV1	Business	Default split
8	Coach	Bus	Business	Driver
9	Coach	Bus	Default split	Passenger

5.5 Transaction Costs

The intervention case could accelerate the rate at which vehicle owners' purchase or upgrade to compliant vehicles. As well as financial costs associated with each transaction (the economic impact of which is discussed under Sections 5.3 and 5.3), each transaction also incurs time costs for vehicle owners relating to identifying and buying a compliant vehicle.

Based on the upgrade data outlined above, Table 5.12 outlines the number of vehicles induced to upgrade earlier than they otherwise planned to, as a result of intervention.

Table 5.12: Upgraded Fleet by Vehicle Type and Euro Standard

	Euro 1	Euro 2	Euro 3	Euro 4	Euro 5	Euro 6
Car Petrol	0	184	1,275	0	0	0
Car Diesel	0	9	261	670	2,771	0
Taxi Petrol	0	108	751	0	0	0
Taxi Diesel	0	5	153	393	1,624	0
LGV petrol	0	5	10	0	0	0
LGV diesel	0	46	173	692	1,850	0
Rigid HGV	0	85	645	0	0	0
Artic HGV	0	1	15	9	123	0
Coaches	0	5	20	10	27	0

Source: Jacobs Transport Modelling

The vehicle type and Euro Standard-specific transaction costs applied to this mix of upgraded vehicles is presented in Table 5.13.

Table 5.13: Weighted Transaction Costs by Euro Standard

Euro Standard	Weighted Transaction Costs		
	Car/Taxi	LGV	HGV
Euro 5	£6	£10	£7
Euro 4	£3	£8	£8
Euro 3	£3	£10	£7
Euro 2	£6	£12	£6
Euro 1	£6	£12	£6

Source: JAQU's National Data Inputs for Local Economic Models

The approach to analysis of transaction costs is outlined in Figure 5.1 (see end of report).

5.6 Accident Impacts

An accident analysis was undertaken using DfT's CoBALT software. See FBC-30 'COBALT – accident impact assessment' Appendix Giii of this FBC for further details.

The analysis estimates the change in accident/casualty frequency and severity attributable to the scheme and can be used to derive a monetary value associated with this change. Over the appraisal period 2021-30, a reduction of 72 accidents is anticipated through intervention, as outlined in Table 5.14.

Table 5.14: Change in Accidents and Casualties

Accident Summary	Small CAZ D
Baseline Accidents	7,066
Intervention Accidents	6,993
Accident Reduction Due to Scheme	72

Source: Jacobs Transport Modelling

5.7 Walking/Cycling Impacts

By inducing mode shift for non-compliant vehicle owners, the intervention case could promote a simultaneous uplift in use of active transport modes (i.e. walking and cycling). By switching to active modes, there is a societal economic benefit driven primarily by increased health and reduced absenteeism from work. To assess the scale of the impact attributable to the proposed scheme, DfT's Active Mode Appraisal Toolkit[11] (AMAT) was utilised.

Key inputs to the toolkit include forecasts of the number of additional walkers/cyclists generated by the scheme. This was estimated by taking the change mode component of the 'Cancel Journey/ Change Mode' behavioural response and applying that proportion to the number of non-compliant vehicle trips forecast to change travel patterns or behaviour.

A further adjustment was made to forecast the scale of mode shift from non-compliant vehicles to walking and cycling specifically, by applying the relevant abstraction rates from car trips to walking (13.75%) and cycling (7.5%) according to Dunkerley et al's (2018) 'Bus fare and journey time elasticities and diversion factors for all modes'[12]. The resulting forecast for number of additional walking and cycling trips each year converted from non-compliant vehicle trips is outlined in Table 5.15.

Table 5.15: Additional Walking and Cycling Trips Converted from Non-Compliant Vehicle Trips in the Baseline

	2021[13]	2022	2023	2024	2025	2026	2027	2028	2029	2030
Walking	36,840	125,103	102,749	91,019	79,206	67,541	56,019	44,574	32,658	21,748
Cycling	67,539	229,356	188,373	166,868	145,211	123,825	102,702	81,719	59,873	39,871
Total	104,379	354,460	291,121	257,887	224,417	191,366	158,721	126,294	92,531	61,619

Source: Jacobs Economic Modelling

[11] Note that the DfT's AMAT was substantially updated in June 2020, with major changes to calculation of various benefits streams (e.g. absenteeism from work, marginal external costs etc). Hence, the updated AMAT generates fundamentally different outputs to previous versions of AMAT, even given the same input data.

[12] Derived from Table 27 'Recommended diversion factor values of an intervention on car' in Dunkerley et al (2018) 'Bus fare and journey time elasticities and diversion factors for all modes'. Based on 6% (cycling) and 11% (walking) of 80% of trips that switch to another mode, pro-rated up to 100% (i.e. ignoring the proportion who do not travel according to the research – already captured via 'cancel' journey response in the current analysis).)

[13] Note that the trips for 2021 reflect an October 2021 switch-on date for the CAZ and broadly reflect 25% of annual trips estimated for this year, based on the approach outlined in Section 2.4

The annual number of active mode trips were converted to daily trips and inputted into the Active Mode Toolkit. No assumptions were made about the quality or service level of any infrastructure that active mode users would utilise. Default National Travel Survey and DfT WebTAG values were utilised to estimate proportion of return journeys, journey length, speed of travel and other trip characteristic data. An independent assessment was run for each year in the appraisal period.

Note that the analysis ignores mode shift to other, non-active modes (i.e. bus, rail, other). Mode shift to these other modes is not monetised beyond the consumer welfare loss induced by switching mode in response to the intervention (where relevant).

6. Costs to Local/Central Government

The capital and operational costs incurred by local and central government are considered in detail as part of FBC-41 'Finance Report' Appendix Q of this FBC. Unlike in the financial analysis, optimism bias has been applied to intervention option costs adopted in the economic case in line with the HM Treasury Green Book benchmark values. These are summarised in Table 6.1. Note that no optimism bias has been applied at this stage to BCC's staff costs, which are based on pre-determined and fixed salary rates applicable for all job roles in Bristol.

Where tender prices were available, the lower bound optimism bias value was adopted. The upper bound value, which represents the average historic optimism bias found at the outline business case stage for traditionally procured projects, was applied where tender prices do not currently exist and there is therefore more uncertainty in costs.

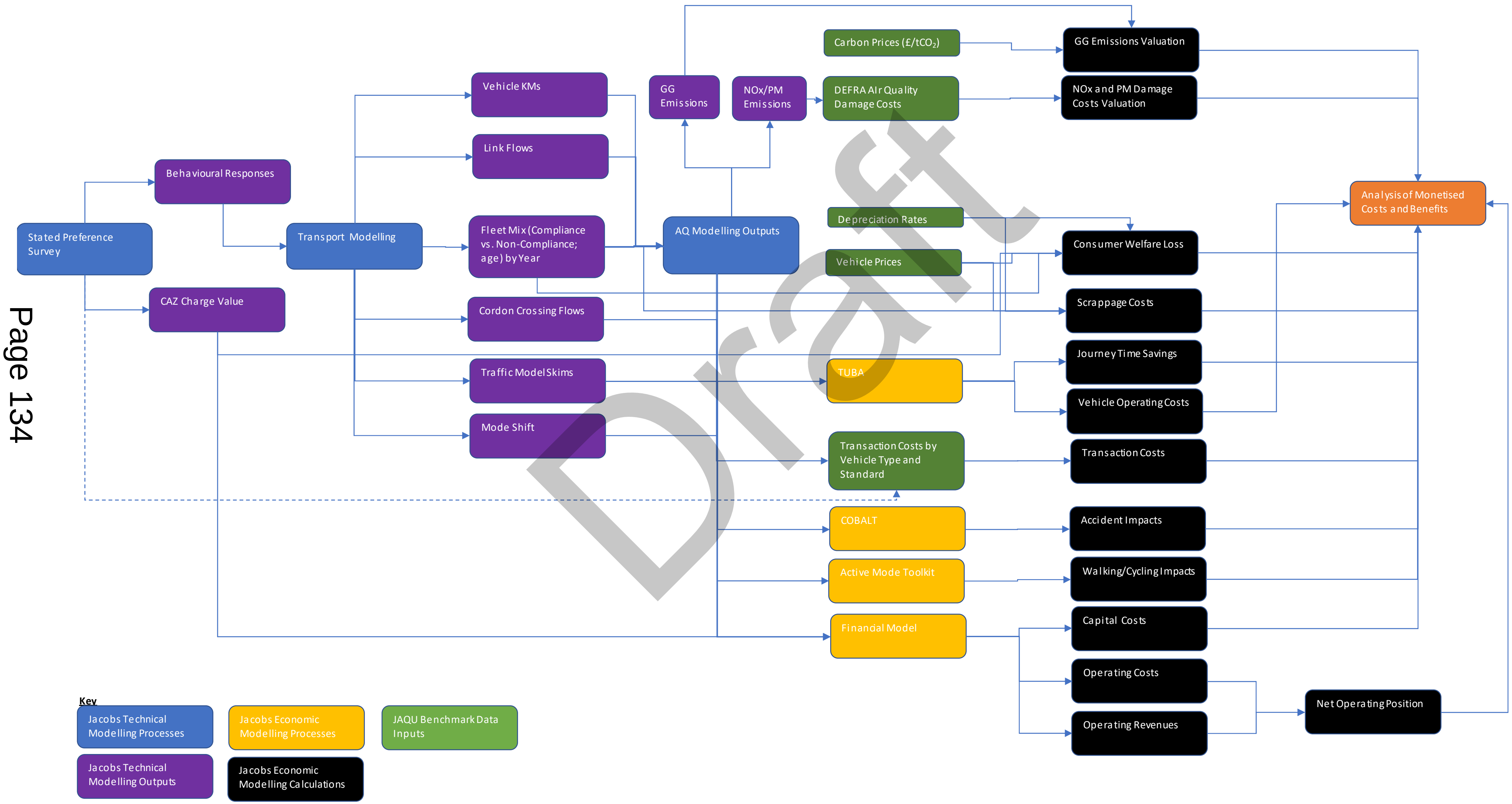
The costs used in the economic assessment are based on an earlier estimate to the final costs presented in FBC-33, the Scheme Costs Report. Detail of the development of the scheme cost is presented in FBC-33.

Table 6.1: Optimism Bias (OB) Adjustments to Costs

Activity	Upper Bound OB	Lower Bound OB	Use
Standard Civil Engineering	44%	3%	For OPEX/CAPEX relating to Highway Works, Decommissioning, Monitoring and Evaluation Activities and Installations, Utilities and all non-charging measures (upper bound, as still estimated rather than based on tender prices)
Equipment/Development	200%	10%	For OPEX/CAPEX relating to IT/Systems (lower bound, as based on tender responses), Revenue Payments, PCN Production, CAZ publicity and advertising (upper bound, as still estimated)
Outsourcing	41%	0%	For any OPEX/CAPEX requiring external support e.g. Delivery Phase Management, Additional permit contractors, back office support, monitoring and evaluation staff (upper bound, as still estimated)
N/A	0%	0%	For BCC staff costs during delivery and operational phase, as costs based on fixed salary rates. No further adjustment applied to QRA.

Source: Jacobs Economic Modelling

Figure 2.1: Overarching Methodological Framework for Economic Analysis



Page 134

Figure 4.1: Approach to Assessing Economic Impacts of Greenhouse Gas Emissions

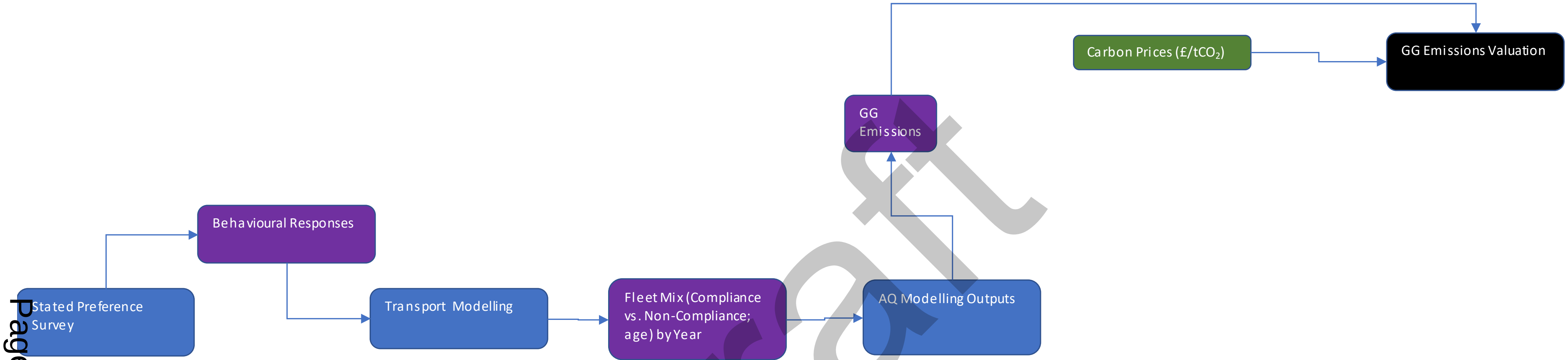


Figure 4.2: Approach to Assessing Economic Impacts of PM/NO_2 Emissions

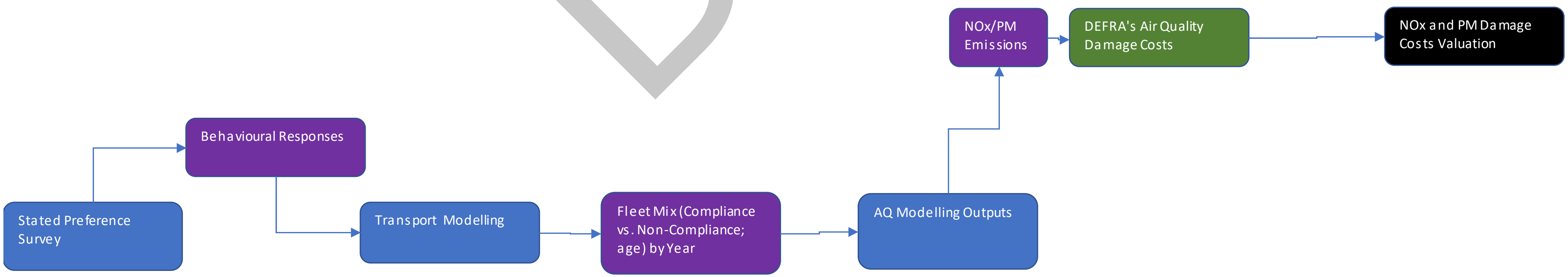


Figure 5.1: Approach to Assessing Economic Impacts of Transaction Costs

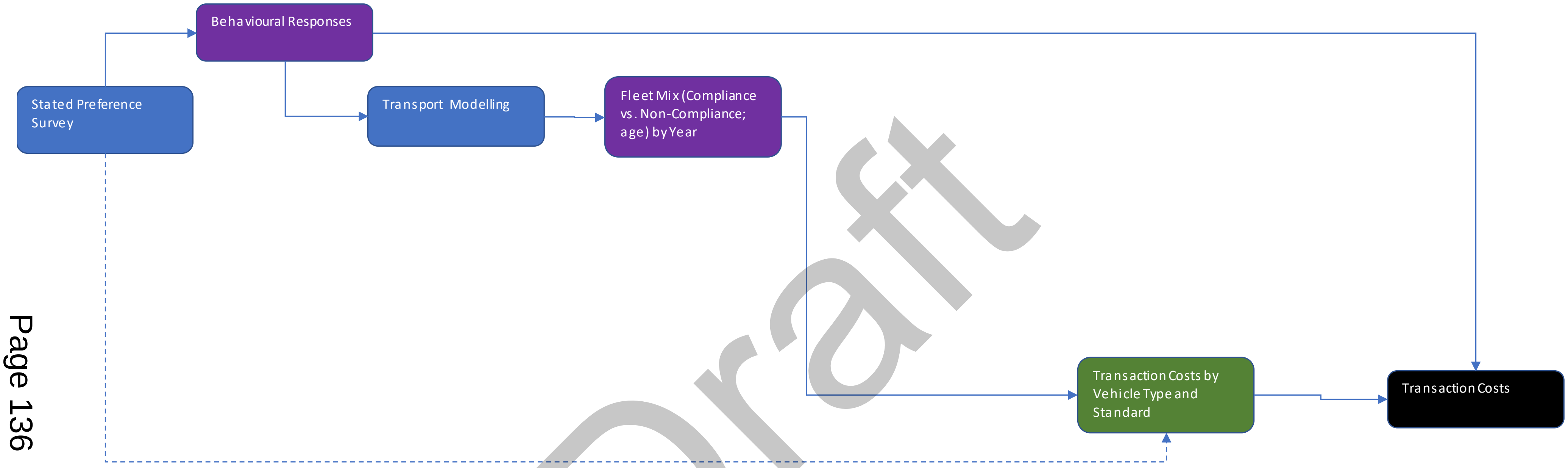


Figure 5.2: Approach to Assessing Economic Impacts of Consumer Welfare Loss

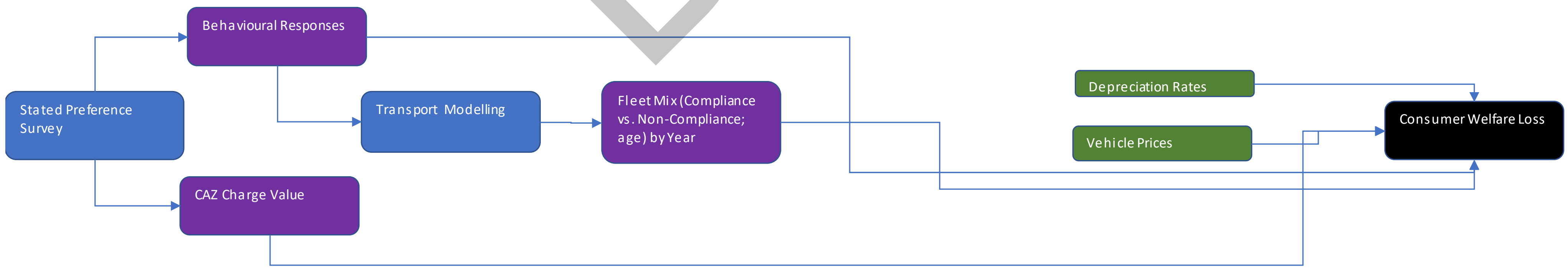
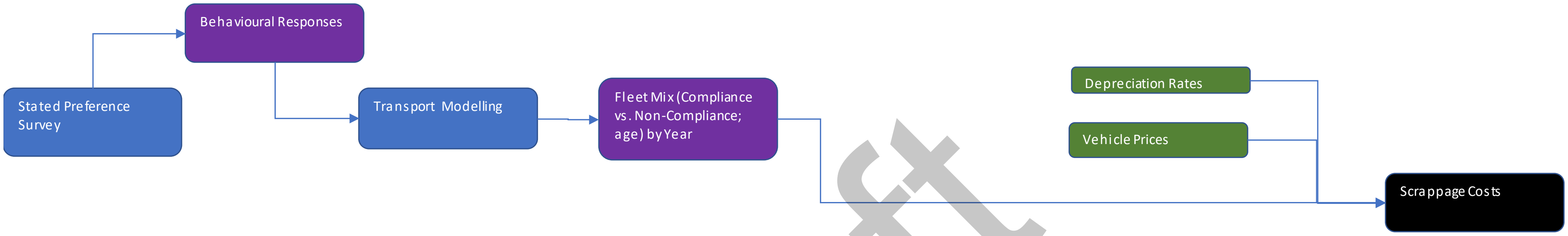


Figure 5.3: Approach to Assessing Economic Impacts of Vehicle Scrappage



Bristol City Council Clean Air Plan

COBALT - Accident Impact Assessment

FBC-30 | 8

17 February 2021

Bristol City Council

Bristol City Council Clean Air Plan

Project No:	673846.ER.20
Document Title:	COBALT - Accident Impact Assessment
Document No.:	FBC-30
Revision:	8
Document Status:	Draft
Date:	17 February 2021
Client Name:	Bristol City Council
Project Manager:	HO
Author:	SO/GW

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Draft

Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
1	16.01.2019	Revision A	SL		HO	
2	23.01.2019	Revision B	SL		HO	
3	11.10.2019	Revision C	SL/SM/GW		HO	
4	24.10.2019	Revision C amended	SL/SM/GW		HO	
5	28.10.2019	Revision C amended	SL/SM/GW		HO	
6	29.06.2020	Revision D	SL/SM/GW		HO	
7	29.01.2021	FBC	SO/GW		HO	
8	17.02.2021	FBC	SO/GW		HO	

Contents

1. Introduction

1.1 Context

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). The Mayor of Bristol has often cited Bristol's 'moral and legal duty' to improve air quality in the city and the administration recognises that achieving improved air quality is not solely a transport issue. Notwithstanding the Council's work on a Clean Air Zone, efforts have been made to make citizens more aware of – and take personal responsibility for – various sources of air pollution, from traffic fumes to solid fuel burning. The Mayor has articulated a 'call to action' for local people, businesses and organisations to consider how small changes can make a significant difference in cutting toxic fumes across the city. BCC has monitored and endeavoured to address air quality in Bristol for decades and declared its first Air Quality Management Area in 2001. Despite this, Bristol has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO_2) and these are predicted to continue until around 2027 without intervention.

The added context is that of the COVID-19 pandemic. Recent research suggests that poor air quality may be correlated with higher death / infection rates from COVID-19. This is further compounded by growing evidence that suggests that those from black, Asian and minority ethnic communities are more at risk of catching and dying from the virus and the fact that individuals from these communities are more likely to live in areas where air quality is poor. The challenge of maintaining public health and supporting economic recovery while also achieving legal air quality levels after lockdown restrictions are lifted will remain live and intersecting issues for the foreseeable future.

The UK Government continue to transpose European Union law into its Environment Bill[2] , to ensure that certain standards of air quality continue to be met, by setting air quality assessment levels (AQALs) on the concentrations of specific air pollutants. It's very unlikely that these AQALs will differ to EU Limit Values prescribed by the European Union's Air Quality Directive and transcribed in the UK's Air Quality Standards Regulation 2010. Therefore, these Limit Values will remain in enforcement post-Brexit. In common with many EU member states, the EU Limit Value for annual mean nitrogen dioxide (NO_2) is breached in the UK and there are on-going breaches of the NO_2 limit value in Bristol. The UK government is taking steps to remedy this breach in as short a time as possible, with the aim of reducing the harmful impacts on public health. Within this objective, the Government has published a UK Air Quality Plan and a Clean Air Zone Framework, both originally published in 2017 (noting there have been subsequent revisions). The latter document provides the expected approach for local authorities when implementing and operating a Clean Air Zone (CAZ). The following business cases have been submitted to JAQU for the Clean Air Plan; Strategic Outline Case (April 2018), and an Outline Business Case (November 2019 and updated between April and June 2020).

1.2 Bristol CAP

The Option being appraised in the FBC is the Small CAZ D Option, which includes the following measures:

- Small Area Class D (charging non-compliant cars, buses, coaches, taxis, HGVs and LGVs);
- Fast Track Measures:
  - Closure of Cumberland Road inbound to general traffic; and
  - Holding back traffic to the city centre through the use of existing signals.

[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] Environment Bill 2019-21 https://services.parliament.uk/bills/2019-21/environment.html

1.3 Purpose of this Report

This report sets out the COBALT assessments carried out for the CAP. This report supports the economic case of the FBC. Previous versions of this report were submitted with the Outline Business Case (October 2019) and Revised Outline Business Case (June 2020).

2. Methodology

2.1 COBALT

COBALT (Cost and Benefit to Accidents – Light Touch) is the DfT's software for assessing, as part of an economic appraisal, the impact of a scheme on accidents. Assessments carried out made use of the latest available version of COBALT, version 2013.02.

Three main data inputs are required for COBALT; these include:

- Forecast traffic flows – taken from the GBATS4 transport model (discussed further below);
- Accident data – this is typically taken from STATS19 records of accidents, and usually covers the period for the last 5 years' data is available (discussed further below);
- Economic parameters – these are contained in files supplied by the DfT and includes parameters such as the costs of accidents and cost growth rates, as well as default accident rates for road types (which can be used where the accident record is incomplete). Two economic parameter files have been used;
  - 2020.1: which is consistent with the July 2020 update of the TAG Data Book (v1.13.1); and
  - 2020.2: based on the equivalent 'sensitivity testing' version of the TAG Data Book (v.1.14), also released in July 2020, aimed at incorporating developing changes in economic parameters in the immediate aftermath of the COVID-19 pandemic.

Traffic and accident data are contained in scheme-specific input files, which define the highway network under consideration, and other scheme details such as opening year. The 'combined' (link and junction accidents) method was used, where accidents that occur at or very near to junctions are all assigned to the nearest adjacent links (along with any accidents that occur on those links).

COBALT outputs include change in the number of accidents, by severity, and the associated costs/benefits.

2.2 Transport model data

The definition of the highway network and the forecast traffic flows are taken from the GBATS4 transport model, which is described in more detail in the T3 Methodology Report appended to the business case. Two forecast years have been utilised, the opening year of 2021 and forecast horizon year of 2031, with the assessment adopting a standard 60 year appraisal period for aggregating impacts. Note though that allowance has been made in reporting results for the actual opening of the scheme to be in late 2021, by scaling figures calculated for 2021 accordingly.

For each link in the network data the link type (capacity index), free-flow speed, traffic flow and link length are extracted from the model and converted to the format required by COBALT. Note that link types in COBALT are defined on a different basis than in GBATS4, so a correspondence between the two systems was set up to convert the model capacity index to the COBALT link type. Several sensitivity tests were carried which showed that the results were not significantly altered by changing the allocation of link types.

COBALT requires the speed limit on each link and an initial allocation was made based on the GBATS4 free-flow speed, rounded up to the nearest 10mph. However, COBALT assumes that there are no accidents on roads with a 20mph speed limit, so to avoid underestimation, all roads with a 20mph speed limit were assigned a speed limit of 30mph. Also, as number of motorway links in the model have free-flow speeds of less than 70mph, a sensitivity test was carried out to determine whether this should be raised, but altering the motorway speed limits did not have a significant impact on outputs. GBATS4 includes spigots where traffic is loaded (via centroid connectors) on to the road network. These were retained in the COBALT network to represent, to some extent, accidents on more minor roads.

Traffic flows for the three modelled time periods (AM peak hour, InterPeak hour and PM peak hour) are expanded to give an Annual Average Daily Traffic (AADT) flow that COBALT requires, using GBATS4 expansion figures. The impact of the CAZ scheme covers most of the GBATS4 modelled area. COBALT tests were carried out using the entire extent of the model network (and results indicate that there is no anomalous generation of benefits away from the CAZ scheme's main impact area).

2.3 Accident data

Observed accident data for the area covered by the GBATS4 model was obtained from the DfT. This data, provided information on location, date and severity of each accident, and is based on the STATS19 reporting system. [3]

Accident records were mapped onto the road network to provide the number of accidents on each COBALT link. The most recently available previous five-year period was used, incorporating data for the years 2015 to 2019 inclusive. Note that this is a change from previous COBALT assessments of CAZ schemes (which used the five years from 2012 to 2016 inclusive). Links which appear in the forecast network only are allocated default accident rates by COBALT (drawn from the economic parameter file as noted).

[3] STATS19 data includes the number of personal injury road traffic accidents in Great Britain that were reported to the police using the STATS19 reporting system. It also includes the number of people killed or injured in these accidents and which road user group they were in. The current set of definitions and detail of information goes back to 1979, providing a long period for comparison. The information used to create these statistics are collected by police forces, either through officers attending the scene of accidents or from members of the public reporting the accident in police stations after the incident, or more recently online. The figures make up part of a long running series going back to 1926, and is now published annually.

3. Outputs

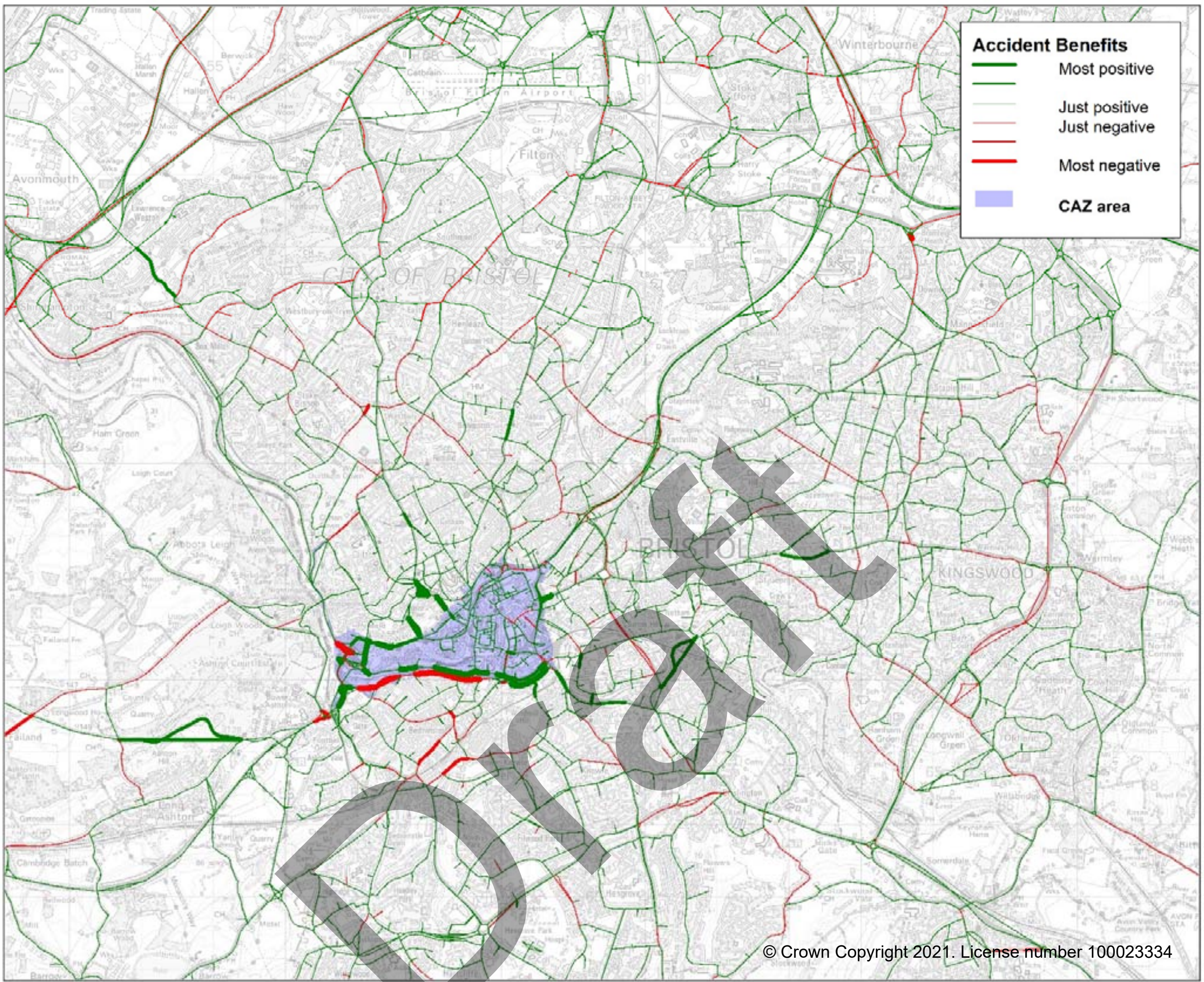
Table 3.1 sets out the results of COBALT assessments. Results indicate a slight beneficial impact on accident occurrences as a result of the scheme, with a reduction in around 157 accidents (and just over 200 casualties) over the appraisal period, and economic benefit of £7.2m. Parameters in the 'sensitivity testing' test have no impact on the numbers of accidents calculated, but reduce the economic benefit to around £6.6m. Figure 3-1 shows where benefits (and disbenefits) are found on the network, indicating that the majority of highway links have small benefits, with some having small disbenefits. Links with the greatest values for (dis)benefits are located in the vicinity of the CAZ area, reflecting the effects of local re-routeing.

Table.3.1: COBALT results

		2020.1 economic parameters TAG Data Book (v1.13.1)	2020.2 economic parameters: 'sensitivity testing' TAG Data Book (v1.14)
Economic Summary			
Without-Scheme Accident Costs		£1,884,749	£1,635,720
With-Scheme Accident Costs		£1,877,555	£1,629,165
Accident Benefits saved		£7,194	£6,554
Accident Summary			
Without-Scheme Accidents		41,673.9	41,673.9
With-Scheme Accidents		41,516.4	41,516.4
Accidents saved		157.5	157.5
Casualty Summary			
Without-Scheme Casualties	Fatal	447.4	447.4
	Serious	5,376.1	5,376.1
	Slight	51,608.9	51,608.9
With-Scheme Casualties	Fatal	447.1	447.1
	Serious	5,356.9	5,356.9
	Slight	51,427	51,427
Casualties saved by Scheme	Fatal	0.3	0.3
	Serious	19.2	19.2
	Slight	182.1	182.1

Costs and benefits are totals for the appraisal period, discounted to 2010 in multiples of a thousand pounds (£'000s)

Figure 3-1: Accident benefits by link (2020.1 parameters)



Bristol City Council Clean Air Plan

Full Business Case

E3 Distribution and Equalities Impact Assessment

FBC-31 | 7

17 February 2021

Bristol City Council

Bristol City Council Clean Air Plan

Project No:	673846CH.ER.20
Document Title:	E3 Distribution and Equalities Impact Assessment
Document No.:	FBC-31
Revision:	7
Document Status:	Draft
Date:	17 February 2021
Client Name:	Bristol City Council
Project Manager:	HO
Author:	GW

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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
1	22 Jan 2019	Draft	FB	GW	HO	
2	18 Sep 2019	Draft – OBC	GW/FB	HO	HO	
3	25 Oct 2019	Draft – OBC	GW/FB	HO	HO	
4	19 Jun 2020	Draft – updated OBC	GW/FB	HO	HO	
5	30 Jun 2020	Draft – updated OBC	GW/FB	HO	HO	
6	13 Jan 2021	Draft – FBC (interim)	GW/FB	HO	HO	
7	17 Feb 2021	Draft – FBC	GW/FB	HO	HO	

Contents

1. Introduction

1.1 Background

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Jacobs has been commissioned to support BCC to produce a 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 Bristol. The FBC assesses the Small CAZ D and Fast Track Measures. In addition to the Small CAZ D scenario the baseline representing the situation within Bristol without any intervention to tackle NO_2 exceedances has also been updated for the FBC to include Street Space Schemes (e.g. restricting access of vehicles onto Baldwin Street) and introducing a dedicated cycle lane on Upper Maudlin St).

This document is written to support the FBC, detailing the distributional impact assessment of the CAP.

[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] Environment Bill 2019-21 https://services.parliament.uk/bills/2019-21/environment.html

1.2 Purpose of this report

The UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations (Defra/DfT July 2017) acknowledges that air quality issues, and NO_2 exceedances, are highly localised. As such it is recommended that any interventions proposed to improve air quality should attempt to minimise their impact on local groups and businesses, especially vulnerable socio-economic groups. In line with JAQU's Options Appraisal Guidance (2017), the key local groups and businesses of interest are:

- Low income households;
- Children and young people;
- Elderly residents;
- Residents suffering from illness and disability;
- Female residents;
- Residents from ethnic minority groups; and
- Businesses, including small and medium enterprises (SMEs) and taxi/private hire firms.

The purpose of the report is to identify positive or negative impacts of the proposed scheme on these interest groups. The social groups listed above (i.e. the first six groups listed) are included in the assessment to fulfil BCC's statutory obligations under the Equality Act 2010. They include people with protected characteristics who may have less ability to adapt to the interventions proposed as part of the Bristol CAP. The businesses referred to in the list above are included in the assessment as the charging CAZ element of the Bristol CAP will produce direct costs to businesses as well as individuals. It may not be possible for businesses to absorb these additional costs, meaning specific consideration of distributional impacts on these businesses, typically small and medium-sized enterprises (SMEs), is also required. Establishing the specific impacts of the scheme on the groups listed above helps to determine whether the scheme unduly advantages or disadvantages a particular group. This enables recommendations to be made about requirements for mitigation to address certain impacts or for more fundamental amendments to the scheme.

1.2.1 Report structure

Within this context, the report is structured as follows:

- Chapter 2 presents the assessment methodology, drawing on JAQU's Options Appraisal Guidance, which in turn is informed by DfT's TAG unit A4-2 'Distributional Impact Appraisal'.
- Chapter 3 presents the screening stage of assessment, providing additional detail on the types of socio-economic groups and impact variables considered in the assessment.
- Chapter 4 outlines the socio-economic context in BCC, which establishes the prevailing conditions within which socio-economic groupings and potential impacts can be assessed.
- Chapter 5 presents the distributional and equalities impact analysis; and
- Chapter 6 summarises the key findings of the assessment.

2. Methodology

2.1 Approach

In accordance with JAQU's Options Appraisal Guidance and WebTAG unit A4-2, a three-step approach has been used for the distributional impact appraisal. These involve:

- Step One: Screening:
  - The variety of impacts that the policy might have is considered and particular impacts are prioritised for further analysis so that only the most relevant indicators for the scheme are appraised to ensure proportionality.
- Step Two: Assessment:
  - Information is collected on the geographical area likely to be affected by the policy and how different social and business groups are distributed within that geographical area.
- Step Three: Appraisal:
  - An assessment is made as to the extent of the impact of the policy on the social groups identified.

Many different methods, including quantitative analysis of statistics and modelling outputs, spatial analysis of geographical datasets and qualitative appraisal drawing on available information and research, are acceptable according to TAG guidance. JAQU guidance however, notes that 'light touch' appraisal is sufficient on some occasions, rather than the detailed guidance of TAG A4-2. This report will determine the impacts likely to be associated with the CAP and what analysis would be best suited to investigating these impacts, depending on the data available and how sensitive the issue is to the CAP scheme in Bristol.

2.2 Identification of study area

A layered approach to identifying the study area for the assessment was adopted. This reflects the potential variation in spatial extent of any impacts that materialise. An immediate study area was defined as BCC's local authority area. A wider study area was also defined, covering BCC and the other administrative areas forming the West of England sub-region (i.e. Bath & North East Somerset Council, South Gloucestershire Council, and North Somerset Council). The study areas are outlined in Figure 2.1, with the small CAZ and BCC area identified more closely in Figure 2.2. Most of the analysis presented in this report focuses on the BCC area and uses the appropriate study area definition based on the socio-economic group and impact variable being considered.

2.3 Distributional impact assessment criteria

To understand whether a particular group is being unduly disadvantaged by the proposed scheme (or indeed is not), it is necessary to understand whether impacts are proportionate or disproportionate. To investigate this, it is necessary to obtain an understanding of how impacts are occurring, whether they are acceptable or whether the scheme should be altered or mitigated. The scale shown in Table 2.1 is used as a guide to determine the scale and extent of an impact.

Note that the assessment scoring outlined in the table is undertaken relative to population sizes, comparing the proportion of net winners or losers in each socio-economic quintile to that socio-economic quintile's share of population in BCC. Therefore, a larger score (of '✓✓✓' or '×××') is indicative of impacts falling disproportionately on a particular quintile relative to that quintile's population share across BCC as a whole. So, if 20% of an impact falls on socio-economic quintile 'X', but socio-economic quintile 'X' only forms 10% of the study area population, a large assessment score will be recorded.

Table 2-1: Distributional impact assessment criteria

Assessment		Impact Description
✓✓✓	Large beneficial	Beneficial impact and the population impacted is significantly greater than the proportion of the group in the total population
✓✓	Moderate beneficial	Beneficial impact and the population impacted is broadly in line with the proportion of the group in the total population
✓	Slight beneficial	Beneficial impact and the population impacted is smaller than the proportion of the group in the total population
-	Neutral	There are no significant benefits or disbenefits experienced by the group for the specified impact
✗	Slight adverse	Adverse impact and the population impacted is smaller than the proportion of the population of the group in the total population
✗✗	Moderate adverse	Adverse impact and the population impacted is broadly in line with the proportion of the population of the group in the total population
✗✗✗	Large adverse	Adverse impact and the population impacted is significantly greater than the proportion of the group in the total population

Figure 2-1: Study Areas

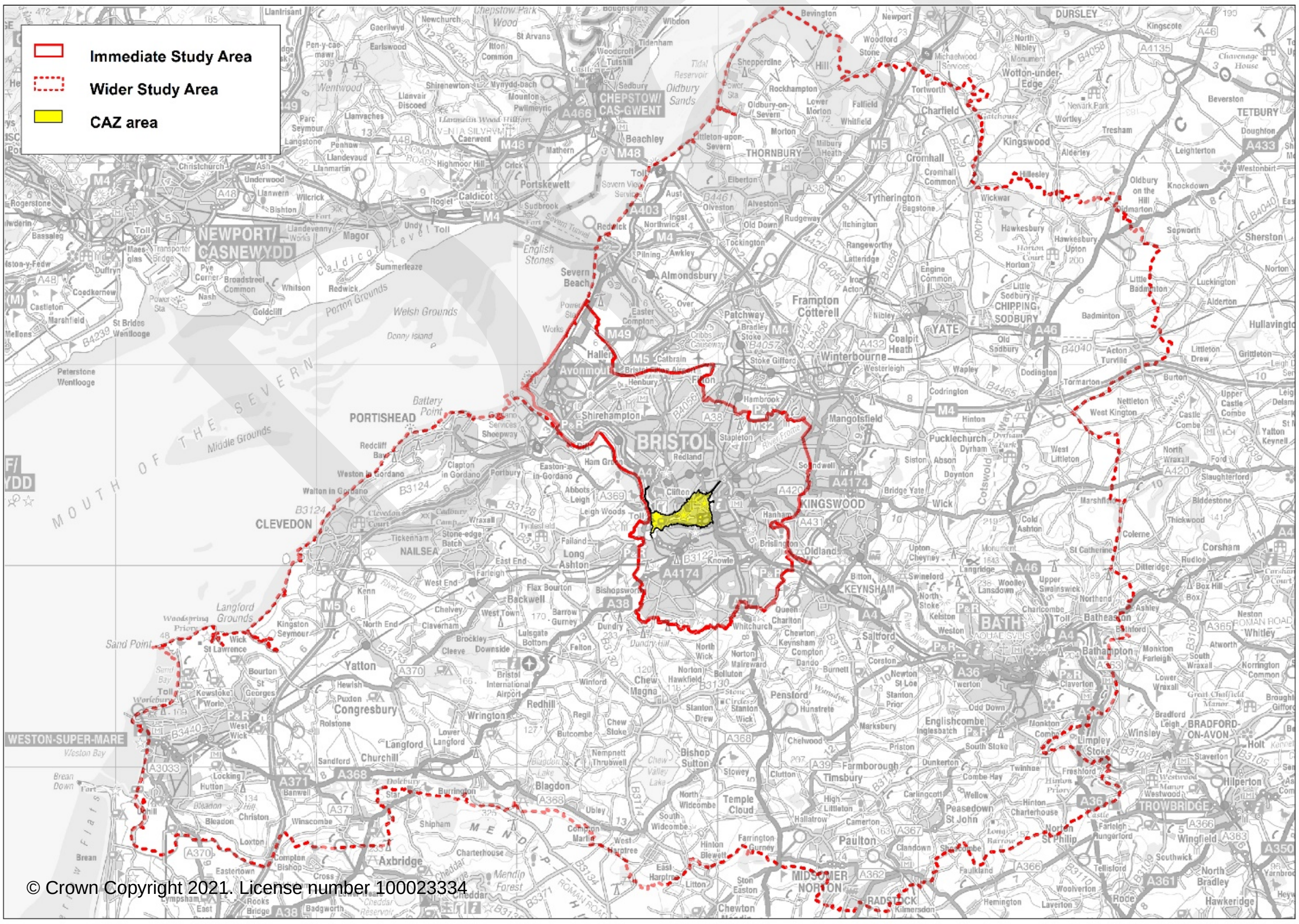
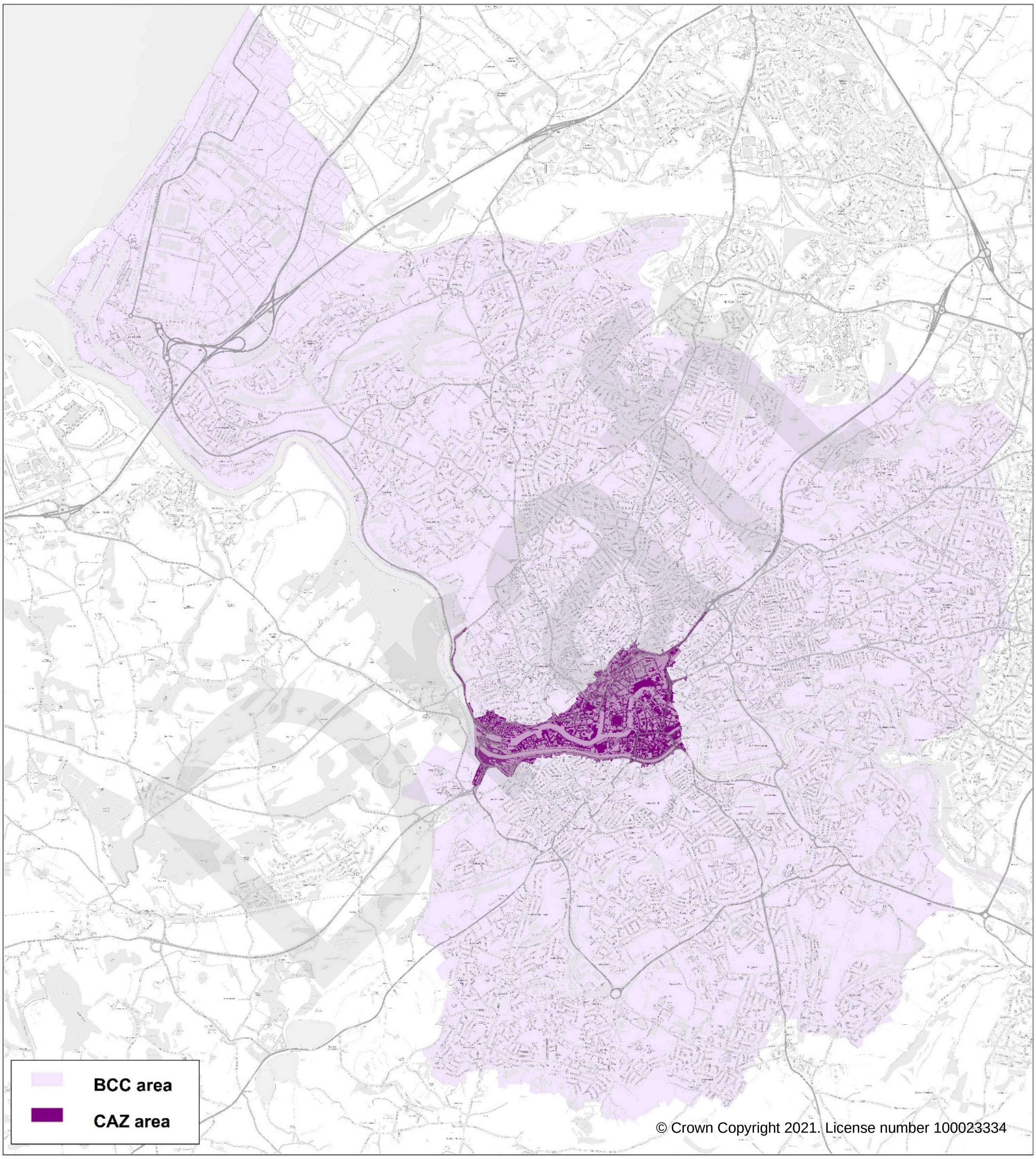


Figure 2-2: Bristol city centre Clean Air Zone (CAZ)



2.4 Appraisal methodology

In line with JAQU's Options Appraisal Guidance, three core distributional impact variables have been identified as most relevant to the Bristol CAP proposals; these are:

- Air Quality:
  - The primary objective and critical success factor of the CAP is to improve air quality, and in particular to ensure compliance with NO_2 limit values and objectives. Therefore, the differential impacts of changes in air quality spatially and across socio-economic groups is an essential element of analysis.
- Accessibility:
  - Elements of the CAP including charging and/or restricting the use of various vehicle types. As such, these elements of the plan could accordingly induce changes in travel patterns and behaviours. As such, it is necessary to establish whether changes in accessibility will disproportionately affect any of the socio-economic groups of interest.
- Affordability:
  - Charging elements will impose direct costs on local people and businesses who use non-compliant vehicles. As such, it is necessary to establish whether such changes disproportionately affect any of the socio-economic groups of interest.

2.4.1 Method of assessing air quality

Within the Full Business Case (FBC) the economic analysis of air quality impacts has been undertaken following the Damage Cost Approach. This approach applies damage costs to changes in emissions data to monetise the impact of air quality improvements. For consistency, the distributional analysis pivots from the same approach, utilising changes in emissions data (as forecast at monitoring locations across the study area) to determine where air quality impacts would be most significant. This information was then overlaid on the spatial distribution of socio-economic groups to determine the variance in air quality impacts.

2.4.2 Method of assessing accessibility

Distributional impacts associated with changes in accessibility were assessed using qualitative and quantitative components. From a qualitative perspective, a mapping exercise that highlighted the spatial distribution of relevant socio-economic groups was undertaken, to highlight key corridors and arterial routes for the socio-economic groups of interest.

From a quantitative perspective, information from the GBATS4 traffic model were utilised, to determine trips between combinations of Lower Super Output Areas (LSOAs[3]) that cross-reference with the CAZ area. Further cross-referencing with the qualitative mapping exercise allows for illustration of impacts between LSOAs with high concentrations of particular socio-economic groups and key trip destinations. In addition, user benefits from TUBA were also interrogated, and overlaid on the spatial distribution of socio-economic groups to determine any variance between the distribution of benefits and the groups. This provides a proxy for accessibility of the differences in journey times that are subtended by the schemes.

2.4.3 Method of assessing affordability

A similar approach to the accessibility assessment was adopted for assessing affordability. The model figures, particularly focused on areas of highest income deprivation and CAZ area, were distributed across LSOAs with high concentrations of particular socio-economic groups based on the mapping exercise described above. Transport operating cost benefits from TUBA were also interrogated and overlaid on the spatial distribution of socio-economic groups to determine any variance between the distribution of benefits and the groups. This provides a proxy for accessibility of the differences in travel costs that are subtended by the schemes.

[3] LSOAs, Lower Super Output Areas, are geographical areas that are used to report small area data.

3. Screening

3.1 Screening for distributional impacts

JAQU's Options Appraisal Guidance (2017) states that, as a minimum, the impacts that should be investigated should include:

- Air Quality: changes in ambient concentrations of air pollutants that affect the health of local people.
- Affordability: changes in the costs of individuals or businesses using vehicles or public transport; and
- Accessibility: changes to the ability and ease of individuals or businesses to get to places of work, social networks and public amenities.

3.2 Relevant grouping variables

The Guidance also outlines the interaction between impact variables and socio-economic groups (replicated in Table 3.1). The matrix overleaf provides an indication of how the impact variables and socio-economic groups can be grouped. It outlines the basis for understanding which impacts should be appraised for each socio-economic group.

Table 3-1: Impact categories in scope for each social or business group

Social or Business Group	Air Quality	Accessibility	Affordability	Justification for Screening
Deprivation / low income	✓	✓	✓	Low income households may be less able to adapt to the impacts of the Bristol CAP. They may be less able to afford to replace vehicles, thus limiting their accessibility and connectivity. Further, low-income households are less likely to own motor vehicles, so any existing accessibility issues are likely to be exacerbated[4]. A higher concentration of non-compliant vehicles in low-income neighbourhoods may also impose localised air quality issues.
Children	✓	✓		Children and young people may be more vulnerable to the health impacts of air pollution[5]. Further, children require access to a range of key amenities (e.g. schools), so any change in accessibility could hinder their ability to reach such facilities.
Elderly people	✓	✓		Elderly people require access to a range of key amenities (e.g. health facilities), so any change in accessibility could hinder their ability to reach such facilities. Further, there is evidence to suggest that the elderly can be disproportionately affected by the public health impacts of air pollution[6].
Disabled people		✓		Disabled people are likely to have concerns over access to a range of key amenities (e.g. health facilities), so any change in accessibility could hinder their ability to reach such facilities.
Women		✓		Women may be less likely to have access to a car[7] and are therefore more reliant on public transport. Any change in accessibility associated with the proposed scheme could further reduce their connectivity.

[4] Census 2011 Table DC6403EW suggests 20% of residents aged 16-64 in BCC have no access to a motor vehicle, but 35% of such residents ranked in the lowest social grades (i.e. grade D and E) do not have access to a car. Social grade is a proxy for income deprivation. Therefore, residents in income deprived areas are nearly twice as likely not to have access to a motor vehicle

[5] World Health Organization (2013) *Review of evidence on health aspects of air pollution – REVIHAAP Project: final technical report.* http://www.euro.who.int/en/health-topics/environment-and-health/air-quality/publications/2013/review-of-evidence-on-health-aspects-of-air-pollution-revihaap-project-final-technical-report

[6] Simoni et al., Adverse effects of outdoor pollution in the elderly, Journal of Thoracic Disease, January 2015 (URL:https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4311079/)

[7] Census 2011 Table DC4109EW1a suggests 57% of people residing in households without access to a car in BCC are female. Females form 50% of the BCC population. Therefore, women are more likely to lack access to a car relative to men.

Social or Business Group	Air Quality	Accessibility	Affordability	Justification for Screening
Ethnic minorities		✓		Ethnic minority groups may be less likely to have access to a car[8] and are therefore more reliant on public transport. Any change in accessibility associated with the proposed scheme could further reduce their connectivity.
Businesses: SMEs			✓	SMEs may struggle to absorb the direct costs (e.g. CAZ charge) associated with implementing the scheme
Businesses: LGVs/HGVs			✓	LGVs and HGVs represent a significant number of business trips. Owners of non-compliant LGVs and HGVs may struggle to absorb the direct costs (e.g. CAZ charge) associated with implementing the scheme
Businesses: taxis			✓	Taxis may struggle to absorb the direct costs (e.g. CAZ charge) associated with implementing the scheme

[8] Census Table DC4203EW indicates that 20% of residents in 'white' households do not have access to a motor vehicle. In comparison, 33% of residents in ethnic minority households do not have access to a motor vehicle. Therefore, ethnic minorities are more likely to not have access to a motor vehicle relative to the white population.

4. Socio-economic context

4.1 Social groups and demographics

The population of BCC was estimated at 459,252 in 2017 (ONS Population Estimates). The city centre core, which is the proposed location of the charging CAZ element of the CAP, is the most densely populated region within the local authority area. Based on 2011 Census data, the three most densely populated lower super output areas (LSOAs) in BCC are located within the city centre core and will be directly affected by implementation of the CAZ.

4.1.1 Low-income households

The distribution of low-income groups in BCC was determined through analysis of the Indices of Deprivation (IoD, 2019), specifically utilising the income score that is part of the overall index of multiple deprivation. The income score ranks LSOA areas in terms of levels of income, measured by the number of people that are out-of-work and those that are in work but who have low earnings. This therefore acts as a suitable proxy for defining low-income groups. Figures 4.1 and 4.2 map the distribution of low-income LSOAs, and by proxy, low-income households across BCC. Figure 4.1 provides the distribution of income deprivation within the wider study area. Figure 4.2 provides a comparison of national levels of income deprivation. Both figures demonstrate that the communities to the immediate north west of the CAZ area are among the most affluent locations, both in the context of the wider study area and nationally.

However, the analysis also shows that a number of neighbourhoods in central Bristol (within and on the edge of the CAZ area) are amongst the most income deprived areas both regionally and nationally. At a national level, communities in Lawrence Weston and Henbury, north of the city centre, Easton and Lawrence Hill to the East, and numerous communities on the southern edge of Bristol City are within the lowest quintile for income deprivation, indicating that these communities are amongst the 20% most income deprived nationally. Some of the most deprived areas are located just outside the CAZ are boundary. Within this context, this means that some neighbourhoods with a high proportion of low-income households could be directly affected by the CAZ.

4.1.2 Children

Figure 4.3 presents the distribution of children across BCC and demonstrates that there are a number of areas with a high concentration of children in the immediate study area. These areas are spread out around the city centre, in the north, east and south of the city, though less within the CAZ boundary. Communities covered by the proposed CAZ itself have a low concentration of children. Those with the highest concentrations are at the eastern edge of the zone, albeit just outside the boundary. Nevertheless, some of the facilities used and relied on by children on the outskirts of Bristol City are located in the city centre core or children may need to pass through the CAZ to access these facilities. Hence, imposition of a CAZ in the central area could inhibit accessibility for children living further out.

4.1.3 Elderly people

Figure 4.4 presents the distribution of elderly people (aged over 65) across Bristol City Council. While the study area is home to a large elderly population, the highest proportions of the more elderly population are primarily concentrated on the peripheral areas of BCC area, well outside of the proposed CAZ boundary. Elderly people living in these communities will be directly impacted by any change in accessibility or air quality generated by the proposed scheme. At the same time, where key amenities used by elderly people are located within or on the opposite side of the city centre, imposition of a CAZ in the central area could inhibit accessibility to amenities for residents living further out in BCC.

4.1.4 Disabled people

Figure 4.5 shows the distribution of disability deprivation across BCC, based on analysis of the Indices of Deprivation (IoD, 2019), utilising the health deprivation and disability score that is part of the overall index of multiple deprivation. This is based on the number of residents with work-limiting morbidity and disability, based on the number receiving benefits due to inability to work through ill health. The map indicates that people with health and disability issues are spread throughout the city, with concentrations in the city centre (some within the CAZ area) and areas north-west of the city centre. The disabled population in central Bristol may suffer from reduced accessibility with the imposition of the proposed CAZ scheme. Further, residents who are disabled and live on the suburban peripheries could suffer from reduced access to the central area with a CAZ in place.

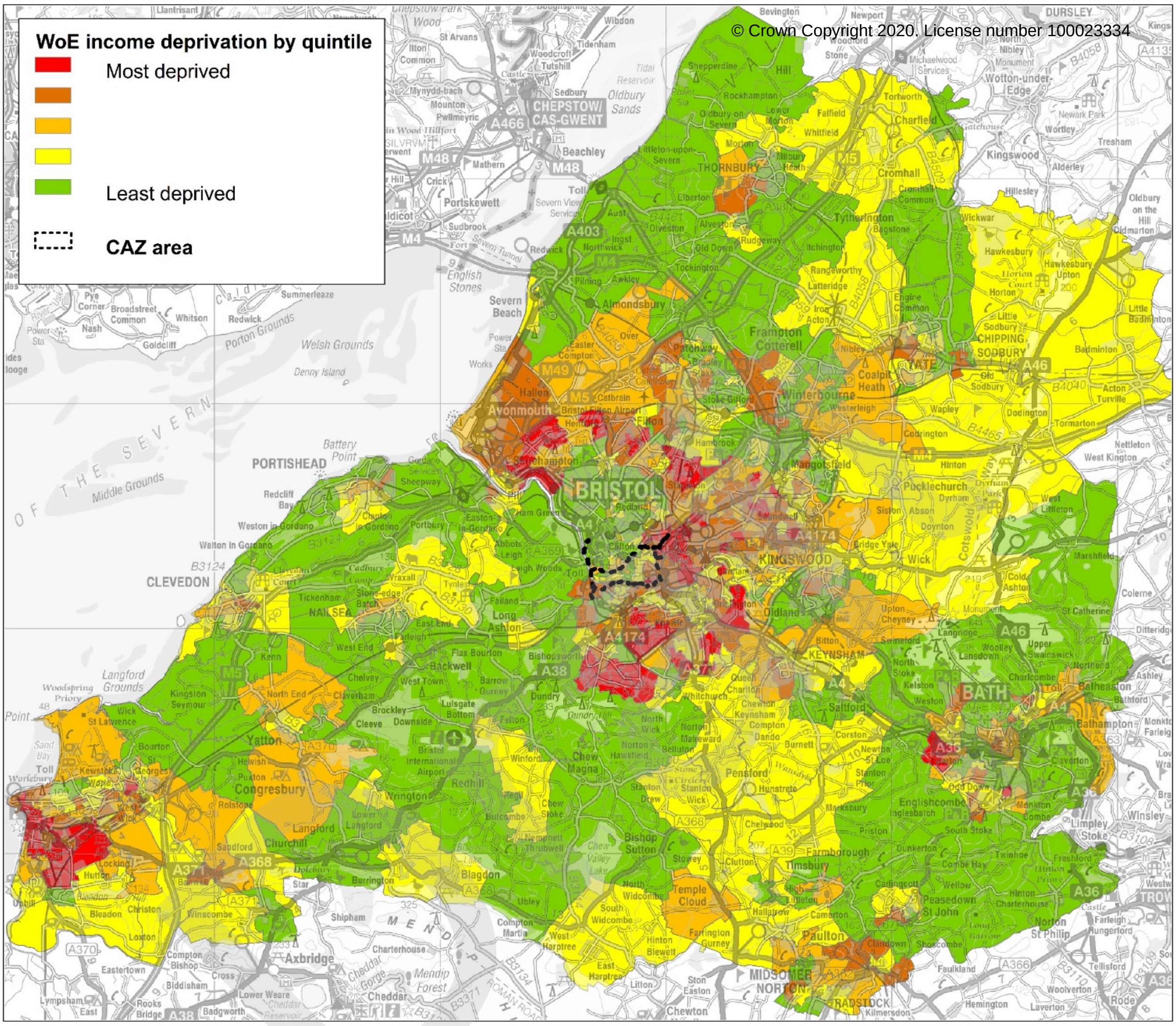
4.1.5 Women

Figure 4.6 provides the distribution of women across BCC and demonstrates that areas with the highest concentrations of female residents are disproportionately located on the periphery of Bristol City. Central areas are home to communities with a relatively low proportion of women. Women in the central and peripheral areas may be impacted by the scheme, if the scheme acts to reduce accessibility to any key trip destinations in the city centre core or that involve passing through the CAZ.

4.1.6 Ethnic minorities

Figure 4.7 provides the distribution of concentrations within the population of ethnic minorities across BCC and demonstrates that the areas with the highest proportion of the population with ethnic minority backgrounds, when compared to the proportion of the population across the city, are located in the city centre and areas immediately adjacent to it, with the highest concentrations to the east. Some of these areas are within the CAZ boundary.

Figure 4-1: Concentration of low-income households in wider study area



Page 161

Figure 4-2: Concentration of low-income households in BCC relative to national benchmarks

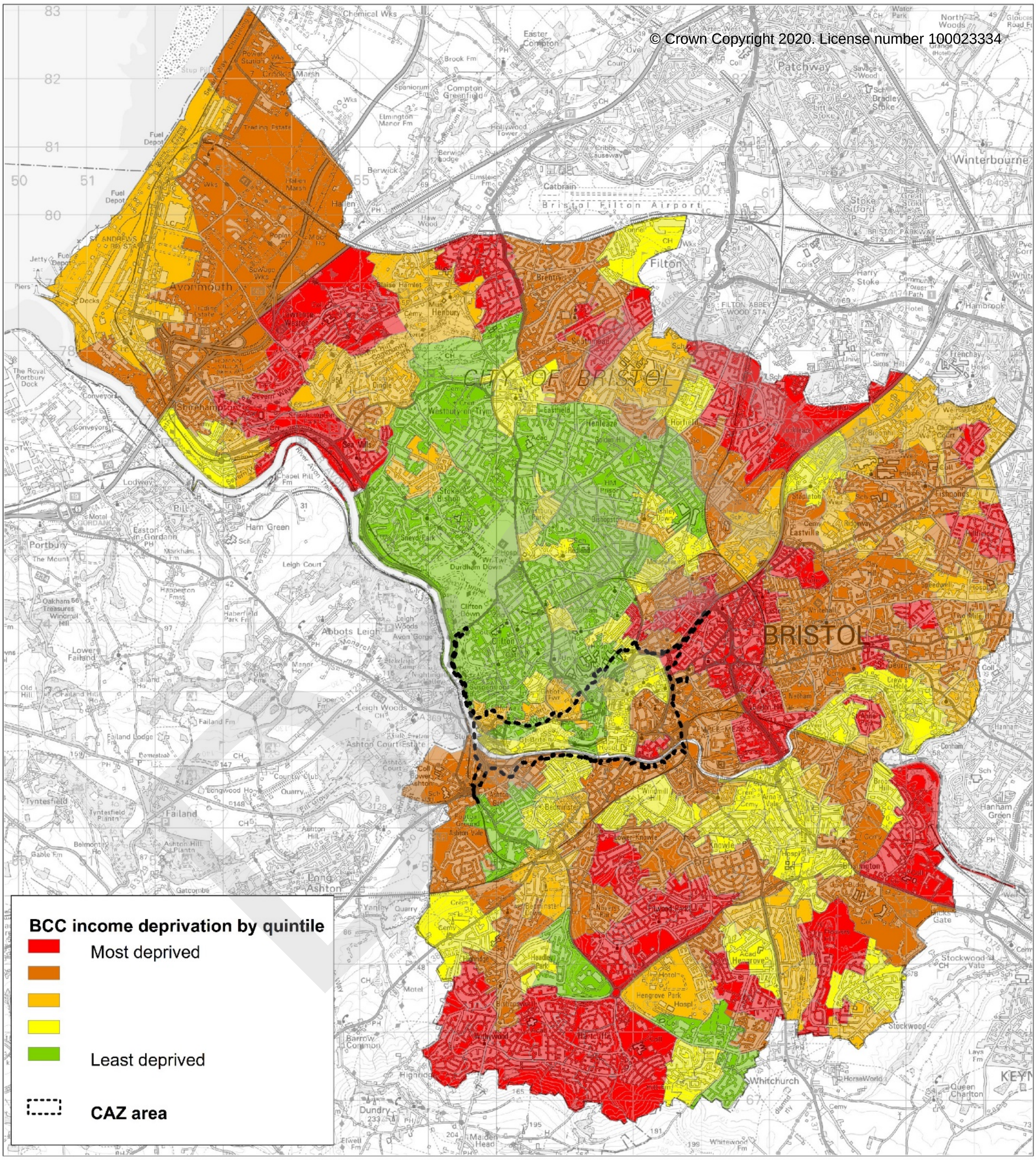
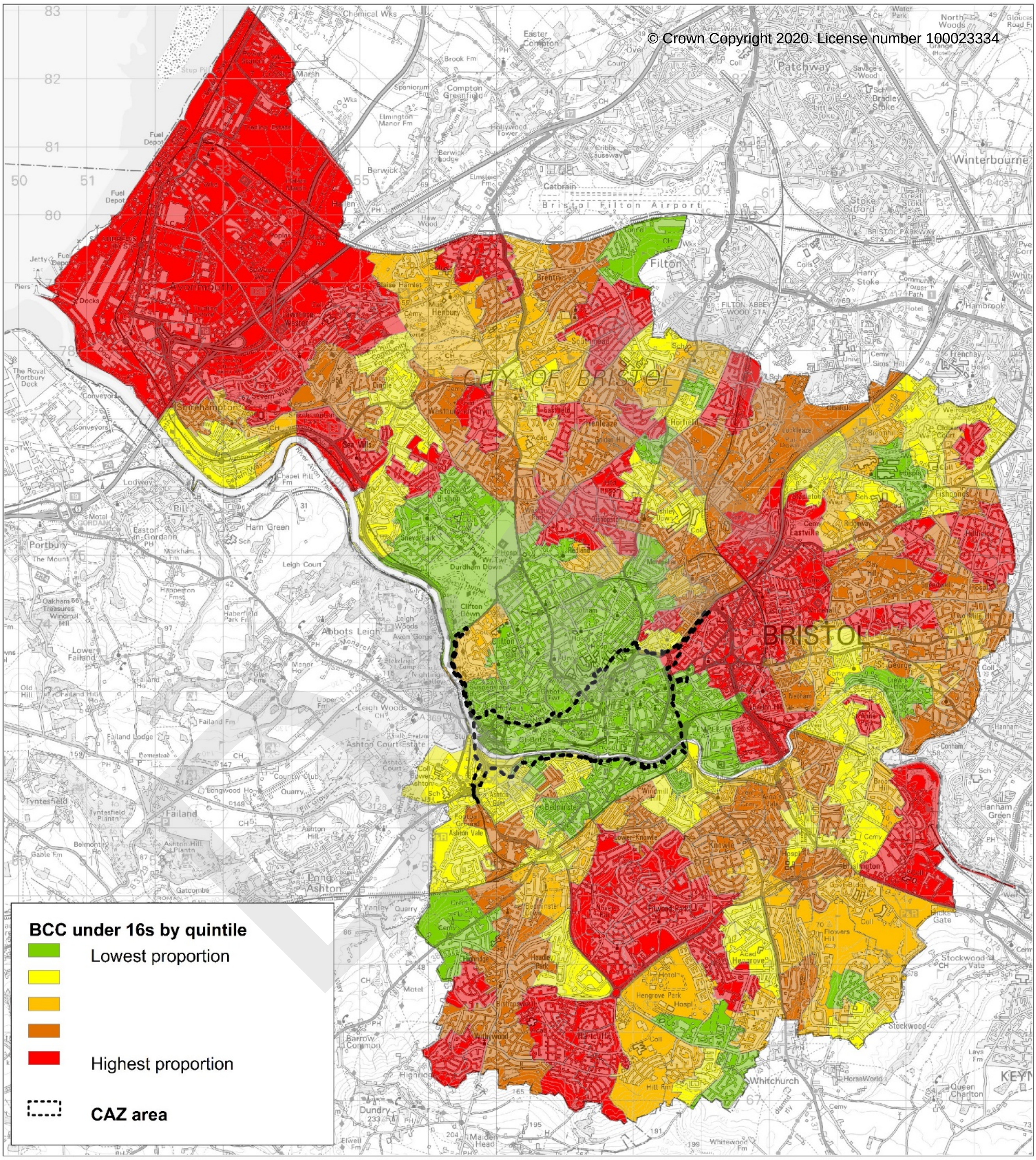


Figure 4-3: Concentration of children in BCC



Page 163

Figure 4-4: Concentration of elderly people in BCC

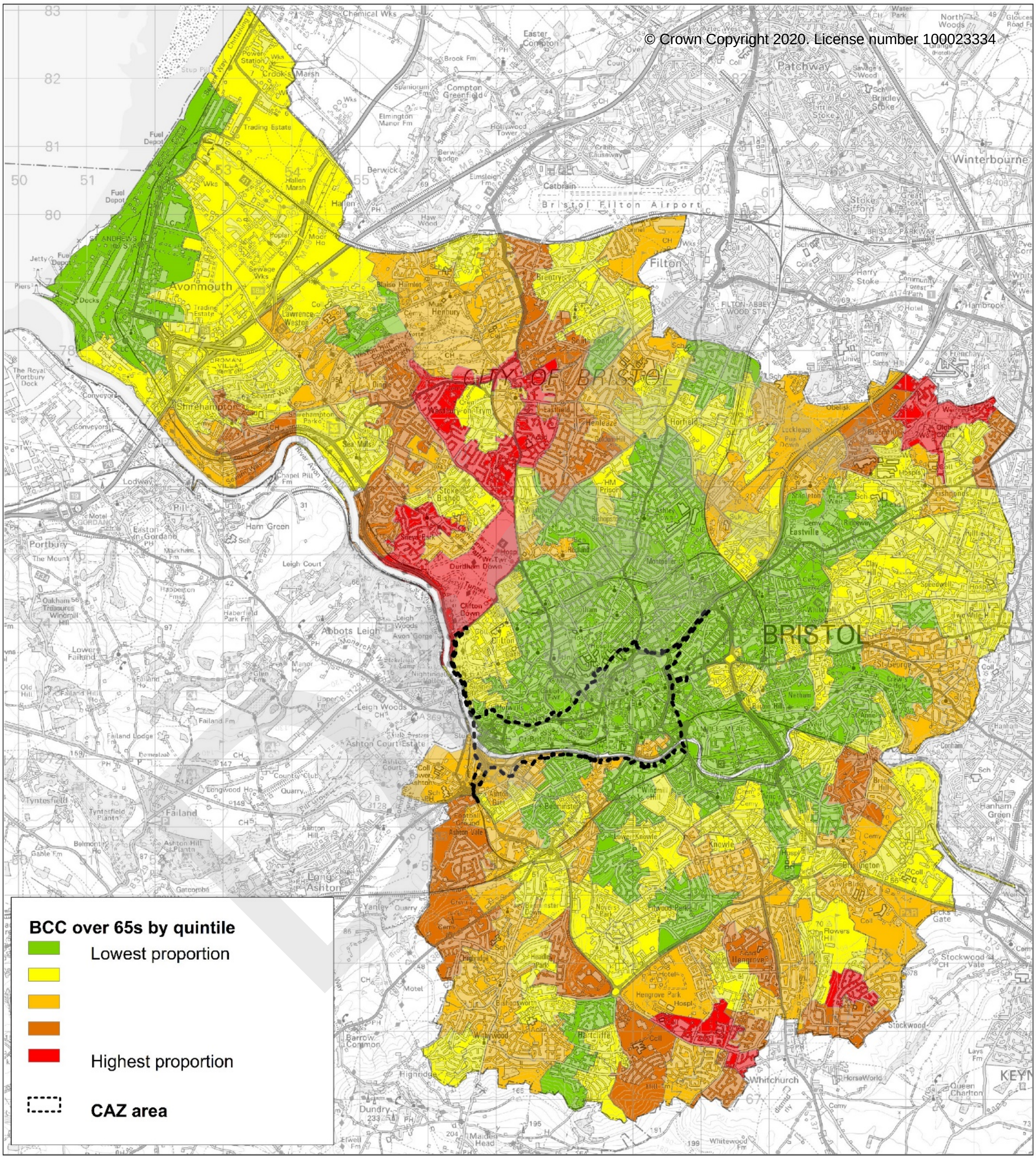


Figure 4-5: Concentration of disabled people in BCC Relative to national benchmarks

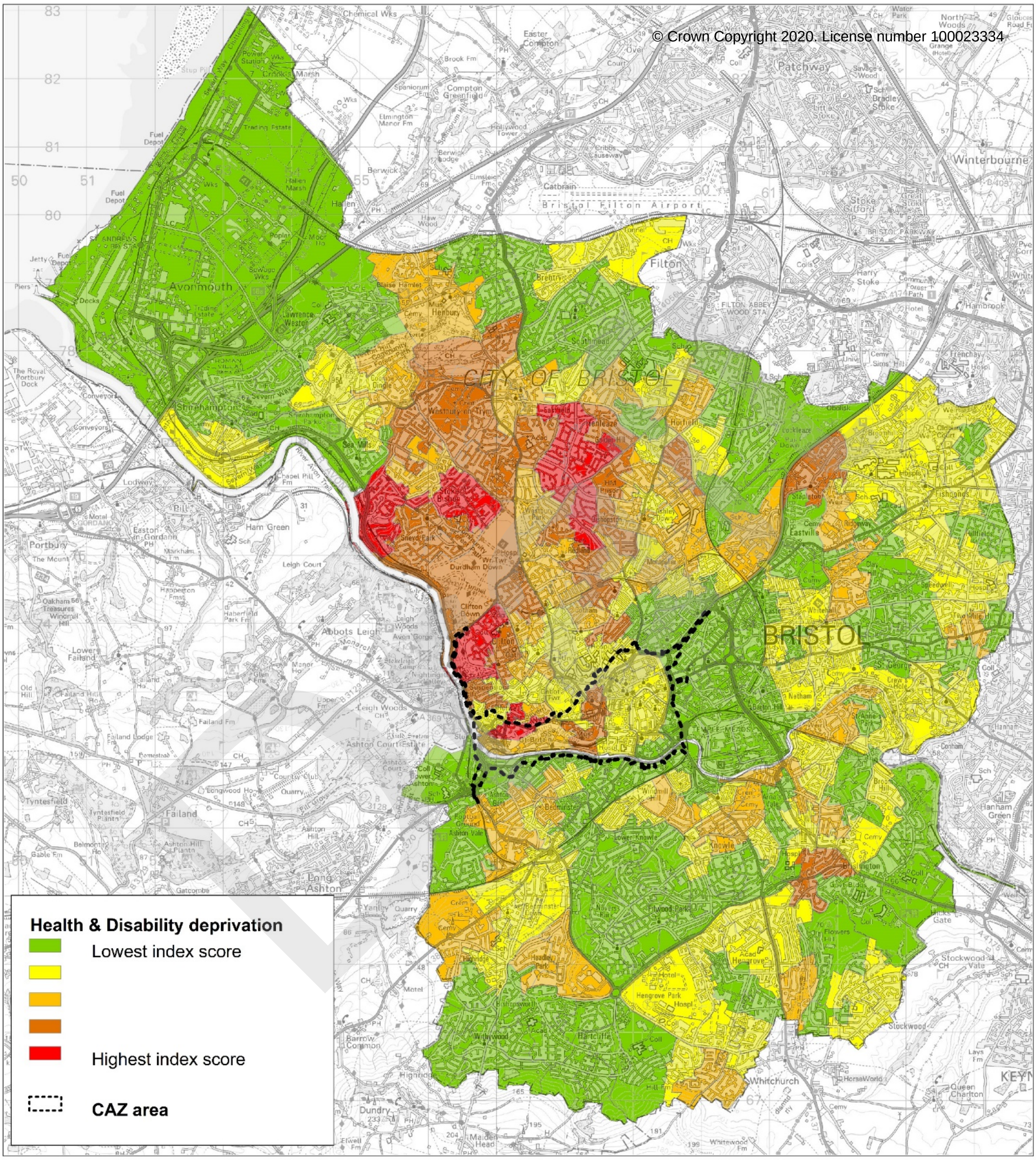


Figure 4-6: Concentration of women in BCC

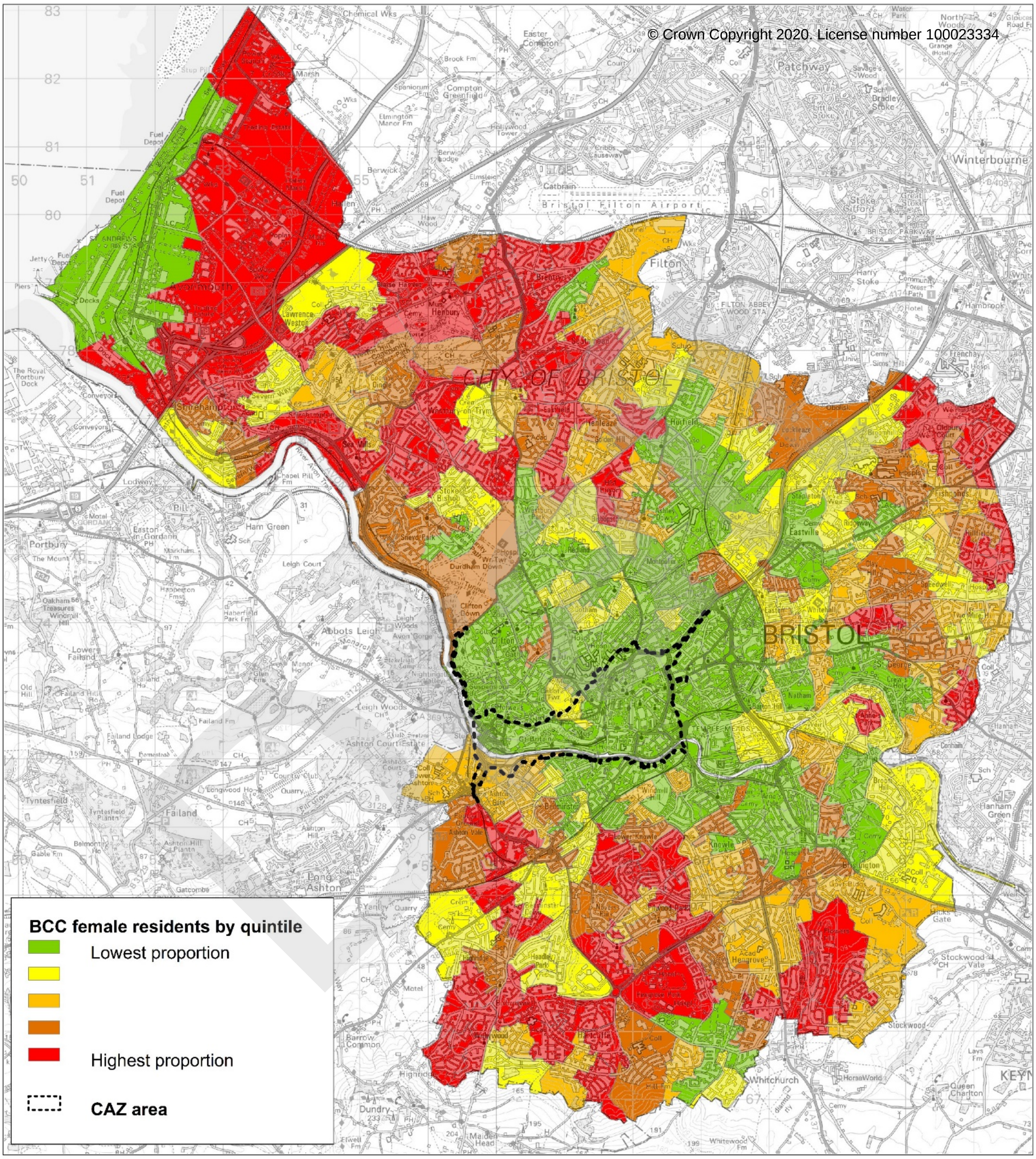
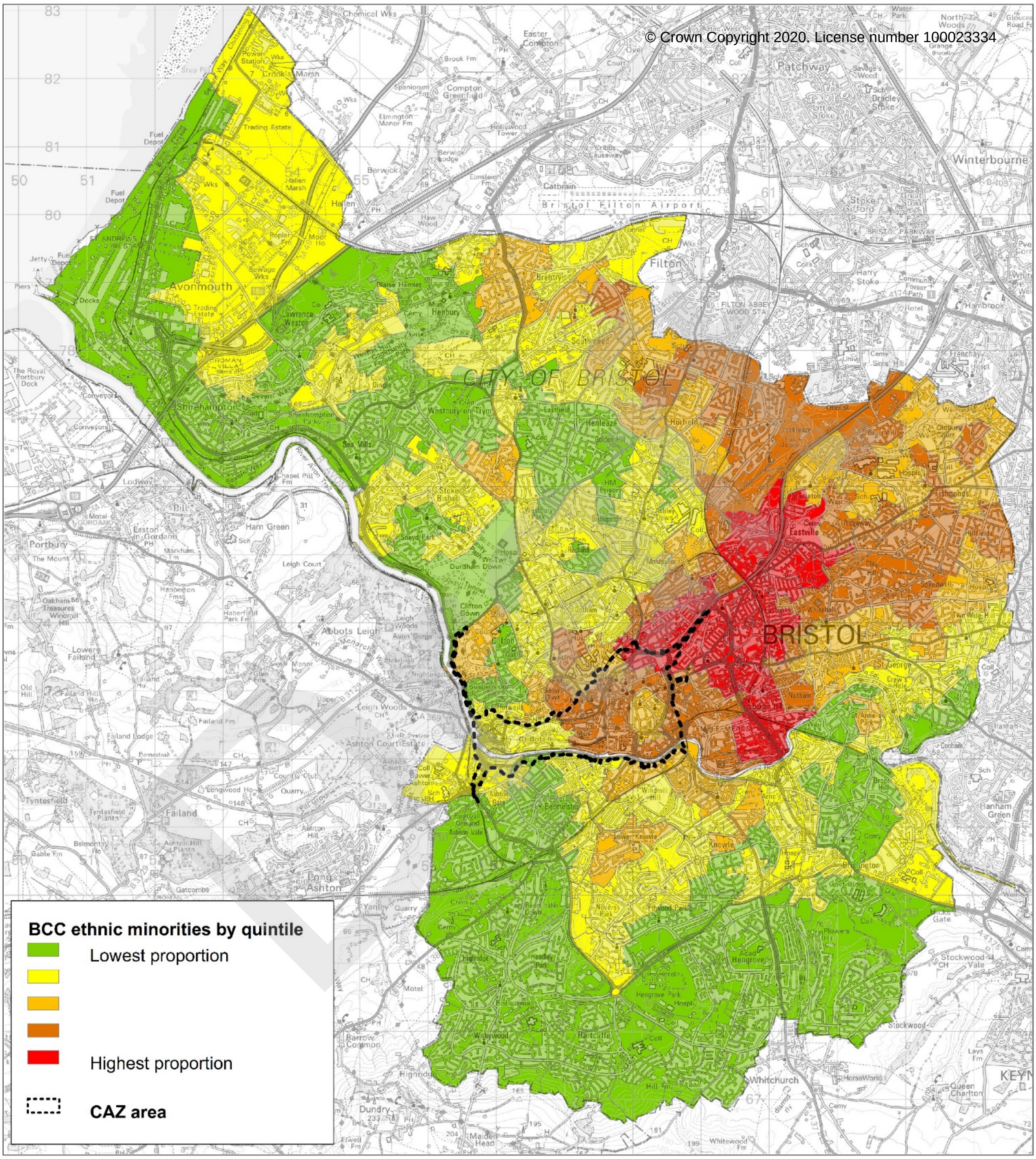


Figure 4-7: Concentration of Ethnic Minorities in BCC



4.2 Vehicle ownership

4.2.1 Current patterns

Car ownership in Bristol is affected by household income, both the numbers of cars owned and the types that this includes. Figure 4.8 shows household car ownership in the Bristol City Council area, cross-referenced with areas of deprivation, using the Indices of Deprivation (IoD, 2019) to determine the level of overall deprivation (by quintile from the least to most deprived areas). Figure 4.9 shows the same information for the CAZ area. Figures 4.10 and 4.11 have similar household car ownership information (as Figures 4.8 and 4.9 respectively), but with reference to specific income deprivation (derived from the income score within the overall index). Figure 4.12 illustrates the information graphically for wards within the city. Figure 4.13 goes on to show how vehicles registered to addresses in Bristol relate to areas of deprivation (IoD, 2019), cross-referenced this time with fuel used and emissions categories (i.e. whether petrol or diesel powered, and compliant or non-compliant with emissions regulations). Figure 4.14 shows the same information, for the CAZ area. Figures 4.15 and 4.16 have similar information related to specific income deprivation (derived from the IoD income score). Figure 4.17 illustrates the information graphically for wards within the city.

The figures illustrate the differences in numbers of cars owned by households across income and deprivation quintiles. There is, though, a degree of similarity in the proportions of 1-car households in all quintiles across Bristol, with the proportion of households owning one car ranging from 41% to 48%, unsurprisingly with the fewest in the most deprived households, which are also more prevalent in wards coincident with the CAZ area (see below). The differences are more starkly illustrated in households with no car available and households with multiple cars. Whereas only 18% of the least deprived households in Bristol have no car (20% of least income deprived), 44% of the most deprived households have no car. Conversely, only 16% of the most deprived households have 2 or more cars, where 37% of the least deprived have 2 or more cars. Figures for intermediate quintiles trend logically between the most and least deprived households.

Analysis of car ownership of residents in the CAZ area shows broadly similar differentials, albeit with a lumpy pattern across intermediate quintiles and more marked extremes, based in part on the denser urban city centre locations of the CAZ area, but also as a result of the relatively small sub-set of the city's total this area includes. For instance, some 64% of the most deprived households in the CAZ area have no cars available, a significantly higher proportion than for Bristol as a whole (44%). This is also reflected in around 40% of the least deprived households having no cars (compared to 18% for Bristol as a whole). Likewise, whereas more than a third of the least deprived households in Bristol have multiple cars, only 17% of the least deprived households in the CAZ area do. Similarly, only 3% of the most deprived households in the CAZ area have 2 or more cars (and very few have 3 or more cars), compared to 16% across Bristol. The numbers of 1-car households in the CAZ area is variable across the deprivation quintiles (from 29% to 43%), with the lowest actually being attributed to the mid-quintile of income deprivation, which also has the highest proportion of no-car households. This is reflected in correspondingly higher 1-car household proportions than might be expected compared to BCC overall in the 2nd least deprived quintile. Conversely, comparison of income deprivation figures indicates lower than would be expected no-car household proportions in the mid and 2nd most deprived quintiles, but higher in the 2nd least deprived. These figures are a function of the source data, in particular the granularity of LSOA and MSOA[9] areas from which ownership and vehicle data is drawn, and positioning of boundaries with respect to the CAZ area.

Overall, the figures indicate that a greater proportion of the vehicles registered in the most deprived areas are non-compliant (approaching 60%, where in the least deprived areas its less than 50%). They go on to illustrate that the ownership of compliant and non-compliant petrol cars follows the amount of deprivation. As such, the proportion of vehicles in the most deprived areas that are non-compliant petrol cars is 27%, but this drops to 19% in the least deprived areas, Conversely, compliant petrol cars make up 39% of the fleet in the most deprived areas, but 47% in the least deprived areas, though the number of cars registered in the least deprived areas is over 30% more than the most deprived areas. For diesel cars the picture is more nuanced, with the proportion cars being diesel powered overall being even across the deprivation quintiles; non-compliant diesel

[9] MSOAs, Medium Super Output Areas, are geographical areas that are used to report small area data; these are bigger than LSOAs, and thus also built-up from constituent LSOAs.

cars registered are broadly similar at around 28%; similarly, the proportions of compliant diesel cars are all in the range 5%-6%, though slightly higher in areas of least deprivation. Again, this is also more prevalent in wards coincident with the CAZ area.

Analysis of vehicles registered in the CAZ area shows a similar pattern to the whole-Bristol situation, with over 50% of vehicles registered in the most deprived CAZ area being non-compliant, compared to under 50% in the least deprived areas, though many more vehicles are registered in the least deprived areas than most (over 1,600 compared to 1,000). There are comparatively few compliant diesels, and the proportions are similar across the deprivation groups, but compliant petrol cars make up a greater proportion of the fleet registered in less deprived areas than more deprived areas.

Figure 4-8: Vehicles registered in Bristol – by household car ownership and overall IoD

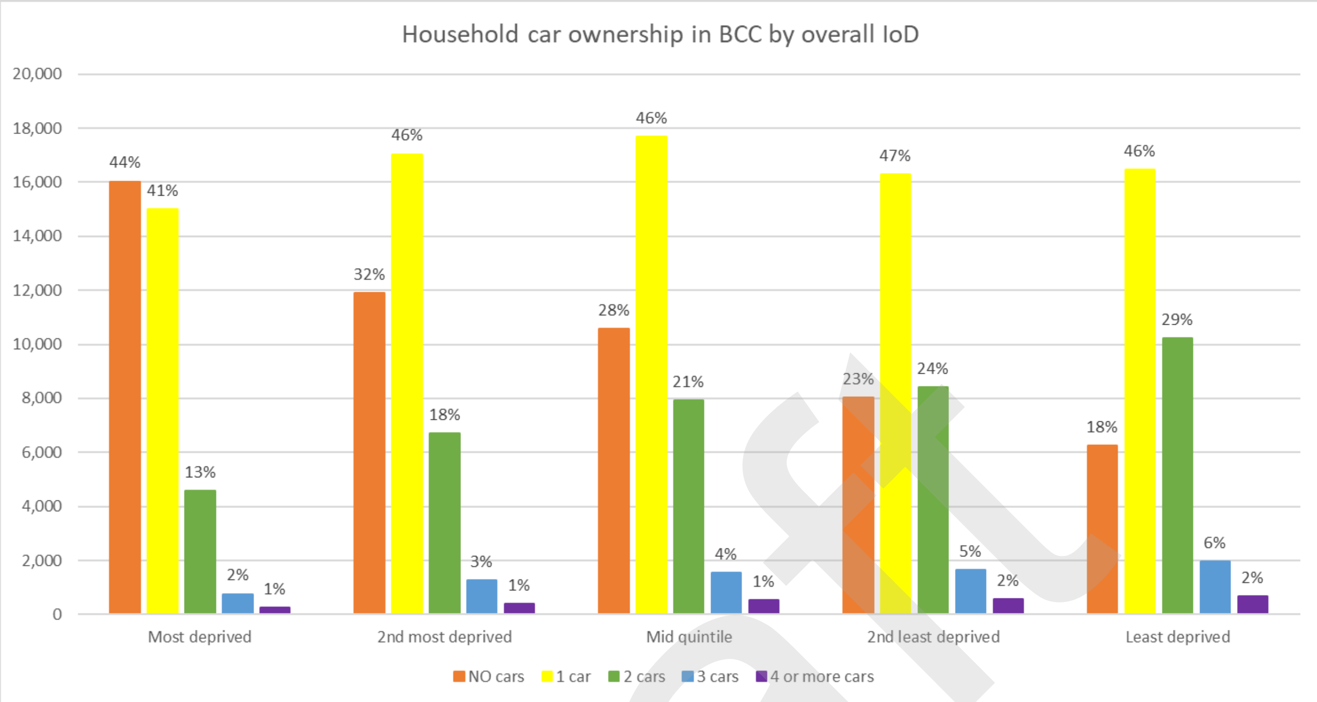


Figure 4-9: Vehicles registered in CAZ area – by household car ownership and IoD

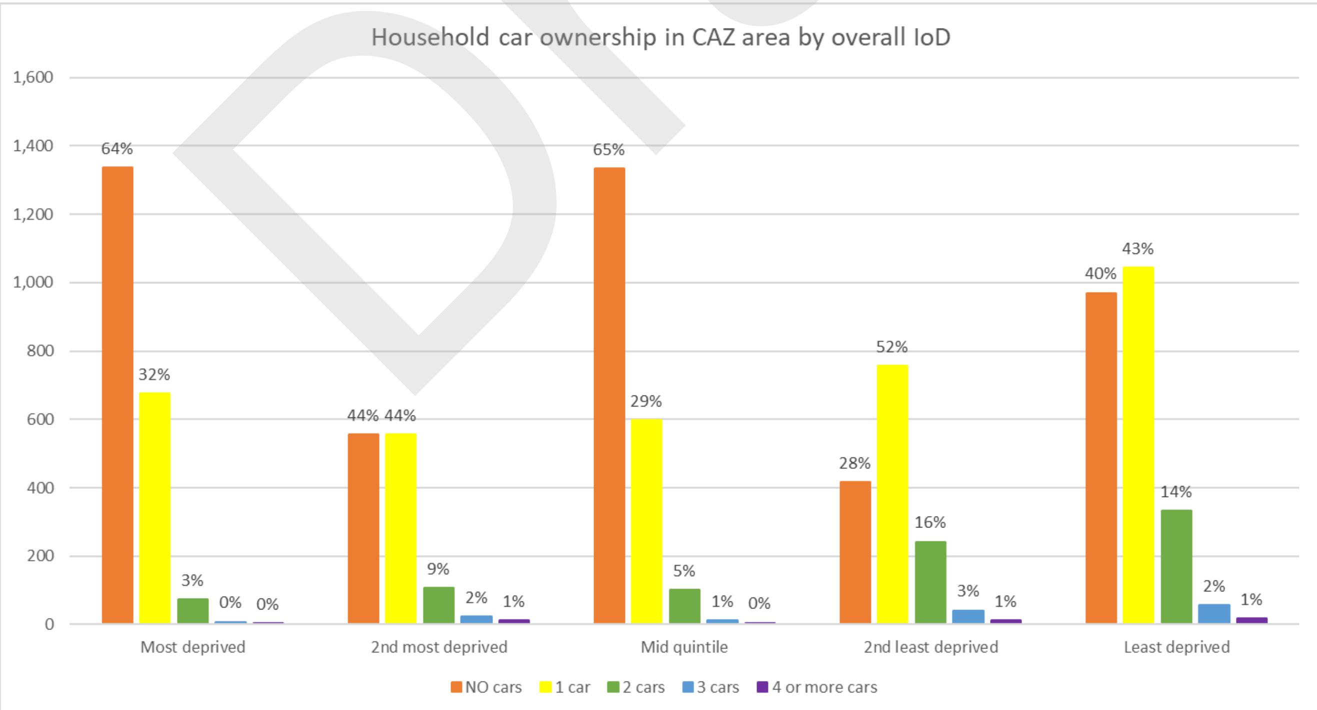


Figure 4-10: Vehicles registered in Bristol – by household car ownership and income deprivation

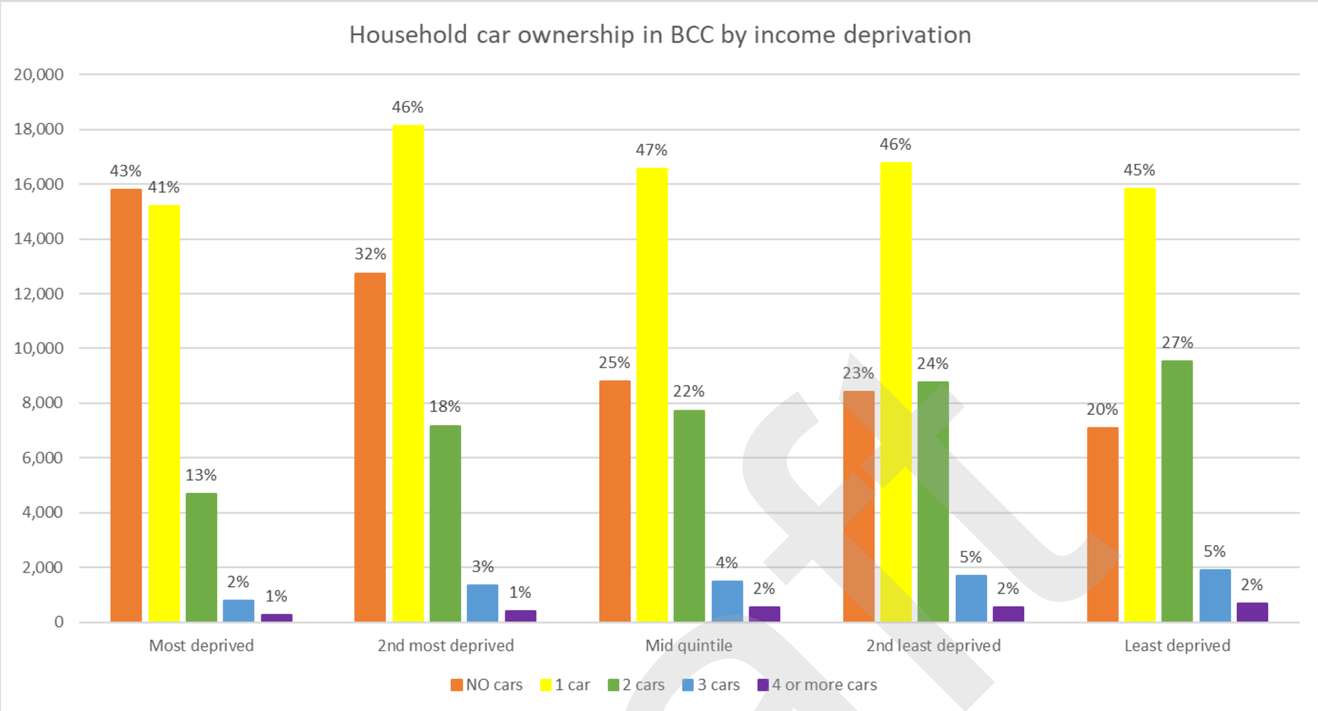


Figure 4-11: Vehicles registered in CAZ area – by household car ownership and income deprivation

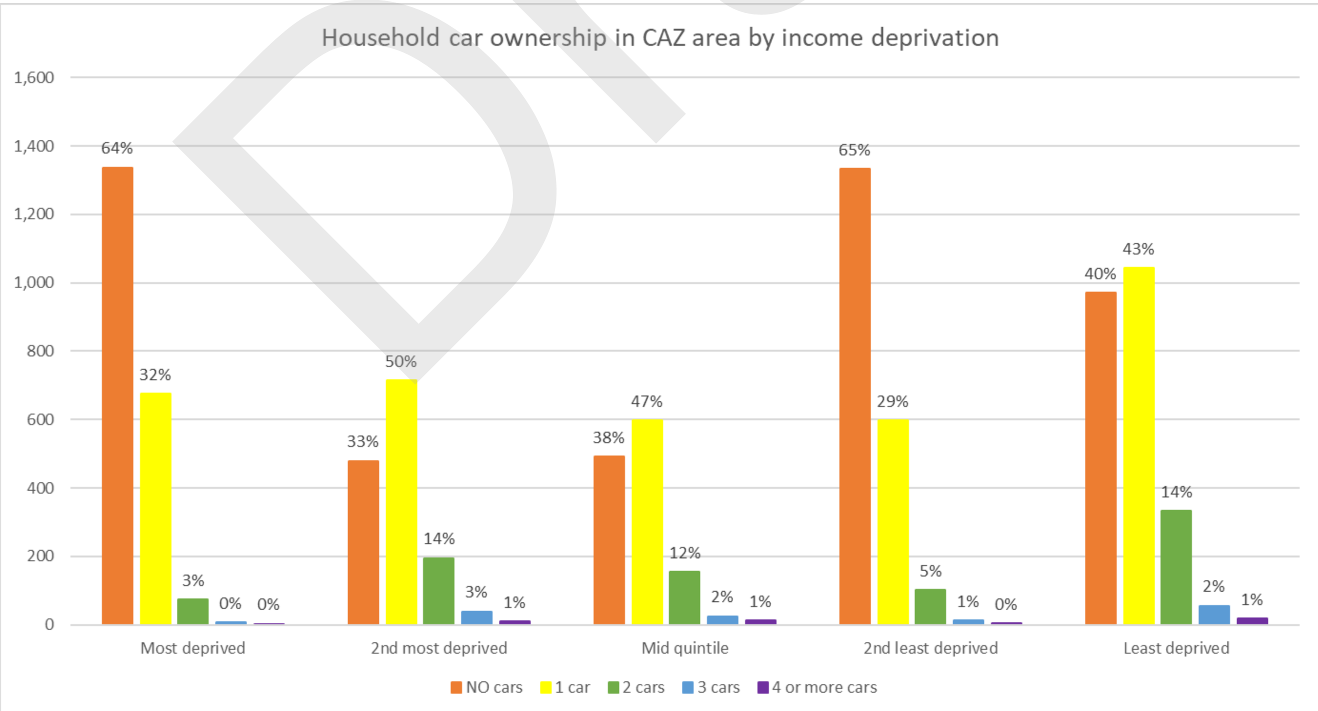


Figure 4-12: Vehicles registered in BCC wards – by household car ownership

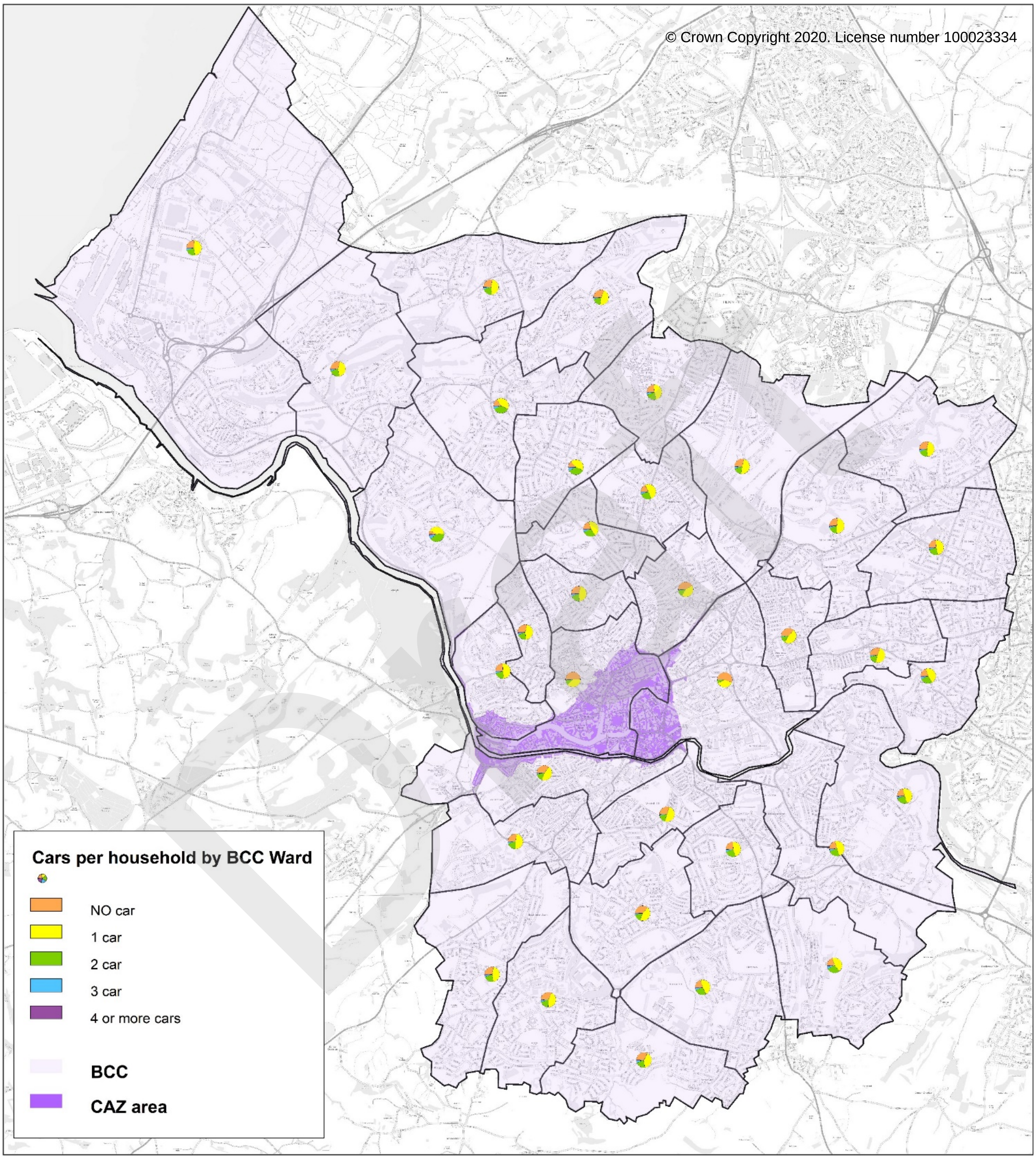


Figure 4-13: Vehicles registered in Bristol – by emissions category and overall IoD

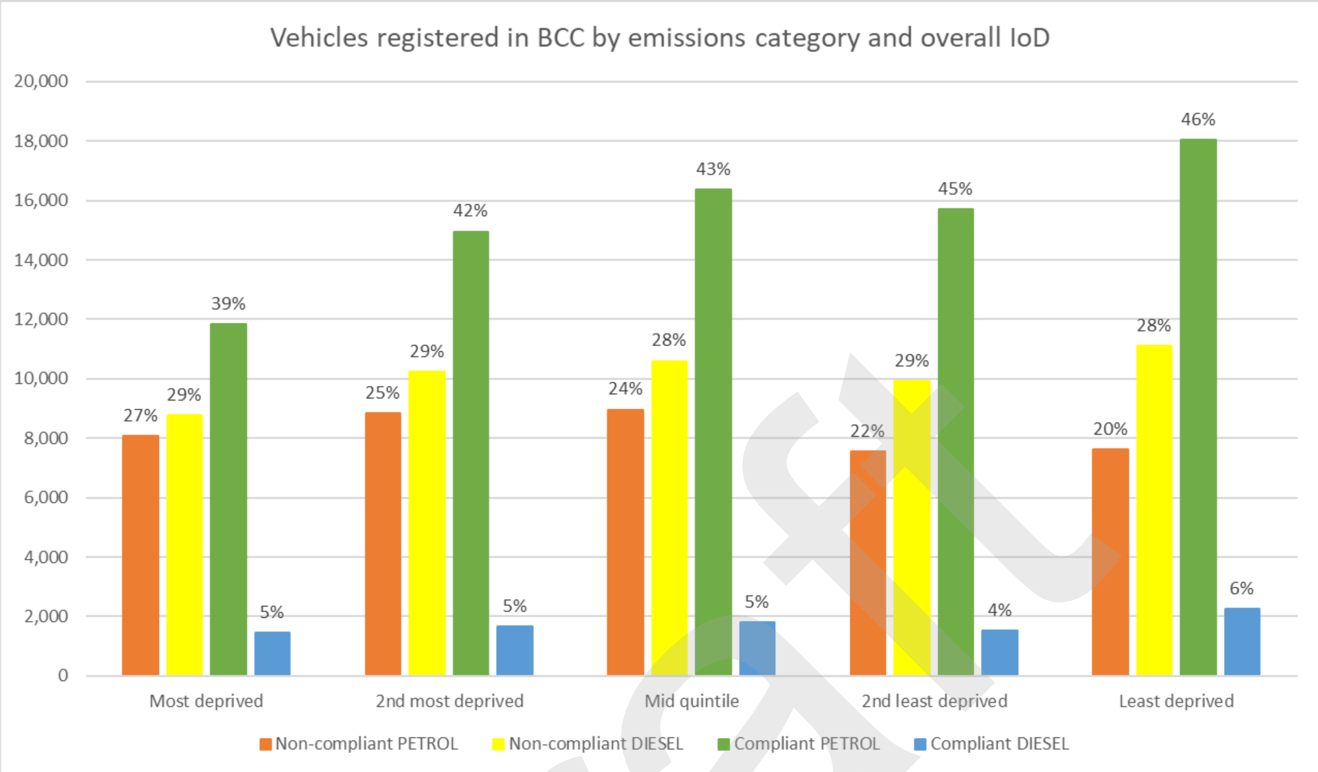


Figure 4-14: Vehicles registered in CAZ area – by emissions category and IoD

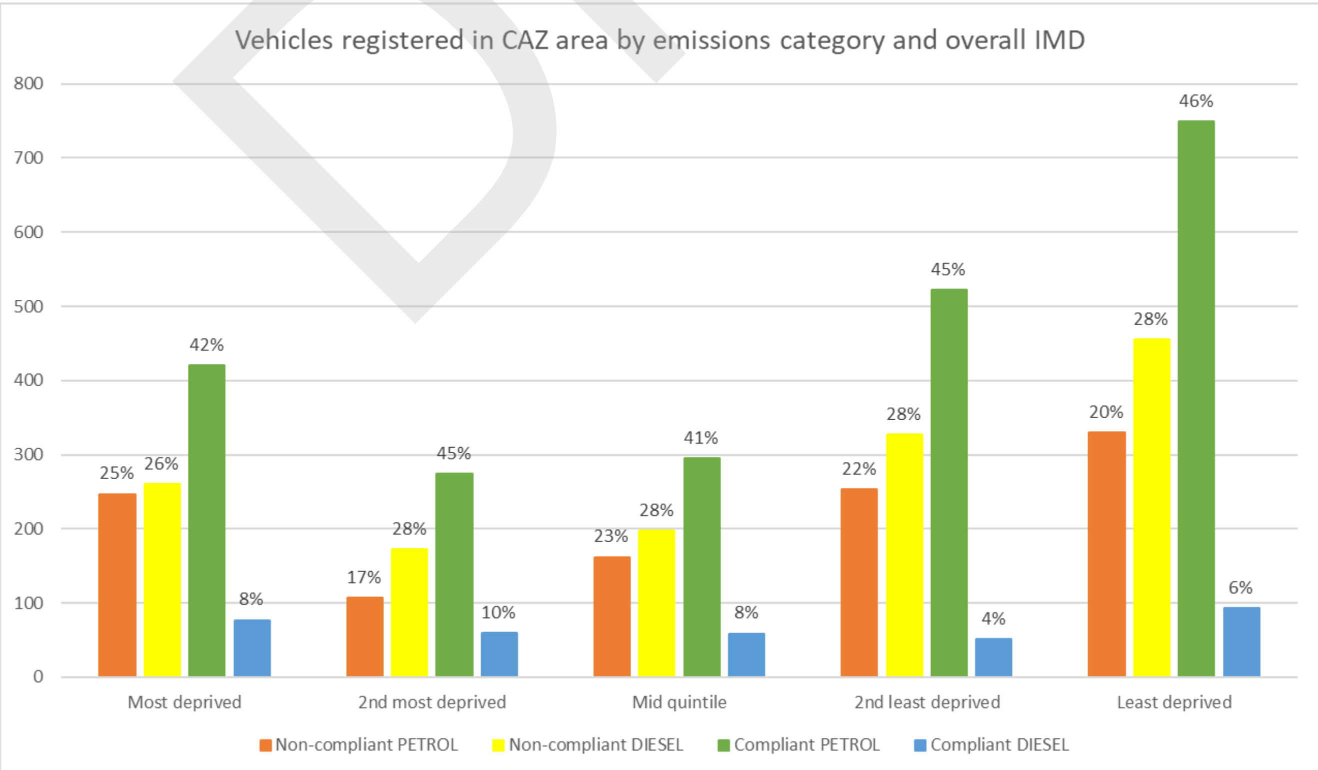


Figure 4-15: Vehicles registered in Bristol – by emissions category and income deprivation

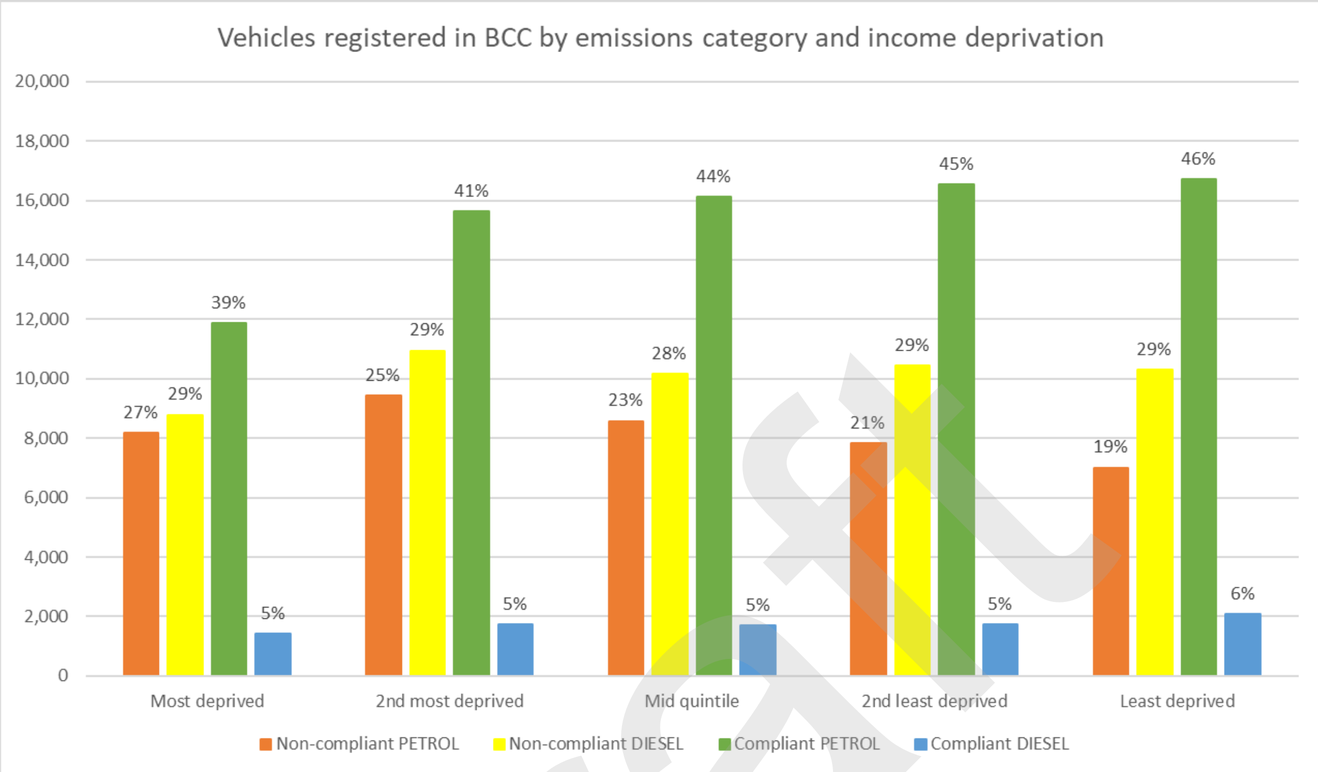


Figure 4-16: Vehicles registered in CAZ area – by emissions category and income deprivation

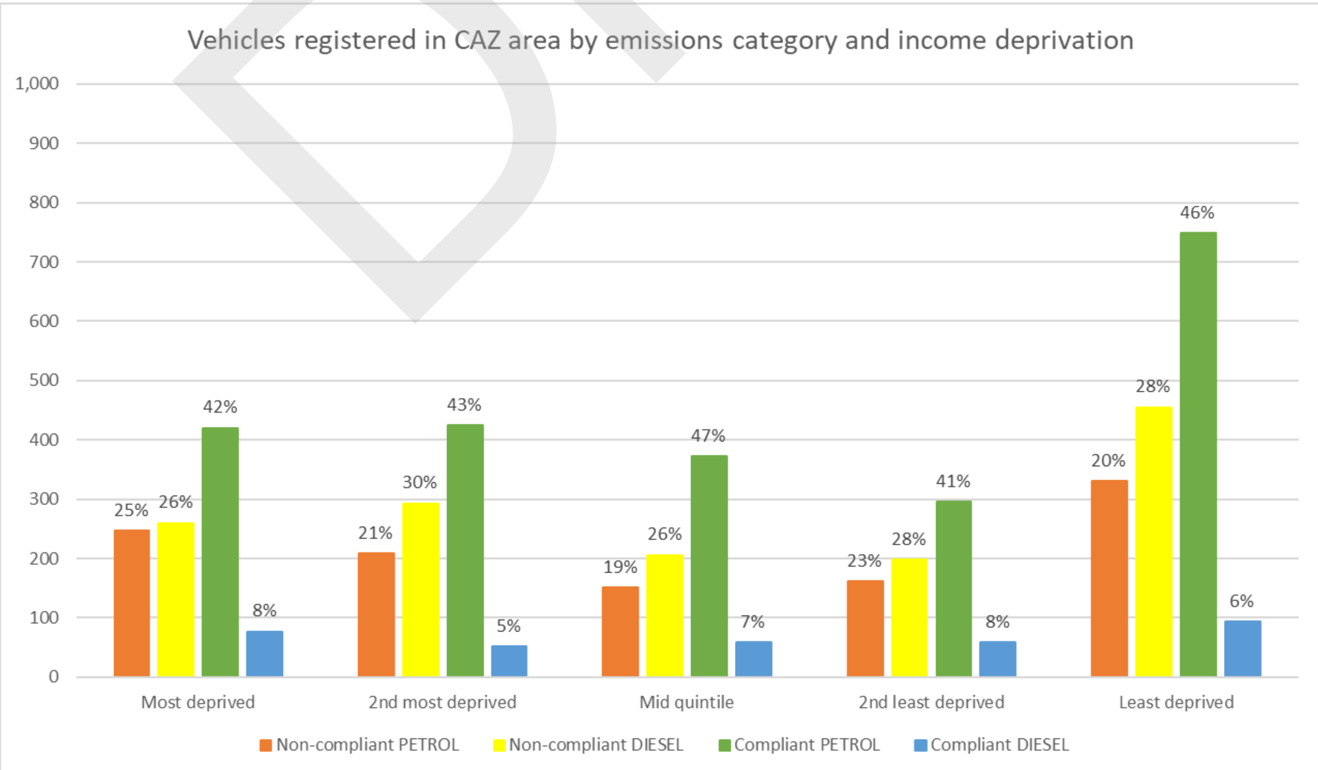
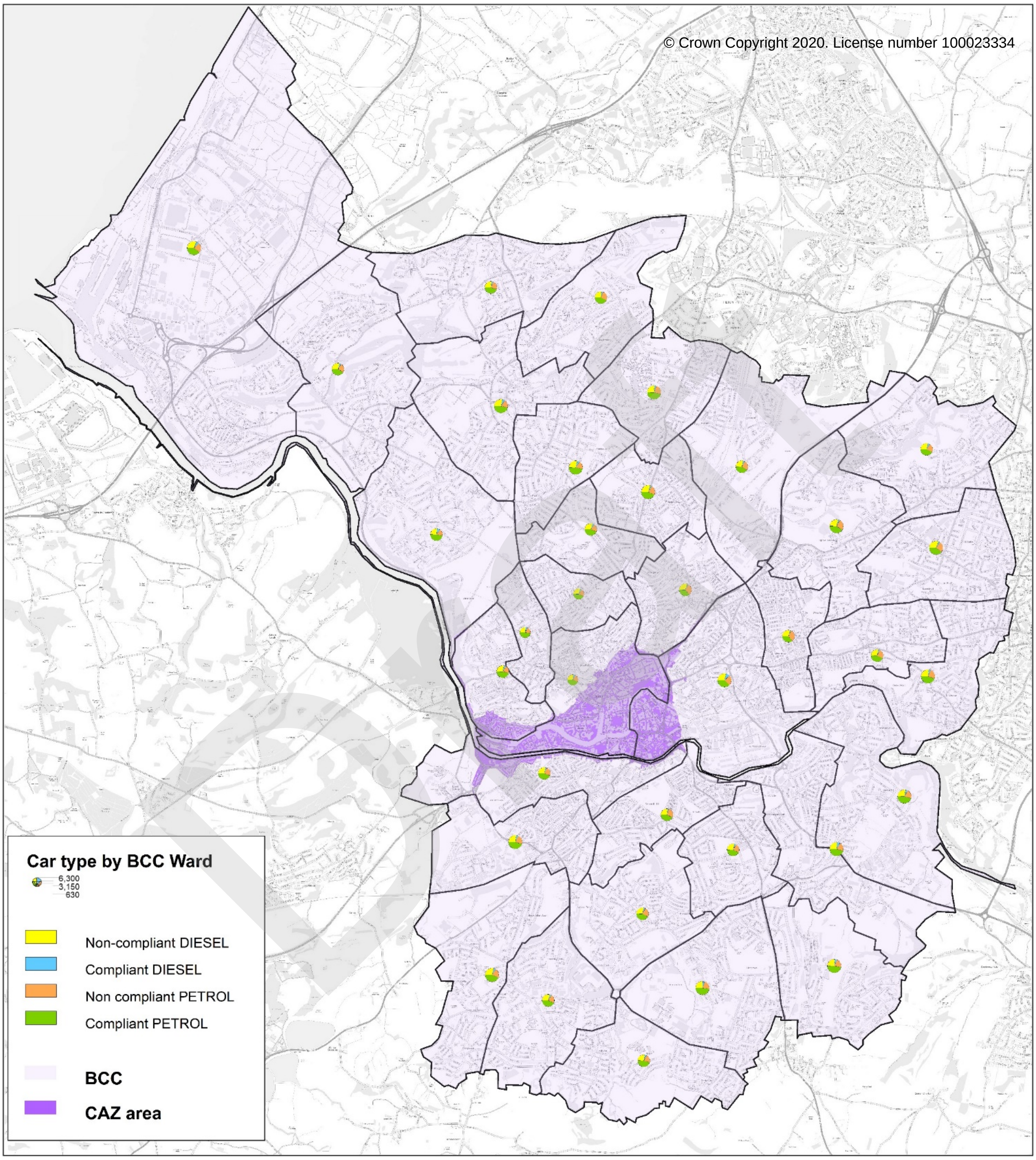


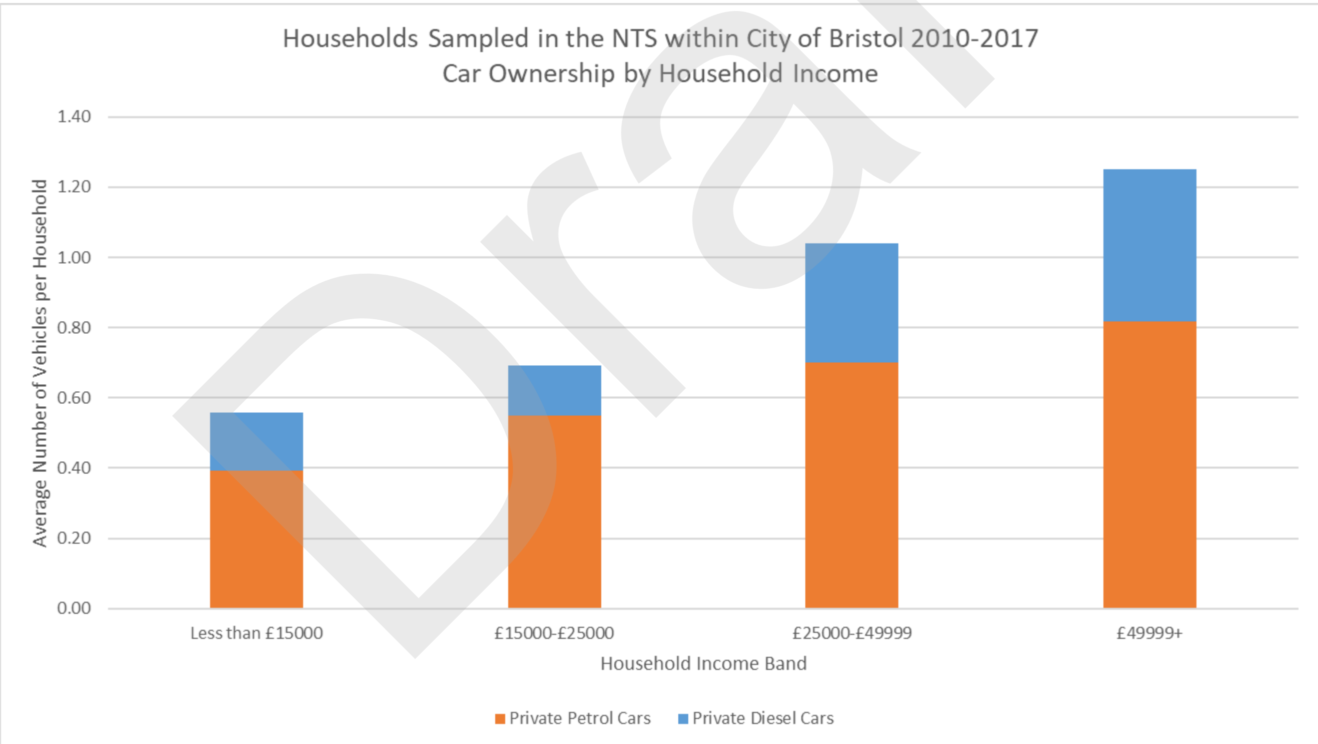
Figure 4-17: Vehicles registered in BCC wards – by car type



Direct comparison between car ownership and specific income is more difficult, as the datasets that are most comprehensive do not include the level of detail necessary. The National Travel Survey (NTS) samples households across the country and includes such questioning. Access to the most detailed information is restricted, but the study team has been able to interrogate this information for the purposes of this study. Households sampled in the Bristol City Council area over the period 2010-2017 reveals there is, unsurprisingly, a correlation between income level and the number of cars owned (though note that only 401 households have been sampled).

Figure 4.18 shows that households with an income of less than £15,000 have a ratio of vehicles per household to less than 1.0; i.e. a significant number are no-car households (as Figures 4.10 and 4.11 also indicated, albeit for the more broadly defined income deprivation rather than income directly). Conversely, households in Bristol with higher incomes (>£50k) have a car/household ratio well over 1.0, tallying with the assertion shown previously that less deprived areas are unlikely to not have a car, and many households have more than on car available. Figure 4.18 also shows that higher income households have a greater proportion of diesel cars than petrol, though not significantly so.

Figure 4-18: Car ownership by income – households sampled in NTS in BCC area (2010-2017)



4.2.2 Link with CAZ measures

It is possible to use the information in this chapter to identify the way that CAZ measures could impact equitably (or otherwise) across the population, relating to car ownership and relative amounts of income and deprivation across the city. This section is non-specific to scheme elements, instead drawing out salient features of vehicle ownership and the relationship to interventions.

Private cars in general

The distributional effect of a measure that targets private cars will have a slightly greater impact on the more deprived areas of the city than less deprived areas (and the situation is amplified within the CAZ area itself). While households in more deprived areas are less likely to own a car at all, and thus would only have indirect impact from a charging CAZ scheme, those that do own a car are more likely to only have one vehicle available than those in less deprived areas. As such, an affected household's options are more limited, and there is a lower likelihood of being able to avoid any scheme elements that incorporate charges for specific vehicle types (for example, non-compliant petrol or diesel cars) through having a choice of vehicle in a household. In terms of mitigation though, it may be possible to target vehicle replacement schemes at appropriate (1-car) households.

Non-compliant cars

A measure that specifically targets non-compliant vehicles will also potentially have a slightly greater impact on the more deprived areas of the city than less deprived areas, because the proportion of the vehicle fleet registered in more deprived areas that is non-compliant is higher than in less deprived areas. It is also worth noting that the previous point about the propensity for households in such areas to only have one vehicle available potentially exacerbates this situation for less affluent areas and households.

For example…

With a CAZ area that levies charges on all non-compliant vehicles for access to/through an area, depending on trips affected, options to avoid paying a charge would include:

- Switch modes (away from car);
- Change the destination of the trip;
- Re-route to avoid the zone; or
- Use an alternative (compliant) vehicle, that does not incur a charge.

In the longer-term an alternative vehicle could mean replacement of a non-compliant vehicle, but in the immediate term any multi-car households where one or more vehicles are compliant could simply choose which vehicle to use to allow the trip to still be made without a CAZ-related charge. However, a household that owns a single non-compliant car would not be able to avoid paying a charge to cross the CAZ boundary, where a household with one non-compliant car and one compliant car available would be able to choose which to use, and potentially make no changes to trip making and pay no charges. This has a greater impact on lower-income and more deprived areas, as more households have a single-vehicle available to them. Regular-trip discounts and/or exemptions could be considered as mitigation.

Although they could apply to any household (particularly those residents within the CAZ area itself), mitigation measures such as a resident's discount or exemption would be desirable and/or necessary in the shorter-term for single-car households, with replacement support having a potentially longer-term impact. As noted earlier, if there is a car available at all in a lower-income or more deprived household, it is likely there will only be one, as fewer such households have more than one vehicle. Hence, if this vehicle is impacted by the scheme the household would thus either be adversely affected or require mitigation.

4.3 Economy

4.3.1 Employment and businesses

Bristol is a major economic hub within the West of England, acting as a key centre for employment and economic activity. Table 4.1 illustrates the sectoral profile of employment for Bristol and the focused geographic scales, compared to national benchmarks. The analysis reveals that within the CAZ area boundary the main industries of employment are business services (industrial sectors: J, K, L, M, and N), accounting for over half of all jobs (53%). This is a larger proportion when compared to those employed in BCC overall (33%) and nationally across England (28%). Indeed, almost two thirds (64%) of all the jobs in these sectors in BCC are located within the CAZ area. These sectors tend to make a significant contribution to economic output and value added, as well as offering competitive salaries. As has been mentioned previously, the CAZ area boundary includes Bristol City Centre which is where the majority of business services jobs are located.

Table 4-1: Proportion of individuals in industrial sectors by context area

Industrial Sectors (Nomis, 2018)	CAZ area	BCC	England
1: Agriculture, forestry & fishing (A)	<1%	<1%	1%
2: Mining, quarrying & utilities (B,D and E)	2%	1%	1%
3: Manufacturing (C)	1%	4%	8%
4: Construction (F)	2%	4%	5%
5: Motor trades (Part G)	<1%	2%	2%
6: Wholesale (Part G)	1%	5%	4%
7: Retail (Part G)	6%	7%	9%
8: Transport & storage (inc postal) (H)	2%	4%	5%
9: Accommodation & food services (I)	8%	7%	7%
10: Information & communication (J)	9%	6%	4%
11: Financial & insurance (K)	11%	6%	3%
12: Property (L)	2%	1%	2%
13: Professional, scientific & technical (M)	19%	11%	9%
14: Business administration & support services (N)	12%	9%	9%
15: Public administration & defence (O)	9%	5%	4%
16: Education (P)	2%	9%	9%
17: Health (Q)	12%	16%	13%
18: Arts, entertainment, recreation, etc (R,S,T and U)	3%	4%	4%

Over 4,400 and 4,600 individuals are employed within the tourism and retail sectors respectively within the CAZ area boundary. At a spatially disaggregated level, more than 25% of all retail employment in Bristol is located within the CAZ boundary. Around 10% of all tourism jobs in Bristol are also located within the CAZ boundary. Figure 4.8 illustrates the concentrations of retail businesses across Bristol.

Business count data from Nomis provides an insight into the number and size of businesses in a given context area. Businesses are classified into various sizes based on the number of employees within that business. Table 4.2 presents the distribution of businesses by type across Bristol. This illustrates that micro-businesses make up a significant proportion (81%) of the market structure within the local authority, whilst small and medium businesses (SMEs) account for 18% of all businesses within Bristol, and that micro and small businesses account for 96.3% of the business within Bristol. Around 3,000 businesses are located within the CAZ area. These figures suggest that 13% of all Bristol businesses will be located within the CAZ area boundary.

Table 4-2: Business types within Bristol

Context Area	Micro (0 to 9)	Small (10 to 49)	Medium-sized (50 to 249)	Large (250+)	Total
Bristol LA	18,025	3,320	700	125	22,170
CAZ area	2,210	675	145	35	3,065

Hence, irrespective of the geographic scale, micro businesses make up the largest proportion of businesses. Further, combining micro and SME businesses reveals that around 99% of all businesses located across the local authority and within the CAZ area boundary employ fewer than 50 employees. As such, there is limited differentiation between the geographic scales from a business size perspective. That said, there are fewer micro businesses and SMEs within the CAZ area boundary compared to the rest of the wider city centre area.

4.3.2 Transport

Based on Census 2011 data, private cars are the most common mode of travel to work in Bristol. Almost 120,000 journeys to work within Bristol are undertaken as car driver or passenger, equivalent to 59% of commuting journeys. For people who live and work in Bristol, this proportion is lower, albeit still almost 48%. For jobs within the CAZ boundary (around 75,000 in total), the mode split is less orientated towards cars for jobs in the area, with around 44% of commuting trips are by cars, though this proportion falls to only around 7% for those who both live and work in the CAZ area.

It is also worth noting that the wider region provides significant numbers of employees that support the economy in Bristol, in particular Bath & North East Somerset (8,400 commuters), South Gloucestershire (34,600) and North Somerset (17,500). In most cases, car drivers represent the bulk of mode share for employees travelling into central Bristol from these neighbouring districts. Within this context, there is significant potential for accessibility and affordability to be compromised by the implementation of the CAZ, for both local residents and employees in the wider region that fall within Bristol's labour supply catchment.

Businesses are heavily reliant on use of LGVs and HGVs for their day-to-day operations. Figure 4.19 shows the concentrations of LGV-reliant business across Bristol, highlighting the CAZ boundary. The number of LGVs registered within an LSOA is reflective of certain types of business activity occurring within it (e.g. tradespeople, courier services, sole proprietors). LGV registration data reveals that 86% of LGVs that are registered within the CAZ area boundary are non-compliant with emissions regulations, while 90% of those registered in Bristol as a whole are non-compliant. Figure 4.20 shows the concentrations of retail businesses, which are a key sub-set of all businesses that currently rely on vehicles to service them.

4.4 Key facilities and social infrastructure

Figure 4.21 highlights again the location of the CAZ area boundary in central Bristol. This demonstrates that the city centre, with its extensive amenities and retail and employment core, is largely covered by the proposed CAZ boundary. In addition, some routes through the city centre are utilised for journeys to other parts of the city. As such, all trips made using non-compliant vehicles to this area, and some beyond it, are likely to be affected by imposition of the CAP.

Figure 4-19: LGV reliant businesses across Bristol

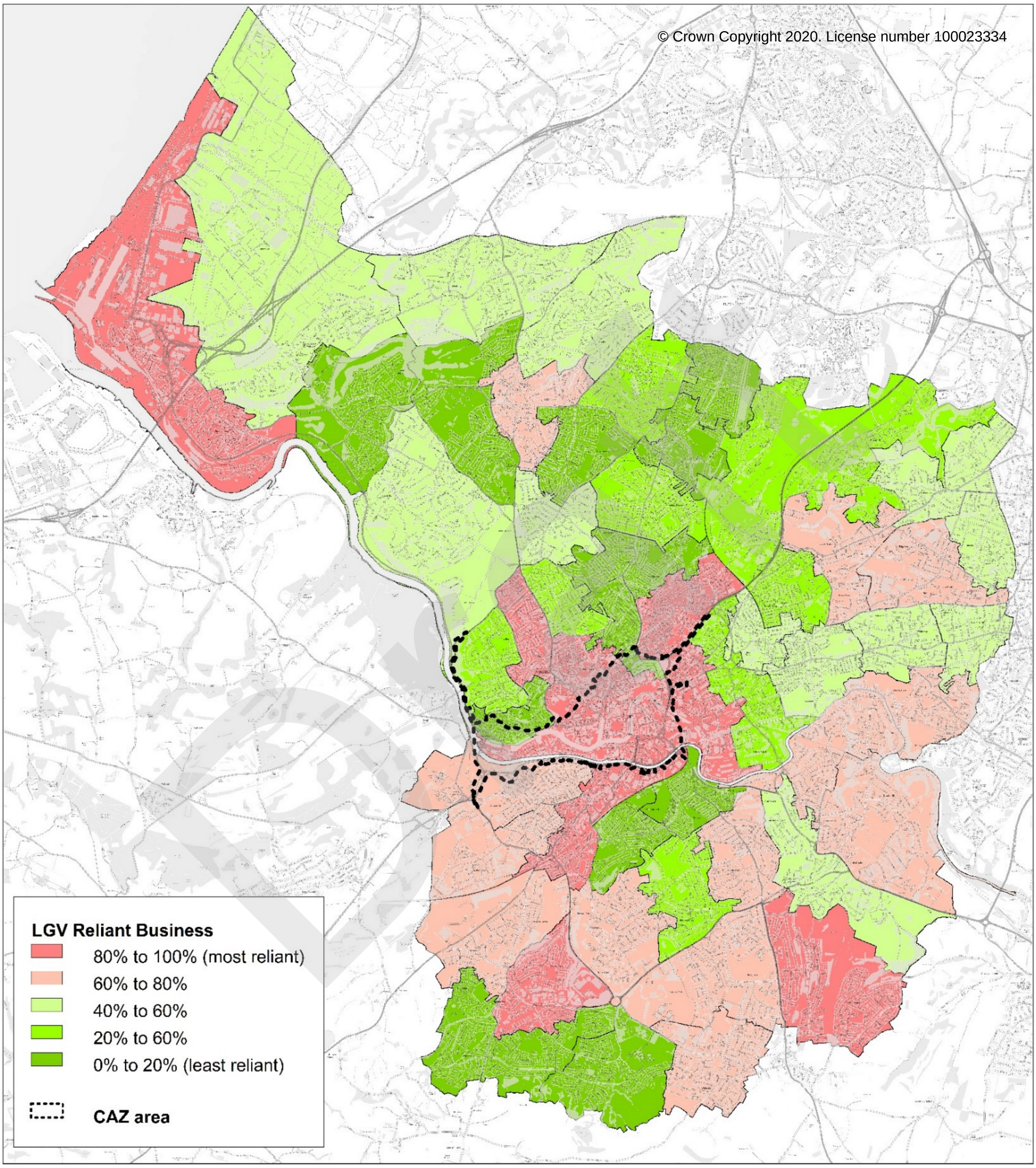


Figure 4-20: Retail businesses across Bristol

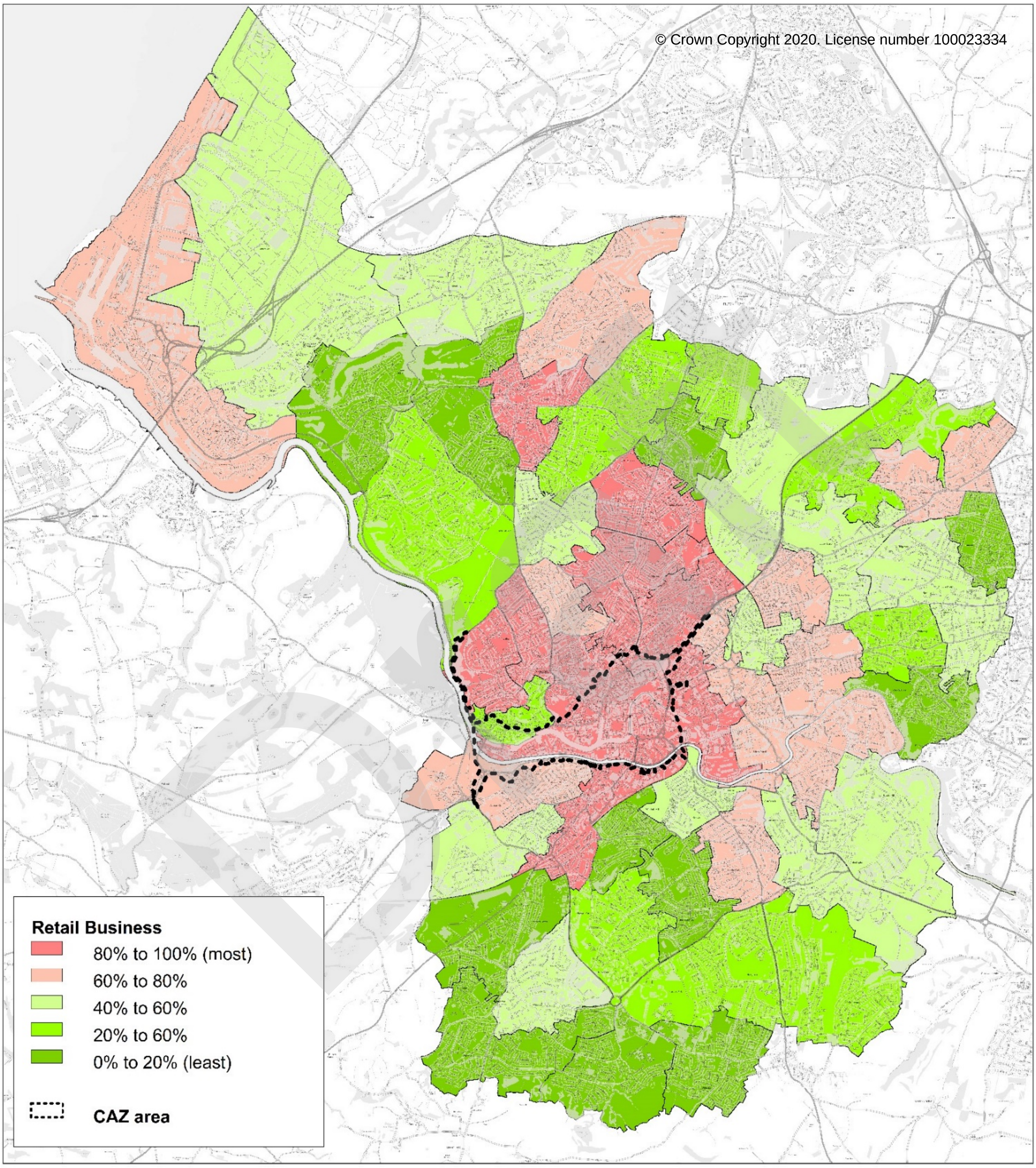
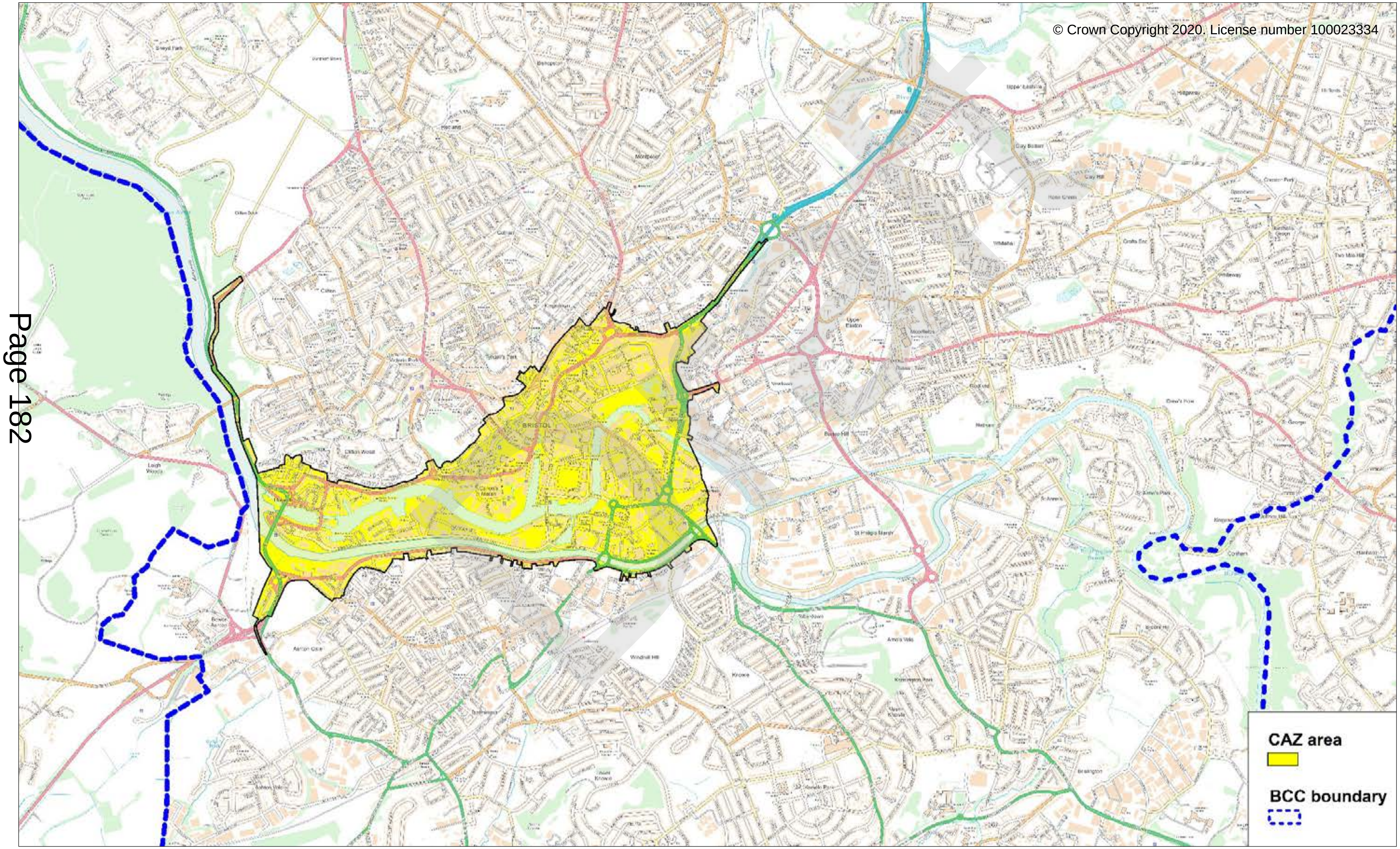


Figure 4-21: Bristol City Centre with CAZ area highlighted



5. Distributional and equalities impact analysis

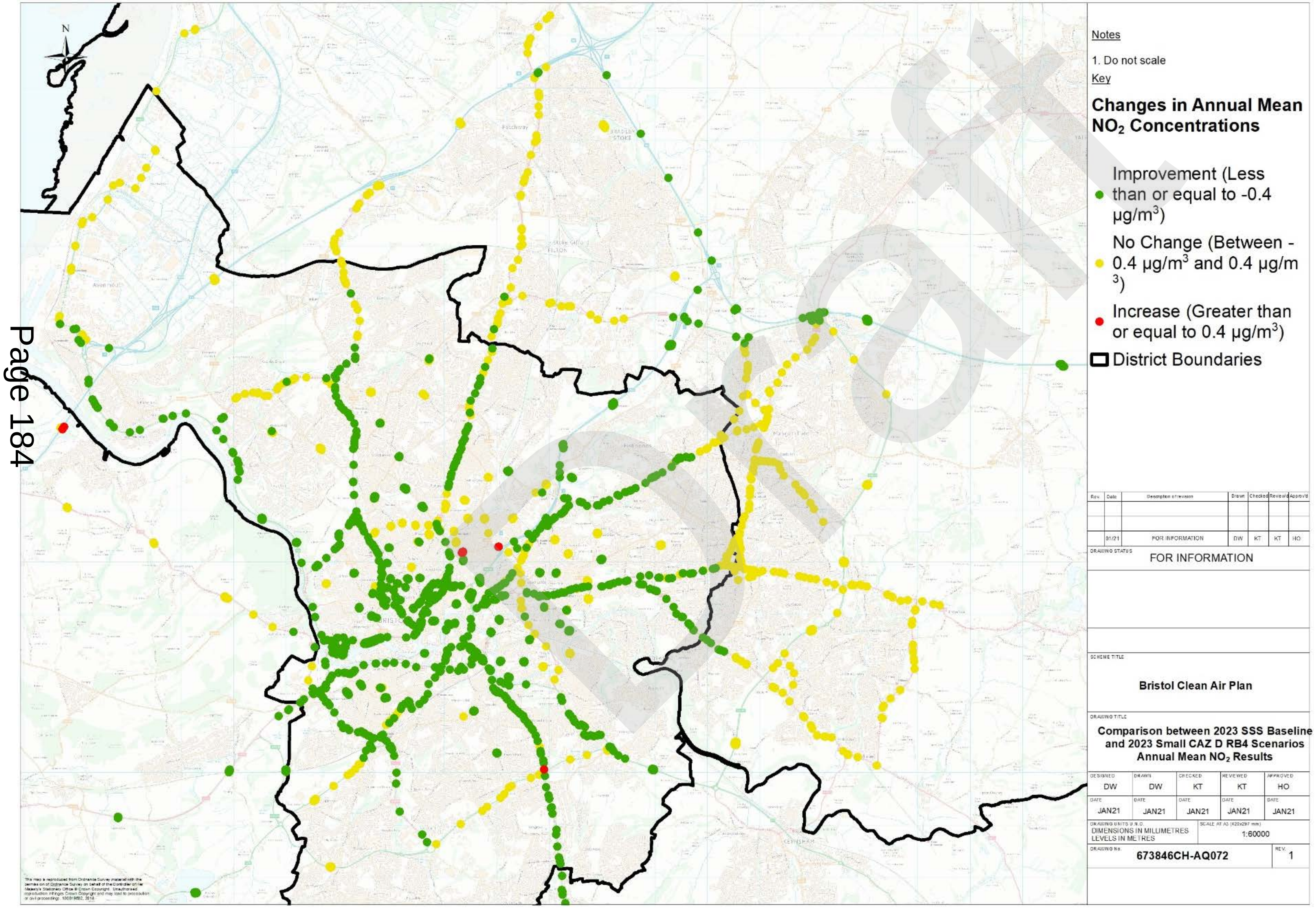
5.1 Air quality

Interrogation of the results of the air quality modelling done indicate NO_2 concentrations are basically predicted to remain unchanged or fall, and that compliance with limits is achieved in all locations; further details are available in OBC-11 'AQ3 Air Quality Modelling Report' within Appendix D of the OBC. Within this though there are some variations across the modelled area, and some links that exhibit minor worsening of air quality. Figure 5.1 shows the changes in NO_2 emissions identified at pollution climate mapping (PCM) receptors shown for the CAP scheme, compared to baseline modelling, using 2023 figures.

This indicates that air quality should improve across the city, with some locations where improvements are slightly greater than others. The CAP is forecast to contribute almost entirely positive impacts within Bristol from an air quality perspective, and these are likely to be felt most strongly in those communities that lie alongside the key arterial routes and within central Bristol. These figures can be cross-referenced visually with the concentrations of various demographic groups. Drawing on the plots of modelling results, the remainder of this section of the report (5.1) goes on to cross-reference the results of air quality modelling with demographic information to determine the distributional impacts of the CAP.

The distributional impact area has been identified as the city of Bristol, only the sites located within the LSOAs of Bristol were used in this assessment. To assess the distributional impact, the locations of the monitoring sites were mapped to the LSOAs for Bristol. The net change in Air Quality for NO_2 were calculated for each LSOA from the receptors within them. Where no receptors are located in an LSOA, it was assumed that this LSOA would experience no change in air quality. For each socio-economic group quintile, the population of those with improved and reduced air quality was calculated from the LSOAs. The proportion of net winners was compared to the proportion of the population for the socio-economic group within the quintile and an assessment score was given.

Figure 5-1: Change in NO_2 based on PCM receptors (2023)



5.1.1 Low-income households

Figure 4.1 and 4.2 indicate that the most acute concentrations of low-income households are located in the outskirts of the city, in particular southern Bristol and towards Avonmouth. Figure 5.1 demonstrates that the receptors across the whole network generally report a decline in NO_2 concentrations, with a number of routes showing little change, some of these being in areas of lower income.

Table 5.1 presents the appraisal matrix for the combination of low-income households and air quality impacts in Bristol for modelled impacts on NO_2. They demonstrate that beneficial impacts accrue across all low-income groups, with significantly greater proportions of low-income households (i.e. those in areas that are most income deprived) benefitting relative to this group's share of the overall population in the Bristol City Council area. Summary results of distributional impacts are as follows:

- All income groups benefit from improved air quality. Those in the 5th quintile (least deprived) receive a higher proportion of net winners compared to the population in the quintile, and the 1st quintile (most deprived) receives a lower proportion of benefits than population, which, while all areas see positive benefits, this makes the distribution of benefits slightly uneven.

Table 5-1: Air quality impacts on low-income households

Quintiles – income deprivation >>>	1 (most deprived)	2	3	4	5 (least deprived)	Total
No. of people with improved air quality	46,451	76,862	39,733	43,491	73,280	279,817
No. of people with reduced air quality	5,315	2,403	-	3,962	1,635	13,315
No. of net winners	41,136	74,459	39,733	39,529	71,645	266,502
Net winners in each quintile as % of total	15.4%	27.9%	14.9%	14.8%	26.9%	100%
No. of net losers	-	-	-	-	-	-
Net losers in each quintile as % of total	-	-	-	-	-	-
Share of population in study area	24.1%	25.8%	13.2%	17.1%	19.8%	100%
Distributional assessment for study area	✓	✓✓	✓✓	✓✓	✓✓✓	

5.1.2 Children

Figure 4.3 demonstrates that the distribution of children and young people in BCC is similar to the distribution of low-income households, with specific concentrations on the western and southern periphery of the built-up area. As a result, cross-referencing this distribution with the change in air quality concentrations reveals similar distributional impacts as reported for low-income households, i.e. air quality is expected to improve for children in all communities.

Table 5.2 presents the appraisal matrix for the children and air quality impacts in combination, for modelled impacts on NO_2. This demonstrates that beneficial impacts accrue across all children, with a slightly greater proportion of children benefitting in areas where there are fewer children. Summary results of distributional impacts are as follows:

- All groups benefit from improved air quality. Distribution is even compared to population, though those in the 5th quintile (highest proportions of children) are slightly lower proportion of benefits than population share.

Table 5-2: Air quality impacts on children

Quintiles – children >>>	1 (fewest children)	2	3	4	5 (most children)	Total
No. of people with improved air quality	6,710	7,320	8,842	12,912	17,113	52,897
No. of people with reduced air quality	836	-	-	942	995	2,773
No. of net winners	5,874	7,320	8,842	11,970	16,118	50,124
Net winners in each quintile as % of total	11.7%	14.6%	17.6%	23.9%	32.2%	100%
No. of net losers	-	-	-	-	-	-
Net losers in each quintile as % of total	-	-	-	-	-	-
Share of population in study area	11.1%	11.5%	14.4%	24.3%	38.7%	100%
Distributional assessment for study area	✓✓	✓✓	✓✓	✓✓	✓	

5.1.3 Elderly residents

Figure 4.4 demonstrates that the distribution of elderly residents in BCC differs from the distribution of low-income households and children, with a concentration of communities with a high proportion of elderly residents on the northern boundary of the urban area plus some pockets in central Bristol, within the proposed CAZ boundary. Cross-referencing this distribution with the change in air quality concentrations suggests that air quality improvements are expected for elderly residents in all communities in the immediate study area.

Table 5.3 presents the appraisal matrix for the elderly residents and air quality impacts in combination, for modelled impacts on NO_2. This demonstrates that beneficial impacts accrue across all elderly residents, with significantly greater proportion of elderly residents benefitting in areas where there is a smaller proportion of elderly residents. Summary results of distributional impacts are as follows:

- All groups benefit from improved air quality, with a broadly even distribution. Those in the 1st quintile (fewest elderly residents) and 4th quintiles (higher proportions) have a slightly higher proportion of benefits than population share (the others slightly lower).

Table 5-3: Air quality impacts on elderly residents

Quintiles – elderly resident >>>	1 (fewest elderly)	2	3	4	5 (most elderly)	Total
No. of people with improved air quality	9,035	8,829	8,650	4,946	2,035	33,496
No. of people with reduced air quality	644	208	-	-	-	853
No. of net winners	8,391	8,620	8,650	4,946	2,035	32,643
Net winners in each quintile as % of total	25.7%	26.4%	26.5%	15.2%	6.2%	100%
No. of net losers	-	-	-	-	-	-
Net losers in each quintile as % of total	-	-	-	-	-	-
Share of population in study area	23.1%	30.1%	26.8%	14.0%	6.0%	100%
Distributional assessment for study area	✓✓	✓	✓	✓✓	✓✓	

5.2 Accessibility

5.2.1 Trip making propensity

Trip matrices from GBATS4 have been interrogated to identify the propensity for movements in, out and through the CAZ area. This has focused on baseline trip situations because these give a good indication of potential impacts. Behavioural response rates suggest that some 40% of non-compliant trips could be cancelled, diverted or switched mode. These responses could lead to adverse accessibility impacts for all households, irrespective of their relative level of income deprivation, though there is clearly greater scope for hardship for income deprived areas. The distributional assessment is concerned with identifying the potential for trip patterns to be disrupted, that can be well-related demographic information such as low-income households and population demographic. Underlying accessibility issues could be compounded for low-income groups, where there is an established lower propensity for motor vehicle ownership. Trips have therefore been cross-referenced with demographic data to 'distribute' the potential impacts across the populations.

AM peak movements across the CAZ boundary into the CAZ area are considered (ostensibly towards and to the city centre, but also encompassing trips that pass through the area in the baseline situation). The reverse has been identified for the PM peak; trips from the CAZ area (again encompassing trips that are passing through the area. Within this interrogation, trips by non-compliant cars have been isolated for the illustrations; thus for trips crossing the CAZ boundaries, trips by non-compliant petrol and diesel powered cars have been identified (analogous with implementation of a CAZ 'D')[10].

5.2.1.1 Low-income households

Table 5.4 identifies trips between BCC and the CAZ area, relating the origin/destination to the amount of income deprivation. This indicates that overall trip making related to the CAZ area in peak periods is slightly skewed towards the least income deprived areas of the city. This is quite marked when considering the CAZ area, unsurprising perhaps because the area basically covers the city centre, which has significant higher-income employment.

Table 5-4: Trips between BCC and CAZ area – low-income households

Car trips between BCC and CAZ area in the AM/PM peaks	Quintiles – income deprivation					Total
	1 (most deprived)	2	3	4	5 (least deprived)	
CAZ area						
AM peak – into CAZ in the AM peak	570	1,095	432	820	1,057	3,974
Share of total	14.4%	27.6%	10.9%	20.6%	26.6%	100%
PM peak – out of CAZ in the PM peak	485	866	477	812	1,187	3,827
Share of total	12.7%	22.6%	12.5%	21.2%	31.0%	100%
Share of population in BCC	24.1%	25.8%	13.2%	17.1%	19.8%	100%

Table 5.5 identifies the number of people living in areas that generate journeys to/from the CAZ area, where the numbers of trips by non-compliant cars are greater or lower than the average proportions of similar vehicles making trips overall. Distribution of trip-making with respect to low income household population is relatively even across income groups.

[10] In this instance, compliant diesel vehicles are those that satisfy Euro 6 emission regulations (registered in approximately 2014/15 or newer), and compliant petrol vehicles are those that satisfy Euro 4 (registered in approximately 2004/05 or newer).

Table 5-5: Use of non-compliant cars to access CAZ area – low-income households

People from areas where more trips are made into/out of CAZ in the AM/PM peaks using non-compliant cars than average	Quintiles – income deprivation					Total
	1 (most deprived)	2	3	4	5 (least deprived)	
CAZ area						
AM peak – into CAZ in the AM peak	30,544	45,524	22,415	23,566	23,468	145,517
Share of total	21.0%	31.3%	15.4%	16.2%	16.1%	100%
PM peak – out of CAZ in the PM peak	57,799	72,817	37,214	57,371	44,158	269,359
Share of total	21.5%	27.0%	13.8%	21.3%	16.4%	100%
Share of population in BCC	24.1%	25.8%	13.2%	17.1%	19.8%	100%

Figures 5.2 & 5.3 show interrogation of baseline (2021) trip matrices for trips across the CAZ area boundary, which can be cross-referenced with the CAP scheme. This identifies the key locations across the city where areas of lower income generate the most trips across CAZ boundary. Figure 5.2 shows the number of trips (ranked) made by non-compliant cars to the CAZ area in AM peak, with Figure 5.5 showing similar information for the reverse trips in PM peak. Unsurprisingly, these align with areas of greatest income deprivation, but, as noted above, the overall distribution of this effect is reasonably even.

Figure 5-2: Low-income areas – trips (ranked) by non-compliant cars to CAZ area, AM peak

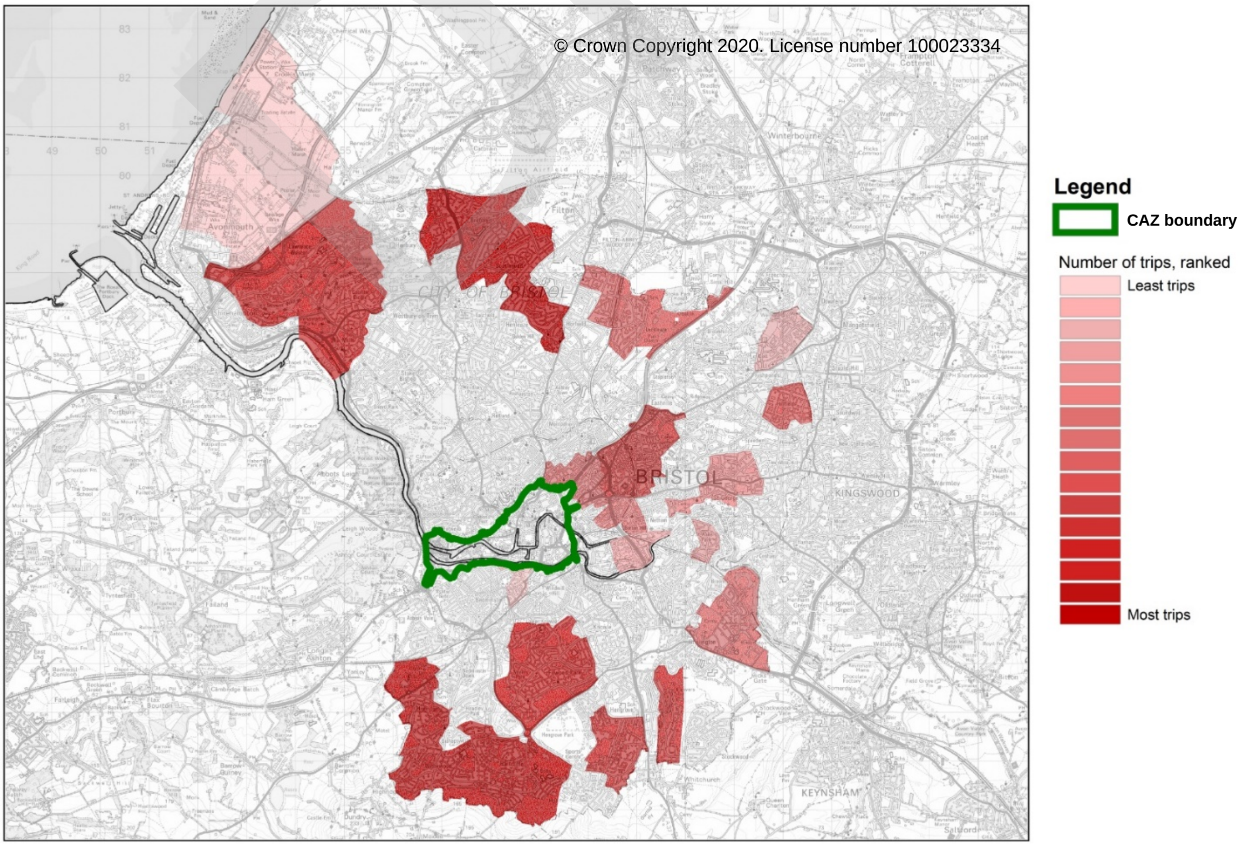
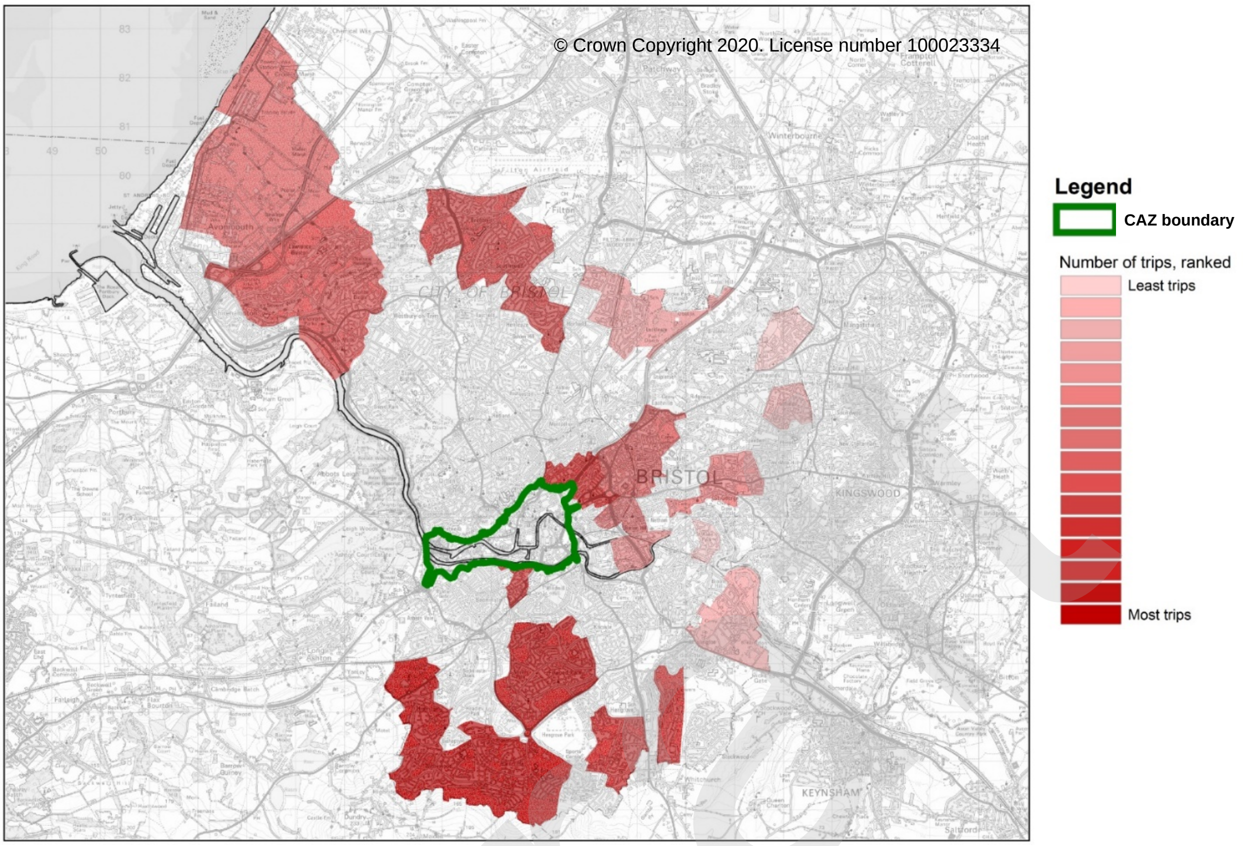


Figure 5-3: Low-income areas – trips (ranked) by non-compliant cars from CAZ area, PM peak



5.2.1.2 Children

Table 5.6 identifies the number of children living in areas that generate journeys to/from the CAZ area, where the numbers of trips by non-compliant cars are greater or lower than the average proportions of similar vehicles making trips overall. Distribution of trip-making with respect to low income household population is relatively even across the population.

Table 5-6: Use of non-compliant cars to access CAZ area – children

People from areas where more trips are made into/out of CAZ in the AM/PM peaks using non-compliant cars than average	Quintiles – children					Total
	1 (least)	2	3	4	5 (most)	
CAZ area						
AM peak – into CAZ in the AM peak	3,505	3,168	4,453	8,724	7,118	26,969
Share of total	13.0%	11.7%	16.5%	32.3%	26.4%	100%
PM peak – out of CAZ in the PM peak	5,950	7,275	7,589	11,314	18,642	50,769
Share of total	11.7%	14.3%	14.9%	22.3%	36.7%	100%
Share of population in BCC	11.1%	11.5%	14.4%	24.3%	38.7%	100%

5.2.1.3 Elderly people

Table 5.7 identifies the number of elderly people living in areas generating journeys to/from the CAZ area, where the numbers of trips by non-compliant petrol and diesel cars, and all diesel cars, are greater or lower than the average proportions of similar vehicles making trips overall. Distribution of trip-making with respect to low income household population is relatively even across the population.

Table 5-7: Use of non-compliant cars to access CAZ area – elderly people

People from areas where more trips are made into/out of CAZ in the AM/PM peaks using non-compliant cars than average	Quintiles – elderly people					Total
	1 (least)	2	3	4	5 (most)	
CAZ area						
AM peak – into CAZ in the AM peak	3,258	5,078	6,626	3,082	382	18,425
Share of total	17.7%	27.6%	36.0%	16.7%	2.1%	100%
PM peak – out of CAZ in the PM peak	8,335	9,474	8,658	3,793	1,150	31,409
Share of total	26.5%	30.2%	27.6%	12.1%	3.7%	100%
Share of population in BCC	23.1%	30.1%	26.8%	14.0%	6.0%	100%

5.2.1.4 Disabled people

Table 5.8 identifies the number of disabled people living in areas generating journeys to/from the CAZ area, where the numbers of non-compliant cars are greater or lower than the average proportions of similar vehicles making trips overall. Distribution of trip-making with respect to low income household population is relatively even across the population.

Table 5-8: Use of non-compliant cars to access CAZ area – disabled people

People from areas where more trips are made into/out of CAZ in the AM/PM peaks using non-compliant cars than average	Quintiles – disabled people					Total
	1 (least)	2	3	4	5 (most)	
CAZ area						
AM peak – into CAZ in the AM peak	13,011	7,378	2,938	894	1,112	25,333
Share of total	51.4%	29.1%	11.6%	3.5%	4.4%	100%
PM peak – out of CAZ in the PM peak	21,442	15,156	6,643	1,822	164	45,227
Share of total	47.4%	33.5%	14.7%	4.0%	0.4%	100%
Share of population in BCC	49.2%	28.4%	14.1%	6.1%	2.3%	100%

5.2.1.5 Women

Table 5.9 identifies the number of women living in areas that generate journeys to/from the CAZ area, where numbers of trips by non-compliant cars are greater or lower than average proportions of similar vehicles making trips overall. Distribution with respect to low income household population is slightly uneven across the population for the CAZ area.

Table 5-9: Use of non-compliant cars to access CAZ area – women

People from areas where more trips are made into/out of CAZ in the AM/PM peaks using non-compliant cars than average	Quintiles – women					Total
	1 (least)	2	3	4	5 (most)	
CAZ area						
AM peak – into CAZ in the AM peak	16,995	11,200	12,404	14,423	18,278	73,300
Share of total	23.2%	15.3%	16.9%	19.7%	24.9%	100%
PM peak – out of CAZ in the PM peak	41,316	20,994	21,731	23,267	28,000	135,309
Share of total	30.5%	15.5%	16.1%	17.2%	20.7%	100%
Share of population in BCC	30.3%	15.4%	17.4%	15.5%	21.4%	100%

5.2.1.6 Ethnic minorities

Table 5.10 identifies the number of ethnic minority people living in areas that generate journeys to/from the CAZ area, where the numbers of trips by non-compliant cars are greater or lower than the average proportions of similar vehicles overall. Distribution of trip-making with respect to low income household population is relatively even across the population.

Table 5-10: Use of non-compliant cars to access CAZ area – ethnic minority population

People from areas where more trips are made into/out of CAZ in the AM/PM peaks using non-compliant cars than average	Quintiles – ethnic minority					Total
	1 (least)	2	3	4	5 (most)	
CAZ area						
AM peak – into CAZ in the AM peak	0	239	2,215	4,799	10,330	17,583
Share of total	0.0%	1.4%	12.6%	27.3%	58.8%	100%
PM peak – out of CAZ in the PM peak	176	323	3,055	7,219	29,864	40,637
Share of total	0.4%	0.8%	7.5%	17.8%	73.5%	100%
Share of population in BCC	0.2%	0.5%	6.3%	17.7%	75.2%	100%

5.2.2 Time benefits

In addition to the assessment of trip making propensity, distributional assessments of the transport benefits of proposed measures have been carried out, to provide a proxy of the potential impacts that the CAP scheme could have on accessibility; this is based specifically on journey time benefits calculated by TUBA.

Benefits need to be attributed to home-based trip making, but it is not possible to directly allocate user benefits to the home-base of trips. As such, it was assumed that benefits in the AM peak are all from the origin; in the PM peak benefits from the destination, and the interpeak (IP) would be an average of origin and destination benefits. All journeys are assumed as non-business. The impact area is the city of Bristol, so benefits in LSOAs (Lower Super Output Areas) of Bristol have been considered. Benefits from TUBA model zones were attributed to the LSOA they are in. Where a zone crosses multiple LSOAs, the proportion of postcodes (OS Code-Point Open) from the zone that were within the LSOA were used to distribute the benefits. Using the income deprivation scores, each LSOA has been assigned to a national quintile. For each quintile, the benefits/disbenefits have been summed, the proportion of benefits/disbenefits calculated and the share of the population within the city of Bristol in found. The proportion of benefits/disbenefits has been compared to the proportion for each quintile and been given an assessment score in line with Table 8 in TAG unit A4.2. For the socio-demographic groups the total user benefits/disbenefits for each LSOA has been multiplied by the percentage of the total population for the group within the LSOA. Each LSOA has been assigned a quintile based upon the percentage of the population of the group compared to the regional figures. Benefits for each quintile were then summed and compared to the proportion of that group within the quintile.

Figure 5.4 shows the locations of LSOAs across Bristol that have the greatest net journey time benefits. The remainder of this section of the report cross-references the locations with demographic data to determine the distributional impacts of the scheme against the various categories.

5.2.2.1 Low-income households

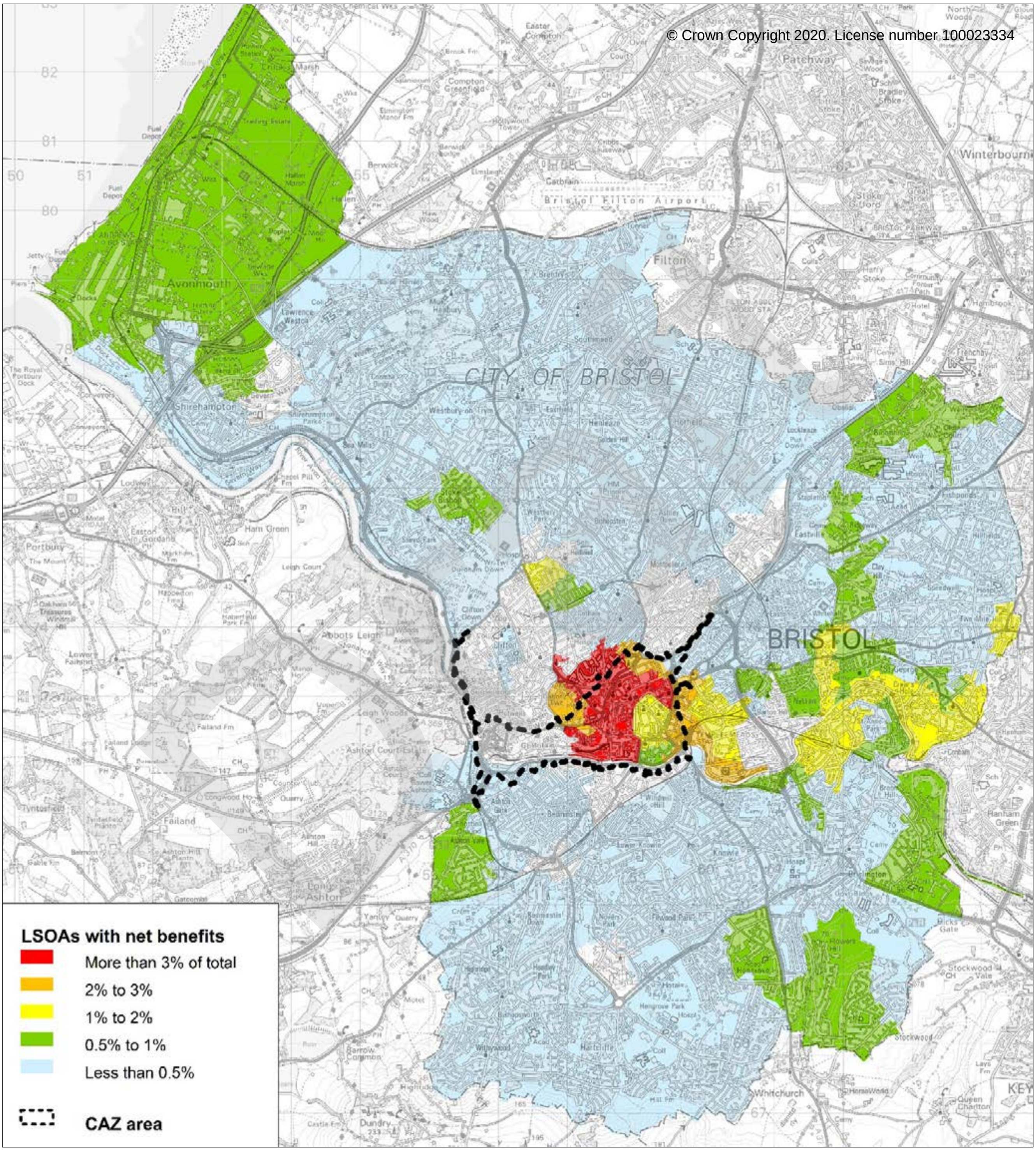
Table 5.11 presents the appraisal matrix for the combination of low-income households and TUBA journey time benefits in Bristol. This demonstrate that beneficial impacts accrue across all low-income groups, with significantly greater proportions of low-income households (i.e. those in areas that are most income deprived) benefitting relative to this group's share of the overall population in the Bristol City Council area. Summary results of distributional impacts are as follows:

- All income groups receive a benefit in journey times. Distribution is slightly uneven, with slightly greater proportion of benefits across middle and less deprived quintiles.

Table 5-11: Accessibility (time benefit) impacts on low income households

Quintiles – income deprivation >>>	1 (most deprived)	2	3	4	5 (least deprived)	Total
Total benefits (sum of LSOAs, £'000s)	£716.76	£1,438.61	£655.23	£1,279.37	£966.22	£5,056.19
Total disbenefits (sum of LSOAs, £'000s)	-	-	-	-	-	-
Share of time benefits	14%	28%	13%	25%	19%	100%
Share of time disbenefits	-	-	-	-	-	-
Share of population in study area	24%	26%	13%	17%	20%	100%
Distributional assessment for study area	✓	✓✓	✓✓	✓✓✓	✓	

Figure 5-4: Distribution of time benefits (accessibility)



Page 193

5.2.2.2 Children

Tables 5.12 presents the appraisal matrix for children and TUBA journey time benefits in Bristol. Summary results of distributional impacts are as follows:

- All quintiles receive a benefit in journey times. Distribution is slightly skewed, with slightly greater proportion of benefits across areas with the lowest proportions of children.

Table 5-12: Accessibility (time benefit) impacts on children

Quintiles – children >>>	1 (fewest children)	2	3	4	5 (most children)	Total
Total benefits (sum of LSOAs, £'000s)	£132.12	£107.36	£162.99	£227.25	£228.92	£858.64
Total disbenefits (sum of LSOAs, £'000s)	-	-	-	-	-	-
Share of time benefits	15%	13%	19%	26%	27%	100%
Share of time disbenefits	-	-	-	-	-	-
Share of population in study area	11%	11%	14%	24%	39%	100%
Distributional assessment for study area	✓✓	✓✓	✓✓✓	✓✓	✓	

5.2.2.3 Elderly residents

Tables 5.13 presents the appraisal matrix for elderly residents and TUBA journey time benefits in Bristol. Summary results of distributional impacts are as follows:

- All quintiles receive a benefit in journey times. Distribution is slightly skewed, with greater benefits for areas with fewer elderly residents (opposite profile of distribution as seen for children), but reasonably even across the distribution of older people.

Table 5-13: Accessibility (time benefit) impacts on elderly residents

Quintiles – elderly residents >>>	1 (fewest elderly)	2	3	4	5 (most elderly)	Total
Total benefits (sum of LSOAs, £'000s)	£134.61	£143.52	£146.39	£99.46	£44.90	£568.89
Total disbenefits (sum of LSOAs, £'000s)	-	-	-	-	-	-
Share of time benefits	24%	25%	26%	17%	8%	100%
Share of time disbenefits	-	-	-	-	-	-
Share of population in study area	23%	30%	27%	14%	6%	100%
Distributional assessment for study area	✓✓	✓	✓	✓✓	✓✓	

5.2.2.4 Disabled residents

Table 5.14 presents the appraisal matrix for the disabled residents and TUBA journey time benefits in Bristol. Summary results of distributional impacts are as follows:

- All quintiles receive a benefit in journey times. Distribution is slightly skewed, with greater benefits for areas with fewer disabled residents (similar, but more pronounced profile of distribution as seen for elderly residents).

Table 5-14: Accessibility (time benefit) impacts on disabled residents

Quintiles – disabled residents >>>	1 (fewest disabled)	2	3	4	5 (most disabled)	Total
Total benefits (sum of LSOAs, £'000s)	£294.10	£350.06	£79.32	£46.07	£10.40	£779.94
Total disbenefits (sum of LSOAs, £'000s)	-	-	-	-	-	-
Share of time benefits	38%	45%	10%	6%	1%	100%
Share of time disbenefits	-	-	-	-	-	-
Share of population in study area	40%	30%	18%	8%	3%	100%
Distributional assessment for study area	✓	✓✓✓	✓	✓	✓	

5.2.2.5 Women

Table 5.15 presents the appraisal matrix for women and TUBA journey time benefits in Bristol. Summary results of distributional impacts are as follows:

- All quintiles receive a benefit in journey times. Distribution is slightly skewed, with greater benefits for areas with fewer women (similar profile of distribution as seen for elderly residents).

Table 5-15: Accessibility (time benefit) impacts on women

Quintiles – women >>>	1 (fewest females)	2	3	4	5 (most females)	Total
Total benefits (sum of LSOAs, £'000s)	£827.59	£425.65	£505.47	£290.50	£459.17	£2,508.38
Total disbenefits (sum of LSOAs, £'000s)	-	-	-	-	-	-
Share of time benefits	33%	17%	20%	12%	18%	100%
Share of time disbenefits	-	-	-	-	-	-
Share of population in study area	30%	15%	17%	15%	21%	100%
Distributional assessment for study area	✓✓	✓✓	✓✓	✓	✓	

5.2.2.6 Ethnic minorities

Table 5.16 presents the appraisal matrix for ethnic minority residents and TUBA journey time benefits in Bristol. Summary results of distributional impacts are as follows:

- All quintiles receive a benefit in journey times. Distribution is relatively even compared to population of ethnic minority residents, albeit with greater benefits for areas with more ethnic minority residents.

Table 5-16: Accessibility (time benefit) impacts on ethnic minorities

Quintiles – ethnic minorities >>>	1 (fewest BAME)	2	3	4	5 (most BAME)	Total
Total benefits (sum of LSOAs, £'000s)	£2.14	£2.42	£41.44	£89.29	£789.24	£924.52
Total disbenefits (sum of LSOAs, £'000s)	-	-	-	-	-	-
Share of time benefits	0.2%	0.3%	4.5%	9.7%	85%	100%
Share of time disbenefits	-	-	-	-	-	-
Share of population in study area	<1%	<1%	6%	18%	75%	100%
Distributional assessment for study area	✓	✓	✓	✓	✓✓✓	

5.3 Affordability

5.3.1 Low-income households

Distributional assessment of affordability impacts is linked with that of accessibility impacts, in particular in comparison with income deprivation. Table 5.17 (copy of Table 5.5) identifies the number of people living in areas that generate journeys to/from the CAZ area, which can be cross-referenced with the CAP scheme, where the numbers of trips by non-compliant cars are greater or lower than the average proportions of non-compliant vehicles making trips in the study area. This provides an initial picture of the way that trip-making can affect distributional assessment of the impacts of the CAP on affordability.

Table 5-17: Low-income households – use of non-compliant cars to access the CAZ area

People from areas where more trips are made into/out of CAZ in the AM/PM peaks using non-compliant cars than average	Quintiles – income deprivation					Total
	1 (most deprived)	2	3	4	5 (least deprived)	
CAZ area						
AM peak – into CAZ in the AM peak	30,544	45,524	22,415	23,566	23,468	145,517
Share of total	21.0%	31.3%	15.4%	16.2%	16.1%	100%
PM peak – out of CAZ in the PM peak	57,799	72,817	37,214	57,371	44,158	269,359
Share of total	21.5%	27.0%	13.8%	21.3%	16.4%	100%
Share of population in BCC	24.1%	25.8%	13.2%	17.1%	19.8%	100%

As well as trip-making and the potential need to make changes to journeys that could result in higher cost of travel, affordability impacts are also influenced by the ability of individuals and households to replace their vehicles or change travel patterns/behaviours. The average cost of replacing a car is estimated at almost £4,800 (see OBC-16 'Primary Behavioural Response Calculation Methodology' within Appendix E of this OBC for more details of this calculation). Whilst low income households may well spend far less replacing their vehicles, this cost represents a significant affordability issue for all households, but particularly for low-income households that have less capacity to replace non-compliant vehicles.

5.3.1.1 Vehicle operating costs

In addition to the assessment of trip making propensity, specific distributional assessments of transport benefits have been carried out, to provide a proxy of the potential impacts that the CAP scheme could have on affordability; this is based specifically on vehicle operating cost benefits calculated by TUBA.

Distribution of vehicle operating cost benefits generated by TUBA has followed the same basic premise as that of journey time benefits (used as a proxy for accessibility). Benefits are attributed to home-based trip making, so benefits in the AM peak are assumed to be from the origin; PM peak benefits from the destination, and an average of origin and destination benefits is used in the interpeak (IP). LSOAs in Bristol have been included, and where a model zone crosses multiple LSOAs, the proportion of postcodes from the zone are used to distribute the benefits. Income deprivation scores and socio-demographic data has been allocated to relevant quintiles and benefits/disbenefits summed accordingly.

Tables 5.18 has the appraisal matrix for a combination of low-income households and TUBA vehicle operating cost benefits in Bristol. They demonstrate that beneficial and detrimental impacts accrue across all low-income groups, with significant variation across groups. Summary distributional impacts are:

- The impact across all income groups is a net benefit in vehicle operating costs, though whereas the two most deprived income groups receive a benefit, the middle and two least deprived groups have disbenefits. Distribution of benefits and disbenefits is relatively even within the quintiles affected, but as there are both net positive benefits and negative disbenefits for individual quintiles, the overall effect is uneven, though the greatest (and net) benefits accrue to the lower income quintiles.

Table 5-18: Affordability (veh.op cost benefit) impacts on low-income households

Quintiles – income deprivation >>>	1 (most deprived)	2	3	4	5 (least deprived)	Total
Total benefits (sum of LSOAs, £'000s)	£62.96	£120.55	-	-	-	£183.51
Total disbenefits (sum of LSOAs, £'000s)	-	-	-£53.63	-£12.73	-£5.93	-£72.30
Net benefits						£111.21
Share of time benefits	34%	66%	-	-	-	100%
Share of time disbenefits	-	-	74%	18%	8%	100%
Share of population in study area	24%	26%	13%	17%	20%	100%
Distributional assessment for study area	✓	✓✓✓	×××	×	×	

5.3.2 Businesses

Many businesses rely on LGVs and HGVs as part of their day-to-day operations (e.g. trades people). In light of the importance of LGVs and HGVs to business operation, the affordability impacts of the CAZ on use of LGVs and HGVs was assessed.

Figures 5.5 & 5.6 interrogate baseline (2021) trip matrices for trips across the CAZ area boundary by LGVs, which can be cross-referenced with the CAP scheme as appropriate. These identify the key locations across the city where businesses reliant on LGVs generate the most trips across the CAZ area boundary. Figure 5.5 shows the number of trips (ranked) made by non-compliant LGVs in AM peak, with Figure 5.6 showing similar information for the reverse trips in PM peak.

Reflecting that retail businesses are the most reliant on HGVs entering the centre of the city, Figures 5.7-5.8 show interrogation of baseline (2021) trip matrices for trips across the CAZ area boundary by HGVs associated with retail business areas. These identify the key locations across the city where the most trips made by non-compliant HGVs generated across the CAZ area boundary. Figure 5.7 shows the number of trips (ranked) made by non-compliant HGVs in AM peak, with Figure 5.8 showing similar information for the reverse trips in PM peak.

This analysis does not take implicitly into account the significant cost of replacing LGVs and HGVs, just illustrating the distribution of impacts across the study area. Note that the average cost of vehicle replacement is estimated to be around £5,900 for LGVs and in the range £18,000 to £24,500 for HGVs (see OBC-16 'Primary Behavioural Response Calculation Methodology' within Appendix E of this OBC for details of this calculation). For small firms operating on small margins or with low turnover and for bigger firms with multiple non-compliant vehicles, these vehicle replacement costs could deter the purchase of compliant vehicles. This could result in such firms incurring the CAZ charge as their vehicles enter the areas, or firms avoiding the areas altogether. This could impact on business profitability and consumer choice.

5.3.3 Taxis

Assessment of transport user costs and benefits using TUBA indicate that transport user costs will increase for taxis. This impact is primarily driven by a significant increase in non-fuel vehicle operating costs, with journey times and fuel vehicle operating costs showing a marginal decrease. Non-fuel vehicle operating costs are expected to increase in response to increased distance related costs and vehicle capital costs associated with working vehicles. A net increase in transport user costs suggests that taxi firms operating will suffer from additional costs and affordability issues.

Further, the cost of replacing a taxi to one of compliant standard is also likely to add to affordability issues for taxi firms. Vehicle replacement costs may be prohibitive to taxi owners, leading to taxis either incurring the CAZ charge or avoiding the CAZ area altogether. If taxis stop entering the CAZ, this could lead to subsequent accessibility impacts for people that rely on taxi journeys to access key amenities and social infrastructure.

5.4 Other Impacts on businesses

As well as the affordability impacts outlined above, businesses are affected in a number of other ways. Firstly, either CAZ could deter footfall in central Bristol as consumers and tourists opt to visit alternative locations. This is a particular concern given that a significant proportion of all retail employment is located within the CAZ area. Further, more than 20% of all employment in tourism-led sectors in Bristol, such as 'accommodation and food services' and 'arts, entertainment and recreation' are located within the CAZ boundary. These sectors could be particularly vulnerable to the potential negative effects of a CAZ, such as decreased footfall. Overall though, this is not atypical, as some 37% of all jobs in Bristol are located within the CAZ boundary.

Secondly, the CAZ could result in increased charges for deliveries to/from businesses located in the central area, providing additional costs that would either need to be absorbed by the business (affecting profitability) or passed on to consumers (increasing prices and potentially deterring custom). Most businesses located within the CAZ are likely to be reliant on LGVs and HGVs to supply/undertake deliveries. In total, there are more than 3,000 business located within the CAZ area, the majority of which are micro business or SMEs (2,200 and 800 respectively). This relates to 14% of all businesses in Bristol that will be directly affected by the CAZ based on their geographic location. In addition, there are a range of businesses located outside the CAZ area that require routeing of LGVs/HGVs through the CAZ area as part of their day-to-day activities (e.g. for trades people or for suppliers/deliveries). Although these businesses are not directly affected by either CAZ based on their geographical location, their business practices may mean regular entry to either CAZ, potentially resulting in charges being imposed.

Thirdly, many businesses rely on employment sourced from a wide geographic labour market; imposing a charge on non-compliant vehicles could cause a contraction of this market as labour located in the wider geographic area choose to work in other locations that are unaffected by a CAZ. Employees using non-compliant LGVs throughout the region could be deterred from undertaking work requiring entry to the CAZ boundary. This is reflected in Figures 4.19 and 4.20 showing LGV reliant businesses and retail businesses respectively.

Further, around 40% of labour demand in the CAZ area is supplied from outside the Bristol City Council area. Significant labour supply is sourced from the other authorities in the West of England. Over 60% of all labour sourced from outside of Bristol travels into central Bristol via private car, so a significant proportion of the labour supply to central Bristol could be directly affected by either CAZ intervention. This could make central Bristol a less attractive place to work (and consequently to set up business). Employees with non-compliant vehicles that currently drive into central Bristol could be incentivised to look elsewhere for employment opportunities, contributing to a labour supply deficit in the short term.

Figure 5-5: LGV-reliant areas – trips (ranked) by non-compliant LGVs to CAZ area, AM peak

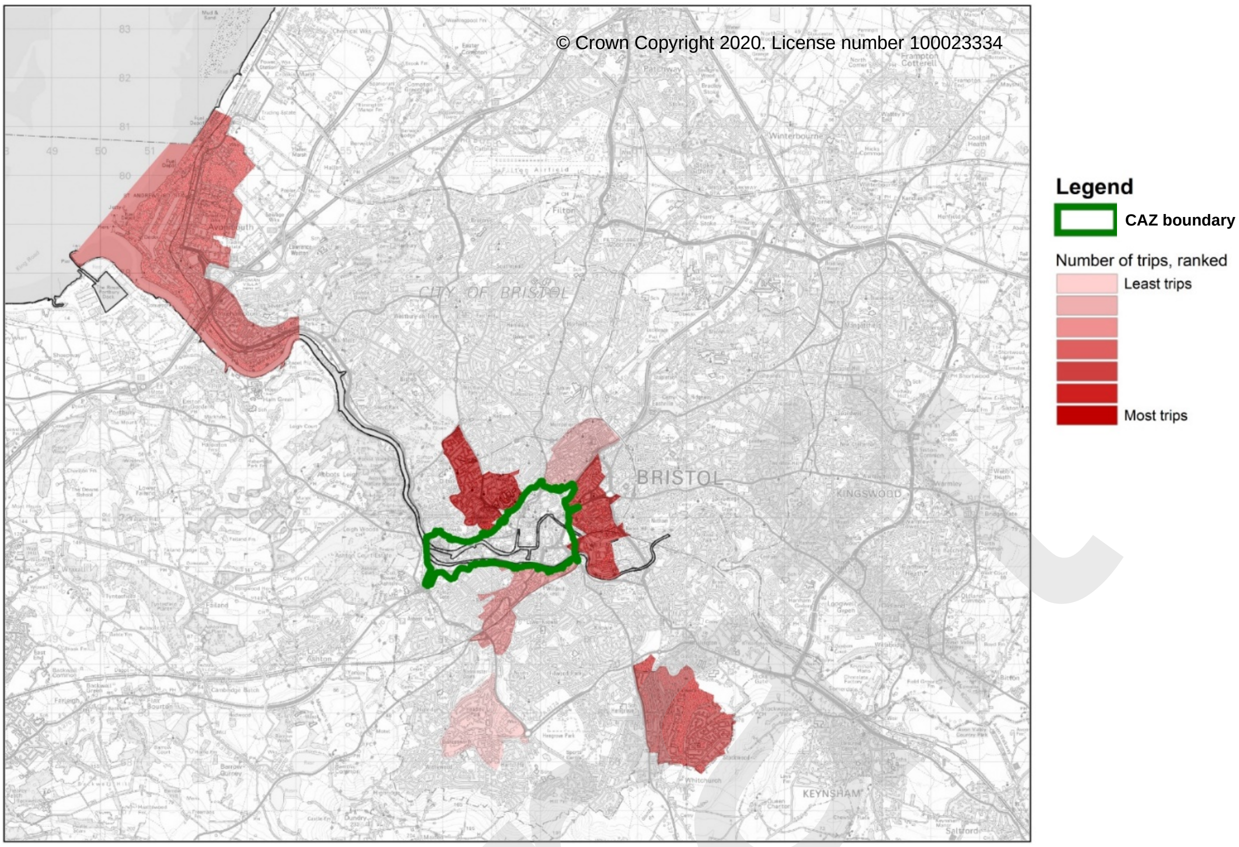


Figure 5-6: LGV-reliant areas – trips (ranked) by non-compliant LGVs to CAZ area, PM peak

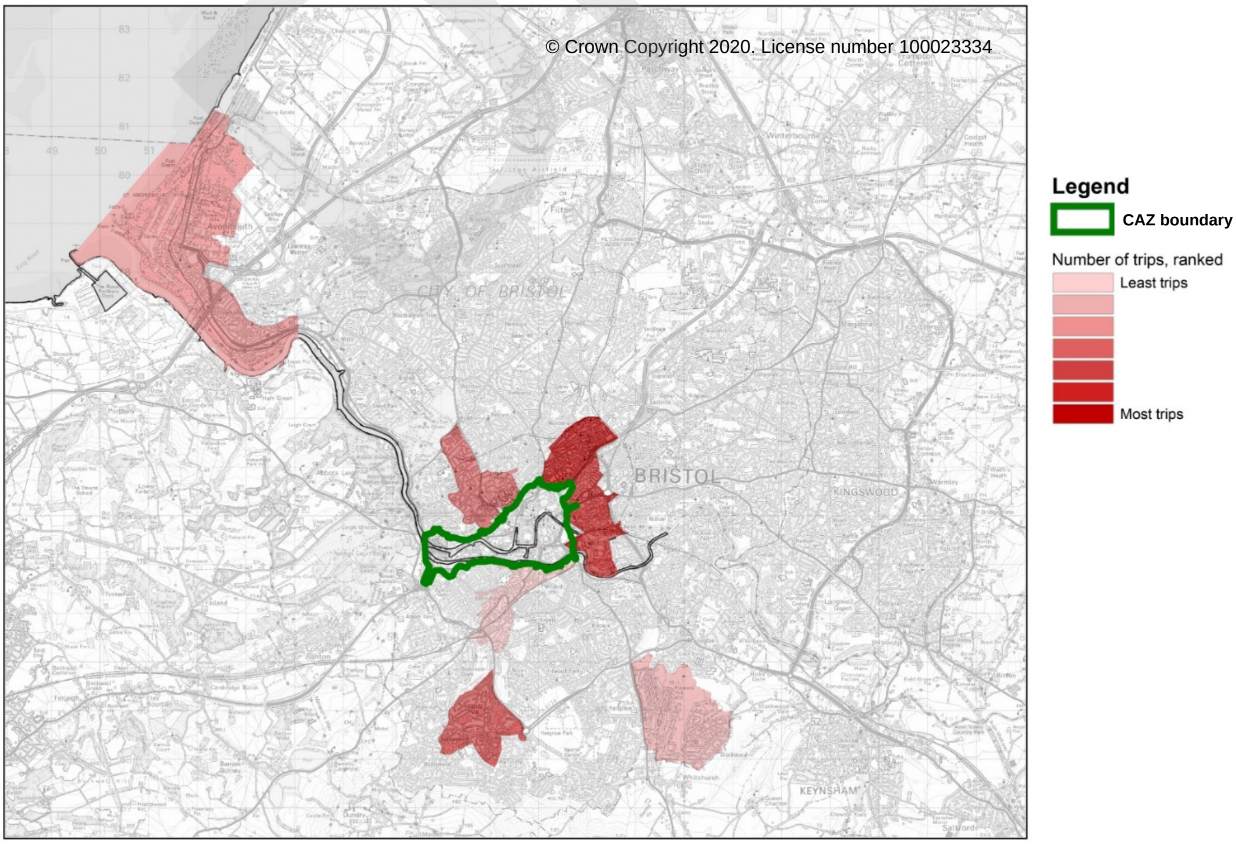


Figure 5-7: Retail areas – trips (ranked) by non-compliant HGVs to CAZ area, AM peak

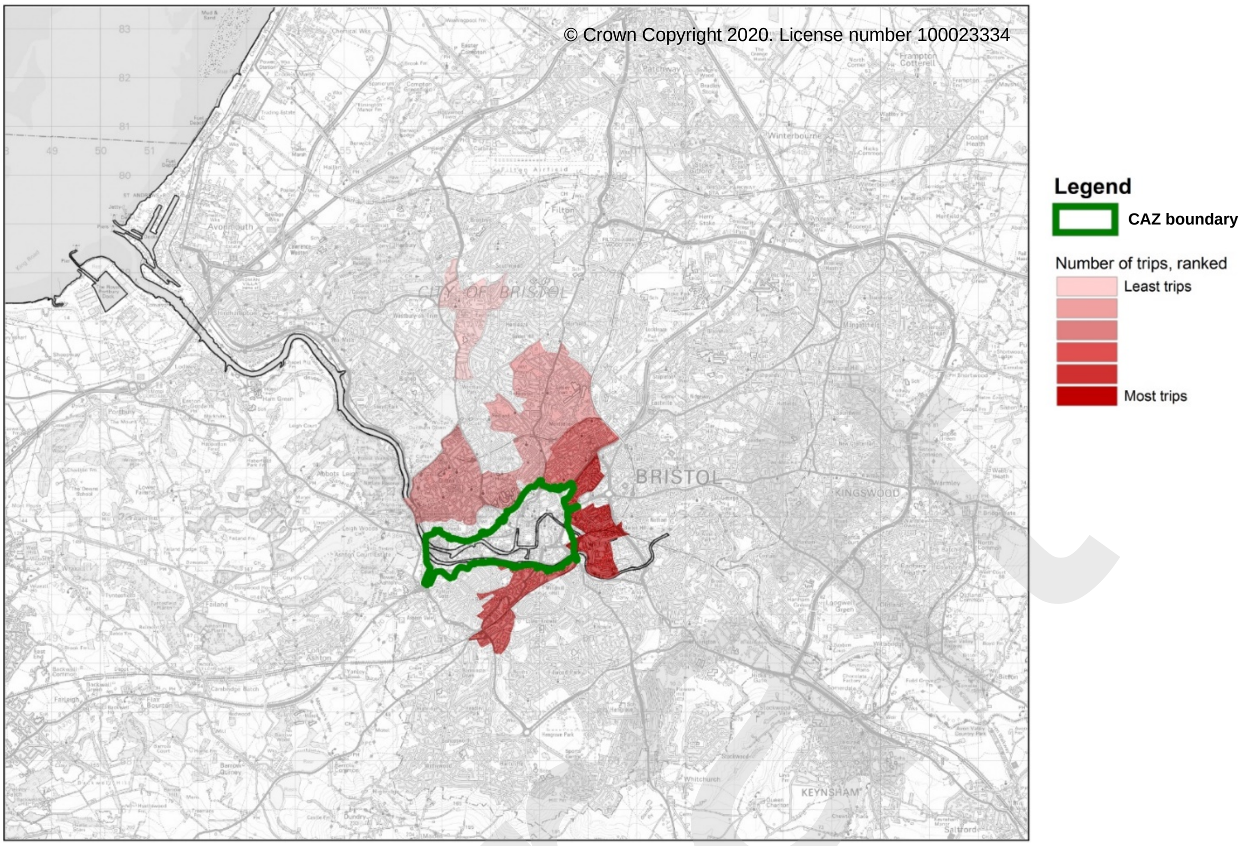
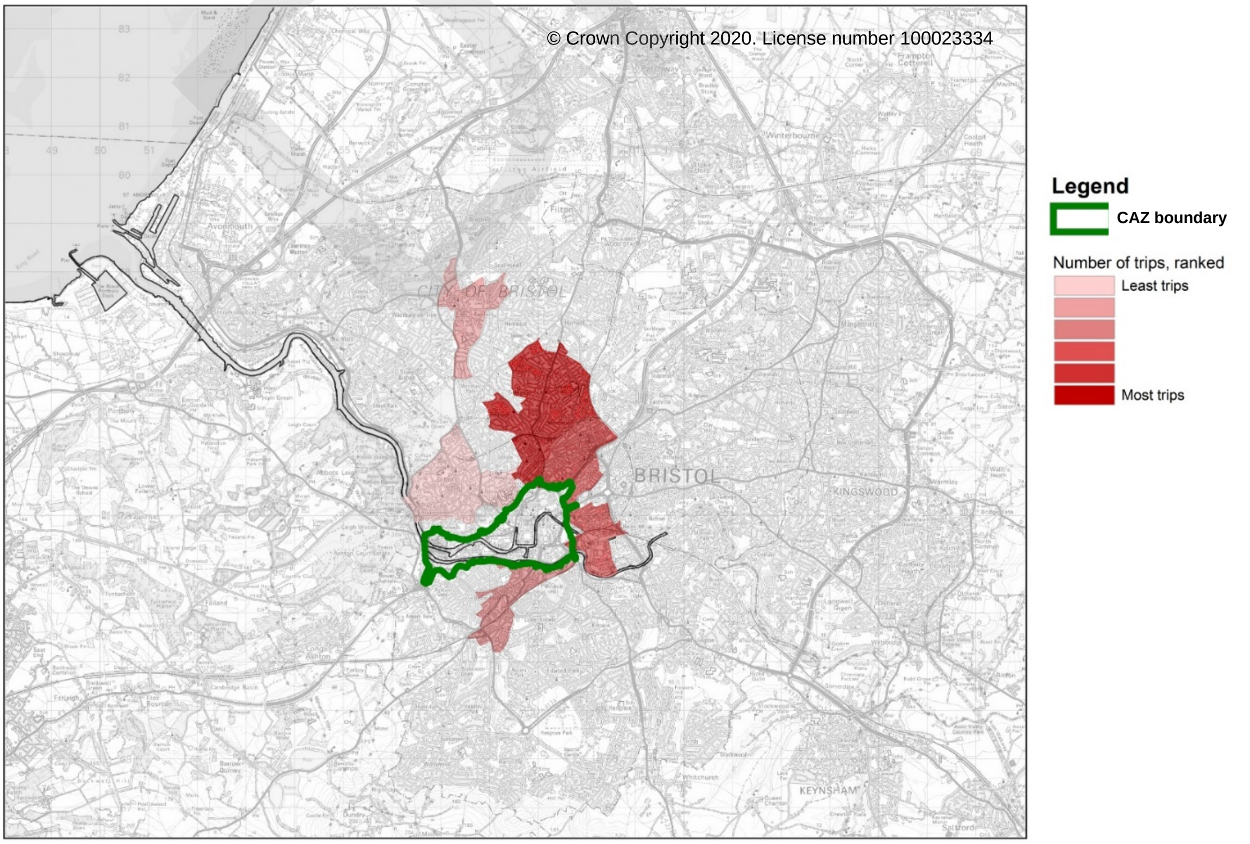


Figure 5-8: Retail areas – trips (ranked) by non-compliant HGVs to CAZ area, PM peak



Page 200

6. Key findings

6.1 Distributional impacts by category

6.1.1 Air quality

Tables 6.1 summarises key findings of the distributional and equalities analysis for air quality on low-income households. Table 6.2 shows similar summary information for impacts on children, with Table 6.3 rounding-up the summary results with information for impacts on elderly residents. In general, air quality improves for most residents. Distributional impacts are broadly even, though impacts for some (a few) combinations demographic groups are not evenly as distributed.

Table 6-1: Air quality impacts on low-income households

Quintiles – income dep. >>>	1 (most deprived)	2	3	4	5 (least deprived)	Distribution
CAP scheme	✓	✓✓	✓✓	✓✓	✓✓✓	Slightly uneven

Table 6-2: Air quality impacts on children

Quintiles – children >>>	1 (fewest children)	2	3	4	5 (most children)	Distribution
CAP scheme	✓✓	✓✓	✓✓	✓✓	✓	Reasonably even

Table 6-3: Air quality impacts on elderly residents

Quintiles – elderly resident >>>	1 (fewest elderly)	2	3	4	5 (most elderly)	Distribution
CAP scheme	✓✓	✓	✓	✓✓	✓✓	Slightly uneven

6.1.2 Accessibility

Accessibility impacts are likely to be mixed, and as such both trip matrices and journey time benefits have been interrogated to determine movements by non-compliant vehicles (and thus propensity to be impacted) and quantified proxy impacts respectively. Trip-making propensity impacts are evenly distributed in comparison with population distributions but are most heavily on the middle and lower quintiles of income deprived areas, areas with the most children and those that have the lowest proportions of females. Impacts are disproportionately felt by the higher quintiles of the concentration of ethnic minorities, middle quintiles for disabled residents and more evenly for elderly residents.

Tables 6.4-6.9 present a summary of the key findings of the distributional and equalities analysis for accessibility (using TUBA time benefits as a proxy) for low-income households, children, elderly residents, disabled residents, women and ethnic minorities respectively. Time benefit impacts are largely beneficial and the distributional impact broadly even.

Table 6-4: Accessibility (time benefit) impacts on low-income households

Quintiles – income dep. >>>	1 (most deprived)	2	3	4	5 (least deprived)	Distribution
CAP scheme	✓	✓✓	✓✓	✓✓✓	✓	Slightly uneven

Table 6-5: Accessibility (time benefit) impacts on children

Quintiles – children >>>	1 (fewest children)	2	3	4	5 (most children)	Distribution
CAP scheme	✓✓	✓✓	✓✓✓	✓✓	✓	Slightly uneven

Table 6-6: Accessibility (time benefit) impacts on elderly residents

Quintiles – elderly residents >>>	1 (fewest elderly)	2	3	4	5 (most elderly)	Distribution
CAP scheme	✓✓	✓	✓	✓✓	✓✓	Reasonably even

Table 6-7: Accessibility (time benefit) impacts on disabled residents

Quintiles – disabled residents>>>	1 (fewest disabled)	2	3	4	5 (most disabled)	Distribution
CAP scheme	✓	✓✓✓	✓	✓	✓	Slightly uneven

Table 6-8: Accessibility (time benefit) impacts on women

Quintiles – female residents >>>	1 (fewest females)	2	3	4	5 (most females)	Distribution
CAP scheme	✓✓	✓✓	✓✓	✓	✓	Reasonably even

Table 6-9: Accessibility (time benefit) impacts on ethnic minorities

Quintiles – ethnic minorities>>>	1 (fewest BAME)	2	3	4	5 (most BAME)	Distribution
CAP scheme	✓	✓	✓	✓	✓✓✓	Reasonably even

6.1.3 Affordability

Affordability impacts will be negative across the socio-economic and business groups that directly interact with CAZ area where non-compliant vehicles are still used, as charges are applied for non-compliant vehicle. However, assessments in terms of vehicle operating costs calculated as part of TUBA assessments of the scheme are positive overall, although impacts are slightly disproportionately felt by the least income deprived communities, which see a slight disbenefit in vehicle operating costs. Table 6.10 presents a summary of the key findings of the distributional and equalities analysis for affordability using TUBA vehicle operating cost benefits as a proxy. Affordability and cost impacts also fall on businesses operating non-compliant LGVs and HGVs who are either based in the CAZ area or operate within central Bristol.

Table 6-10: Affordability (vehicle operating cost benefit) impacts on low-income households

Quintiles – income dep. >>>	1 (most deprived)	2	3	4	5 (least deprived)	Distribution
CAP scheme	✓	✓✓✓	×××	×	×	Uneven

6.2 Summary distributional impacts

Tables 6.11 and 6.12 show summary results, with Table 6.11 bringing together elements, and Table 6.12 summarising the distributional impacts for each social/business group.

Table 6-11: Distributional impacts

Quintiles >>>	1 (most)	2	3	4	5 (least)	Distribution
Air quality impacts						
Low-income households	✓	✓✓	✓✓	✓✓	✓✓✓	Slightly uneven
Children	✓✓	✓✓	✓✓	✓✓	✓	Reasonably even
Elderly residents	✓✓	✓	✓	✓✓	✓✓	Slightly uneven
Accessibility (time benefit) impacts						
Low-income households	✓	✓✓	✓✓	✓✓✓	✓	Slightly uneven
Children	✓✓	✓✓	✓✓✓	✓✓	✓	Slightly uneven
Elderly residents	✓✓	✓	✓	✓✓	✓✓	Reasonably even
Disabled residents	✓	✓✓✓	✓	✓	✓	Slightly uneven
Women	✓✓	✓✓	✓✓	✓	✓	Reasonably even
Ethnic minorities	✓	✓	✓	✓	✓✓✓	Reasonably even
Affordability (vehicle operating cost) impacts						
Low-income households	✓	✓✓✓	×××	×	×	Uneven

Table 6-12: Summary impact:

Social or Business Group	Air Quality		Accessibility		Affordability	
	Net +ve impact	Distribution	Net +ve impact	Distribution	Net +ve impact	Distribution
Deprivation / low income	✓	Slightly uneven	✓	Slightly uneven	×	Uneven
Children	✓	Reasonably even	✓	Slightly uneven		
Elderly people	✓	Slightly uneven	✓	Reasonably even		
Disabled people			✓	Slightly uneven		
Women			✓	Slightly uneven		
Ethnic minorities			✓	Reasonably even		
Businesses – SMEs					×	Reasonably even
Businesses – LGVs/HGVs					×	Uneven
Businesses – taxis					×	Reasonably even

6.3 Summary of distributional impacts

6.3.1 Impact summary

Table 6.13 provides a brief qualitative summary of the distributional impacts of the CAP scheme. Table 6.14 indicates some of the potential mitigation target groups that could arise from the CAP scheme.

Table 6-13: Summary distributional impacts

Impact group	CAP scheme
Air quality	Improvements across the city. Distribution of impacts is reasonably even across social groups, though slightly uneven compared to distributions of income deprivation and elderly residents.
Accessibility	Time benefit calculations are all positive, and the distributional impact is slightly reasonably for some groups, but would not overall be considered problematic. Trip-making propensity by people with non-compliant cars related to the CAZ area is evenly distributed.
Affordability	Vehicle operating cost impacts are unevenly distributed, being disproportionately felt by the least income deprived communities, which see a slight net disbenefit in vehicle operating costs; others have net benefits.
Businesses	There are potential direct impacts on costs for LGV/HGV reliant businesses. Though trips by non-compliant LGV/HGV reliant businesses are reasonably spread around the city, those making trips related to the CAZ area will be affected; the CAZ area is reasonably small, but covers most of the city centre.
Car owners	Impact on all non-compliant car owners. Distribution of non-compliant car ownerships is slightly skewed to lower income groups, but ability to react to charges more so (such as households with more than one vehicle).

Table 6-14: Summary distributional impacts – potential mitigation targets

Potential mitigation target group [a]	CAP scheme
Residents	
Residents of the CAZ area	✓
Specific trip needs	
Disabled people – blue badge	✓ [b]
Disabled people – with specialist vehicle adaptions	✓ [b]
Out-patient access to hospital	✓ [b]
Car owners	
Low income non-compliant car owners	✓
Low-income compliant car owners	✗
1-car households	✗
Businesses	
SMEs located in the CAZ area	✓
LGV/HGV-dependent businesses not specifically located in the CAZ area but that need to travel into it	✓
Taxi owners/drivers – BCC registered	✓
Taxi owners/drivers – other authority registration	✓

Note:

a) Groups that could be potential mitigation targets indicated with; '✓' are those where there is the potential for mitigation to be sought by or on behalf of the group, though not necessarily that it would be granted as part of implementing the CAP; '✗' indicates that it is less likely that any mitigation would applicable to this group. However, both are indicative, and neither a positive nor negative indication in this table is a definitive indicator of future proposals.

b) Could be linked with a destination specifically in the CAZ area and/or owning/using a non-compliant car

6.3.2 Concluding remarks

Air quality improves for most residents. Distributional impacts of air quality changes are also broadly even, though exceptions again exist, with impacts for some demographic groups not being evenly distributed.

Accessibility impacts are likely to be mixed. Trip-making propensity impacts are evenly distributed in comparison with population distributions but are most heavily on the middle and lower quintiles of income deprived areas, areas with the most children and those that have the lowest proportions of females. Impacts are disproportionately felt by the higher quintiles of the concentration of ethnic minorities, middle quintiles for disabled residents and more evenly for elderly residents. TUBA time benefits are also used as a proxy for accessibility; these are largely beneficial and the distributional impact broadly even.

Affordability impacts are likely to be negative across the socio-economic and business groups that directly interact with CAZ area, especially where there are charges for non-compliant cars or any restrictions on specific movements. Impacts are disproportionately felt by the second most and least income deprived communities. Impacts also fall on businesses operating non-compliant LGVs and HGVs who are either based in the CAZ area or based elsewhere but operate within central Bristol and hence also interact with the CAZ area. Using TUBA vehicle operating cost benefits as a proxy for affordability indicates that the impacts are positive overall across the city as a whole, although impacts are slightly disproportionately felt by the least income deprived communities, which see a slight disbenefit in vehicle operating costs.

There will be direct impacts on the costs of operation for LGV/HGV reliant businesses, where their operations interact with the CAZ area. Trips by non-compliant LGV/HGV reliant businesses are reasonably spread around the city.

The extent of impact on non-compliant car owners varies with the extent of users' trip-making requirements associated with the class 'D' charging measures in the CAZ area. Distribution of non-compliant car ownership is slightly skewed to lower income groups. However, the (in)ability of households to react to restrictions is unevenly felt by lower income groups (for instance, there are fewer multi-car households that could potentially using a compliant vehicle).

Bristol City Council Clean Air Plan

Full Business Case Procurement Strategy

FBC-32

17 February 2021

Bristol City Council

Bristol City Council Clean Air Plan

Document Title:	Procurement Strategy
Document No.:	FBC-32
Date:	17 February 2021
Author:	BCC

Contents

1. Introduction

This strategy supports the FBC Commercial Case, providing more detail and context. The detail herein is commercially sensitive due to the naming of suppliers and for that reason is only briefly referenced within associated documents. The strategy covers procurement methods, work packages to be procured, soft market testing and contract management.

2. Details on the Overarching Procurement Strategy

Bristol City Council (BCC) has identified the most efficient routes to market for three key work packages; Cameras, Back Office system and Signs/Lines, in order to meet the tight timescales of the project. Compliance with PCR2015 Regulations and achieving value for money remain key objectives for the project.

By using pre-existing contracts and frameworks where they are available and suitable, the procurement timescales will be reduced over that of a traditional OJEU tender. Options for work packages which require tailored procurement exercises are detailed throughout this strategy.

The existing contracts and frameworks that BCC are intending to use have all been competitively tendered for via OJEU in line with the Council's procurement rules. Regular benchmarking and close contract management of each contract assures BCC that these are still the most effective arrangements offering value for money and so full market testing and compliance is assured for the CAZ project. If BCC were to need to undertake a competitive process through the OJEU, the Open procedure would be used to enable award of contract within the shortest timeframes, whilst maintaining compliance and achieving the desired result on the Most Economically Advantageous Tender (MEAT criteria).

Contract Models for each of the frameworks and contracts identified to deliver the works and services, mandate the use of the NEC3 suite of contracts. Where an alternative route to market is required the most appropriate contract will be used which may be the NEC3 contracts or Bristol City Council's suite of contracts depending on the requirement type.

3. Summary of services required

3.1 Design – including specification

The BCC project team have completed the preliminary design which will meet legal air quality requirements and detailed designs have been commenced. BCC is using the Professional Services Framework which it set up in January 2016, via a competitive OJEU procedure, to commission a design team.

The detailed design work will largely be carried out by Engineering Design Consultancy via a resource which has already been allocated, with support from the selected supplier; Jacobs Engineering Ltd (part of the Professional Services Framework). There could be deliverables where BCC consider that in the interests of time, suppliers who are awarded other elements of the work packages may be awarded a 'design and build' contract from an approved Framework. BCC intend to use the most effective route to market and the most appropriate contract terms to provide the design elements of the CAZ project and confirmation of this is fully detailed in this report following market engagement.

3.2 Approved Device (ANPR, data Connectivity and Back Office System)

BCC considered several options to deliver the purchase, installation and maintenance of the Approved Devices.

Since publishing the OBC in November 2019, BCC continued to research the most effective procurement route from the options available and have determined that the Traffic Management Technology II framework (Lot 2) is the most appropriate route to market for the Approved Devices.

The other option considered was a current BCC contract:

- The Supply, Installation and Maintenance of Equipment and Infrastructure for the Control and Management of Traffic and Related Services contract, has a specific provision for the supply, installation and maintenance of ANPR cameras. This includes the provision of electrical and data connections and street furniture where required. The contract (Traffic signal maintenance/install - Dynniq) was awarded following a tender in the OJEU in June 2014 and runs until June 2022. Further investigation found that the contract would not allow for the direct award of the supply, installation and maintenance of Approved Devices and as such this option was discounted.

The CCS framework has been reviewed and we will be using the following:

- Traffic Management Technology 2 framework which has 15 lots was tendered by CCS in October 2016 and work can be awarded to suppliers through this agreement until October 2020, but any call off contracts in place before that date can be let for the required duration of the project in order to deliver the goods or services. The lot that is most relevant to BCC's requirement is:
    - lot 2 – Traffic Monitoring, Traffic Enforcement Cameras and Security Body Worn cameras
    - Lot 7 Urban Traffic Management Control and Common Database Systems
    - Lot 11 Traffic Management Communications
    - Lot 12 Traffic Management Professional Services
    - Lot 13 Ancillary Roadside Equipment

These Lots can be used in isolation or in any combination to achieve the best outcomes, required by BCC to provide the CAZ for Bristol. Lots 2, 7 and 11 could provide the elements of the Approved Device. Lot 12 could provide the VCA certification and Lot 13 any data cabinets or power supply cables that may be required.

Since publishing the OBC, it has been decided that Lot 2 of the framework is the most appropriate route to market in terms of Value for Money (the national framework has the collaborative spend of the whole public sector behind it and we will test this further with BCC specific requirements at mini-competition stage), Technology Specification (the end to end Approved devices can be procured from a single vendor in order to achieve the VCA approvals that BCC require), timescales and programme (the framework has already undertaken the Selection stage and Contract negotiations which will reduce the procurement times and we will also be able to ensure that the delivery programme meets BCC's project deadlines).

Further design work has highlighted that the Approved Devices will be mounted on lighting columns, this has opened up the use of an existing BCC Lighting Contract with Volker Highway as the supplier. This will reduce timescales as BCC will be able to engage with Volker Highway very quickly and we intend to appoint them to the role of Principle Contractor. Their contracted schedule of rates will be used to confirm the budget requirement for the installation of new columns and the management of the Approved Device installations. Due to the nature of this procurement until the camera supplier is known and a co-design phase can begin to finalise the scheme detail, for the purposes of FBC we have submitted two pricing options for the lighting column work package. The design phase (following award of contract to the camera supplier), will establish on a site by site basis the type of camera and data connection type required. This will have an impact on the column specification required e.g. due to the weight of the camera and bracket required and whether a mobile or hardwired data connection is most appropriate.

3.2.1 Mobile Enforcement Vehicles

BCC intends to have one mobile enforcement vehicle to assist with the enforcement if the CAZ within the zone. The Approved Device equipment required for this vehicle will be procured at the same time as the fixed Approved Devices and the awarded supplier will be expected to fit out the vehicle as per the BCC specification. The vehicle will be purchased by the council's Fleet Team, a full EV.

Bus Lane Enforcement Cameras:

BCC explored the opportunity to combine procurement of the CAZ Approved Devices with the Bus Lane Enforcement project (to upgrade BCC's current BLE Approved device stock), so that a single procurement exercise would deliver a contract to cover both requirements.

As with the above work, an initial tender exercise was undertaken for the CAZ provision in November 2019. This was subsequently abandoned because of Covid-19 and the uncertainty of the effects this would have on the baseline and existing proposals. A formal report was undertaken to review how the Council should proceed. Following this period of review, a new and revised tender exercise was approved that aligned more with the current and emerging situation.

Due to the tight deadlines as per the legal direction to reach compliance in the shortest possible time, a 2nd procurement exercise was undertaken and published via the same framework set out above. After receiving submissions, this has now reached the post evaluation and seeking Board approval for the award stage.

3.2.2 Infrastructure – On Road

Non-Illuminated Signage:

Set up by BCC in October 2017, the Bristol Highway Asset Management and Associated Works Framework (BHAMAAWF) can be called off against until October 2021, with any purchase orders raised before that date valid until the goods/services are provided. The BHAMAAWF has 15 Lots which can be used to provide the relevant requirements and it is envisaged that Lot 5 – Road Markings and Lot 6 - Highway works < £150k or Lot 7 - Highway works > £150k will be used to deliver the on-road requirements and Non-Illuminated signage. BCC has extensive experience of using BHAMAAWF to deliver major road schemes since 2017 and would utilise this learning for the CAZ delivery.

The table below shows the suppliers awarded to those Lots:

Lot 5	Road Markings	Glamorgan
Lot 6 (a single supplier Lot with ETM as the single preferred supplier. If ETM cannot provide the service and turns down the work then and only then it would be open to the other suppliers).	Highway works < £150k	**ETM**
		Eurovia
		Alun Griffiths
		NM Construction
		SGlos
Lot 7 (open tender contract)	Highway Works > £150k	ETM
		Eurovia
		Alun Griffiths
		NM Construction
		Dyer & Butler

To enable call off from the BHAMAAWF, BCC has several options available to it. The following excerpt is from the Framework Agreement describing those options:

> "This Selection and Quotation Procedure sets out how a contractor is selected to provide a Work Package. There are three methods of selecting a contractor to carry out a Works Package.
>
> The Council will in its sole discretion decide:
>
> a) which method to use to select a contractor for each work package;
>
> b) the appropriate works to include in each work package and size of each work package; and
>
> c) from which Lot to procure each work package

Method A (selection by Schedule of Rates)

This will be for works which the Customer considers are standard and the Customer considers are adequately described in the Generic Pricing and Works Information and to be carried out in usual circumstances without unusual constraints.

Method AA (selection by Limited Mini-Competition)

This will be for works which involve items not listed in the Schedule of Rates and/or with limited constraints but which the Customer considers are otherwise adequately described in the Generic Pricing and Works Information.

Method B (selection by Mini-Competition)

This will be for major works or packages which are non-standard or which the Customer considers to be carried out in unusual circumstances or with unusual constraints"

Lot 5 is used to procure the Road Markings and Method A will be used as this lot has a single supplier awarded to it – Glamorgan (there are another 4 successful contractors if Glamorgan turn down the job). The schedule of rates within the agreement will be used when submitting the quotation for the works required.

Lot 6 is used to procure Highways works under £150,000. ETM is the first placed supplier and under the call off terms of the framework is the single preferred supplier. If ETM cannot provide the service and turns down the work BCC would open the opportunity to the other suppliers on the lot.

Or; Lot 7 is used to procure Highways works over £150,000 and is accessed by re-opening competition for the individual requirements to all of the five suppliers awarded a place on this lot, which is the method BCC have chosen for the non-illuminated signs procurement.

Illuminated Signs: This work package will be let through the current BCC Street Lighting term contract with Volker Highway. This will enable BCC to engage with the supplier swiftly whilst also providing assurances that value for money has already been tested with the supplier.

The original tender for this provision was run alongside the initial abandoned tender of a BLE and CAZ solution. It was never awarded. Since that point they have not run another tender because they need to know first the CAZ solution that is to be implanted implemented. Our legal advised them they could not go out on a proviso basis, as was done with second run CAZ & BLE.

3.3 Enforcement

BCC has an existing 'Provision of SiDem Suite Support' contract with Conduent for the provision of an enforcement management system (SiDem). BCC were an early adopter of this system when it was first introduced and as such own all required licences in perpetuity, only the support and maintenance is an annual cost against this software. The current support and maintenance agreement expires in March 2021, with an option to extend this for a further two, 12 month periods to March 2023. BCC do not currently anticipate changing the enforcement management system and have engaged with the supplier, to modernise how BCC currently access the service (from an on-prem deployment to a managed hosted option), so that the increase in demand due to the CAZ for Bristol can be easily accommodated.

3.4 Infrastructure

There are several schemes which BCC propose as additional measures to support the CAZ for Bristol. Listed below are those measures which can all be procured using the BCC BHAMAAWF. This framework is the compliant, market tested and robust framework put in place by BCC for similar projects. BCC has a long history of successfully delivering transport schemes with DfT funding e.g. MetroBus, Cycling Ambition Fund, Better by Bus Area Fund etc.

- Increase, Improve, update Legible City Signage – part of the CAF Bid to mitigate the impact of the scheme
- Purchase of additional air quality monitoring units – part of implementation of the scheme
- Old Market Gap cycle route – part of the implementation of the scheme

Each work package will be procured through the BHAMAAWF and either Lot 6 or 7 as appropriate, following the prescribed call off procedure in line with the complexity of each specification, once drawn up.

Lot 6	Highway works < £150k	ETM
		Eurovia
		Alun Griffiths
		NM Construction
		SGlos
Lot 7	Highway Works > £150k	ETM
		Eurovia
		Alun Griffiths
		NM Construction
		Dyer & Butler

3.4.1 Provision of Additional Measures – Mitigation Measures

- Provision of loans and grants for taxi, private hire, LGV and HGV drivers to upgrade and / or retrofit their vehicles. BCC will outsource the provision of administering the grants, using the agreement set up by Bath and North Somerset Councils (B&NES) in support of their own CAZ provision, within which Bristol City Council are named as an authority permitted to use the agreement. B&NES invested both resource and budget into ensuring that the agreement was fit for purpose, was in line with all relevant regulatory requirements and that other Authorities could use the agreement to leverage best value. As this agreement is available to BCC and our

Legal and Commercial teams have reviewed and approved its use, the complexity of running our own procurement would have few if any advantages over the B&ANES agreement.

- Provision of a loan scheme to assist businesses and members of the public meeting certain criteria to replace their vehicles. BCC will outsource the provision of administering the grants for this purpose to a third party. BCC intend to procure this via the framework set up by Bath and North Somerset Councils (B&NES) in support of their own CAZ provision, within which Bristol City Council are named as an authority permitted to use the agreement. B&NES invested both resource and budget into ensuring that the agreement was fit for purpose, was in line with all relevant regulatory requirements and that other Authorities could use the agreement to leverage best value. As this agreement is available to BCC and our Legal and Commercial teams have reviewed and approved its use, the complexity of running our own procurement would have few if any advantages over the B&ANES agreement.

- Provision of a grant for scheduled bus services to retrofit their vehicles.

- The provision of a Micro-consolidation unit with cargo freight bikes. The Office of Low Emissions Go Ultra Low West (GULW) project, which BCC are running alongside the CAZ project, will provide a grant for the provision of a trial hub for the purposes of 'last mile' and "only mile" deliveries to addresses within the CAZ area.

  If the service model proposed proves successful BCC intends to use lessons learned from this trial along with further market engagement to fully understand the complexity of offering such a hub. This will inform the specification to roll this out to other locations and will outsource this provision by way of a concessions contract. Calculations are still being validated, however, this which will be advertised in line with the Concessions Contracts Regulations 2016 (CCR16) as an open competition, if expected turnover from the concession is >£4.1M over the term of the concession. If the turnover is estimated to be <£4.1M then internal BCC procurement regulations will be adhered to. BCC terms and conditions for the provision of a concession will be adapted to provide a robust contractual position and ensure that the deliverables are met to the satisfaction of BCC.

- Mobility credits and/or subsidised bus travel for certain demographic or income groups. Business support including personalised travel planning, targeted door knocking and roadshows, travel plan support and CAF scheme promotional publicity.

3.5 Detailed Requirements

Each procurement item will be managed depending on the requirement, value and length of contract in line with existing BCC procurement rules and policy. The two tables below show what is being sought, staffing plans and interfaces with existing council policy, strategies and contracts. The first is for all infrastructure items and the second covers all remaining items to be procured.

Item	Description	Lead Team/Resource Pressure	Risks and impacts	Mitigation
1	Non- illuminated signs (CAZ D boundary, advanced signs and repeater camera	BCC internal Engineering Design Service	-Timescale changes to tendered works	-Early decision on powers.

Item	Description	Lead Team/Resource Pressure	Risks and impacts	Mitigation
	signs - Supply, installation and connection.)		and limited or no site investigations. -Subject to specifications, approvals and permissions to work on neighbouring authorities. -WPD supply	-Tender CAZ C and diesel advanced signs separately. Completed – awaiting award
2	Non illuminated signs (Advanced signs on Highways England Network) – Design, procurement and supervision	Highways England (HE)/Kier	-Approvals. -Designer resource.	Early HE engagement
3	Non illuminated signs (Advanced signs)- Supply and installation.	Highways England/Kier & Contractor	-Approvals. -Contractor resource.	Early HE engagement
4	Civils only for cameras - trenching, BNET ducting, feeder pillars and reinstatement for cameras (as required i.e. 4G not used).	BCC internal Engineering Design Service. BNET Service Delivery Manager.	Timescale and changes to tendered works. -Limited or no site investigations.	-Separation of ducting for BNET and signs. -Trial pits where we anticipate problems.
5	Civils only for illuminated signs – trenching, electrical ducting and reinstatement.	BCC internal Engineering Design Service.	-Timescale and changes to tendered works. -Limited or no site investigations.	Separation of ducting for BNET and CAZ C signs.

Item	Description	Lead Team/Resource Pressure	Risks and impacts	Mitigation
6	Structural assessment and testing of lighting columns which cameras are to be erected on.	Highways Maintenance Street lighting and Voker Laser.	Higher than anticipated failure rate.	Recruit for additional staff members if required.
7	Replacement of lighting columns if required following assessment (above).	Street Lighting / Volker Laser	-Designer and contractor resource. -Timescale and changes to tendered works.	Recruit for additional staff members if required.
8	Illuminated signs (HGV and diesel ban) - Supply, installation and connection.	Street Lighting / Volker Laser	-Contractor resource. -WPD permit to work on cables.	
9	Electrical - transfers, disconnections and injections.	Street Lighting / Volker Laser	-Designer and contractor resource. -Timescale and changes to tendered works.	
10	Enforcement Cameras, brackets and connection to lamp column or other agreed platform. Include maintenance and decommissioning if required.	Procurement team Competition via the TMT II Framework.	-Timescale and changes to tendered works. -Approvals process.	Completed, awaiting award.
11	BNET connection and not including civils i.e. cabling.	BCC internal Engineering Design Service.	Timescale and changes to tendered works	
12	Enforcement Cameras – erection of masts.	Volker Highway	-Designer and contractor resource.	

Item	Description	Lead Team/Resource Pressure	Risks and impacts	Mitigation
			-Timescale and changes to tendered works.	
13	Enforcement Cameras – erection of oversized signal poles at junctions.	Volker Highways	-Designer and contractor resource. -Timescale and changes to tendered works.	
14	Back office systems for above	Included as part of the Approved Device procurement the TMT II		Tender completed and awaiting award
15	Decommissioning of existing camera locations (if not included in new camera contract).	Network Management. To be included in the Approved Device tender	5 years hence – estimate.	Tender completed and awaiting award
16	4G camera cards (Every 100 cameras cost circa £180,000 for 5 years).	Procurement team Included as part of the Approved Device procurement through TMT II	Timescale and changes to tendered works.	Tender completed and awaiting award
17	VMS signs - replacement and installation (if included).	Signals	-Designer and contractor resource. -Timescale and changes to tendered works.	
18	Temporary signage for launch – including VMS.	Engineering Design / Network Management		

Item	Description	Lead Team/Resource Pressure	Risks and impacts	Mitigation
19	Non illuminated signs - Decommissioning at project end.	Engineering Design / Street Lighting		
20	Illuminated signs - Decommissioning at project end.	Street Lighting and or Engineering Design		

	Details	Staffing and stakeholders	Consents and interfaces.
CAZ System and Implementation	Enforcement	Staff already in place to deliver this. Liaison with the Police and other agencies utilizing the camera system and processes will be required	The enforcement will be combined and managed alongside the bus lane enforcement as a standalone project complete with project team
	Operations (staff)	In House provision using BCC existing resource and contracts as required / appropriate. Existing BCC recruitment policies in place and able to be utilized to get in the level of staff required to deliver the scheme	
	Communications and Engagement	In House provision using BCC existing resource and contracts as required / appropriate, additional staff already recruited due to the requirement to engage early	This project will need to align with other related projects being planned and delivered across the city. This has been made a top council priority which is being aligned with existing systems and resources
	Old Market Gap cycle scheme	BCC Highways framework (BHAMAAWF)	The BHAMAAWF has already been through a procurement and tendering process. The BCC cycling and walking team will lead this project and have extensive experience of delivering similar schemes

	Details	Staffing and stakeholders	Consents and interfaces.
	New air quality monitoring units	In House provision using BCC existing resource and contracts as required	
Additional Measures	Provision of grants and loans for taxi, private hire, HGV and LGV drivers to upgrade and / or retrofit their vehicles	B&NES have established an agreement which has been approved for use by BCC legal and Commercial teams	Early liaison with the licensing team will ensure alignment with existing and new policies as required
	A loan and grant scheme to assist businesses and the public meeting certain criteria to replace their vehicles	B&NES have established an agreement which has been approved for use by BCC legal and Commercial teams	BCC finance team and legal will need to be involved in how we set this scheme up based on previous experience
	Provision of a grant for scheduled bus services to retrofit their vehicles	In House provision using BCC existing resource and contracts as required / appropriate, additional staff already recruited due to the requirement to engage early	
	Increase, Improve, update Legible City Signage	BHAMAAWF	As above

4. Other considerations

4.1 Payment mechanism

Through the Public Contract Regulations 2015, public sector buyers must include 30-day payment terms in their contracts; and require that this payment term be passed down the supply chain. BCC fully adheres to this regulation and all procurement routes under consideration comply with this requirement.

The support and maintenance of current software such as Sidem is paid annually in advance as per the existing contract terms.

Where appropriate, stage payments will be included within the works required to allow suppliers to manage their cash flow and for BCC to forecast committed spend within the project budgets. For example:

The NEC3 contract suite, which is in place for the BCC BHAMAAWF and CCS TMT2 frameworks, provides options on payment mechanism (Option A to F). Due to the programme being a key driver and challenge due to the diverse deliverables being provided by various contractors, payment options which foster a partnership approach will be considered, for example incentivisation models, such as:

- Milestone incentives – Contractors can be incentivised for meeting key dates of the programme but penalised for missing them.
- As a new contract let following a competition via the TMT11 framework, the Approved Devices contract has stage payments tied to key milestones in the delivery, along with penalties for delays which result in the postponement of the go-live date for the CAZ for Bristol.

The payment mechanism in place for the BCC BHAMAAWF is as follows:

- The Contractor submits a first programme for acceptance within XX days – XX is determined by call off contract duration.
- The period for payment is 35 days
- The Contractor submits an application for payment on or within seven days before the assessment date. The Project Manager considers the Contractor's application in assessing the amount due. The Project Manager gives the Contractor details of how the amount due has been assessed.

The payment mechanism for the contract with Volker is as follows:

- The Contractor submits a plan for acceptance within four weeks of the Contract Date
- The period for payment is 35 days
- The Contractor submits an application for payment on or within seven days before the assessment date. The Project Manager considers the Contractor's application in assessing the amount due. The Project Manager gives the Contractor details of how the amount due has been assessed.

The payment mechanism for the framework for the Mobile Enforcement Vehicles is as follows:

- After award, an order for the requirement will be raised.
- An invoice from the supplier (referencing the order no.) will be issued after delivery of the vehicle(s).

- The 30 days cycle would then start upon receipt of this official invoice.

4.2 Programming and interdependencies

Procurement for:	Proposed Procurement Route:	Indicative Days to Complete:
Design (including specification)	BCC Framework – Direct Award	45
Approved Device	BCC Contract – Direct Award	60
Infrastructure (on road)	BCC Framework – Direct Award	60
Traffic Management	Framework – Direct Award	45
Additional Measures – Infrastructure	BCC Framework – Direct Award	60
Additional Measures – Mitigation Measures	B&NES Framework – Direct Award	45

The stages of procurement for a direct award through a framework follow the call off procedures set out in each of the frameworks BCC intends to utilize. It will include the identification of the most appropriate supplier, which may be the top ranked supplier from the original tender process.

If BCC consider that running a competition under the framework is more appropriate then the same steps will be followed as with the direct award procedure above, but will involve all of the suppliers on the lot/framework. Evaluation of the submissions will follow a robust and pre-published set of criteria and will be overseen and managed by a member of the BCC procurement team. Following the evaluation, the bidders will be informed of the outcome and BCC will adhere to the discretionary ten day standstill period before awarding the contract.

With a direct award, there needs to be confidence that the supplier being awarded can deliver what is required from the specification and commercial terms. Sometimes that isn't possible as the BCC specification may have non- standard requests included. In that case, BCC will open competition to 'test' that the suppliers can deliver the request.

For work packages which, following further clarity on the requirements to be met, will require an Open tender process via the OJEU, the full regulated process will be followed, however it is not expected that this will be necessary for the vast majority of the contracts required. The Open procedure is a single stage process which includes a questionnaire to confirm bidders' suitability, capability and capacity to deliver the contract. The specification will be evaluated against robust and pre-published criteria to establish the Most Economically Advantageous Tender. Following the evaluation the bidders will be informed of the outcome and BCC will adhere to the regulated ten day standstill period before awarding the contract.

4.3 Risk Allocation and Transfer

As with any procurement agreement, there is always risk. BCC have identified where these risks can be mitigated by the procurement approach and/or by the contractual terms applied to the agreements. Using existing contracts or established frameworks provides mitigation.

Procurement Risk	Likelihood	Impact	Mitigation
Lack of clarity in scope of what is to be procured (e.g. back office systems / signs)	M	H	Be clear on the scheme, so the scope of the system can also be clear. Agree scope with all stakeholders, including Smart Cities and Highway Signage teams. Utilise JAQU specification guidance for the enabling technologies.
Delays in BCC internal approvals from Procurement Board to progress with planned	M	H	Procurement engaged early in the OBC process. Obtain the necessary internal approvals to progress procurement in line with OBC submission.
Delays in procuring approved ICT hardware, e.g. secure managed network switches.	M	M	Agree scope early with BCC ICT. Use existing approved hardware where possible. Try to avoid 'gold plating' the solution.
Unsuccessful contractors challenge procurement process	M	M	Follow a robust procurement process and be clear on what is being asked and how it will be evaluated. Seek early input from Procurement teams.
No clear plan or budget for decommissioning on street equipment when not required anymore (5-year life / large signs?)	L	M	Plan for decommissioning, including a suitable budget with protections to ring fence it
Procurement of signs for neighbouring local authorities / HE – not covered by the BCC Framework.	M	H	Engage with HE and neighbouring LAs to agree procurement routes
Ability to successfully procure a third party to manage non-UK vehicles since the volume will be very low and there will be little incentive for bidders as the reward will be less than the effort	M	H	We have no alternative but to accept this risk since our existing contract for Foreign Vehicles is tied in with Debt Recovery and offered FOC but this expires in April 2022

4.4 Risks due to Covid-19

BCC have engaged with all suppliers to understand the impacts of Covid-19 on their business and what measures, risks and mitigations need to be considered to enable contracts to be fulfilled both safely and without untenable interruption to delivery. Once award decisions are published the CAZ specific contracts can be reviewed to ensure that any measures put in place will continue to deliver best value and are reasonable and acceptable to both parties.

4.5 Soft market testing

BCC will be utilizing current frameworks and contracts to deliver the CAZ for Bristol, wherever appropriate. Soft market testing will have been undertaken for all of these at their inception. CCS frameworks are put in place following extensive soft market testing to ensure that the framework is suitable for both public sector buyers but also to confirm that the market is be able to supply the requirements. For the Approved Devices competition the framework suppliers were sent an RFI to enable the specification to be written in a market facing format whilst ensuring that JAQU guidelines would be met.

Where new BCC contracts and frameworks are proposed a similar process is undertaken to fully understand the market position and offerings available to ensure a healthy competition between bidders and the right outcome for BCC is achieved.

4.6 TUPE

There have been no TUPE implications identified for any of the deliverables.

4.7 Social value

Social Value is a key strategic aim / outcome for the city of Bristol and is very high on the Mayor's agenda. Social value is about maximising the impact of public expenditure to get the best possible outcomes: improving the economic, social and environmental wellbeing of the area.

BCC have developed a social value toolkit in association with city partners, councillors, and organisations representing small businesses, micro businesses and the voluntary community sector.

The toolkit will:

- make sure the processes used to award grants or contracts recognise the contribution the organisation will make to Bristol, particularly for disadvantaged groups or communities
- help organisations make social value part of their procurement and management processes and bids for funding
- be used to measure and report on the social value of activity and the contracts and grants that we award
- be used in future commissioning activity

All new procurement activities provide for Social Value within the evaluation criteria with a target weighting of 20% of the overall tender score. BCC have partnered with The Social Value Portal which is an on-line solution that allows us to measure and manage the contribution that BCC and our supply chain makes to society, according to the principles laid out within the Public Services (Social Value) Act 2012. This solution allows BCC to report both non-financial and financial data and rewards organisations for doing "more good" in our community.

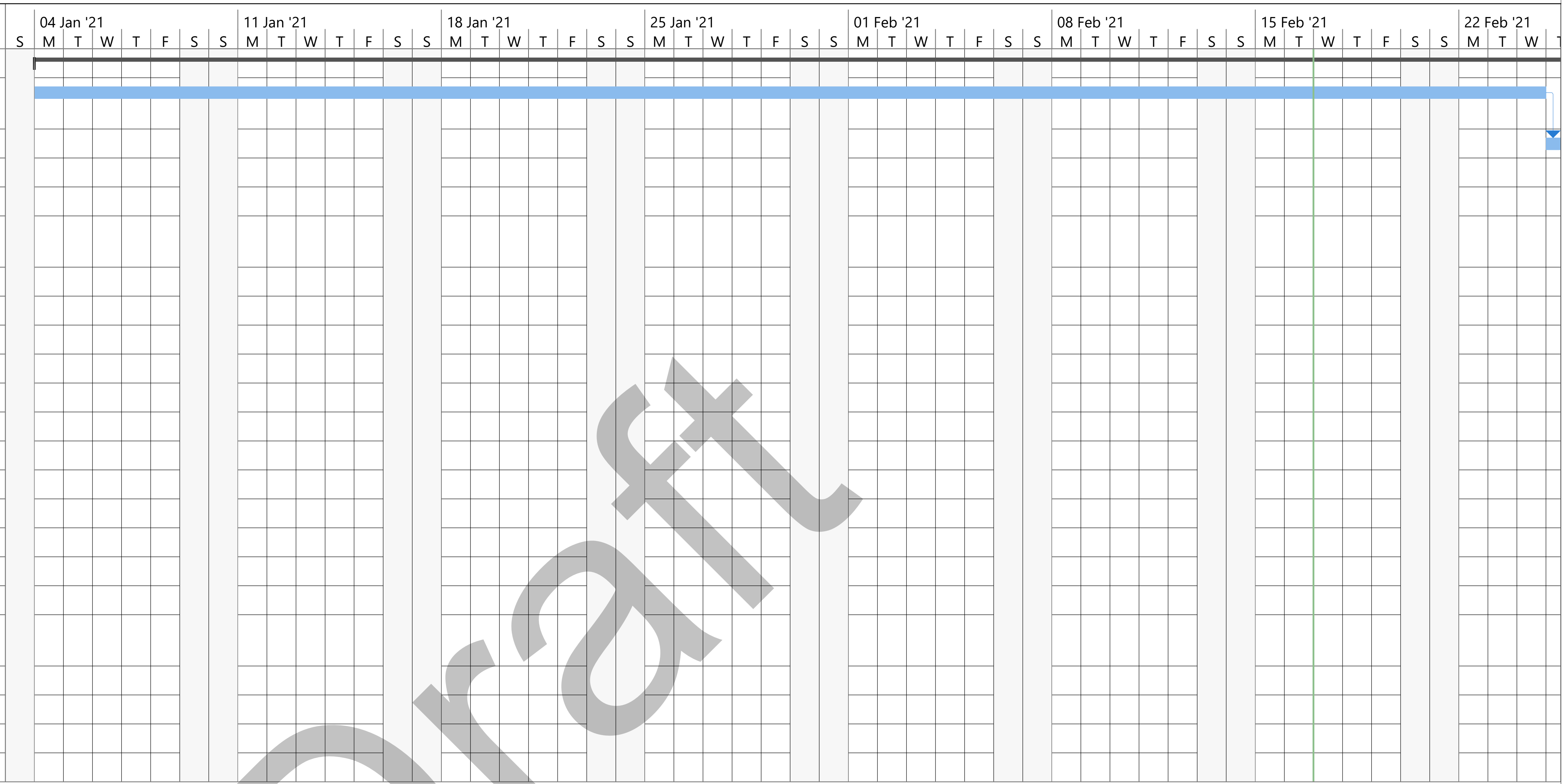
Awarded suppliers on current frameworks such as CCS, TMT2 have been evaluated for social value policies and opening competition, where appropriate for this project, will allow for BCC to re-test this with Bristol specifically in mind during the performance of the contract.

4.8 Contract Management

BCC have robust contract management arrangements in place and intend to replicate these for the management of all of the contracts involved in the delivery of the CAZ for Bristol. Individual project managers working on discrete work packages will report to the CAZ programme manager who will maintain overall responsibility. The contractors' performance will be monitored and reported on using Key Performance Indicators (KPIs) to ensure any issues are highlighted early and can be remedied before effecting dependant work-packages. These KPIs' were pre-agreed in order for suppliers to access the framework.

Where BCC are using NEC3 contracts there are a number of roles to help administer the contract and these will be filled with the right resources to ensure that the objectives are achieved, the NEC Project Manager role is key to managing these objectives. There is also a Supervisor role to check that the works are delivered in accordance with the contract

ID	Task Mode	Task Name	Duration
1		**FBC and Charging Order**	**70 days**
2		FBC preparation and Board sign off	38 days
3		Cabinet and Full Council	1 day
4		FBC submission	1 day
5		Charging Order submitted	6 wks
6		JAQU approve FBC and release funding	1 day
7		**CAZ D - Signage**	**176 days**
8		Procurement and signage ter	4 wks
9		Tender award	1 wk
10		Contract mobilisation	8 wks
11		Signage installation	5 mons
12		**Enabling Technology**	**149 days**
13		Mobile Camera Enforcement	35 days
14		Production of cameras	80 days
15		Software Development	90 days
16		Systems Tests and Integratio	149 days
17		Data development	80 days
18		Spares Procurement	20 days
19		Site works and contractor activity	65 days
20		Comms and engagement	198 days
21		**'Fast Track' and CAF mitigation**	**456 days?**
22		CAZ 'Fast Track' measures	456 days?
23		CAF mitigations	456 days?



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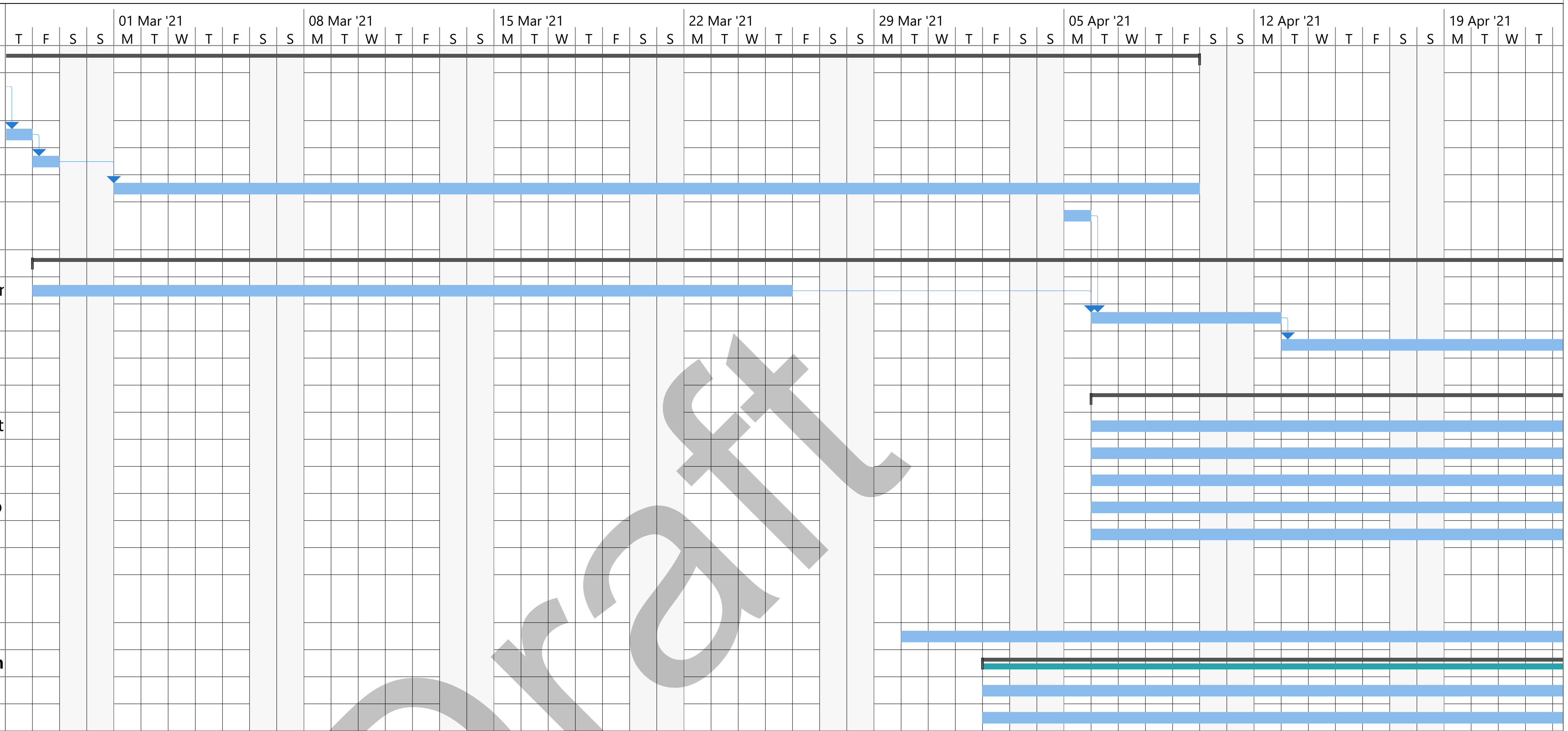
23		CAF mitigations



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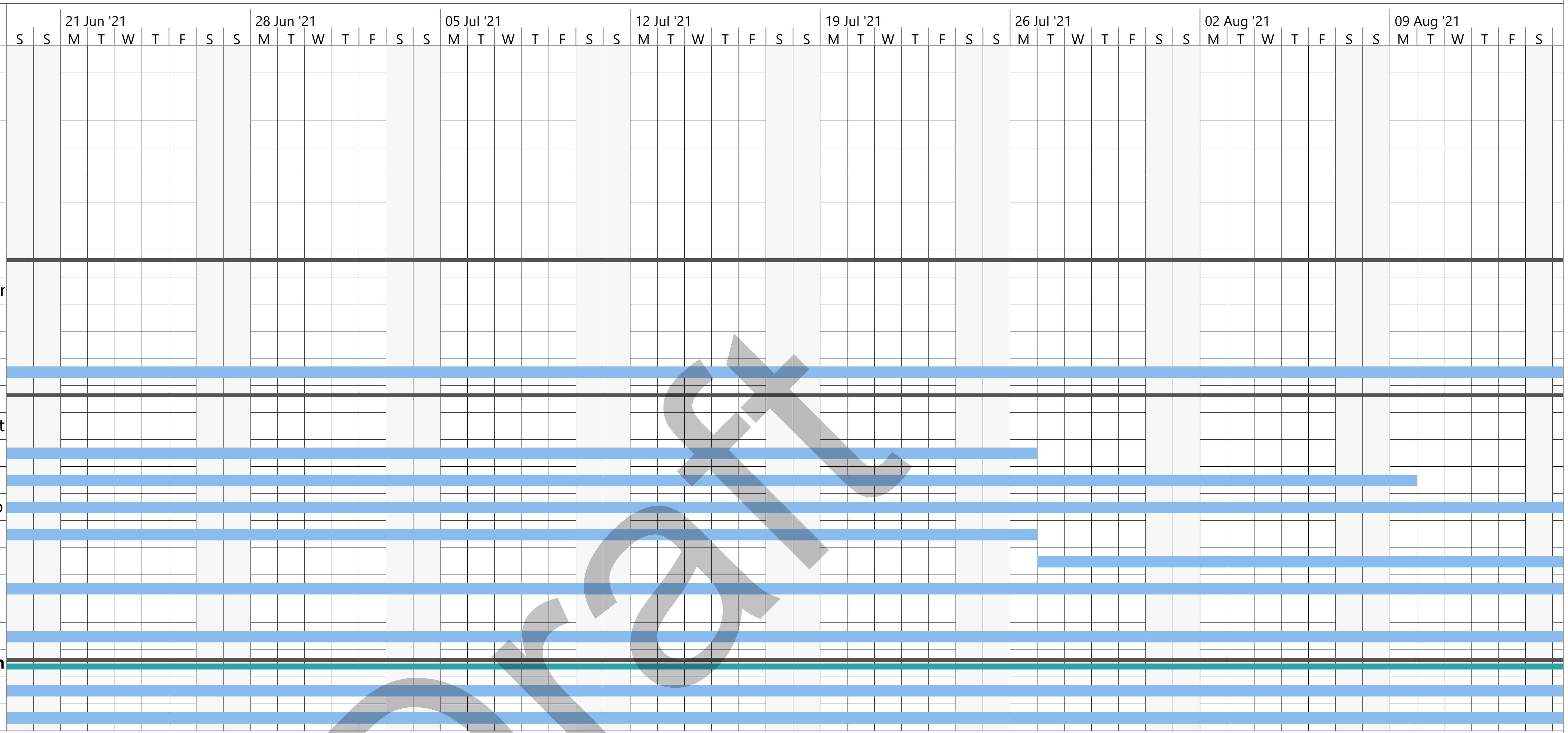

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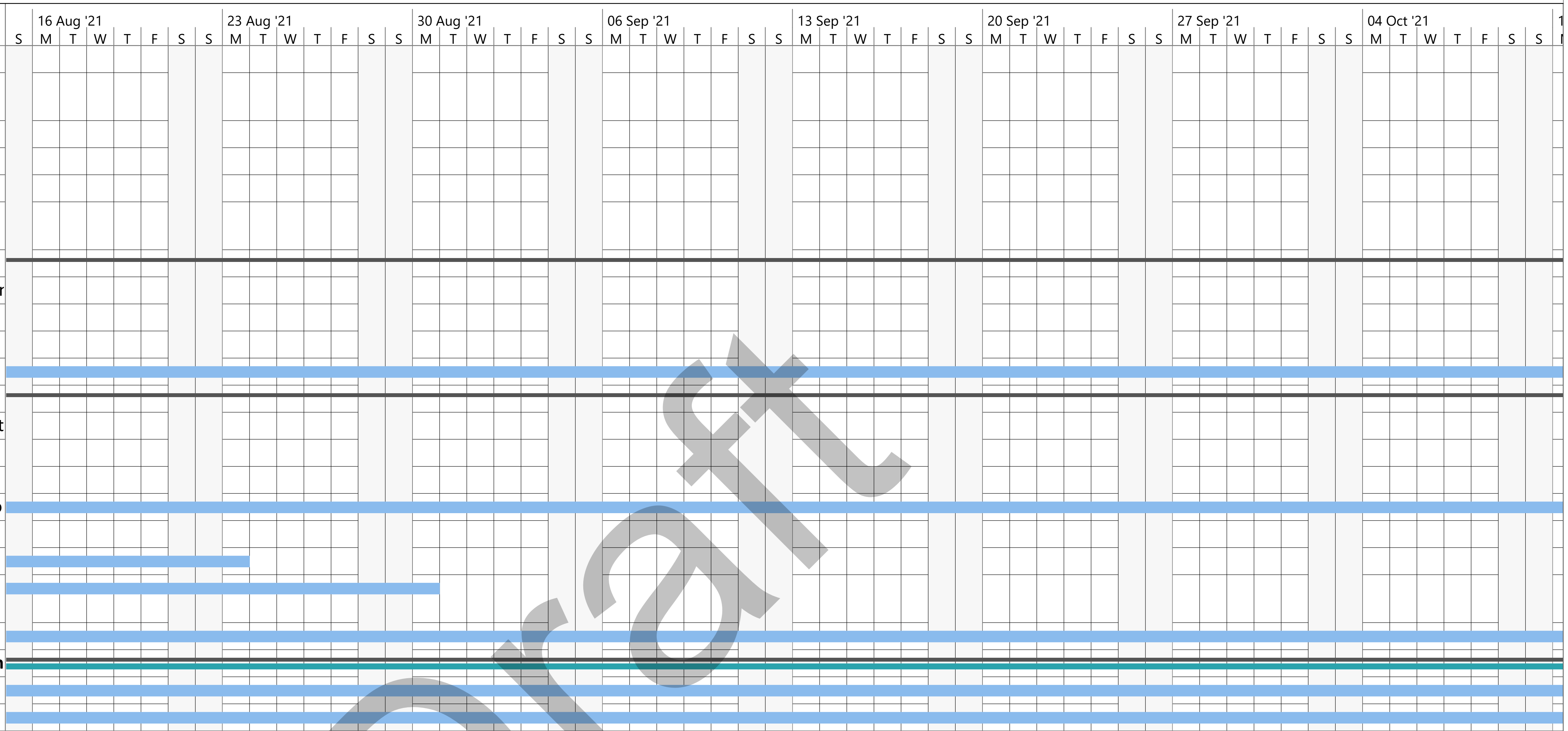

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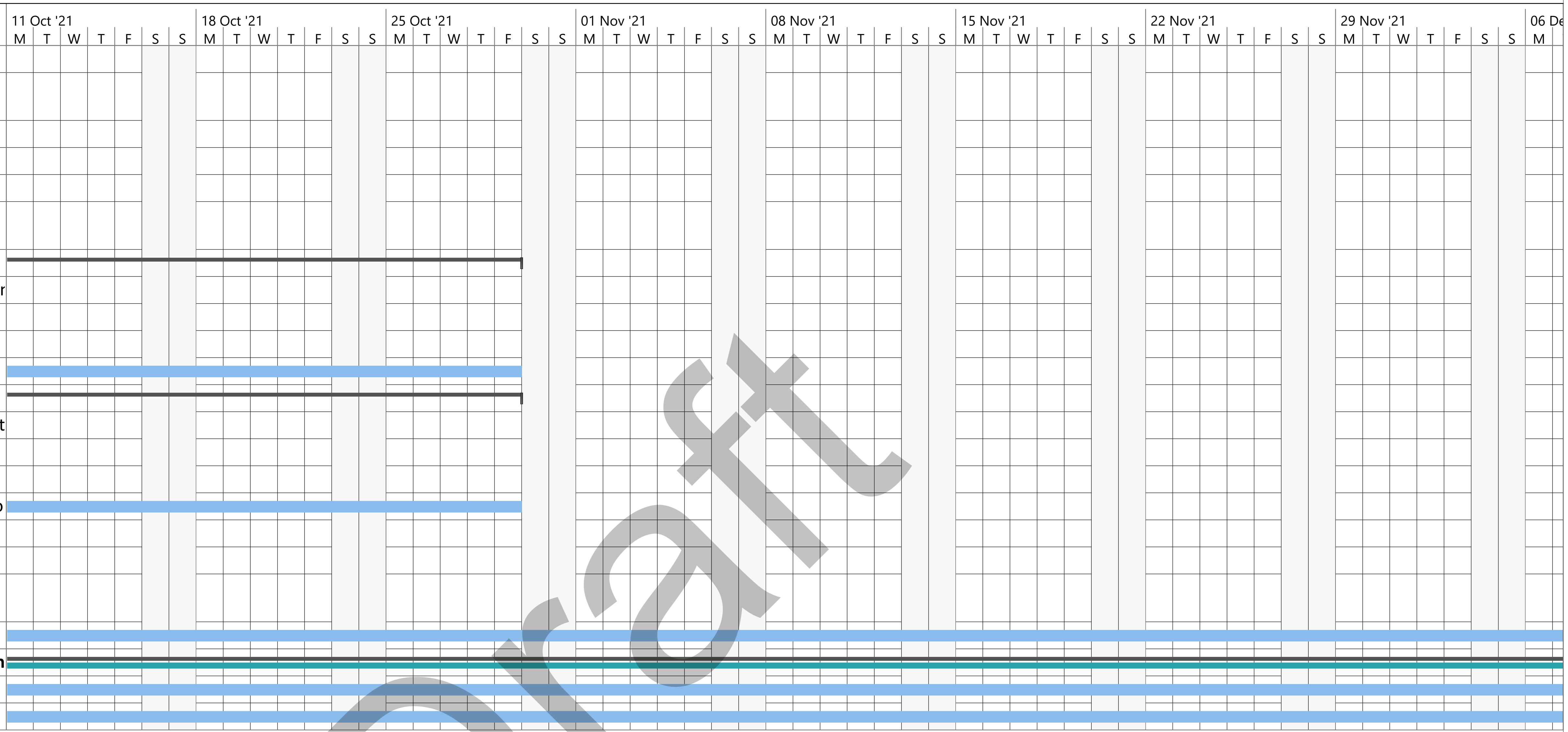

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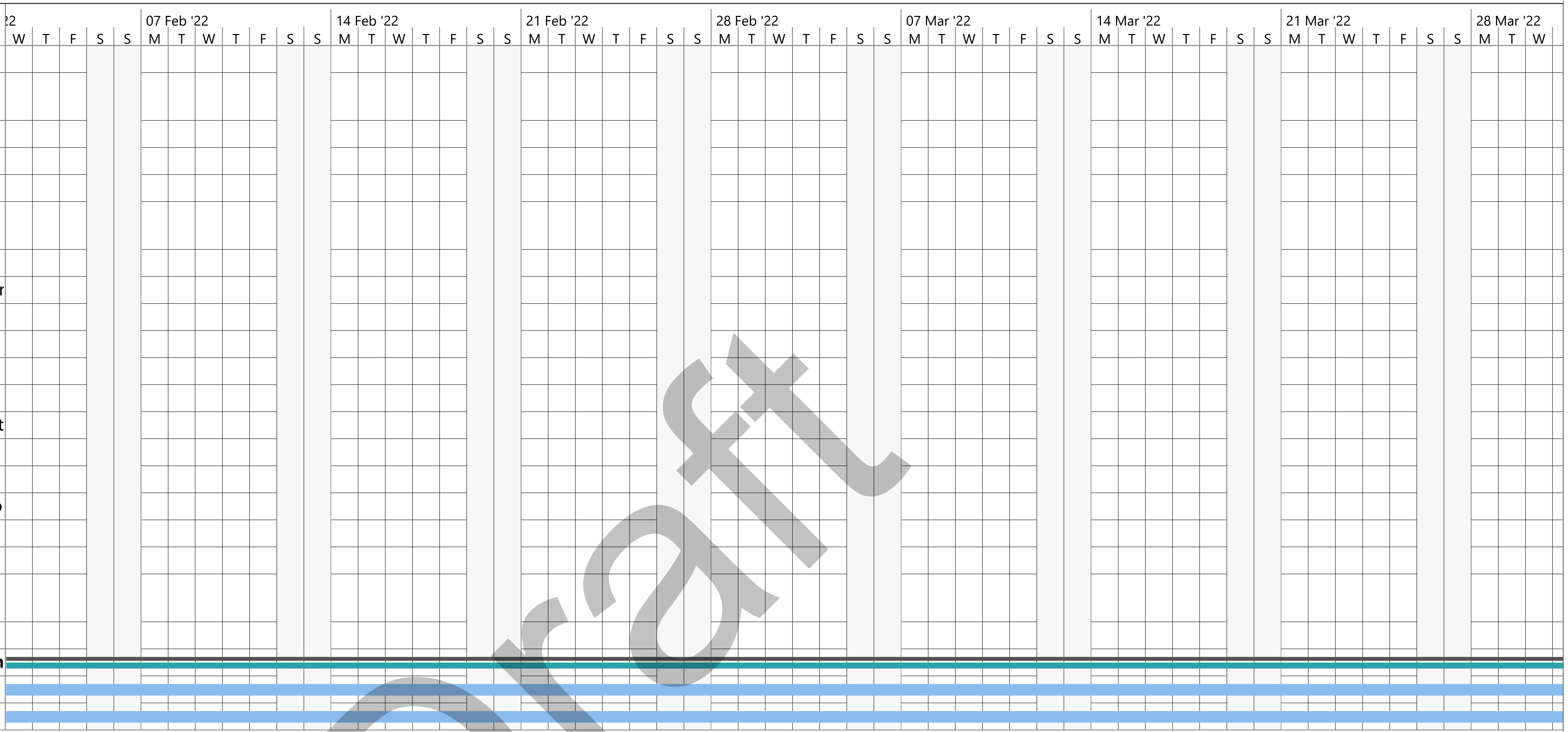

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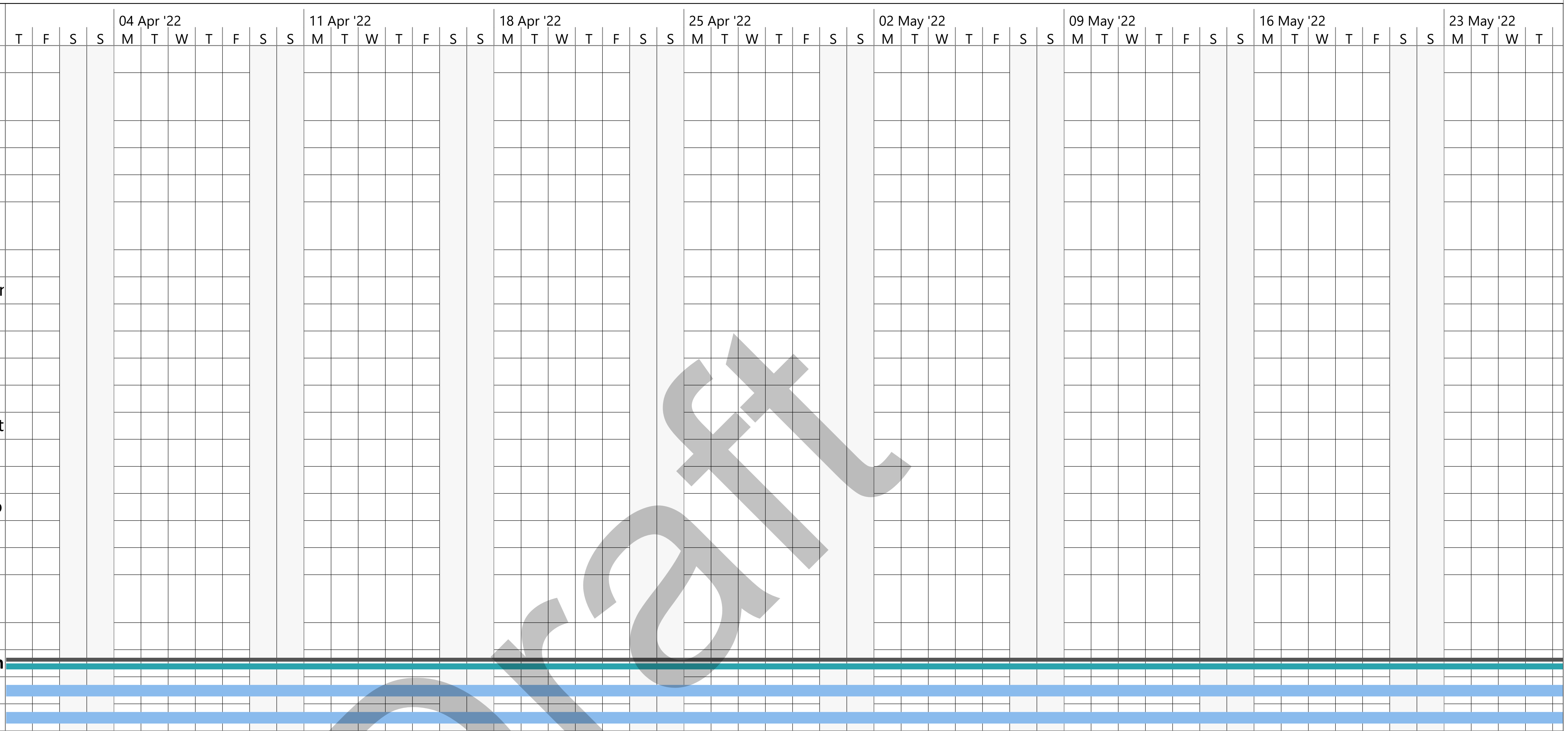

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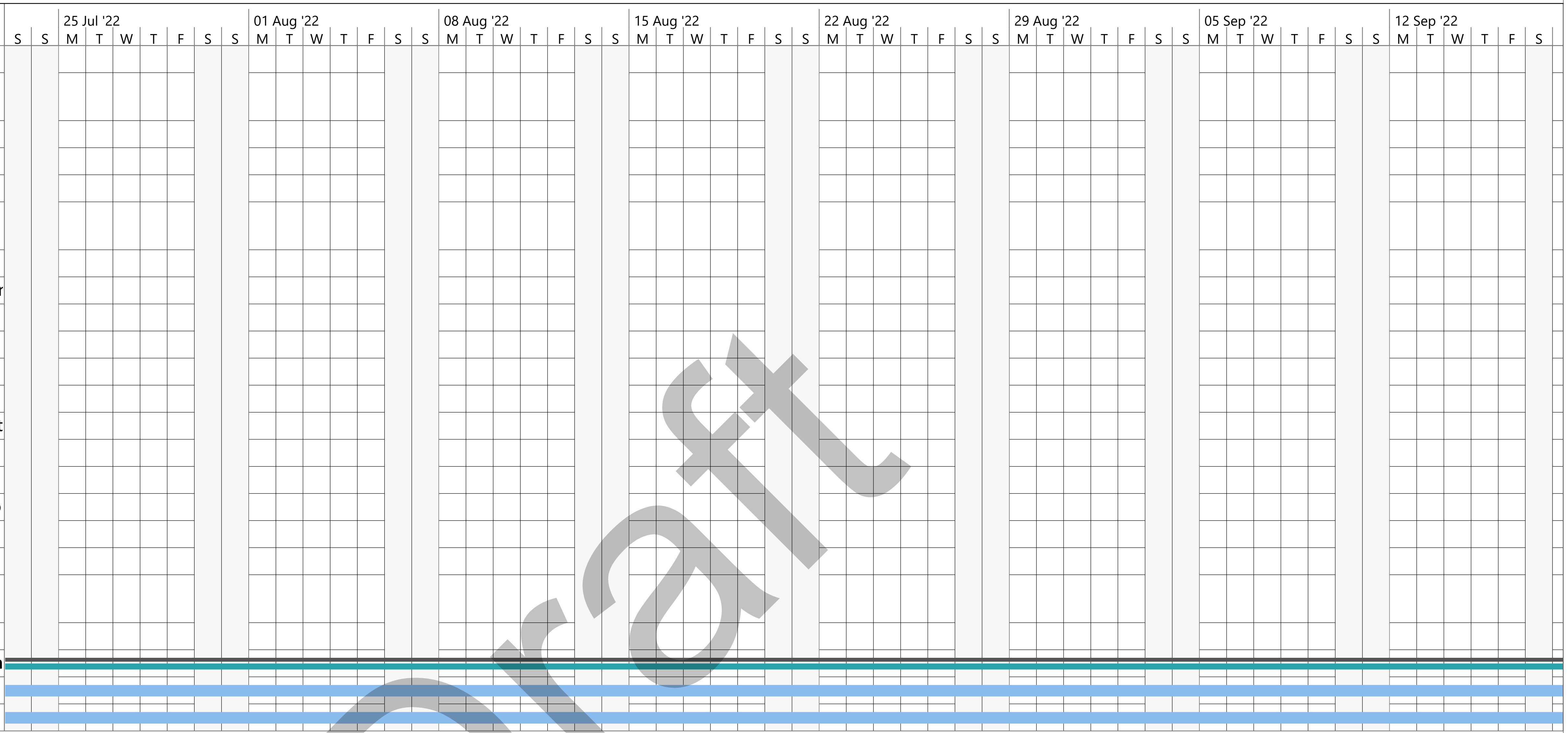

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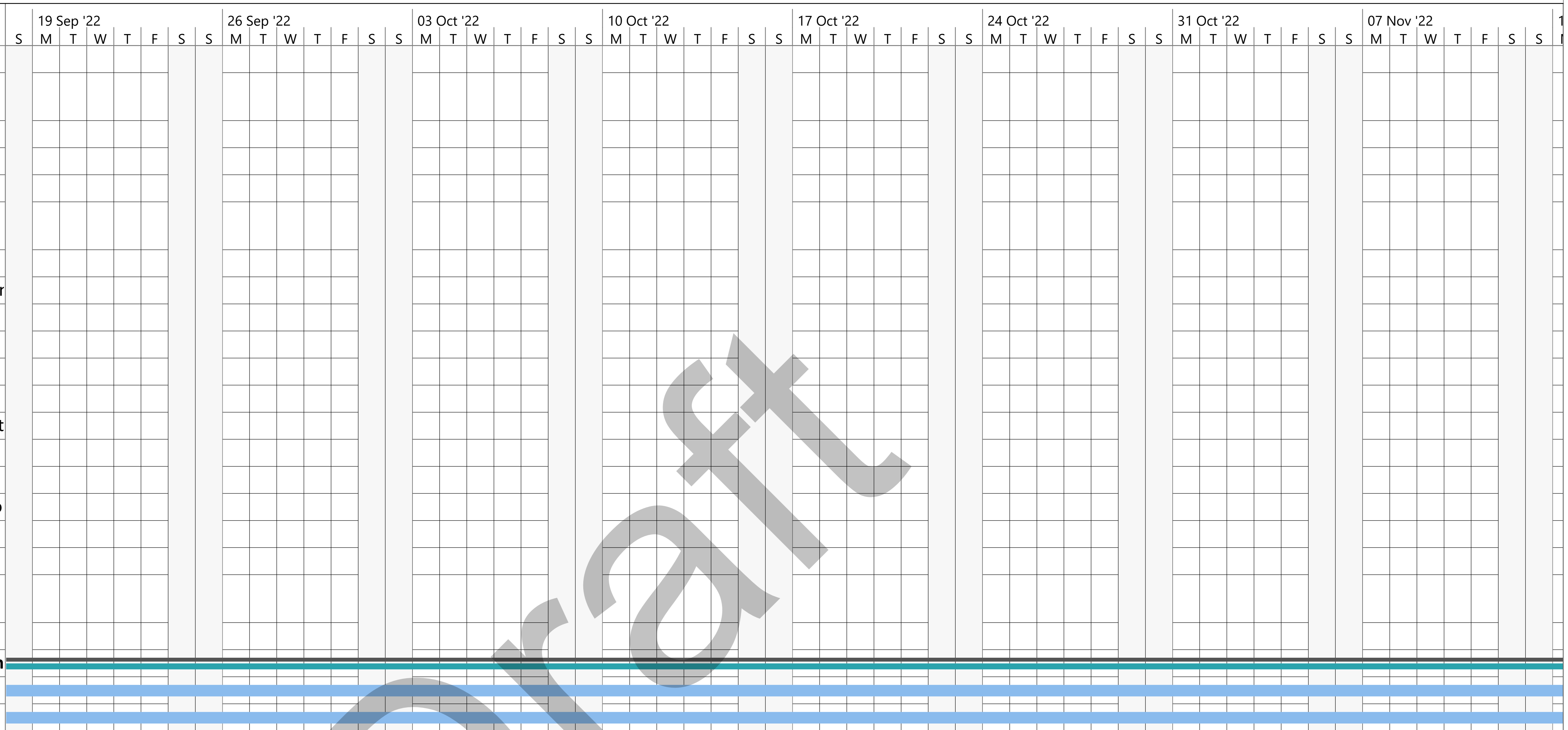

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14 Nov '22 | 21 Nov '22 | 28 Nov '22 | 05 Dec '22 | 12 Dec '22 | 19 Dec '22 | 26 Dec '22 | 02 Jan '23 | 09 Ja

Bristol City Council Clean Air Plan

Full Business Case

Engagement Report

16 February 2021

Bristol City Council

Clean Air Zone

Document Title:	Engagement Report
Date:	16 February 2021
Author:	Bristol City Council

Contents

Executive Summary

The Transport Engagement and Active Travel team led on the business engagement element of the Clear Air Zone (CAZ) consultation due to the expertise within the team. The team also provided support on awareness raising to the public and completed the data inputting and free text analysis for the CAZ consultation survey.

The Business Engagement Officers work with businesses to encourage investment in sustainable travel modes both for their fleets and for their employees by providing expert advice, free support and signposting them to the key offers (Appendix 1). The advice and support range from match funded grants, electric bike loans, and workplace travel audits, to staff engagement events, personalised travel planning and bike maintenance sessions.

The Travel Advisors within the team led on the phone calls and emails as instructed by the Business Engagement Officers to raise awareness of the consultation and to offer support for sustainable travel modes.

As part of this work the Business Engagement Officers also held a range of virtual meetings with the larger employers in the city to delve a little deeper into the details of CAZ and what that will mean for their organisations. The officers answered questions, talked through any concerns, and have agreed to continue these meetings to provide ongoing support whilst the details of the CAZ are developed.

Overall, the team put in over 650 hours of officer time supporting businesses during the consultation. The officers have since supported on the paper copy data input and the coding of the free text analysis which contributed to another 100 hours of officer time.

1. Business consultation calls/emails

The objectives of this work were:

1. To get businesses and staff to complete the online Traffic Clean Air Zone Consultation
2. To inform and encourage uptake of the sustainable travel advice and support services available to Bristol businesses

The main piece of work was to research, email and call 1,385 businesses using the Travel Advisors.

- An initial list of 592 businesses was created focusing on those perceived to be impacted most by the measures, this includes:
    - 316 General businesses (Bristol markets, builders merchants, catering, cleaning, distribution, engineering, financial, housing associations, legal, manufacturing, trade and membership organisations)
    - 116 Retail businesses
    - 132 Transport businesses (car clubs, car hire, taxi, driving schools, transport operators, garages)
    - 28 utilities companies (energy, water, telecoms)

- The team also contacted 446 business contacts where close working relationships have been developed as part of the Access West project.

- The team also focused on business parks organisations and contacted an additional 347 businesses in various business parks across Bristol during the consultation period.

This resulted in 749 conversations with businesses that:

- informed them about the Traffic Clean Air Zone proposals
- answered questions they had
- directed them to the consultation survey
- informed them about the Sustainable Travel offers.

Of the remaining business 81 messages were left, and officers were unable to speak to 489 businesses after 2 attempts.

Officers sent 1,005 businesses one or more emails with information about the Traffic Clean Air Zone, a call to action to complete the consultation and information about the Access West support.

<u>Conversations/ Feedback</u>

Under normal circumstances the engagement process would have been different. It would normally entail face to face meetings and door knocking shifts where the team would visit on each business, speak to the relevant person, give them physical copies of the information and guide them through the consultation on an iPad.

Due to COVID-19 and the restrictions at the time, all of the engagement work was carried out remotely via email, telephone and video conferencing.

The team sent initial emails explaining the CAZ consultation and detailing the current sustainable travel support. The Travel Advisors then telephoned all business where a response had not been obtained. This enabled officers to reach more businesses as the initial data gathering exercise often returned general email addresses. By telephoning the team could often get to speak to the correct person or obtain an email address for them.

Below outlines the main themes the Travel Advice team reported after having the 749 telephone conversations. Responses varied widely depending on type of business and area, from very supportive, to supportive but I don't agree with the measures, to not supportive.

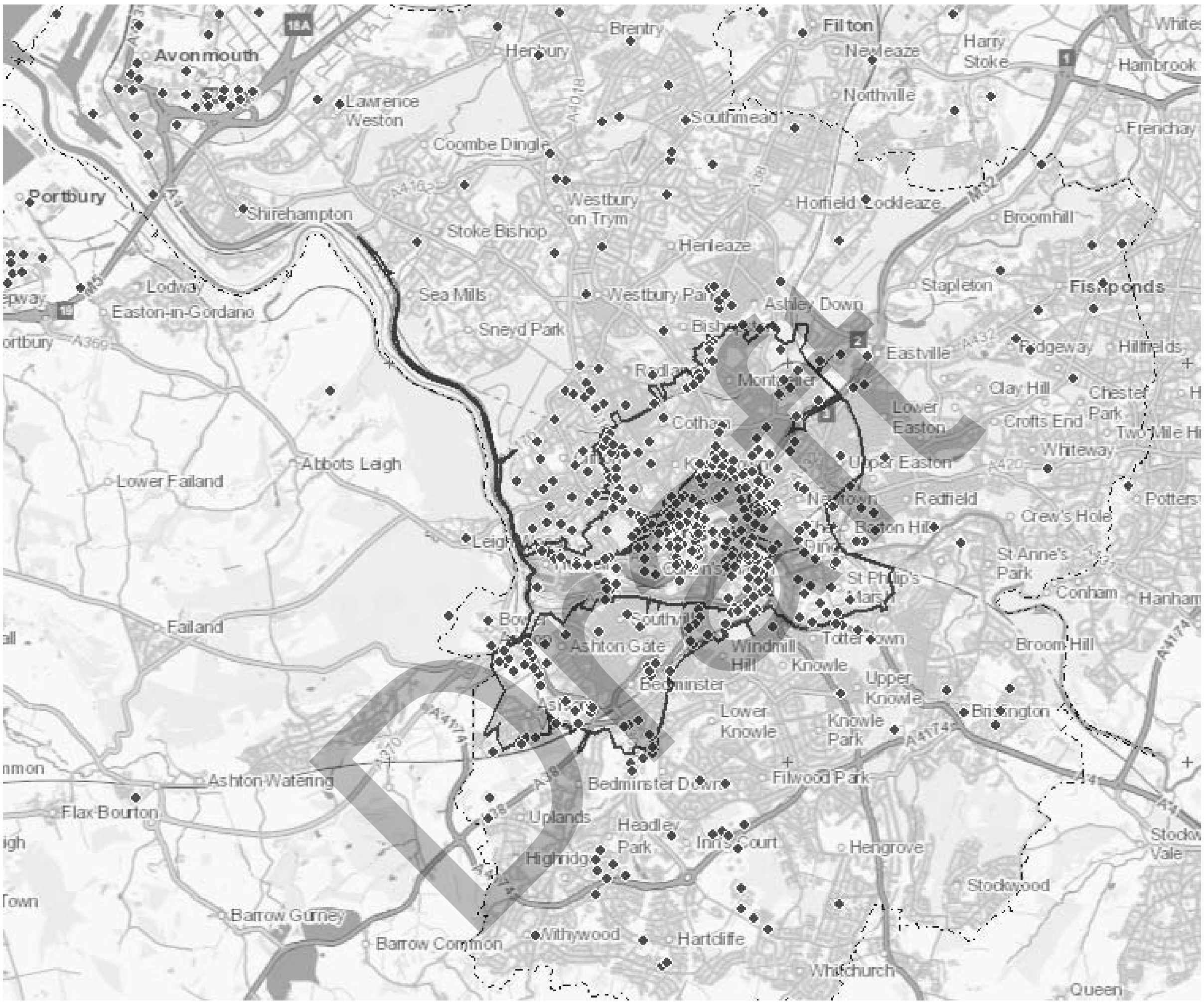
Common themes from conversations:

- At the time of calling there were several announcements from the government about COVID-19 restrictions, Bristol going into Tier 3, a second national lockdown and uncertainty around the Brexit negotiations. This impacted some of the conversations. Some businesses like pubs, restaurants and many smaller businesses did not answer as they were closed. In these instances, messages were left with a web link and emails were resent. Some businesses were clearly under a lot of pressure, with the restrictions and responded negatively saying "we have enough to worry about without this". Also, they might not fully understand the proposals or potential impact on their business, they were often very busy, and some had reduced staff numbers due to COVID-19.
- A common issue was getting through to right person. This varied widely from business to business. The team found it easy to speak to the correct person in larger corporate organisation with a receptionist or switchboard. In small and medium sized companies, it was easier to talk to the relevant person or owner more quickly. Large national companies with call centres were harder to be put through to the correct person. Where the correct person was not found the team sought email addresses so that information could be sent. It was also more difficult to speak to the correct person in some of the smaller businesses on industrial estates, for example Quickfit, Fowlers Motorcycles, where calls went through to the workshop.
- Many of the businesses were happy and grateful for being consulted. Although the feedback they gave was not always supportive of the proposed changes, they appreciated the fact the team took the time to call and they could ask questions and get answers.
- Conversations were generally positive as people recognise that something needs to happen to improve air quality; there was some uncertainty about what the business needed to do as the decision on which CAZ is yet to be decided.

- From the contacts who really engaged around CAZ, there was a good mix of those who were enthusiastic and those who were dismissive. Those who were enthusiastic also included the few who went on to discuss the wider sustainable travel support offers, although for some it was not the right time for them to take up any support, mainly due to COVID-19 and waiting to hear the decision on which CAZ be implemented. We also had several in depth behaviour change discussions.
- Some of the businesses had already completed the consultation, and the call was used to answer any CAZ related queries and talk through the sustainable travel support offers.
- Other businesses had received the email but had not filled in the survey due to other work pressures; calling gave us the opportunity to explain the importance of completing the consultation and follow up with a targeted email. They were mostly grateful for the prompt.
- Several good conversations were had with businesses who have not engaged previously with the team, for example several different Jewson branches; one manager wanted to know about access to old city/Bristol Bridge and was directed to the relevant project officer. Other useful conversations were undertaken with the Electrical Contractors Association and Federation of Small Businesses.
- Nearly all engagement resulted in a request for email information. Mostly with a promise to forward on either generally to all staff or to those who roles meant it relevant.
- Some sectors like the automotive industry are concerned about the impact on their businesses as this is an unknown factor at present. Also, tradespersons that rely on vans to travel around the city are concerned about the impact of CAZ on their business.
- Emphasise had to be put on this being an engagement about new CAZ proposals, different than the previous ones. Some contacts assumed the proposals were the same as before i.e. diesel ban. There was some anger from businesses who felt they have not been given enough notice, and some who responded saying they had already completed the consultation a year ago.
- Businesses fed back that they want as much support, information and guidance, with as much notice as possible.
- Most businesses spoken to were very busy and wanted to read the information when they had time in their schedule. In the next phase of the engagement work, the team will set up a booking system so businesses can arrange a convenient to speak, rather than officers calling out of the blue. This should hopefully enable more businesses to be able to fully engage with the conversation. This approach worked well with individual travel planning.

Map of businesses

Below is a map of the businesses contacted by team. 954 businesses are mapped, but 431 have not been included due to lack of postcode data. The focus of the engagement was within the zones as these businesses will be directly affected, other areas of focus where business parks, often many businesses share the same postcode.



2. Wider public consultation support

The team also played a role in raising awareness of the consultation survey to the wider public and stakeholders by working closely with the consultation team. At the beginning of the consultation the team distributed emails with the CAZ toolkit to the key stakeholders who included:

- Emergency services – police, fire, ambulance representatives
- Businesses – membership organisations, telecoms, trade associations, builder merchants, catering, cleaning, consultants, legal, distributors, energy firms, engineering, estate agents, finance sector, car garages, housing associations, local government, facility, and water companies etc
- Retail – large supermarkets, markets, shopping centres etc
- Transport operators - car club operators, car hire firms, caravan groups, driving schools, motorcycles groups, taxi forum, public transport operators, cycling groups, walking groups, scooter hire companies, motoring groups etc
- Education – primary schools, secondary schools, universities, and colleges
- Equality groups - faith groups, equality groups, voluntary and community sector groups.
- Healthcare – GP surgeries, medical centres, public health colleagues
- Community and tourism groups – hotels, campaign groups, destination Bristol, sport clubs, community groups

The team also put up 120 posters in shops in the central area and main shopping centres on busy high streets.

During the consultation weekly meetings were held where officers from communications, transport and the consultation team would assess the response level of the survey so far. This would involve assessing the profile of respondents, their geographical location and whether they were a business/organisation. This information was used to help formulate a strategy to boost responses from under representative groups such as younger people, those in the most deprived wards and business owners. The strategy included:

- Targeted social media posts using a range of channels more prominent with different age groups (delivered by the communication and consultation teams).
- Targeted newsletter articles and the mayors blog (delivered by the communication and consultation teams)
- Targeted business park engagement focusing on those within and on the boundary of the CAZ proposals (delivered out by the transport engagement team).
- Dissemination of CAZ toolkit to stakeholders such as such as Business West, Bristol Improvement Districts, business parks management companies to boost responses from businesses (rolled out by the transport engagement team).

- Dissemination of CAZ toolkit to faith groups and voluntary and community sector groups targeting ethnic minority communities and the more deprived wards (rolled out by the transport engagement team)
- Face to face outreach work (COVID19 secure) in deprived wards where officers had Ipads and asked people to fill in the survey or give out paper copies (delivered by the transport engagement team prior to the change to Tier 3).
- Distribution of 2000 surveys to targeted areas where responses were low (delivered by the transport engagement team).

The face to face community engagement locations that were able to be carried out before the COVID-19 Tiers changed were located in the central ward in College Green and Queen Square, in Hengrove and Lawrence Weston on Crow Lane and Blaise Castle and in Lockleaze in Gainsborough Square.

The team also provided support when dealing with queries and managed the Transport engagement email address, answerphone and postal address that was put onto all correspondence.

Over 60 emails were received during the consultation period – 23 from businesses and 38 from residents. The queries ranged from simply wanting a paper copy, wanting to know about exemptions for businesses, asking about the diesel ban and those supporting the idea, but having reservations about the need to be implemented correctly. 7 phone calls were also received, 5 from members of the public and 2 from transport workers (bus and taxi drivers) asking about if they would be compliant and timeline of when this will come in.

3. Larger organisations engagement

The Business Engagement Officers have long established relationships with many of the large employers in the city so by using 'live' contacts officers were able to offer and deliver CAZ sessions.

The large organisations that were directly briefed:

- University Hospital Bristol NHS Trust
- Southmead Hospital
- University of Bristol
- University of West of England
- Bristol Workplace Travel Network
- Business West
- Bristol Clean Air Alliance
- Bristol Walking Alliance
- Bristol Physical Access Chain
- Waste contractors

The officers also briefed colleagues in neighbouring councils and project teams.

The team also distributed the consultation via the following communication channels:

- Business newsletter, Bristol Workplace Travel Network, Hengrove & Temple Forum, Future Economy Network, Ways 2 Work Network, Bristol 247, Bristol City Council Public Health distribution list, South Glos, North Somerset, B&NES business engagement teams.
- Travel to Work Survey list who selected "I want to hear about relevant consultations led by the West of England Authorities" – 1,000 contacts
- Active October– 1,000 engaged participants
- Love to Ride – 2,300 engaged participants

Below follows a summary of the briefing sessions and feedback held with the larger organisations and networks:

Organisations

University Hospital Bristol NHS Trust

The Transport Engagement and Active Travel team have monthly meetings with the Sustainable Transport Team at the hospital and have had several in-depth conversations about the Clean Air Zone. These include detailed conversations about exemptions and the impact of CAZ on different staff populations. For example, community nurses who use their own private vehicles to visit patients, low paid workers and patients travelling to the hospital. There are also regular high-level meetings at senior management level

The trust declared a climate emergency in October 2019, an ecological emergency in February 2020 and is concerned about local air quality due its contribution to climate change and impacts to human health.

The BRI has 10,500 staff, and around 3,000 daily patients. It has 30 fleet vehicles and is heavily reliant on staff using private vehicles for field work. The hospital also makes use of a team of volunteers that bring patients to hospital, particularly from more rural and remote areas. At present around 2,000 staff drive to work, with just over half using hospital owned car parks. Hospital parking is prioritised with an exclusion zone meaning only staff living outside of the zone can apply for a parking permit. The hospital runs its Hubs bus service that picks up from Temple Meads Train Station, Cabot Circus and the Hospital with no charge to staff or patients.

The hospital is currently revising its travel plan and car parking management policy with guidance from the team.

In the past 18 months the hospital has been working to address its non-compliant fleet. They do not however have funding to replace all non-compliant vehicles before October 2021 and would benefit from funding and support through CAZ specifically to upgrade buses and fleet vehicles.

The hospital is planning to electrify its fleet and is also looking at car club options to reduce grey fleet mileage. They are planning to make use of a consolidation service in Avonmouth for deliveries to the hospital to reduce the number of individual trips to the hospital. The site would benefit from improvements to public bus services as it is currently poorly connected despite the relatively central location.

The trust recently joined with Western Hospital which has resulted in an increase in journeys between sites. They are looking at more sustainable options for example the door to door bus or more use of the long Ashton Park and Ride.

In terms of the support to the hospital the team offer ongoing travel plan support, business grants, but the hospital needs more substantial support and funding to implement the changes it has planned.

Southmead Hospital

Southmead hospital is generally supportive and wants to see clean air in the city in-line with public health and national NHS priorities. However, they are concerned about the impact on their operations and the need to transfer staff, patients and materials to other NHS sites for instance.

University of Bristol

The University of Bristol employs 5,500 staff and is home to 20,000 students. The University is supportive of a CAZ, but they expect wider transport improvements in the area to help them avoid operational difficulties. In April 2019 the University declared a climate emergency and are currently writing a new travel plan. There is a long-term aspiration to remove as much car parking from its site as possible, but they can only do this with public transport improvements as not everyone can or will be able to walk or cycle. The University aspires to increase the amount of shared space around its campuses and improve bus stops. They would like to see more public bus services from the city centre, major transport hubs and park and ride sites.

The University currently runs its own bus network and the student union runs a successful loan bike scheme with over 50 bikes. They have a strong car parking management policy with an exclusion zone for staff applying for parking permits. In 2023 the new campus opens on the site near Bristol temple Meads.

They hope to use the Clean Air Zone as an opportunity to engage and encourage staff and student mode shift towards sustainable travel. The University has applied for two business grants. The first is to expand current cycle parking provision by 323 spaces for staff and students. The second to implement a staff electric bike loan scheme similar to the individual loan scheme operated by the Transport Engagement and Active Travel team. The scheme will loan staff an electric bike for them to commute and travel between sites. UoB are also planning to increase the number of buses it operates and is reducing the number of student parking spaces.

From conversations with both the University Hospital Bristol and the University of Bristol there are some synergies emerging. For example, staff, students and patients travel from Temple Meads, Long Ashton Park and Ride, North Somerset sites in Weston-Super-Mare and Langford veterinary school to the hospitals and University.

University of West of England

The officers contacted both the University and the Student Union. All of the sites except for the Arnolfini are outside of the CAZ. The majority of their fleet are now ULEV and the most of the other vehicles remaining are compliant. The main impact of the CAZ implementation will be on grey fleet and commuters.

Amazon

Although we did not receive a formal response, from conversations Amazon were confident they will be able to adapt to any of the proposed measures. This aligns with their corporate strategy to provide a cleaner delivery fleet.

Networks

Bristol Workplace Travel Network

The majority of businesses who attended the network meeting are waiting for the zone to be announced and are more focused on the impact of COVID-19 on their operations. Bristol University presented at the meeting on the work they are doing on staff and student travel.

Business West

The Transport Engagement and Active Travel team presented to Business West, giving information about the consultation answering questions and myth busting. Around 55 businesses attended the meeting. It was perceived there was a general low level of knowledge about CAZ from the businesses present prior to the event. Representatives from Business West voiced support to take action on air pollution. However, there were concerns over the amount of notice given prior to changes being implemented, and clarity about what will be happening. They also pointed out that the message "our preferred approach is to encourage less polluting travel behaviour, uncertainties surrounding the ongoing impact of the COVID-19 pandemic and people's travel behaviour mean we must consider additional measures" confused business, and lacked the clarity needed to make decisions. They reiterated that businesses need to have certainty so that it can make informed decisions, and they need a reasonable amount of time to implement changes.

Business West helped direct the engagement work, thanks to their knowledge of business in the city and the team were able to engage an additional 347 businesses in business parks across the city. Of the participants, around 10 businesses were active in the discussion segment. There were several specific questions around timescales, confusions around the boundary of each area, queries about comparing pollution from commercial versus private vehicles, exemptions for deliveries to a business within the zone and other specific questions.

Saint Peters Hospice present at the meeting raised a point about the impact of CAZ on its volunteers. Volunteers drive to site to volunteer and some use their own vehicle to transport donations between sites. The Hospice cannot afford to pay volunteers a mileage allowance to move goods and is concerned CAZ will stop some people offering to move goods. They are also concerned about volunteer traveling by car to volunteer.

Waste contractors

The team presented to the client manager that deals with the circa 15 waste providers in the city. We received no specific CAZ related comments from the providers. For example, Bristol Waste had no concerns as most of their fleet is already compliant. Bristol Waste is looking at innovative solutions such as retrofitting electric milk floats for pedestrianised areas and they will likely want to seek funding.

Campaign/ Community Organisations

Bristol Clean Air Alliance

The meeting with the Bristol Clean Air Alliance took place with project officers and officers City Innovation & Sustainability. It was focused more on technical details and specifics that officers were able to answer, for example how the CAZ will be implemented. The Bristol Clean Air Alliance see clean air as an urgent issue and want there to be no further delays in implementation and asked for it to be extended as far as possible.

Bristol Walking Alliance

The Bristol Walking Alliance generally supports the clean air zone. They want to see good clear information and improvements for walking with pedestrianisation, road space reallocation and less pavement parking. The Bristol Walking Alliance is supportive of the Streetspace schemes, for example Bristol Bridge closure and the Old City pedestrianisation.

Bristol Physical Access Chain

The Bristol Physical Access Chain is pleased there is a national exemption for vehicles with a disabled tax class. Their concern is that it is difficult to communicate that to those eligible, for instance this will not include all blue badge holders. They suggest comprehensive and targeted communication is needed to reach this group.

Internal Discussions

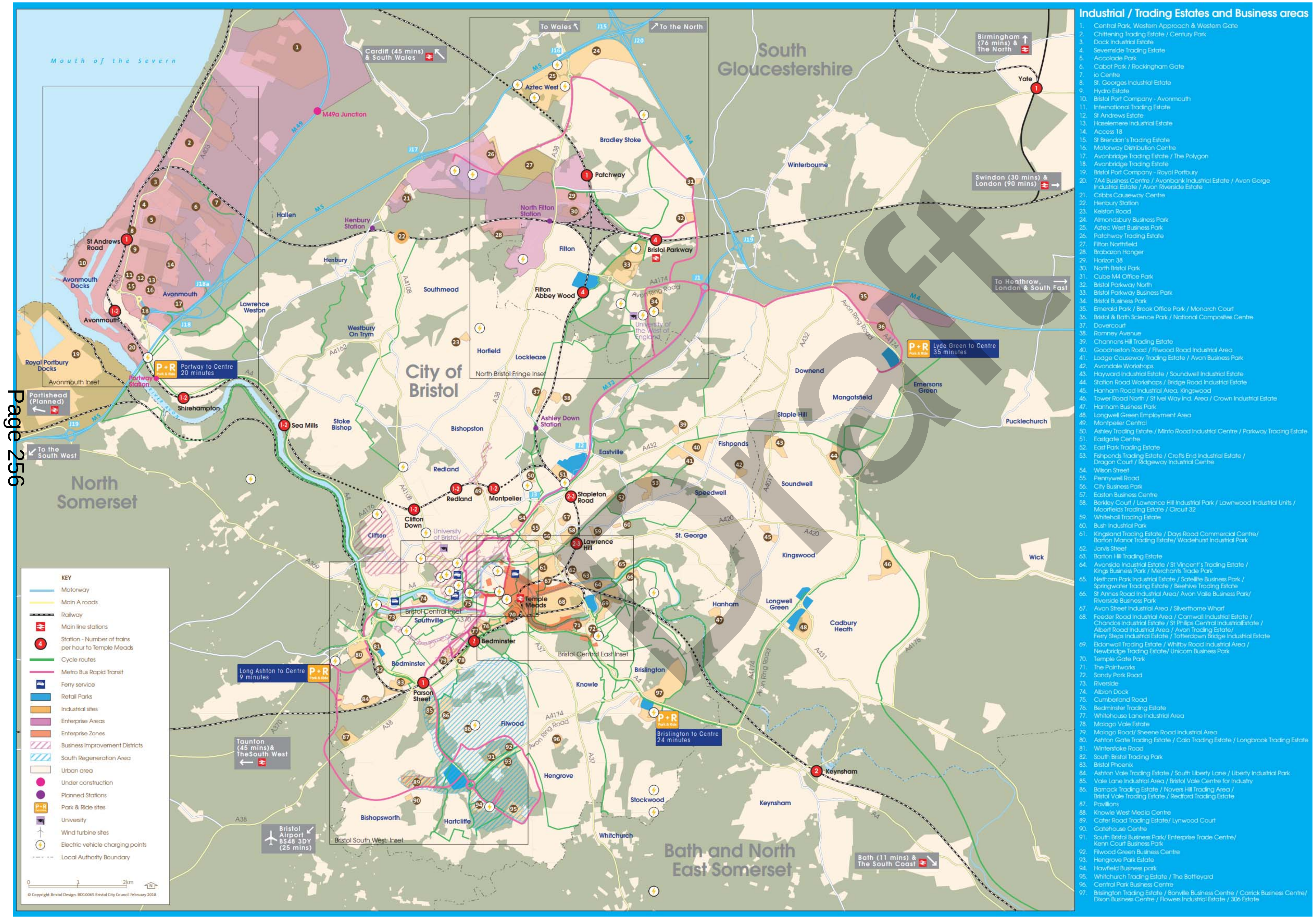
Public health

There was concern from social care providers about low-income workers that need to travel through the CAZ to visit clients.

Bristol City Council Fleet

It will not be possible to upgrade all non-compliant vehicles before October 2021. Attempts to assign non-compliant vehicles to outer areas is unlikely to be completely successful as nearly all fleet vehicles travel through the CAZ on a regular basis. There is currently around a one-year lead in time on some new vehicles as many other cities are implementing Clean Air Zones, driving up demand. Typically, fleet managers upgrade vehicles every five to seven years. This has not been the case for some public sector organisations due to limited funds.

4. Industrial/Trading Estates and Business areas



The map above shows the industrial estates and business parks in Bristol. The team focused on engaging businesses within these industrial locations such as Avonmouth and Filwood Green as these are more likely to rely on larger vehicles which may be affected by the introduction of a CAZ. Below is a summary of the engagement conversations and feedback:

Avonmouth Business Engagement

Most companies were not aware of the CAZ consultation, but two had responded. The main businesses are distribution centres and engineering and manufacturing which have a heavy reliance on HGVS.

Staff can often travel into the area from areas that are further afield such as South Wales and South Gloucestershire. Very few live within cycling distance. Feedback about cycling was that it feels too dangerous to cycle, cars parked in cycle lanes, dangerous over taking by trucks, fast and busy roads, and doing shift work means working late or early and cycling is less appealing in cold and dark.

Many companies noted that many employees drive due to the location of Avonmouth, the fact they shift work, poor public transport provision and the dangerous roads conditions for cycling. There were however, some ideas for staff travel after COVID-19 which included a shuttle bus and car sharing scheme promotions which the team can assist with.

Filwood Green Business Engagement

Many of the businesses engaged with the messaging and want to make changes to work travel to be more sustainable. There is a desire for infrastructure improvements e.g. electric vehicle charging points in residential areas. Four businesses were also interested in workplace travel audit.

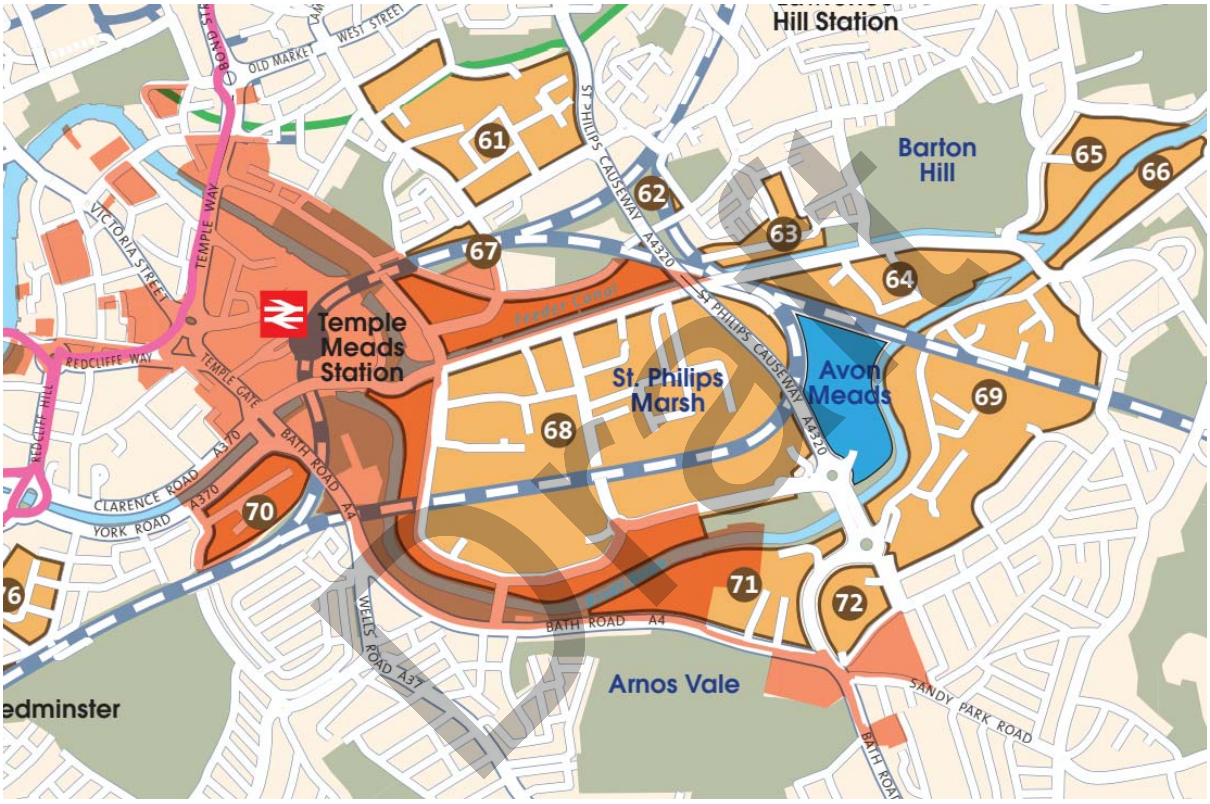
Moving forward the team will intensely engage with the businesses in the area as they are receptive to the messages. The officers will promote all of the offers, but in particular will promote cycle routes in the area, PTP, loan bikes, cycle training and eCargo Bikes .

Barnack Trading Estate

Two common themes on this trading estate are concerns about LGV and HGV deliveries to businesses via other companies and concerns about connectivity between North to South Bristol if vehicles are trying to avoid the CAZ.

5. St Phillips Marsh - Case Study

St Phillips Marsh is a commercial area with many vans and lorries going in and out daily. Officers speaking to businesses in the area reported that the need to do something to improve air quality is widely accepted. However there is a concern about the impact a CAZ C will have on the businesses that are operating there. Of the businesses spoken to the issue is with other businesses and their vehicles coming into the area to access services. For example, LGVs driving into the area for MOTs and repairs, trades people picking up materials from trade counters, deliveries to wholesalers and haulage. The map below shows the trading estate and its central location which is why it was selected for the case study.



Four of the companies that the officers contacted were: Venture Tyres, TLC Electrical Distributors, Wood recycling project and Mail Handling International

Venture Tyres

There main concern is that 70% of their business is from personal LGV owners travelling to the site for MOT testing, tyres and vehicle repairs. They are a Class 4 and 7 MOT test centre. Class 7 is for commercial vehicles over 3 years old, a proportion of these vehicles will be non-compliant.

TLC Electrical Distributors

As a trade counter TLC Electrical Distributors have a constant stream of deliveries and collections. They have 3 vans themselves, 2 Euro Category 6, 1 Euro Category 5. The main impact of CAZ will be on suppliers and customers. Deliveries are mostly from HGV and collection mostly by LGV. A lot of customers are self-employed who drive non-compliant vans. The business also sends equipment out using courier services. Couriers are often self-employed sub-contractors to a big firm like Parcel Force and are more likely to have non-compliant van as they own it themselves. They estimate over 200 vehicles per day. They worry that CAZ C would impact on customers coming into the area and they may need to relocate the business outside of area if this is brought in. This is similar for other business on the same road – air conditioning and roofing suppliers.

Wood Recycling Project

Wood recycling Project operate 2 non-compliant LGVs, as not for profit and are unable to afford to replace vehicles. They also have customers driving into the area using non-compliant vehicles to purchase wood.

Mail Handling International

Mail Handling International is reliant on road haulage. They subcontract outbound deliveries to Hills Delivery next door, all their vehicles except 1 are Euro Category 6, they have 1 Euro Category 5. MHI are not in control of inbound deliveries, these come from all over Europe and are not all compliant. They wanted to know how will CAZ C impact operators delivering into the area as they are worried that it will negatively impact the business.

6. Data analysis

As the team managed the email address, answerphone, and postal address they took responsibility for the sorting, labelling and data inputting of the paper surveys. Due to the volume of paper copies this role was divided up amongst the officers to ensure they were input swiftly.

Once complete the second task of coding the free text responses was required to provide the consultation team with the information required for the consultation report. There were five free text analysis questions to categorise which included questions on:

- Changes to travel
- CAZ exemptions and concession
- CAZ option 1
- CAZ option 2
- Any other comments

Each question ranged in the number comments from 650 to over 3500 and in total the team categorised over 10,000 comments.

7. Further Engagement / Next Steps

The current UK COVID-19 restrictions will dictate future engagement work. Ideally, the team will be able to carry out face to face engagement activities, door knocking and arranging meetings at business premises. If this is not possible the same approach as in the first phase, relying on email, telephone and video conferencing will be used.

The second phase of engagement is to provide information about CAZ, exemptions and mitigation measures, and encourage behaviour change. The team will speak to the 1,385 businesses contacted in the first phase, as well as all of the large employers and networks who were engaged. The team will also attempt to reach more businesses through mailing information.

In the next phase a booking system will be set up where businesses can reserve a meeting slot to talk to the team at a convenient time for them. This will lead to better quality conversations. A similar system is already operating for individuals as part of our personalised travel planning (PTP) offer. Part of the booking process will contain a short survey about the business to help the team prepare for the conversation. Initial contact will be made via email, telephone, door drops, door knocking, and the team's networks. The workplace travel audit will be offered; an assessment tool that helps businesses to understand their workforce's travel behaviour, identifying areas for improvement. The audit covers areas such as: parking policy, workplace facilities, support measures, business travel, staff travel and information communication.

Initial questions as part of the meeting booking process:

- Business Name
- Postcode
- Type of Business
- Number of staff
- Number of sites
- Number and type of fleet vehicles
- Specific transport / CAZ issues

Appendix 1 - Sustainable travel advice and support services

Resources

Workplace Travel Audit	A comprehensive assessment to understand your workforce's travel behaviour, and report identifying areas for improvement. Ideal for businesses that do not have an existing travel plan.
50% Match funded grants	To improve facilities to support sustainable travel in the workplace. Grants can be used to pay for: • cycle stands and shelters • business pool bikes • accessibility improvements and signage • car-sharing parking improvements • events to encourage sustainable commuting • electric vehicle charging
Electric pool bikes	Pool bikes can be used for meetings, client visits and deliveries. Loans are for 3-6 months, with accessories, delivery and maintenance all covered by us. We also loan e-bike and trailers for businesses moving larger loads.
Active travel champions	Champions lead the way and encourage staff to walk and cycle. We support champions with information, guidance, events and equipment – each champion gets an emergency cycle repair kit worth £150 for their organisation to support and raise the profile of cycling.

Events

Staff engagement events	Pre COVID-19, we ran face to face events in businesses to engage staff about sustainable travel our expert travel advisors give information, advice, resources and sign participants up to our support services – loan bikes, cycle training, car sharing, bus tickets. Since March 2020 this has moved online, we now attend virtual meetings and present the latest transport information in Bristol, and promote sustainable travel.
Dr Bike sessions	A mechanic will come to your site and carry out basic safety checks and minor repairs for staff bicycles.
Bike maintenance sessions	A mechanic will come to you and to teach staff how to maintain their bike. We have a series of 4 sessions – bicycle safety check, punctures, brakes and gears. This session is limited due to COVID-19

Individual support

Borrow a Bike	We loan hybrid, folding and electric bikes for individuals to try cycling before they buy a bike. Loans are up to 1 month.
Adult cycle training	1-2-1 cycle training gives you the skills and ability to cycle confidently. You can have up to 3 sessions: • beginner – if you can't ride a bike or are a bit wobbly, we can help you get going. • intermediate – When you are confident cycling on traffic-free routes, we teach you to cycle confidently in traffic. • advanced – For experienced cyclist. We can help you negotiate complex junctions more easily, improve your rush hour strategies and road position.
Personalised Travel Planning	Personalised travel planning encourages people to think about the way they currently travel and shows the options and benefits of sustainable travel – in a very individual and motivating way. Sessions last around 30 minutes and currently take place over the telephone or by video call.

Wheels to work

The Wheels to Work scheme provide support to people who are looking to start, change or return to work. The scheme is offered to Bristol residents who are aged 16+ and fall into at least one of the following categories:

- Are unemployed and seeking work
- Have been offered a job in the last four weeks
- Earn less than the living wage
- Are in training, an apprentice or on a work placement

The following travel support is offered as part of Wheels to Work in Bristol. In order to access our offers please visit one of our partner organisations or fill in our referral form:

- Free bus travel
- £100 discount on the cost of a refurbished bike, with free lock and set of lights
- Travel training

Bristol City Council Clean Air Plan - Full Business Case

Evaluation, Monitoring and Benefits Realisation Plan

FBC-38 | 4

February 2021

Bristol City Council

Bristol City Council Clean Air Plan Full Business Case

Project No:	673846CH.ER.20.01
Document Title:	Monitoring, Evaluation and Benefits Realisation Plan
Document No.:	FBC – 38
Revision:	4
Document Status:	N/A
Date:	February 2021
Client Name:	Bristol City Council
Project Manager:	HO
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Document history and status

Revision	Date	Description	By	Reviewed	Approved
1	October 2019	First draft	SB	HO	HO
2	October 2019	Draft report	SB	HO	HO
3	January 2021	Draft report	SB	HO	HO
4	February 2021	Draft report	SB	HO	HO

Contents

Acronyms and Abbreviations

ANPR	Automatic Number Plate Recognition
AQO	Air Quality Objective
BCC	Bristol City Council
CAZ	Clean Air Zone
CSF	Critical Success Factor
Defra	Department for Environment, Food & Rural Affairs
DfT	Department for Transport
EU	European Union
EV	Electric Vehicle
FBC	Full Business Case
GDP	Gross Domestic Product
HGV	Heavy Goods Vehicle
ITS	Institute of Transport Studies
JAQU	Joint Air Quality Unit
JSA	Job Seekers Allowance
LEP	Local Enterprise Partnership
LAQM	Local Air Quality Management
LGV	Light Goods Vehicle
NOx	Nitrogen Oxides
NO_2	Nitrogen Dioxide
OBC	Outline Business Case
ONS	Office for National Statistics
PCM	Pollution Climate Mapping
PHV	Private Hire Vehicle
PM	Particulate Matter
ROAMEF	Rationale, Objectives, Appraisal, Monitoring, Evaluation and Feedback
SME	Small to Medium Enterprise
SOC	Strategic Outline Case
VMS	Variable Message Sign

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 Bristol City Council (BCC). The Mayor of Bristol has often cited Bristol's 'moral and legal duty' to improve air quality in the city and the administration recognises that achieving improved air quality is not solely a transport issue. Notwithstanding the Council's work on a Clean Air Zone, efforts have been made to make citizens more aware of – and take personal responsibility for – various sources of air pollution, from traffic fumes to solid fuel burning. The Mayor has articulated a 'call to action' for local people, businesses and organisations to consider how small changes can make a significant difference in cutting toxic fumes across the city. BCC has monitored and endeavoured to address air quality in Bristol for decades and declared its first Air Quality Management Area in 2001. Despite this, Bristol has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO_2) and these are predicted to continue until around 2027 without intervention.

The added context is that of the COVID-19 pandemic. Recent research suggests that poor air quality may be correlated with higher death / infection rates from COVID-19. This is further compounded by growing evidence that suggests that those from black, Asian and minority ethnic communities are more at risk of catching and dying from the virus and the fact that individuals from these communities are more likely to live in areas where air quality is poor. The challenge of maintaining public health and supporting economic recovery while also achieving legal air quality levels after lockdown restrictions are lifted will remain live and intersecting issues for the foreseeable future.

The UK Government continue to transpose European Union law into its Environment Bill[2] , to ensure that certain standards of air quality continue to be met, by setting air quality assessment levels (AQALs) on the concentrations of specific air pollutants. It's very unlikely that these AQALs will differ to EU Limit Values prescribed by the European Union's Air Quality Directive and transcribed in the UK's Air Quality Standards Regulation 2010. Therefore, these Limit Values will remain in enforcement post-Brexit. In common with many EU member states, the EU Limit Value for annual mean nitrogen dioxide (NO_2) is breached in the UK and there are on-going breaches of the NO_2 limit value in Bristol. The UK government is taking steps to remedy this breach in as short a time as possible, with the aim of reducing the harmful impacts on public health. Within this objective, the Government has published a UK Air Quality Plan and a Clean Air Zone Framework, both originally published in 2017 (noting there have been subsequent revisions). The latter document provides the expected approach for local authorities when implementing and operating a Clean Air Zone (CAZ). The following business cases have been submitted to JAQU for the Clean Air Plan; Strategic Outline Case (April 2018), and an Outline Business Case (November 2019 and updated between April and June 2020).

In line with Government guidance BCC is considering implementation of the 'Small CAZ D Option' which includes a charging scheme for non-compliant buses, taxis, HGVs and LGVs and cars alongside a number of other measures.

A Full Business Case (FBC) has been produced 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 FBC proposes a preferred option including details of delivery. The FBC forms a bid to central government for funding to implement the CAP.

This document is written to support the FBC and sets out how the benefits of the scheme will be monitored, evaluated and realised. It has been produced in line with the Inception, Evidence and Options Appraisal packages of Guidance issued by the JAQU in 2017, and the HM Treasury Green Book.

The objective of the scheme is to deliver an option including a package of measures which will be most likely to bring about compliance with the Limit Value for annual mean NO_2 in the shortest time possible in Bristol and reducing human exposure as quickly as possible. To understand whether the scheme meets this objective, it is

[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] Environment Bill 2019-21 https://services.parliament.uk/bills/2019-21/environment.html

recommended that the "Standard Monitoring" approach set out in the Department for Transport's (DfT) "Monitoring and Evaluation Framework for Local Authority Major Schemes" (September 2012) is followed.

This report sets out the evaluation strategy and benefits realisation plan for the BCC Clean Air Plan scheme, covering the monitoring of impacts and the approach to determining the projected benefits, impacts and objectives. In line with HM Treasury's Magenta Book (2011) and DfT's 'Monitoring and Evaluation Strategy' (2013), the plan also covers two stages of the ROAMEF concept (Rationale, Objectives, Appraisal, Monitoring, Evaluation and Feedback). This ensures that the Plan is aligned with the Government's broad policy making and delivery cycle, depicted in Figure 1-1.

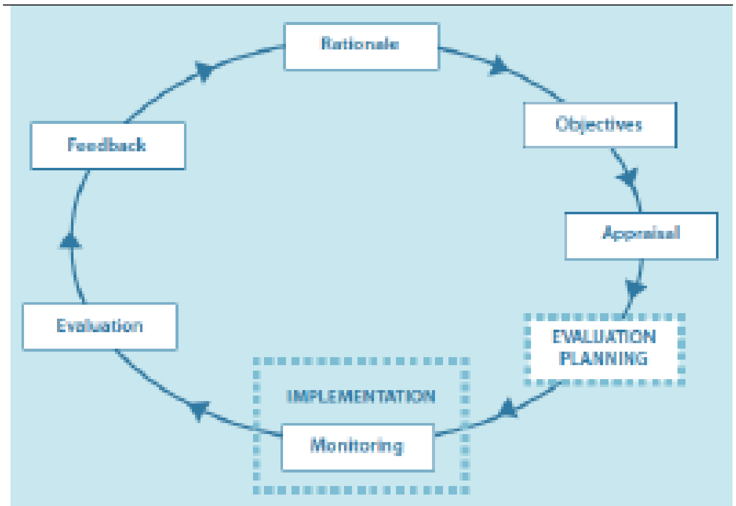


Figure 1-1: The ROAMEF cycle

In addition to local monitoring and evaluation of the BCC CAZ Scheme, JAQU are undertaking a central evaluation which will take place over two to three years by a separate organisation, with certain local authorities selected as a case study for a more detailed assessment. The central evaluation will provide BCC and other Local Authorities with learning that can be used to help delivery of Local Plans. This should include an understanding of what measures are working to reduce emissions in the shortest possible time and improve on the understanding of how Local Plan measures may affect local areas. The central evaluation will also provide Local Authorities with advice on approaches to gather robust data.

1.1 Summary of Evaluation Approach

The proposed approach is designed to assess whether the outputs and impacts of the scheme deliver the desired benefits and overarching objectives. The approach reflects the scale and type of scheme, plus the resources available to complete an evaluation providing a strong evidence base to feed into the benefits realisation assessment, inform stakeholders and where necessary, refine schemes.

The evaluation will include quantitative and qualitative measures, thereby covering a range of outcomes and impacts. Furthermore, the evaluation strategy will help influence similar schemes. It will comprise both 'process evaluation' and 'impact evaluation', with the former focusing on the processes by which the scheme was undertaken and the latter focusing on whether the desired impacts of the scheme were realised.

Based on DfT monitoring and evaluation guidance, and the requirement to undertake 'standard evaluation' for this scheme, the key types of questions to be addressed through this process are:

- How was the scheme delivered?
- What difference did the scheme make?
- Did the benefits justify the costs?

To enable evaluation to take place, a monitoring framework needs to be in place. The requirements of the "Standard Monitoring" outlined in the September 2012 DfT guidance have been used as a guide. The requirements are:

- Scheme Build
- Delivered scheme
- Costs
- Scheme objectives
- Travel demand, including behavioural change
- Travel times and reliability of travel times
- Out-turn value for money
- Impacts on the economy
- Carbon impacts.

The primary purpose of the scheme is to improve air quality within Bristol. Therefore, air quality will also be monitored, despite not being included within the 'standard monitoring' requirements.

The plan is defined in two parts, with the first part (process evaluation) covering the first three areas listed above (scheme build, delivery and costs) and the second area covering the scheme outputs, outcomes analysis and impacts to inform the benefits realisation. The second part will draw on the requirements in so far as they are applicable for this scheme.

Figure 1-2 illustrates the stages involved within the evaluation strategy and benefits realisation process. This process includes the following stages:

- Desired Impacts – These are based on the project's Critical Success Factors and reflect the intended effects of the scheme. These impacts are defined within Section 3.11 (listed as D1-D6).

- Monitoring Outputs – These include datasets that are likely to be impacted by the scheme. They are summarised within Section 3.2 (listed as M1-M8).

- Outcomes – These relate to the wider consequences of the scheme on society and the economy and are closely linked to the desired impacts. These outcomes are defined in Section 3.4 Outcome Analysis (listed as O1-O3).

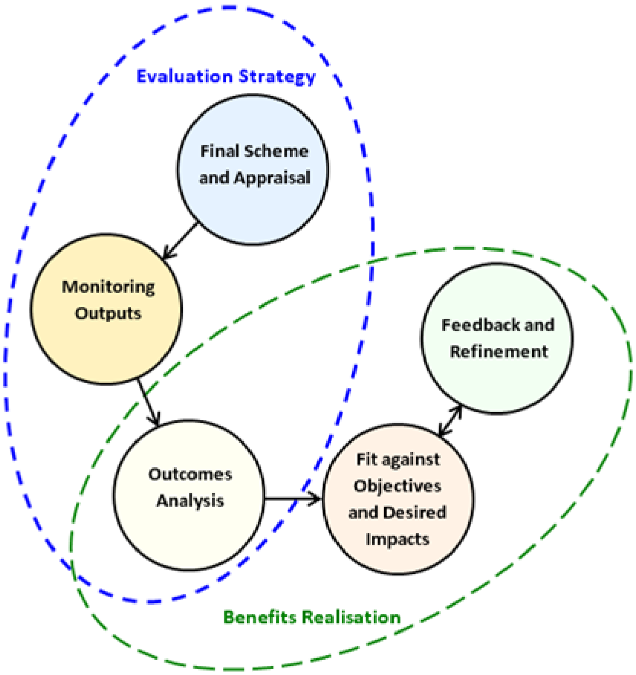


Figure 1-2: Flow diagram for Evaluation and Benefits Realisation Strategy

1.2 Scope of the scheme

The United Kingdom (UK) has in place air quality legislation, passed down from the European Union (EU), to ensure that certain standards of air quality are met. The legal limit for concentrations of NO_2 is 40 µg/m^3 as an annual mean. This legal limit is breached across a number of cities in the UK, including at several locations in Bristol.

BCC, along with 27 other local authorities, has been directed to produce a Clean Air Plan (CAP) to achieve air quality improvements in Bristol in the shortest possible time.

After detailed analysis, the 'Small area CAZ D' was selected as the preferred scheme to comply with government guidance (see the FBC Options Assessment report for more detail on this process). This option is expected to achieve compliance by 2023. These measures aim to reduce NO_2 levels within Bristol to legal limits within the shortest possible timeframe.

- The Small CAZ D Option applicable to specific zones of operation shown in Figure 1-3 includes: Small Area Class D (charging non-compliant cars, buses, coaches, taxis, HGVs and LGVs);
- Fast Track Measures:
  - Closure of Cumberland Road inbound to general traffic
  - Holding back traffic to the city centre through the use of existing signals.

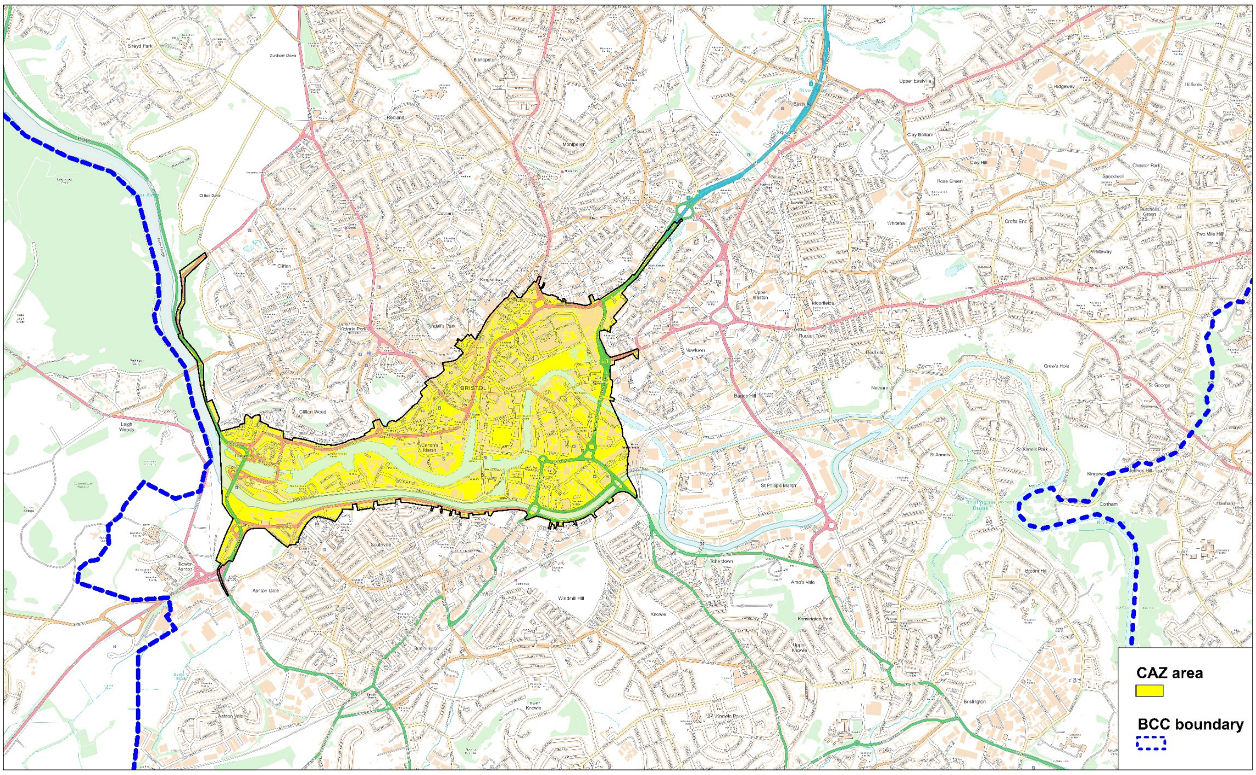


Figure 1-3: Bristol Small area CAZ D boundary

The Small CAZ D Option measures described above, would be delivered through funding from the Implementation Fund and Clean Air Fund, provided by central government. The Implementation Fund provides funding to deliver measures required to achieve compliance with air quality standards in the shortest possible time. The Clean Air Fund provides funding via a competitive bid process, to deliver measures that aim to mitigate and adverse impacts which are expected fall upon disadvantaged groups. Additional schemes and mitigation measures could potentially be funded by any net revenue produced from the charging zone, although this revenue is not guaranteed.

The ongoing base revenue cost for the CAZ to operate along with all other associated measures was estimated at £8,445,591 over the three-year period in which the CAZ is expected to operate before compliance is achieved. The total base capital cost for the proposed CAZ was estimated at £44,268,554 – this includes risk but excludes an uplift for contingency.

Timescales for delivery include:

- Scheme opening – 2021
- Modelled year of NO_2 compliance – 2023

2. Process Evaluation

Process evaluation seeks to answer the question 'How was the scheme delivered?'. This involves the assessment of whether a scheme is being implemented as intended, by monitoring the intervention's processes, timelines and budget throughout the implementation phase. This information will be used to inform the case for similar schemes across the UK.

The three areas of monitoring, evaluation and reporting will be:

- **Scheme build –** Covering procurement of the scheme, achievement of timescale and key milestones, risk outcomes and stakeholder feedback.

- **Delivered scheme –** Covering scheme refinements and success of the proposed design and materials used. This will include any measure taken to minimise any identified negative impacts during implementation.

- **Outturn costs –** These will be compared to forecasts covering capital and on-going operating and maintenance costs, ensuring the scheme financial performance is in line with the business case.

These three aspects of the scheme will be reported one year before scheme opening, as well as annually from 1 to 5 years after scheme opening.

3. Impact Evaluation

In line with the HM Treasury's 'Magenta Book' (2011), impacts evaluation attempts to provide an objective test of what changes have occurred, and the extent to which these can be attributed to the scheme.

3.1 Scheme Critical Success Factors

A number of Critical Success Factors (CSF) have been developed for the scheme in order to assess each scheme option. The CSFs summarise the desired impacts of the intervention and it is necessary to understand these intended effects before assessing and evaluating the changes caused by the scheme. The following CSFs were used for the current scheme:

Primary Critical Success Factor

- Deliver compliance with NO_2 air quality Limit Values[3] and Air Quality Objectives[4] in the shortest possible timescales

Secondary Critical Success Factors

- **Strategic**
    - Provide equity across different vehicle type and trip purpose
    - Compliance with Defra Draft CAZ framework, including minimum requirements
- **Economic**
    - Mitigate financial impact on low income households
    - Improve health of low-income households
    - Maximise positive effects on the economy, whilst minimising any negative impacts
    - Improve public health across Bristol
- **Commercial**
    - Delivery timescale risks of procurement
- **Financial**
    - Likelihood of revenue equating to implementation/operational costs[5]
    - Upfront capital required for scheme
    - Risk of financial penalty to the Council/s
- **Management**
    - Public acceptability which could impact on the option's deliverability
    - Political acceptability which could impact on the option's deliverability

3.1.1 Desired Impacts to Monitor

A number of desired impacts have been identified based on the scheme CSFs. These impacts will be monitored and assessed in order to feed into the benefits realisation plan and are considered appropriate to evaluate the outcomes of the proposed scheme. These desired impacts include:

Implementation Fund Scheme:

- D1 – Deliver compliance with NO_2 air quality Limit Value in the shortest possible time
- D2 – Deliver compliance with NO_2 Air Quality Objective in the shortest possible time

[3] (EU NO_2 concentration Limit Values)
[4] (LAQM air quality Objectives for NO2 as set out in the Air Quality (England) Regulations (SI2000/928 as amended))

[5] Complying with the legal test which was set out by the High Court in November 2016 in R (ClientEarth) (NO_2) V Secretary of State for Environment Food and Rural Affairs [2016] EWHC 2740 (Admin), only shortlisted options which achieve compliance with the NO_2 Limit Value in the shortest possible time, are appraised across this criterion. The relevant analysis is presented in the Financial Case chapter of the Strategic Outline Case.

Clean Air Fund Scheme:

- D3 – Minimise the negative impacts and maximise the benefits of the scheme on local businesses
- D4 – Minimise adverse impacts on traffic
- D5 - Facilitate use of public transport and sustainable travel
- D6 - Minimise the impacts of the scheme on residents, particularly low-income households

One of the main aims of the scheme is to improve public health across the city, and to ensure that low income households also benefit from any health impacts. However, the public health benefits of improved air quality are long term (over lifetimes) and therefore would not be appropriate to include as a desired impact, as they could not be adequately assessed within a short period of scheme delivery. Improvements to air quality have been shown to produce beneficial impacts on public health[6], therefore the public health aims of this scheme should be achieved if the air quality objectives and EU NO_2 Limit Values are met.

3.2 Central evaluation

As well as the local scheme plan, information gathered will be provided to support the central evaluation of all the CAPs implemented in the UK. The following aspects are to be assessed centrally:

- What impact have Local Plans had on air quality, NO_2 emissions and health?
- How have Local Plans affected behaviours of car owners, public transport users, local businesses? Have behaviours changed in expected or unexpected ways?
- How has the impact of the Local Plans varied for different local groups, including more vulnerable residents or transport users?
- How have external factors influenced the effectiveness of the Local Plans?
- How does the approach to implementing Local Plans affect the scale and pace of impacts?

The central evaluation will be undertaken by a separate organisation, with certain local authorities selected as a case study for a more detailed assessment. BCC will submit quarterly reports to JAQU for central evaluation, covering air quality and traffic data.

3.3 Monitoring Plan

In order to assess whether the impacts of the scheme are as predicted, a monitoring plan has been produced, outlining the programme of data collection and information collation tasks for the scheme.

Key questions which the monitoring plan seeks to answer include:

- Was the scheme delivered to costs and timescale?
- Has the scheme delivered the desired impacts and benefits as forecast?
- Has the scheme shown out-turn value for money as predicted?
- What lessons can be learnt to help shape air quality strategies for Bristol?
- Has the scheme had any unpredicted impacts?

Where possible, methods of data collection have been selected which are completed as part of ongoing air quality and transport monitoring, in order to minimise additional costs whilst maximising the data available to identify scheme impacts.

The area to be monitored includes those parts of the city within the proposed charging zone, but also those areas neighbouring the zones and across the wider city, as appropriate.

[6] 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

Further details of the proposed ANPR camera locations, which will be used to monitor data as well as enforcing the charging zone, are available within the FBC.

Table 3-1 lists the data to be collected and collated as part of the monitoring plan, with information on the method and frequency of data collection and rationale for its inclusion.

The areas of data collection include:

- M1: Air quality data
- M2: Vehicular fleet information
- M3: Traffic flows
- M4: Jobs seekers allowance information
- M5: UK business count data
- M6: Retail/business/office space vacancy figures
- M7: Walking and cycling counts
- M8: Stakeholder feedback from council user group forums

Table 3-1 Data Collection and Collation

Measure	Data to be used	Rationale for inclusion	Data collection methods	Frequency of data collection
M1: Air quality data	NO_2 concentrations data collected at existing monitoring locations within the BCC area.	To understand changes in air quality (particularly NO2 concentrations).	Diffusion tubes and real time monitoring	Baseline (pre-scheme) and then ongoing monitoring.
M2: Vehicular fleet information	Number of compliant/non-compliant vehicles driving within the BCC charging zone.	To understand how the type of vehicles travelling in Bristol changes over time	ANPR cordon, cross-referencing with DVLA vehicle database	Baseline (pre-scheme) and then continuously through permanent ATCs (analysed quarterly)
M3: Traffic flows	Traffic flows within the charging zone as well as across the wider city	To understand how the scheme impacts on traffic flows and speeds along key routes within the highway network	ANPR cordon Permanent Automatic Traffic Counts (ATCs) SCOOT Loop Data	At least 2 weeks during baseline monitoring (pre-scheme) and then continuously through permanent ATCs (analysed quarterly)
M4: Job seekers allowance (JSA) information	ONS data from NOMIS web, relating to JSA benefits claimants in BCC	To understand any changes in the number of individuals applying for JSA within BCC, in	Publicly available data. Will be compared against other similar cities to help isolate the	Baseline (pre-scheme) and then annually for five years

Measure	Data to be used	Rationale for inclusion	Data collection methods	Frequency of data collection
		order to assess impacts on the local labour market and economy.	impact of the scheme from other unconnected variables.	after scheme opening
M5: UK Business Count Data	ONS data from NOMIS web, relating to business demography	To understand changes in the number and type of businesses operating in Bristol in order to assess economic impacts.	Publicly available data. Will be compared against other similar cities to help isolate the impact of the scheme from other unconnected variables.	Baseline (pre-scheme) and then annually for five years after scheme opening
M6: Retail/business/office space vacancy figures	Vacancy statistics from internal council data. Market data from property consultants.	In order to understand economic impacts of the scheme in terms of changes to the number of businesses operating within Bristol.	Internal data collection as part of ongoing process. Regular property market reports published by property consultants in the public domain could also be used.	Baseline (pre-scheme) and then annually for five years after scheme opening
M7: Walking and cycling counts	Pedestrian and cycle counts on key routes within the city	To understand changes to the number of people walking and cycling along key routes within Bristol	Commissioning of new surveys Use of survey data from Street Space Scheme monitoring	Baseline (pre-scheme) and then annually for five years after scheme opening
M8: Stakeholder feedback from council user group forums	Stakeholder feedback covering relevant elected members, stakeholder groups, the LEP.	To understand the opinions of stakeholders on scheme delivery and impacts. To understand some of the less quantified impacts such as package effects.	Part of the on-going consultation process for transport strategies in the City.	1, 3, 5 years after scheme opening

3.3.1 Air Quality and Traffic Data Collection

Modelling indicates that the Small CAZ D Option will achieve compliance of the NO_2 Limit Value in 2023 compared to a modelled natural compliance year of 2027. Additional air quality monitoring will be focused on the effectiveness of the Small CAZ D Option.

Location and number of monitoring sites for air quality and traffic flows have been established based on the work completed within the OBC stage. Monitoring has begun at these sites and the data collected will provide information for the pre-scheme situation and the impacts of the scheme once measures are implemented.

In total, 95 additional diffusion tubes will be installed as part of the CAZ scheme. Additionally, a new continuous NO_x air quality monitoring site will be established on Marlborough Street, a key corridor where compliance is predicted to be late.

This data will be collected prior to implementation up until 2028 (i.e. one-year post 2027 the likely year of natural compliance). Existing BCC monitoring sites were used if they were suitable for air quality monitoring. This will provide data on measure M1 (air quality data).

ANPR surveys will be used to collect traffic data. These surveys will take place for one week prior to implementation, 2022, 2025 at 48 locations that have been identified as showing compliance issues in the OBC baseline 2024 model. This will provide data for monitoring of measures M2 and M3 (vehicular fleet information and traffic flows). A number of permanent traffic data collection sites will be established at points of interest within Bristol, this data will feed into JAQU's central evaluation process.

Baseline Data

Data has already been collected and is scheduled to be collected as part of the monitoring of other BCC transport schemes as well as to monitor the impacts of the COVID-19 pandemic on traffic and air quality. Data collected from these sources will be used to monitor the effects of the Small CAZ D Option, as well as the situation prior to implementation. Through the use of existing data sources, the need for new surveys and data collection will be minimised.

Traffic flow data has already been collected from February 2019 to November 2020 at key locations around the city. This data can be used to form a baseline of traffic for the CAZ scheme. Key traffic count locations, where monitoring took place, include the following:

- St Michaels Hill (Southbound)
- Lower Maudlin Street (Westbound at Lewins Mead)
- Marlborough Street (Westbound at Dighton Street)
- Newfoundland Street (Inbound)
- Newfoundland Street (Outbound)
- Perry Road (Eastbound)/ Colston Street

In addition, daily count data has been collected for working days from the 3rd February to the 4th December 2020 to assess the changes in traffic due to COVID-19.

As part of the monitoring of the Street Space Scheme measures, vehicle counts are also due to take place at the following locations in 2021:

- Park Row/Marlborough Street Junction
- Lewins Mead/Haymarket Junction
- St Michael's Hill Junction

Air quality data has already been collected from around the City during the period 25th March 2019-1st November 2019 and 24th March 2020-31st October 2020. This data will be used to create a baseline for the CAZ scheme.

These Monitoring sites were situated at the following locations:

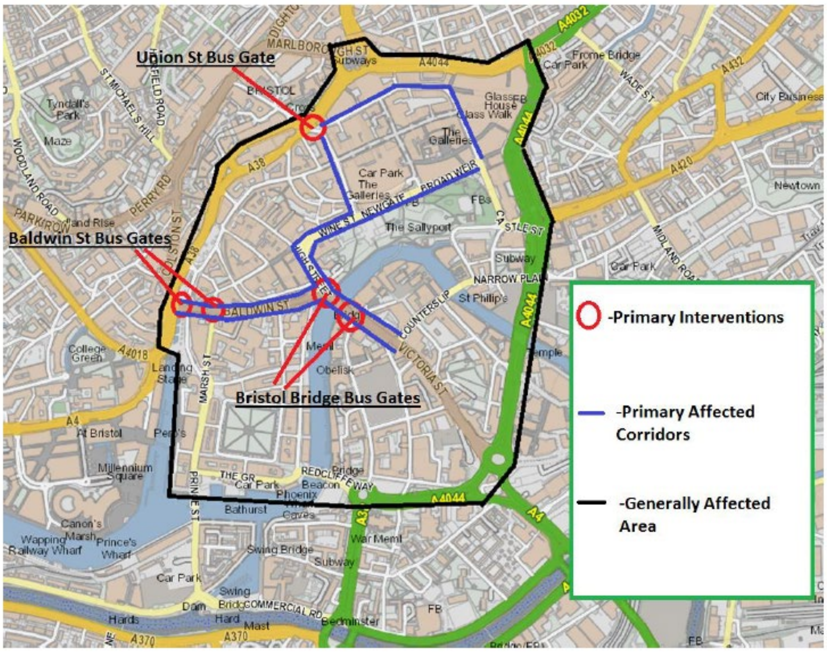
- Temple Way
- Colston Avenue

During the COVID-19 pandemic a number of Street Space Schemes were proposed within Bristol in order to free up road space, which would normally be used by traffic and parking, for the use of public transport, cyclists and pedestrians. One of these Street Space Schemes included measures surrounding Bristol Bridge. Monitoring is due to take place within the area shown in Figure 3-1 below, this includes the following:

- Vehicle counts and journey time information sourced from SCOOT loops and ANPR cameras
- Pedestrian and cycle counts sourced from manual counts and Vivacity Traffic Sensors
- Air quality levels sourced from diffusion tube data.

This data will be used to establish baseline data for the CAZ Scheme.

Figure 3-1: Areas to be monitored by Bristol Bridge scheme



3.4 Monitoring Outputs and Desired Impacts

Table 3-2 summarises the links between Monitoring Outputs and Desired Impacts.

Table 3-2: Monitoring Outputs for Assessing Desired Impacts (primary links only)

Monitoring Outputs (M) by Desired Impacts (D)	D1: Deliver compliance with NO2 air quality Limit Values	D2: Deliver compliance with NO2 Air Quality Objectives	D3: Minimise the negative impacts and maximise the benefits of the scheme on local businesses	D4: Minimise adverse impacts on traffic	D5: Facilitate use of public transport and sustainable travel	D6: Minimise the impacts on residents, particularly low-income households
M1: Air quality data						
M2: Vehicular fleet information						
M3: Traffic flows						
M4: Job seekers allowance (JSA) information						
M5: Changes in business numbers						
M6: Retail/business/office space vacancy figures						
M7: Walking and cycling counts						
M8: Stakeholder feedback from council user group forums						

3.5 Outcome Analysis

Outcome analysis investigates the wider longer-term benefits of the scheme on the city and will be assessed based on data collected as part of the scheme monitoring outcomes (M1-M8). These outcomes are strongly linked to the desired impacts of the scheme (D1-D6) and are listed below:

- O1: Deliver compliance with NO_2 air quality Limit Values and Air Quality Objectives in Bristol
- O2: Minimise financial impacts of the scheme on low income households within Bristol
- O3: Overall neutral or benefit to the local economy

Figure 1-2 illustrates how monitoring outputs are used to feed into the outcome analysis and benefit realisation process. Table 3-3 maps how each monitoring output (M1-M8) will be used to evaluate the outcome analysis (O1-O3) and therefore contribute to the assessment of benefits realisation.

Table 3-3: Mapping of Monitoring Outputs and Outcomes Analysis (primary links only)

Monitoring Outputs (M) by Outcome Analysis (O)	O1: Deliver compliance with NO_2 air quality Limit Values and Air Quality Objectives in Bristol	O2: Minimise financial impacts of the scheme on low income households within Bristol	O3: Overall neutral or benefit to the local economy
M1: Air quality data			
M2: Vehicular fleet information			
M3: Traffic flows			
M4: Job seekers allowance (JSA) information			
M5: Changes in business numbers			
M6: Retail/business/office space vacancy figures			
M7: Walking and cycling counts			
M8: Stakeholder feedback from council user group forums			

3.6 Benefits Realisation

The data collected as part of this Monitoring and Evaluation Plan will be used to demonstrate the realisation of the scheme benefits and objectives.

Table 3-4 summarises the relationships between the desired impacts of the scheme (D1-D6) and the scheme outcomes (O1-O3). Alongside Table 3-2 and Table 3-3, this identifies the links between the data outputs collected as part of the monitoring process (M1-M8), the desired impacts (D1-D6) and outcomes (O1-O3) which form part of the benefits realisation. The process of monitoring and benefits realisation can be refined as necessary to allow optimisation of benefits and assessment of all objectives and desired impacts.

3.6.1 Benefits Profile

BCC was instructed to reduce NO_2 concentrations within the city to legal levels in the shortest time possible. Modelling of the preferred Small CAZ D Option indicate that this primary CSF should be achieved by 2023. Therefore, benefits to air quality produced by the Clean Air Plan are likely to be realised in a reasonably short timeframe from implementation. Monitoring of scheme outcomes and impacts will continue for five years after scheme opening, in order to assess the realisation of air quality benefits. This will take place alongside monitoring of impacts to the economy and transport within the city, in order to assess how these factors develop over the course of the scheme. A monitoring period of five years is recommended within the guidance[7] and this should provide an appropriate timescale to assess the wider impacts and benefits of the scheme.

Table 3-4: Mapping of Desired Impacts and Outcome Analysis (primary links only)

Outcome Analysis (O) by Desired Impacts (D)	O1: Deliver compliance with NO_2 air quality Limit Values and Air Quality Objectives in Bristol	O2: Minimise financial impacts of the scheme on low income households within Bristol	O3: Overall neutral or benefit to the local economy
D1: Deliver compliance with NO_2 air quality Limit Values			
D2: Deliver compliance with NO_2 Air Quality Objectives			
D3: Minimise the negative impacts and maximise the benefits of the scheme on local businesses			
D4: Minimise adverse impacts on traffic			
D5: Facilitate use of public transport and sustainable travel			
D6: Minimise the impacts of the scheme on residents, particularly low-income households			

[7] DfT's 'Monitoring and Evaluation Framework for Local Authority Major Schemes' (September 2012)

4. Delivery of the Monitoring & Evaluation and Benefits Realisation Plan

4.1 Costs

The costs associated with the evaluation, monitoring and benefits realisation analyses are outlined within this section.

A total cost of £410,018 will be required for monitoring, evaluation and benefits realisation. This estimate is included within the project costs supporting the Financial Case of the FBC. The timing of expenditure on monitoring, evaluation and benefits realisation is assumed to be consistent across the assessment period, given the common frequency of data collection and assessment. Costs are as outlined in Table 4-1 to Table 4-3.

A sum has also been included within the scheme costs for the provision of BCC staff to undertake ongoing monitoring of the scheme. An estimate of £20,000 was included for 1FTE staff member for this role. Air quality monitoring (installations) forms part of the scheme capital costs, and the air quality ongoing monitoring will be included within operational costs.

Table 4-1: Scheme costs over monitoring and evaluation period

Activity	Total Cost
Air Quality Monitoring (ongoing monitoring)[8] (Including costs for Marlborough Street site)	£269,869
Traffic Levels Monitoring (ongoing monitoring)	£50,000
Economic Indicators (ongoing monitoring)	£25,000
Active Modes (ongoing monitoring)	£25,000
Staff (ongoing monitoring)	£20,000
Air Quality Monitoring (Installations) (Including Infrastructure at Marlborough Street, staff costs and site decommission)	£20,149
Total	£410,018

Table 4-2: Air Quality Monitoring Revenue Costs

Year	Revenue cost
2021	£30,348.52
2022	£31,258.97
2023	£32,196.74
2024	£33,162.64
2025	£34,157.52
2026	£35,182.25
2027	£36,237.71
2028	£37,324.85

[8] These costs include air quality monitoring up to and including one full year post the date of natural compliance.

Table 4-3: Air quality monitoring costs (capital and revenue)

Item	Number	Cost Capital	Cost Revenue (pcm)
Marlborough Street continuous monitor and works	1	£14,027.00	
Replacement aircon at 4 years	1	£2,350.88	
Establish diffusion tubes	1	£1,885.63	
Decommission diffusion tubes	1	£1,885.63	
Change tubes and calibrate monitor	93		£942.82
Tube analysis	93		£306.90
Continuous analyser service contract	1		£250.00
Reporting and analysis	1		£935.67
Calibration gas	1		£20.00
Totals		£20,149.14	£2,455.38
Total to 2028		£20,149.14	£269,869.20

4.2 Timescales

A summary of data collection timescales is presented below:

- Stage 1 – Before opening– surveys pre-implementation
- Stage 2 – 1 year after full opening of the scheme – surveys in 2022
- Stage 3 – Ongoing monitoring until a year after natural compliance 2028

Air quality data and traffic flow, composition and speed data will be collected quarterly during stages 2 and 3.

4.3 Reporting

The evaluation and benefits realisation strategy and reporting will be managed by the BCC Project Manager, with support from relevant officers. They will ensure the plan is successfully completed in accordance with the quality assurance defined by BCC.

Central evaluation has been set up by JAQU in order to gain a better understanding of which schemes and policies work best in reducing nitrogen dioxide (NO_2) within England in the shortest possible time. JAQU has commissioned Ispos MORI, the Institute of Transport Studies (ITS), Enviro Technology Services and Air Quality Data Management in order to undertake the central evaluation.

Air quality data and traffic flow, composition and speed data will be shared with JAQU on a quarterly basis (at the end of March, June, September and December). Air Quality data will include information from real time monitoring and diffusion tubes, which will be provided to the central evaluation team. If available, historical data ATC and speed data (from 2015 or earlier) will also be submitted to the ITS within the first submission. This will include any historical air quality, ATC or traffic speed data. Air quality data will be submitted to JAQU in the format of the 'Air Quality Monitoring reporting template' provided within the guidance. ANPR data, alongside other traffic data including vehicular fleet information and walking and cycling counts, will be provided to the ITS.

Data and reports submitted to the central evaluation and ITS will be used by JAQU and BCC to adapt and improve their approach to the scheme and also will be used to assess how effectively Local Plans have been in meeting their aims. The findings of the central evaluation will be reported back to BCC through a quarterly newsletter to all Local Authorities, annual reports and individual reports from deep-dive and rapid-assessment case studies to Local Authorities. These reports are intended for internal use only. Learning from the central evaluation will be shared with other Local Authorities by JAQU.

BCC will also submit a report to JAQU outlining programme management factors including information on activity undertaken, financial spend, review of programme risks and performance against key indicators. These reports will be submitted quarterly.

BCC monitoring reports will be made available to stakeholders via the CleanAirforBristol.org website.

4.4 Governance

The evaluation and benefits realisation strategy and reporting will be managed in accordance with the management strategy and quality assurance defined by BCC within the FBC Management Case.

4.5 Risks and Mitigations

There are a number of risks associated with the completion of the monitoring and benefits realisation plan. These risks include:

- It is assumed that data from third parties will be available for use by BCC. For example, information from private companies (e.g. First data on bus patronage) and from other local authorities may not be made available by these organisations.

- Some publicly available data is only available with a minimum one-year lag. This could lead to some delay in the assessment when using data available in the public domain.

- Many of the variables being monitored within this plan are impacted by a large number of external factors. This is particularly true of economic factors such as retail footfall, which are likely to be affected by wider national and international policies and economic performance. To try to isolate and measure the explicit impact of the CAP, a benchmarking exercise will be undertaken to compare economic performance in Bristol against other comparable cities.

- It is assumed that the current BCC programme of air quality monitoring will be continued for the evaluation and benefits realisation period.

- Diffusion tubes are used by BCC to monitor air quality data; however, this method generally produces lower quality measurements than automatic monitors. This could reduce the accuracy of the air quality data collected

4.6 New Data Collection

This plan has been developed in a way that minimises additional data collection. Where possible, data has been sourced from data sets which are already collected as part of BCC and third-party organisation's ongoing operations. Efforts have been made to use monitoring outputs which can be used to assess multiple impacts and outcomes. Information on how data will be provided for each monitoring output (M1-M8) and whether new data surveys are required, is summarised in Table 4-4.

Table 4-4: Summary of new and existing data sets required for monitoring

Monitoring Outputs (M)	Stage 1 – before opening	Stage 2 – 1 year after opening	Stage 3 – 2-5 years after opening
M1 (Air Quality Data)	This data will be collected by BCC through a network of automatic and passive (diffusion tube) monitoring locations.	This data will be collected by BCC through a network of automatic and passive (diffusion tube) monitoring locations.	This data will be collected by BCC through a network of automatic and passive (diffusion tube) monitoring locations.
M2: Vehicular fleet information	Data available from ANPR survey undertaken as part of business case preparation	ANPR cameras installed to enforce the diesel ban and charging zones will provide this information	ANPR cameras installed to enforce the diesel ban and charging zones will provide this information
M3: Traffic flows	New traffic surveys will be required Data available through monitoring of Street Space Scheme Measures and existing traffic counts (see Section 3.3.1)	Data on traffic flows will be available from ANPR cameras installed to enforce the diesel ban and charging zones, alongside new traffic surveys in areas outside of these zones.	Data on traffic flows will be available from ANPR cameras installed to enforce the diesel ban and charging zones, alongside new traffic surveys in areas outside of these zones.
M4: Job seekers allowance information	Publicly available Job Seekers Allowance data will be available from NOMIS (ONS)	Publicly available Job Seekers Allowance data will be available from NOMIS (ONS)	Publicly available Job Seekers Allowance data will be available from NOMIS (ONS)
M5: UK business council data about changes in business	Publicly available business demography data from ONS	Publicly available business demography data from ONS	Publicly available business demography data from ONS
M6: Retail/business/office space vacancy figures	Data collected by BCC and property consultants as part of on-going processes.	Data collected by BCC and property consultants as part of on-going processes.	Data collected by BCC and property consultants as part of on-going processes.
M7: Walking and cycling counts	New surveys required Data collected as part of monitoring of Bristol Bridge Scheme will be used	New surveys required	New surveys required
M8: Stakeholder feedback from Council user group forums	Collected as part of BCC existing on-going consultation process	Collected as part of BCC existing on-going consultation process	Collected as part of BCC existing on-going consultation process

As summarised above, new data collection will only be required for monitoring outputs M1, M2, M3 and M7. Further details of transport and air quality data collection is set out below.

It is proposed that the following Air Quality data is collected:

- Air quality monitoring at 95 additional diffusion tube sites. Data will be collected pre implementation up until 2028.
- Establishment of a new continuous NOx air quality monitoring site on Marlborough Street, a key corridor where compliance is predicted to be late.
- Use of some existing BCC sites if locations are suitable

It is proposed that the following Traffic Data is collected:

- Repeat ANPR surveys for one-week pre-implementation, 2022, 2025.
- Additional ANPR surveys at 48 locations (those showing compliance issues in the OBC baseline in 2024) for one-week pre-implementation, 2022, 2025.

Bristol City Council Clean Air Plan Final Business Case

Sensitivity Testing Report

FBC 39

February 2021

Bristol City Council

Bristol City Council Clean Air Plan Final Business Case

Project No:	673846.ER.20
Document Title:	Sensitivity Testing Report
Document No.:	FBC-39
Revision:	7
Date:	February 2021
Client Name:	Bristol City Council
Project Manager:	HO
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Document history and status

Revision	Date	Description	Author	Checked	Reviewed	Approved
1	11.10.2019	Initial OBC draft for comment	KT / KW	CB	HO	HO
2	27.10.19	OBC draft	KT / KW	CB	HO	HO
3	28.10.19	OBC draft	KT / KW	CB	HO	HO
4	18.05.20	FBC draft	KT / KW	CB	HO	HO
5	19.05.20	FBC draft	KT / KW	CB	HO	HO
6	11.2.21	FBC Draft	DW / KW	CB/KT	HO	HO
7	17.2.21	FBC Draft	DW / KW	CB/KT	HO	HO

Contents

Acronyms and Abbreviations

ANPR	Automatic Number Plate Recognition
BCC	Bristol City Council
CAZ(s)	Clean Air Zone(s)
CAP	Clean Air Plan
CO_2	Carbon Dioxide
Defra	Department for Environment Food & Rural Affairs
DfT	Department for Transport
EFT	Emissions Factors Toolkit
Euro	European
FBC	Full Business Case
HGV	Heavy Goods Vehicle
JAQU	Joint Air Quality Unit
LAQM	Local Air Quality Management
LGV	Light Goods Vehicle
HGV	Heavy Goods Vehicle
NOx	Nitrous Oxides
NO_2	Nitrogen Dioxide
OBC	Outline Business Case
OS	Ordnance Survey
PM	Particulate Matter
RSI	Roadside Interview
SP	Stated Preference
(Web)TAG	Transport Analysis Guidance

1. Introduction

1.1 Context

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). The Mayor of Bristol has often cited Bristol's 'moral and legal duty' to improve air quality in the city and the administration recognises that achieving improved air quality is not solely a transport issue. Notwithstanding the Council's work on a Clean Air Zone, efforts have been made to make citizens more aware of – and take personal responsibility for – various sources of air pollution, from traffic fumes to solid fuel burning. The Mayor has articulated a 'call to action' for local people, businesses and organisations to consider how small changes can make a significant difference in cutting toxic fumes across the city. BCC has monitored and endeavoured to address air quality in Bristol for decades and declared its first Air Quality Management Area in 2001. Despite this, Bristol has ongoing exceedances of the legal limits for Nitrogen Dioxide (NO_2) and these are predicted to continue until around 2027 without intervention.

The added context is that of the COVID-19 pandemic. Recent research suggests that poor air quality may be correlated with higher death / infection rates from COVID-19. This is further compounded by growing evidence that suggests that those from black, Asian and minority ethnic communities are more at risk of catching and dying from the virus and the fact that individuals from these communities are more likely to live in areas where air quality is poor. The challenge of maintaining public health and supporting economic recovery while also achieving legal air quality levels after lockdown restrictions are lifted will remain live and intersecting issues for the foreseeable future.

The UK Government continue to transpose European Union law into its Environment Bill[2] , to ensure that certain standards of air quality continue to be met, by setting air quality assessment levels (AQALs) on the concentrations of specific air pollutants. It's very unlikely that these AQALs will differ to EU Limit Values prescribed by the European Union's Air Quality Directive and transcribed in the UK's Air Quality Standards Regulation 2010. Therefore, these Limit Values will remain in enforcement post-Brexit. In common with many EU member states, the EU Limit Value for annual mean nitrogen dioxide (NO_2) is breached in the UK and there are on-going breaches of the NO_2 limit value in Bristol. The UK government is taking steps to remedy this breach in as short a time as possible, with the aim of reducing the harmful impacts on public health. Within this objective, the Government has published a UK Air Quality Plan and a Clean Air Zone Framework, both originally published in 2017 (noting there have been subsequent revisions). The latter document provides the expected approach for local authorities when implementing and operating a Clean Air Zone (CAZ). The following business cases have been submitted to JAQU for the Clean Air Plan; Strategic Outline Case (April 2018), and an Outline Business Case (November 2019 and updated between April and June 2020).

Following the submission of the OBC, further work was undertaken to develop the scheme, which resulted in the development of a new option - the Small area CAZ D. This work, and the option development work undertaken as part of the OBC, is presented in an updated Option Assessment Report (Appendix C FBC-16). The OBC version of this report is appended to the updated Option Assessment Report.

This report provides details of the following sensitivity tests on the Small CAZ D scenario:

- Behavioural response to charging;
- Fleet renewal delay by one year; and
- Euro 6 Vehicles (Low and High Emission scenarios).

[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] Environment Bill 2019-21 https://services.parliament.uk/bills/2019-21/environment.html

A summary of all sensitivity tests and key findings in this report is provided in section 6.

1.2 Scheme description

The Small CAZ D scheme includes the following components:

- Small Area Class D – (charging non-compliant cars, buses, coaches, taxis, HGVs and LGVs);
- Closure of Cumberland Road inbound to general traffic; and
- Holding back traffic to the city centre through the use of existing signals.

Full details of the modelling methodology for this scheme can be found in FBC-23 Local Plan Transport Modelling Methodology Report (T3) and transport model results can be found in FBC-27 Local Plan Transport Model Forecasting Report (T4).

2. Previous Sensitivity Testing

Sensitivity testing has been carried out on previous scenarios, the Hybrid Option and the Medium area CAZ C/Small area CAZ D option in October 2019 and May 2020 respectively. The outcomes of these various sensitivity tests carried out on the options are shown in FBC-39 Sensitivity Testing Report submitted in May 2020.

3. Consideration of tests to be undertaken at the FBC stage

Following the submission of the BCC CAZ OBC, further work was undertaken to develop the scheme, and this work resulted in the development of a new option, Small CAZ D option. This work, and the option development work undertaken as part of the FBC is presented in an updated Option Assessment Report (Appendix C FBC-16). Further to this, JAQU have provided feedback on the OBC from the T-IRP.

Consideration has been given to the choice of sensitivity tests to support the FBC. A list of the sensitivity tests undertaken for the FBC are set out in Table 3.1.

Table 3-1: Sensitivity tests supporting this FBC

Source	Description	Recommended to be undertaken for the FBC
OBC sensitivity test	Behavioural response to charging	Yes – previous pessimistic test showed slightly higher mean NO_2 when compared to the previous core scenario (Medium CAZ C/Small CAZ D) – so redo this test
OBC sensitivity test	Euro 6 vehicles	Yes – previous high emissions test showed slightly higher mean NO_2 when compared to the previous central case – so redo this test
JAQU	One-year fleet renewal delay	Yes – as COVID-19 may have an impact of the natural uptake of newer/cleaner vehicles.

In deriving the list above, consideration was given to other potential sensitivity tests, the rationale for not undertaking these tests is set out in Table 3-2.

Table 3-2: Justification for not undertaking further sensitivity tests in this FBC

Description	Justification for not undertaking the sensitivity test in the FBC
Age of transport model	Adjustments made to the model to account for the age of the model have been included in the core scenario.
Fleet splits by fuel type: ANPR vs.NAEI (EFT)	Latest Core Scenario uses EFT splits
HGV adjustment factors	Previous test showed slightly lower mean NO_2 when compared to a previous core scenario (the hybrid)
Emissions at low speeds	Previous high emissions test shows no difference in the mean NO_2 compared to the previous central case
Background concentrations	Assessment showed that without a local calibration factor being applied to Defras national pollution background maps, the predicted concentrations are generally lower than if backgrounds are calibrated, receptors remain compliant.
Air Quality model verification	No evidence to justify test in the OBC
Gradient	Previous test without gradients test showed slightly lower mean NO_2 when compared to the previous with gradients test
Primary NO_2 factor	Previous low test showed lower mean NO_2 when compared to the previous central case

4. Traffic Modelling

4.1 Overview

In estimating the effects of the Core Scenario, the air quality predictions are dependent upon the traffic data used in the modelling. These data are a combination of national predictions, JAQU guidance, consultations with BCC, and local studies. The data sources used in the traffic modelling have been selected to give the best possible representation of the effects of the CAZ. Like all predictions, this methodology has several uncertainties associated with it. A detailed account of the forecasting methodology and core scenario assumptions can be found in FBC-27 Transport Model Forecasting Report (T4). In this section, a series of sensitivity tests have been developed based on known uncertainties in these assumptions.

Section 4.2 considers uncertainties in the predicted behavioural response to charging by developing and analysing the most likely 'pessimistic' alternative scenario. Section 4.4 considers a fleet renewal delay of one year. These four variations are modelled using the Small CAZ D option. When appropriate, air quality testing has been performed to estimate the emissions, NO_2 concentrations, and compliance of the test scenarios and compare the results to the core scenario. Air quality modelling indicates that the Small CAZ D will achieve total compliance in 2023.

4.2 Behavioural Response to Charging

The success of the Clean Air Zone depends largely on how it influences the behaviour of drivers in the region. The drivers of non-car vehicles are expected to respond to the charging Small area CAZ D by either avoiding the area, changing their travel mode, or changing to a compliant vehicle, all of which will help to improve NO_2 pollution in Bristol. However, some drivers will decide to pay the CAZ charge instead of changing their behaviour.

For the Core scenario, the behavioural response to charging CAZ D was predicted using a variety of sources. A stated preference (SP) survey was conducted on drivers in Bristol and the surrounding areas to determine how they would respond, and how likely they would be to upgrade their vehicle based on various CAZ charges and upgrade costs. The final response rates were based on statistical models from the SP survey and predicted costs for upgrading to a compliant vehicle. For non-compliant light goods vehicle, responses for 'vans' from the stated preference surveys were used. A full report of the SP survey and statistical modelling is provided in FBC-28 Stated Preference Surveys Report. For coaches and HGVs, the proportions from 'Table 2 – Behavioural responses to charging Clean Air Zones' within the JAQU Evidence package have been used. Bus and Taxi responses are based on talks with Bristol City Council and the service providers.

The final Core scenario response rates for the Small CAZ D option are provided in Table 4.1. A detailed report on the methodology for calculating these response rates is available in FBC-26 Response Rates Technical Note Appendix E of the FBC.

Table 4-1: Core Scenario Primary Behavioural Response Rates – Small CAZ D

Response	Cars Low Income	Cars Medium Income	Cars High Income	Cars Employers Business	Taxis	LGVs	HGVs	Buses	Coaches
Pay Charge	4.3%	10.4%	5.4%	6.8%	4.1%	15.9%	8.8%	0.0%	17.8%
Avoid Zone	15.6%	19.0%	15.7%	7.7%	0.0%	19.2%	4.3%	0.0%	0.0%
Cancel Journey / Change Mode	39.8%	20.4%	14.2%	30.7%	0.0%	2.6%	4.3%	6.4%	11.4%
Replace Vehicle	40.4%	50.3%	64.6%	54.8%	95.9%	62.2%	82.6%	93.6%	70.8%

4.2.1 Development of Pessimistic Scenario

Non-Car Vehicle Types

To account for uncertainties in the Core scenario response rates, an alternative scenario was developed assuming pessimistic driver responses in terms of expected air quality impacts. The pessimistic scenario accounts for the most-likely uncertainties that would cause more drivers to pay the CAZ D charge than in the Core scenario. In this case, there would be a smaller behavioural response to charging and therefore a smaller improvement to the NO_2 pollution in Bristol city centre. To develop a pessimistic scenario for the charging non-car vehicle types, the replace vehicle response was decreased by 20% for taxis, HGVs and Coaches and the change in the replace vehicle response was compensated for by a change in the pay charge response.

For LGVs, the parameters of the SP survey statistical models were adjusted to the bottom end of their 95% confidence intervals so that more drivers would pay the charge over replacing their vehicles over a 24-hour time-period. The pessimistic response rates for the non-car vehicle types are given in Table 4-2.

Table 4-2: Pessimistic Scenario Primary Response Rates– Non-Car Vehicle Types

Response	Taxis	LGVs	HGVs	Buses	Coaches
Pay Charge	23.3%	27.2%	25.3%	0.0% *	31.9%
Avoid Zone	0.0%	19.2%	4.3%	0.0%	0.0%
Cancel Journey / Change Mode	0.0%	2.6%	4.3%	6.4%	11.4%
Replace Vehicle	76.7%	51.0%	66.1%	93.6%	56.7%

** This value was 0.0% in core scenario, so a percent change cannot be calculated.*

Cars

For the Small CAZ D, where cars are also charged over the Small CAZ area, the parameters of the Stated Preference survey statistical models were adjusted to the top or bottom end of their 95% confidence intervals so that more drivers would pay the charge over the replace their vehicles over a 24-hour time-period. The pessimistic response rates for the Small CAZ D are given in Table 4-3.

Table 4-3: Pessimistic Scenario Primary Response Rates – Small CAZ D

Response	Cars Low Income	Cars Medium Income	Cars High Income	Cars Employers Business
Pay Charge	10.0%	19.8%	13.6%	8.8%
Avoid Zone	15.6%	19.0%	15.7%	7.7%
Cancel Journey / Change Mode	39.8%	20.4%	14.2%	30.7%
Replace Vehicle	35%	41%	56%	53%

4.2.2 Results from Air Quality Testing

The air quality summary statistics for the 'pessimistic' scenario are presented in Table 4-4 and as distributional box plots in Figure 4-1. In each case, results are presented for the 2023 reference case, central case for the Core scenario (i.e. Small Area CAZ D) and the sensitivity test. Generally, as expected air quality was adversely affected with the mean NO_2 concentration increasing by 0.1 μg/m^3 and the maximum by 1.3 μg/m^3.

The maximum modelled annual mean NO_2 concentration was 41.6 μg/m^3, indicating that a compliance year of 2023 would not be achieved in this scenario. However, as 2023 was the only modelled year for this scenario, it is not possible to discern the anticipated compliance year. The model results at critical locations are presented in Table 4-5.

Table 4-4 Simple Summary Statistics for Sensitivity Testing of the pessimistic scenario (μg/m^3) – 2023 Annual mean NO_2 concentrations

Statistic	Reference Case	Central Case	Pessimistic scenario
Mean	23.3	22.0	22.1
Median	22.1	21.2	21.3
Maximum	49.4	40.3	41.6
Minimum	12.3	12.2	12.2
Upper Quartile	26.2	24.6	24.7
Lower Quartile	18.9	18.4	18.5
Standard Deviation	6.2	5.2	5.3
Range	37.1	28.1	29.4

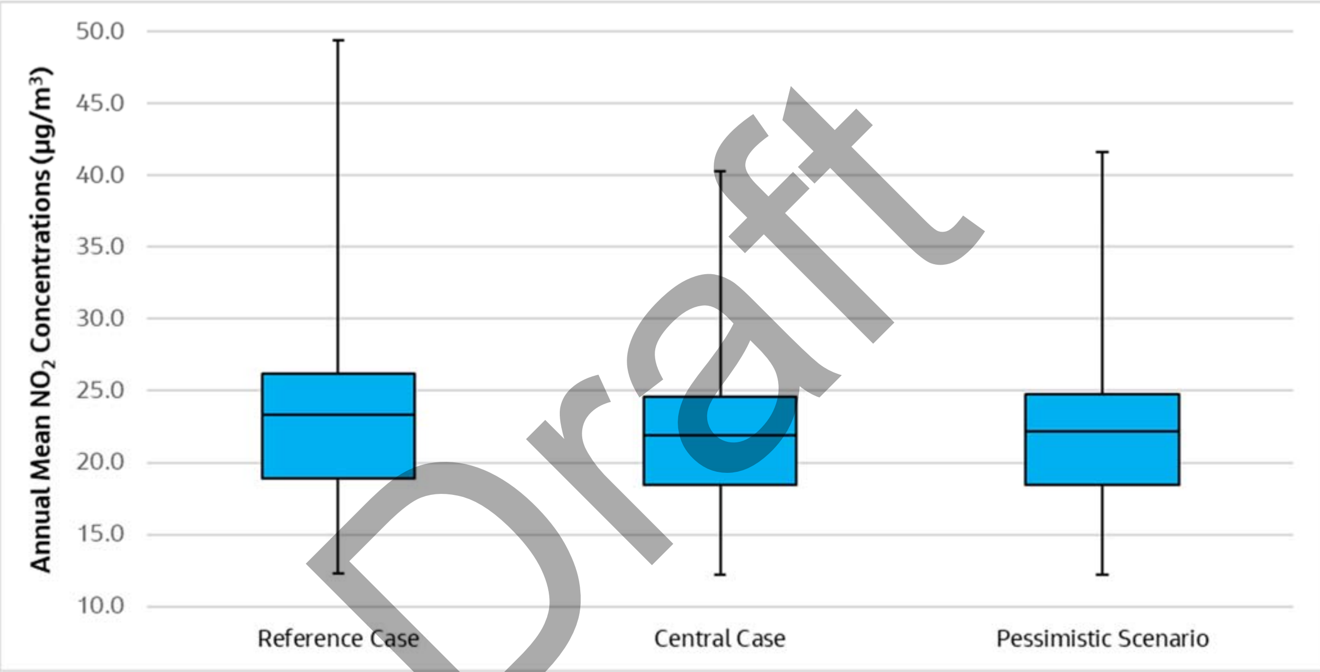

Figure 4-1 Distribution of 2023 Annual Mean NO_2 Concentrations for Sensitivity Testing of the pessimistic scenario

Page 299

Table 4-5 2023 Modelled Annual Mean NO_2 Results for Sensitivity Testing of the Pessimistic Scenario

	Rupert Street	Marlborough Street	Upper Maudlin Street	Park Row	Park Street	Queen's Road	College Green	Cheltenham Road	Newfoundland Way	Church Road	Baldwin Street
Receptor ID (Reference Case Max)	15160	12649	12636	12014	6925	7098	11949	12708	13742	24587	11589
2023 Modelled Annual Mean NO_2 Results (µg/m³)											
Reference Case (Baseline)	46.0	49.4	42.1	38.9	32.4	30.1	35.2	37.0	43.9	37.9	23.7
Central Case (Small Area CAZ D)	39.8	40.3	34.6	32.7	26.5	25.8	29.7	35.5	36.3	36.5	22.2
Pessimistic scenario	40.6	41.6	35.4	33.5	27.3	26.2	30.5	35.7	37.1	36.7	22.3
Difference (Sens Test – Central Case)	0.8	1.3	0.8	0.8	0.8	0.4	0.8	0.2	0.8	0.2	0.1

4.3 One-Year Fleet Delay

JAQU requested that a one-year fleet renewal delay be undertaken as a sensitivity test. The test was assumed to represent the potential effect of COVID-19 on the natural fleet turnover. Therefore, the 2023 vehicle compliance splits and fuel type splits have been replaced with 2022 values.

The fleet projection tool within the EFT v9.1b was used to project the euro standard splits from the 2017 ANPR data to the Baseline compliance splits. The forecast compliance splits by vehicle type for 2022 are summarised in Table 4-6. These were used for the one-year fleet delay sensitivity test from which the Small CAZ D core response rates were applied. The core response rates are shown in Table 4-1.

Table 4-6: 2022 Compliance Splits by Time Period

Vehicle Category	AM		IP		PM	
	Compliant	Non-compliant	Compliant	Non-compliant	Compliant	Non-compliant
Cars	78.5%	21.5%	77.4%	22.6%	78.0%	22.0%
LGV	66.4%	33.6%	71.0%	29.0%	66.5%	33.5%
HGV rigid	79.9%	20.1%	78.7%	21.3%	73.9%	26.1%
HGV artic	89.4%	10.6%	90.0%	10.0%	89.0%	11.0%
HGV	82.2%	17.8%	81.4%	18.6%	78.9%	21.1%
Taxi	68.8%	31.2%	68.8%	31.2%	68.8%	31.2%
Bus	100.0%	0.0%	100.0%	0.0%	100.0%	0.0%
Coach	75.9%	24.1%	76.5%	23.5%	77.4%	22.6%
Total	76.7%	23.3%	76.8%	23.2%	76.9%	23.1%

The EFT v9.1b has been used for the fuel splits for 2022. An additional adjustment has been made to car fuel splits due to identification by BCC of an increase in petrol taxis replacing diesel. These were applied to the traffic link data extracted from the model runs via post-processing before input to the EFT. Table 4-7 shows the fuel type splits from the 2022 and 2031 EFT v9.1b with taxi adjustment.

Table 4-7: Fuel Type Splits (2022)

Vehicle Category	2022		
	Petrol	Diesel	Electric
Cars	61.02%	37.98%	1.00%
LGVs	0.46%	99.32%	0.22%

4.3.1 Results from Air Quality Testing

The air quality summary statistics for the One-Year Fleet Delay for the Core scenario are presented in Table 4-8 and as distributional box plots in Figure 4-2. In each case results are presented for the 2023 reference case, central case for the Core scenario and the sensitivity test. For this test, air quality is likely to worsen to a greater extent than the Pessimistic scenario, as indicated by the increase in the mean of modelled values of 0.8 μg/m^3. This is because the Pessimistic scenario focusses predominantly on trips associated with the CAZ area and immediate surroundings, whereas assumptions in the One-Year Fleet Delay scenario affect the whole model domain. The maximum value increased by 1.2 µg/m^3, which is actually slightly less than the Pessimistic scenario.

As with the Pessimistic scenario, the compliance year is likely to be after 2023, but it is not possible to calculate when it is likely to occur.

Table 4-8 Simple Summary Statistics for Sensitivity Testing of the One-Year Fleet Delay scenario (µg/m^3) – 2023 Annual mean NO_2 concentrations.

Statistic	Reference Case	Central Case	One-Year Fleet Delay scenario
Mean	23.3	22.0	22.8
Median	22.1	21.2	21.9
Maximum	49.4	40.3	41.5
Minimum	12.3	12.2	12.6
Upper Quartile	26.2	24.6	25.8
Lower Quartile	18.9	18.4	19.0
Standard Deviation	6.2	5.2	5.6
Range	37.1	28.1	28.9

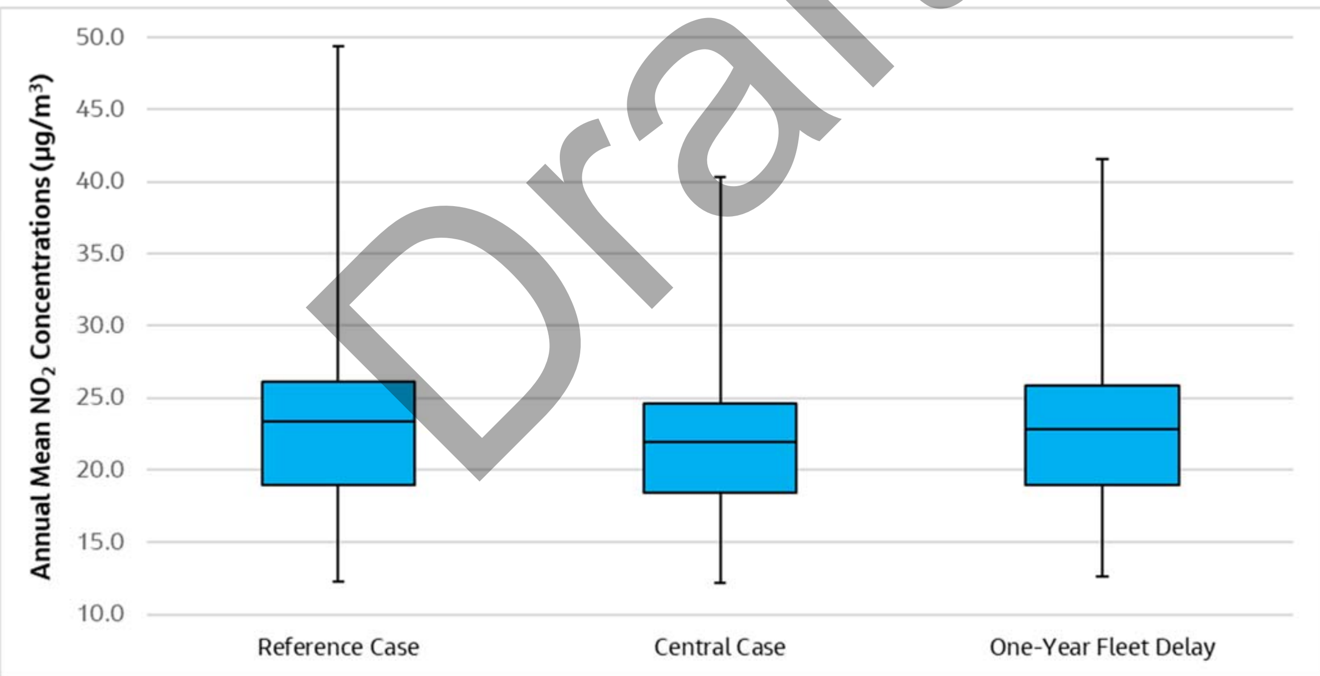

Figure 4-2 Distribution of NO_2 Concentrations for Sensitivity Testing of Speed and Flow adjusted

Table 4-9 2023 Modelled Annual Mean NO_2 Results for Sensitivity Testing of the One-Year Fleet Delay Scenario

	Rupert Street	Marlborough Street	Upper Maudlin Street	Park Row	Park Street	Queen's Road	College Green	Cheltenham Road	Newfoundland Way	Church Road	Baldwin Street
Receptor ID (Reference Case Max)	15160	12649	12636	12014	6925	7098	11949	12708	13742	24587	11589
2023 Modelled Annual Mean NO_2 Results ($\mu g/m^3$)											
Reference Case (Baseline)	46.0	49.4	42.1	38.9	32.4	30.1	35.2	37.0	43.9	37.9	23.7
Central Case (Small Area CAZ D)	39.8	40.3	34.6	32.7	26.5	25.8	29.7	35.5	36.3	36.5	22.2
One-Year Fleet Delay scenario	41.4	41.5	36.1	34.0	27.4	26.6	30.9	37.0	38.1	39.0	22.6
Difference (Sens Test – Central Case)	1.6	1.2	1.5	1.3	0.9	0.8	1.2	1.5	1.8	2.5	0.4

5. Air Quality Sensitivity Test Results

5.1 Vehicle-Specific Emission Factors – Euro 6 Diesel Vehicles

The EFT includes NOx speed-emission coefficients taken from the European Environment Agency COPERT 5 emission calculation tool[3], and fleet and fuel compositions in line with Department for Transport projections. COPERT 5 predicts different NOx emissions from Euro 6 diesel vehicles registered in different years. This is based on a general expectation that emissions from these vehicles will reduce over time. Over a similar timeframe, new aspects of the Euro 6 emissions standards will come into force, but it is important to recognize that the Euro 6 emissions reductions assumed within COPERT 5 do not, and were not intended to, coincide precisely with specific iterations of the Euro 6 emissions standards themselves. Thus, for example, COPERT 5 does not contain emissions factors specific to Euro 6d-temp vehicles.

The JAQU suggest that local authorities run a 'low emissions' and 'high emissions' scenario for the future emissions standards in their projected reference year and 'with measures' model runs. The JAQU suggest that an appropriate 'low emissions' scenario would be to assume that Euro 6c diesel cars and LGVs achieve the same emissions level as Euro 6d vehicles. This can simply be achieved by moving the proportion of diesel cars and LGVs in the Euro 6c category of the EFT into the Euro 6d category.

For the 'high emissions' scenario the JAQU recommended that Euro 6c cars and LGVs achieve emissions halfway between Euro 6 and Euro 6c and that Euro 6d cars and LGVs achieve emissions halfway between Euro 6c and Euro 6d. This can be achieved by moving 50% of the cars and LGVs in the Euro 6c category of the EFT into the Euro 6 (non-RDE) category and moving 50% of the cars and LGVs in the Euro 6d category of the EFT into the Euro 6c category.

Table 5-1 and Figure 5-1 provide the summary statistics requested in JAQU's 'Supplementary Note on Sensitivity Testing'. Table 5-1 then presents the modelled annual mean NO_2 concentrations at the critical locations for each of these scenarios, as well as the 'Central' case. These sensitivity tests demonstrate that the potential effect of the assumed uncertainty in future Euro 6 diesel vehicles is relatively high. The Low Emission Euro 6 scenario was predicted to reduce the maximum concentration by 3.6 $\mu g/m^3$, whereas the High Emission Euro 6 scenario predicted a 2.7 $\mu g/m^3$ increase. The mean concentration changed by approximately -0.8 and +1.2 $\mu g/m^3$ for the Low Emission and High Emission scenarios respectively.

The results indicate that the central case is particularly sensitive to the assumptions around the categorisation of Euro 6 light duty vehicles.

With just the 2023 results, it is not possible to calculate specific compliance years for these sensitivity tests, although it is clear that the High Emission scenario does not achieve compliance in 2023. Given the large decrease in maximum modelled values in the Low Emission scenario, it is possible to speculate that this scenario may bring overall compliance forward to an earlier year than 2023. The modelled results at the critical locations are presented in Table 5-2.

Table 5-1 Simple Summary Statistics for Sensitivity Testing of Euro 6 Diesel Vehicle Emissions ($\mu g/m^3$) – Annual mean NO_2 concentration.

Statistic	Reference Case	Euro 6 – High Emission	Central Case	Euro 6 – Low Emission
Mean	23.3	22.8	22.0	20.8
Median	22.1	21.9	21.2	20.1
Maximum	49.4	43.0	40.3	36.7
Minimum	12.3	12.6	12.2	11.7
Upper Quartile	26.2	25.7	24.6	23.2
Lower Quartile	18.9	18.9	18.4	17.6
Standard Deviation	6.2	5.6	5.2	4.6
Range	37.1	30.4	28.1	25.0

[3] http://copert.emisia.com

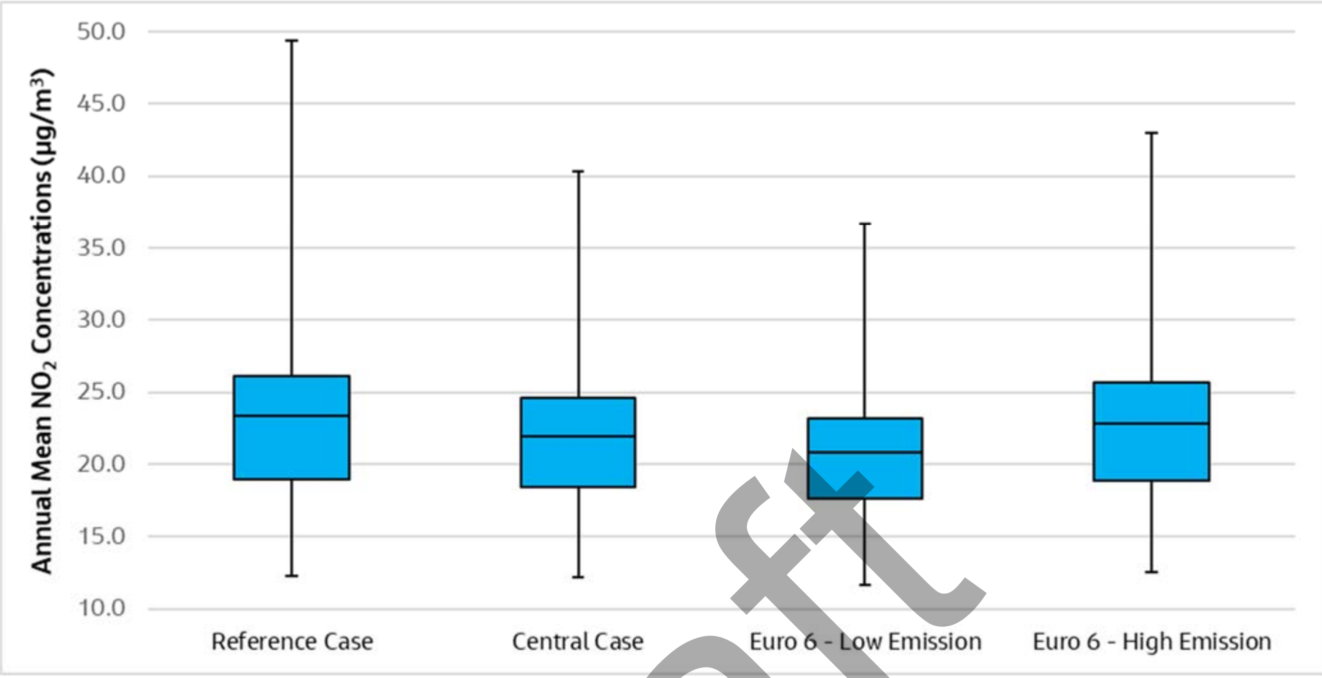

Figure 5-1 Distribution of NO_2 Concentrations for Sensitivity Testing of Euro 6 Diesel Vehicle Emissions

Table 5-2 2023 Modelled Annual Mean NO_2 Results for Sensitivity Testing of Euro 6 Diesel Vehicle Emissions

	Rupert Street	Marlborough Street	Upper Maudlin Street	Park Row	Park Street	Queen's Road	College Green	Cheltenham Road	Newfoundland Way	Church Road	Baldwin Street
Receptor ID (Reference Case Max)	15160	12649	12636	12014	6925	7098	11949	12708	13742	24587	11589
2023 Modelled Annual Mean NO_2 Results (μg/m³)											
Reference Case (Baseline)	46.0	49.4	42.1	38.9	32.4	30.1	35.2	37.0	43.9	37.9	23.7
Central Case (Small Area CAZ D)	39.8	40.3	34.6	32.7	26.5	25.8	29.7	35.5	36.3	36.5	22.2
Euro6 – High Emission scenario	42.2	43.0	37.1	35.1	27.7	27.1	31.4	37.1	39.2	38.6	22.7
Difference (High Em. Scenario – Central Case)	2.4	2.7	2.5	2.4	1.2	1.3	1.7	1.6	2.9	2.1	0.5
Euro6 – Low Emission scenario	36.6	36.7	31.3	29.6	24.8	24.0	27.5	33.4	32.5	33.7	21.4
Difference (Low Em. Scenario – Central Case)	-3.2	-3.6	-3.3	-3.1	-1.7	-1.8	-2.2	-2.1	-3.8	-2.8	-0.8

6. Results Summary Table

For all sensitivity tests, a summary and key results is provided in Table 6-1 below:

Table 6-1 Summary of sensitivity analysis

Test	Section Number	Summary	Key Results
Transport Modelling Based Sensitivity Tests			
Behavioural Reponses to Charging	4.2	Defined pessimistic response rates based on confidence intervals of SP survey statistical modelling and adjusted assumptions for other vehicle types. Compared NO_2 concentrations to Small D scenario.	Air quality is likely to be adversely affected with the mean concentration increasing by 0.1 µg/m^3 and the maximum by 1.3 µg/m^3. The compliance year is pushed back beyond 2023. This test illustrates the "breaking point" of the scheme as it shows that adjusting the response rates based on the Stated Preference survey confidence limits will delay the scheme compliance beyond 2023.
One Year Fleet Delay Test	4.3	One-year fleet renewal delay undertaken as a sensitivity test due to the potential effects of COVID-19 on the natural fleet turnover through time.	Air quality is likely to be adversely affected across the whole model domain, with the mean concentration increasing by 0.8 µg/m^3 and the maximum by 1.2 µg/m^3. The compliance year is pushed back beyond 2023.
Air Quality Modelling Based Sensitivity Tests			
Euro 6 Vehicles (Low and High Emission scenarios)	5.1	The EFT is based on COPERT 5 which predicts different NOx emissions from Euro 6 diesel vehicles registered in different years (based on the expectation that Euro 6 emissions will reduce over time). Sensitivity test outlined in JAQU's 'Supplementary Note on Sensitivity Testing' has been run.	The Low Emission Euro 6 scenario was predicted to reduce the maximum concentration by 3.6 µg/m^3, whereas the Euro 6 High Emission scenario predicted a 2.7 µg/m^3 increase. In terms of the compliance year, the High Emission scenario pushed the compliance year back beyond 2023 at the Marlborough Street critical location. The Low Emission scenario may have brought the compliance year forward from 2023, although without other modelled years for this scenario, it is not possible to tell. The results indicate that the central case results are sensitive to changes in Euro 6, 6c and 6d proportions and the associated NOx emissions standards expected from diesel light duty vehicles.

TRANSPORT ACT 2000

Bristol Clean Air Zone Charging Order 2021

Made TBC

Coming into force TBC

ARRANGEMENT OF INSTRUMENT

THE ORDER

SCHEDULE TO THE ORDER

BRISTOL CLEAN AIR ZONE CHARGING SCHEME

ANNEXES TO THE SCHEME

1. Deposited plans
2. Non-chargeable vehicles
3. Emissions standards for compliant vehicles
4. Transitional provisions and temporary non-chargeable vehicles
5. Application of proceeds:

    Part 1 – the Council's general plan for applying its share of the proceeds of the Scheme during the opening ten year period

    Part 2 – The Council's detailed programme for applying its share of the proceeds of this Scheme during the opening five year period

WHEREAS

(1) It appears to the City Council of Bristol ("the Council") desirable, for the purposes of facilitating the achievement of the Joint Local Transport Plan 2011 to 2026 and the West of England Combined Authority's local transport policies, that it should make the following Order

(2) Appropriate persons have been consulted in accordance with section 170 of the Transport Act 2000

Now therefore the Council, in exercise of the powers conferred on it by Part III and Schedule 12 of the Transport Act 2000, Parts 2 and 6 of The Road User Charging Schemes (Penalty Charges, Adjudication and Enforcement) (England) Regulations 2013, and all other powers enabling it in that behalf, hereby makes the following Order:—

Citation and commencement

1. This Order is made on the day of 2021 and comes into force on the day of 2021 and may be cited as the "Bristol Clean Air Zone Charging Order 2021

The Scheme

2.—(1) The Scheme in the Schedule to this Order ("the Scheme") has effect in accordance with paragraphs (2) and (3).

(2) The Scheme, other than article 7 of the Scheme, comes into force on the day on which this Order is made

(3) Article 7 of the Scheme comes into force on such date, not being earlier than 2021 as may be appointed by the Council in accordance with paragraph (4)

(4) The Council shall cause to be published in a newspaper circulating in the area notice of the appointment of a date under paragraph (3), and the date so appointed shall not be earlier than the expiration of 28 days after the publication of the said notice.

(5) The notice referred to in paragraph (4) shall include the following particulars:
(a) the date appointed under paragraph (3);
(b) the general effect of article 7 of the Scheme coming into force on that date; and
(c) details of a place at which this Order may be inspected and the times when it may be inspected.

THE COMMON SEAL of

THE CITY COUNCIL of BRISTOL

was hereunto affixed in

the presence of:

Article 2

SCHEDULE TO THE ORDER

BRISTOL CLEAN AIR ZONE CHARGING SCHEME

Interpretation

1.—(1) In this Scheme—

(a) “1994 Act” means the Vehicle Excise and Registration Act 1994;

(b) “approved retrofit scheme” means the Clean Vehicle Retrofit Accreditation Scheme and such other accreditation scheme or schemes as may from time to time be specified by the Council;

(c) “business” includes a trade, profession or employment and includes an activity carried on by a body of persons, whether corporate or unincorporated;

(d) “business premises” means premises that the Council is satisfied, by the production of such evidence as it may reasonably require, are permanently occupied for the purposes of carrying on a business;

(e) “charge” means a charge imposed by article 7 except to the extent that this Scheme otherwise provides or that context otherwise requires;

(f) “charging day” means the period of twenty four hours from midnight to midnight;

(g) “Class M1” vehicles are those falling within class M1(a) and class M1(b) as specified in Schedule 1 of the Vehicle Classes Regulations;

(h) “Class M2” vehicles are those falling within class M2(a) and class M2(b) as specified in Schedule 1 of the Vehicle Classes Regulations;

(i) “Class M3” vehicles are those falling within class M3(a) and class M3(b) as specified in Schedule 1 of the Vehicle Classes Regulations;

(j) “Class N1” vehicles are those falling within class N1(a) and class N1(b) as specified in Schedule 1 of the Vehicle Classes Regulations;

(k) “Class N2” vehicles are those falling within class N2(a) and class N2(b) as specified in Schedule 1 of the Vehicle Classes Regulations;

(l) “Class N3” vehicles are those falling within class N3(a) and class N3(b) as specified in Schedule 1 of the Vehicle Classes Regulations;

(m) “Clean Air Zone” means the road or lengths of road which are indicated as being within the area identified as the Clean Air Zone in the plans as defined at paragraph 1(1)(nn);

(n) “Clean Air Zone Boundary Plan” means a deposited plan specified in Part 2 of Annex 1 defining part of the boundary of the Clean Air Zone by showing areas within the Clean Air Zone as shaded yellow;

(o) “Clean Air Zone Plan” means the plan corresponding with sheet A of Part 1 of Annex 1;

(p) “commencement date” means 2021

(q) “commercial vehicle” means—(i) a relevant vehicle of Class M2 other than a taxi or private hire vehicle, or any relevant vehicle of Class M3, Class N2 or Class N3; and (ii) a relevant vehicle of Class N1 that the Council is satisfied is owned by a company or a sole trader;

(r) “compliant vehicle” has the meaning given by article 4;

(s) “compression ignition engine” means an internal combustion engine in which combustion is initiated by heat produced from compression of the air in the cylinder or combustion space;

(t) “compression ignition vehicle” means a vehicle powered wholly or partly by a compression ignition engine;

(u) “Council” means the City Council of Bristol;

(v) “deposited plans” means the portfolio of plans comprising the Clean Air Zone Plan Plan, the Clean Air Zone Boundary Plans and the Clean Air Zone Key Plan— (i) deposited at the offices of the Council at ; and (ii) consisting of the plans bearing the sheet numbers or letters, dates and revision numbers specified in Annex 1 to the Scheme;

(w) “designated road” means one of the designated roads specified in article 2(2);

(x) “electric vehicle” means a vehicle—

> (i) for which a nil licence is in force by virtue of it being an exempt vehicle for the purposes of the 1994 Act in accordance with paragraph 20G (electrically propelled vehicles) of Schedule 2 to that Act; or
>
> (ii) which the Council is satisfied operates wholly by means of an electrically powered propulsion system that draws its motive power from either a hydrogen fuel cell or from a battery that can be fully recharged from an external source of electricity and has tailpipe CO2 emissions of 0 grams per kilometre;

(y) “Enforcement Regulations” means the Road User Charging Schemes (Penalty Charges, Adjudication and Enforcement) (England) Regulations 2013;

(z) “ESC test” means a test as described in section 2.12 of Annex I to Council Directive 88/77/EEC and carried out using the procedure described in Appendix 1, Annex III of that Directive;

(aa) “ETC test” means a test as described in section 2.14 of Annex I to Council Directive 88/77/EEC carried out using the procedure described in Appendices 2 and

3, Annex III of that Directive or a test carried out by means of a chassis dynamometer using a test cycle that the Council is satisfied replicates so far as practicable the standard ETC test cycle;

(bb) “Euro 4” means the emissions limit values set out in the rows corresponding with Category B in the first of the tables at section 5.3.1.4 of Annex I to Council Directive 70/220/EEC;

(cc) “Euro 6” means the emissions limit values set out in Table 2 of Annex I to Commission Regulation 715/2007 of 20 June 2007 as amended;

(dd) “Euro IV” means the emissions limit values set out in Row B1 of Table 1 and Table 2 of section 6.2.1 of Annex I to Council Directive 88/77/EEC;

(ee) “Euro VI” means the emissions limit values set out in the table in Annex I to Commission Regulation 595/2009 of 18 June 2009 as amended;

(ff) “licence” means a licence purchased under article 9;

(ee) “local road” means any road in respect of which the Council is the local traffic authority;

(hh) “maximum mass” in relation to a vehicle means the technically permissible maximum laden mass as specified by the manufacturer;

(ii) “National Payment Body” means the body charged with receiving road user charges made pursuant to clean air zone charging schemes and administering the National Payment Portal;

(jj) “National Payment Portal” means the standardised payment system developed by Government through which payment of road user charges in clean air zones nationwide will be administered;

(kk) “non-chargeable vehicle” is to be construed in accordance with Annexes 2 and 4;

(ll) “NOx” means oxides of nitrogen;

(mm) “penalty charge” and “penalty charge notice” have the meaning given in Regulation 2(1) of the Enforcement Regulations;

(nn) “positive ignition engine” means an internal combustion engine in which combustion is initiated by a localised high temperature in the combustion chamber produced by energy supplied from a source external to the engine;

(oo) “positive ignition vehicle” means a vehicle powered wholly or partly by a positive ignition engine;

(pp) “private hire vehicle” has the meaning given in section 80 of the Local Government (Miscellaneous Provisions) Act 1976;

(qq) “reference mass” in relation to a vehicle means the mass of the vehicle with bodywork and, in the case of a towing vehicle, with coupling device, if fitted by the manufacturer, in running order, or mass of the chassis or chassis with cab, without bodywork and/or coupling device if the manufacturer does not fit the bodywork and/or coupling device including liquids and tools, and spare wheel if fitted, and with the fuel tank filled to 90% and the other liquid containing systems, except those for used water, to 100% of the capacity specified by the manufacturer), increased by a uniform mass of 100 kilograms;

(rr) "register" means the register or registers of compliant and non-chargeable vehicles to be maintained by the Council and the National Payment Body under article 10;

(ss) "registered keeper" means—

(i) in relation to a vehicle registered in the United Kingdom, the person in whose name the vehicle is registered under the 1994 Act; or

(ii) in relation to any other vehicle, the person by whom the vehicle is kept;

(tt) "relevant vehicle" has the meaning given by article 3;

(uu) "retrofitted" means adapted so as to meet the standards required of a compliant vehicle—

(i) in accordance with an approved retrofit scheme; or

(ii) in such other manner as the Council is satisfied is of equivalent efficacy to an accredited retrofit scheme;

(vv) "sole trader" means an individual who is self-employed and registered for self - assessment within the meaning of section 9 of the Taxes Management Act 1970;

(ww) "taxi" means a vehicle licensed as a hackney carriage under the Town Police Clauses Act 1847 as amended;

(xx) "Type I test" means a test as described in section 5.3 of Annex I to Council Directive 70/220/EEC (test for simulating/verifying the average tailpipe emissions after a cold start) and carried out using the procedure described in Annex III of that Directive;

(yy) "Vehicle Classes Regulations" means the Road User Charging and Workplace Parking Levy (Classes of Motor Vehicles) (England) Regulations 2001;

(zz) "WHSC" means the World Harmonised Steady state Driving Cycle as defined in Regulation No. 49 of the Economic Commission for Europe of the United Nations;

(aaa) "WHTC" means the World Transient Steady state Driving cycle as defined in Regulation No. 49 of the Economic Commission for Europe of the United Nations.

(2) In this Scheme—

(a) a reference in any provision to an instrument of the European Community is to that instrument—

(i) as amended at the commencement date, if the instrument concerned is in force at that date; or,

(ii) as amended at the date of its repeal, if that instrument has been repealed before the commencement date;

(b) a reference in any provision to an authorised person is to a person authorised by the Council for the purposes of that provision and different persons may be authorised for the purposes of different provisions; and

(c) where a person has been authorised to act on behalf of the Council in relation to any matter a reference to the Council is taken to include a reference to that person.

Designation of roads in respect of which charges are imposed

2.—(1) Charges are imposed by this Scheme in respect of the designated roads.

(2) The designated roads are all local roads within the Clean Air Zone.

Relevant vehicles

3.—(1) A relevant vehicle is a vehicle of a Class and type specified in paragraph (2) that is not—

(a) a compliant vehicle; or

(b) a non-chargeable vehicle.

(2) The vehicles specified for the purpose of paragraph (1) are Class M1, Class M2, Class M3, Class N1, Class N2 and Class N3

Compliant vehicles

4. A vehicle is a compliant vehicle if—

(a) the vehicle meets the standards required of a compliant vehicle for the purposes of this Scheme; and

(b) particulars of the vehicle are for the time being entered in the register.

Non-chargeable vehicles

5. Annex 2 to this Scheme, which specifies categories of non-chargeable vehicles, has effect.

Emissions standards required of compliant vehicles

6. A vehicle meets the standards required of a compliant vehicle for the purposes of this Scheme if the Council is satisfied that the vehicle is—

(a) an electric vehicle
(b) a Hybrid vehicle

(c) An alternative fuel vehicle

(d) a positive ignition vehicle that meets the standards specified for that vehicle in Table 1 of Annex 3 (Euro 4/IV Standards For Positive Ignition Vehicles); or

(e) a compression ignition vehicle that meets the standards specified for that vehicle in Table 2 of Annex 3 (Euro 6/VI Standards For Compression Ignition Vehicles).

Imposition of charges

7.—(1) Subject to the following provisions of this Scheme, a charge of an amount specified in article 8(1) is imposed in respect of any relevant vehicle specified in article 3(2)(a) for each charging day on which it is at any time used on one or more designated roads.

(2) Subject to the following provisions of this Scheme, a charge of an amount specified in article 8(2) is imposed in respect of any relevant vehicle specified in article 3(2)(b) or (c) for each charging day on which it is at any time used on one or more designated roads.

Amount of charge payable by purchase of a licence

8.—(1) The cost of a charge imposed by article 7(1) is £xxx per charging day.

(2) The cost of a charge imposed by article 7(2) is— £xxx per charging day.

Payment of charges

9.—(1) A charge imposed by article 7 must be paid by the purchase of a licence in accordance with the provisions of this article.

(2) A licence must be issued in respect of a particular vehicle and for a single charging day

(3) A vehicle referred to in paragraph (2) must be identified by its registration mark, and—

(a) the purchaser of a licence must specify the registration mark of the vehicle in respect of which that charge is paid;

(b) a licence will not be valid in respect of any vehicle having a registration mark different from the mark so specified.

(4) A licence may only be purchased—

(a) on the charging day concerned;

(b) on the charging day immediately following that charging day; or

(c) on a day falling within such period of days immediately preceding the charging day concerned as the Council may, in accordance with the requirements of the National Payment Portal, specify on its website.

(5) Charges imposed by this Scheme must be paid by such means as the Council may, in accordance with the requirements of the National Payment Portal, specify on its website as being acceptable.

(6) Where a licence is purchased otherwise than in cash and payment is not received (whether because a cheque is dishonoured, a direct debit, credit card or debit card payment is declined, or otherwise) before the end of the charging day following the charging day to which the licence relates, the charge to which the licence relates will be treated as not paid and the licence will be void.

Register of compliant and non-chargeable vehicles

10.—(1) The Council and the National Payment Body will maintain one or more registers which will together identify compliant vehicles and non-chargeable vehicles ("the register") for the purposes of articles 4 and 5 and Annexes 2 and 4 which require particulars of such vehicles to be entered in the register.

(2) An application to enter particulars of a vehicle on the register—

(a) must include all such information as the Council or the National Payment Body may reasonably require; and

(b) must be made by such means as the Council or the National Payment Body may accept.

(3) If the Council or the National Payment Body is satisfied that a vehicle—

(a) complies with the standards required of a compliant vehicle; or

(b) falls within a class of non-chargeable vehicle,

it will enter particulars of the vehicle in the register.

(4) If the Council or the National Payment Body is satisfied that a vehicle, particulars of which are entered in the register, no longer—

(a) complies with the standards required of a compliant vehicle; or

(b) falls within a class of non-chargeable vehicle,

it may remove the particulars of the vehicle from the register.

(5) Where the registered keeper of such a vehicle is aware that the vehicle has ceased or will cease to—

(a) comply with the standards required of a compliant vehicle; or

(b) fall within a class of non-chargeable vehicle,

the registered keeper must notify the Council or the National Payment Body of the fact and the Council or the National Payment Body may remove the particulars of the vehicle from the register forthwith, or from the date notified to the Council or the National Payment Body as the date on which it will cease to be such a vehicle.

(6) Nothing in this article prevents the making of a fresh application under paragraph (2) for particulars of a vehicle to be entered in the register after they have been removed from it in accordance with any provision of this article.

Penalty charge for non-payment of charge

11. (1) A penalty charge will be payable, in addition to the charge imposed under article 7, for each charging day as respects which—

(a) a relevant vehicle has been used on a designated road in circumstances in which a charge is imposed by article 7;

(b) that charge has not been paid in full in the manner in which and within the time by which it is required to be paid by article 9.

(2) A penalty charge payable by virtue of paragraph (1) must be paid within the period ("the payment period") of 28 days beginning with the date on which a penalty charge notice is served under regulation 7 of the Enforcement Regulations and in a manner specified in the penalty charge notice.

(3) The amount of a penalty charge payable in accordance with paragraph (1) is £XXX but, if the penalty charge is paid before the end of the fourteenth day of the payment period, the amount will be reduced by one half to £XXX.

(4) Where a charge certificate is issued in accordance with regulation 17(1) of the Enforcement Regulations, the amount of the penalty charge to which it relates will be increased by one half to £XXX.

Immobilisation of vehicles

12. (1) Provided that—

(a) none of the circumstances in paragraph (2) of Regulation 25 of the Enforcement Regulations apply; and

(b) the conditions in paragraph (3) of that Regulation apply,

an authorised person may immobilise a vehicle in accordance with paragraphs (4) and (5) of that Regulation.

(2) A vehicle to which an immobilisation device has been fixed in accordance with the provisions of this Scheme —

(a) may be released only by or under the direction of an authorised person; and

(b) subject to paragraph (a), will be released—

(i) if all outstanding charges under article 7 are paid;

(ii) if all outstanding penalty charges are paid to the Council; and

(iii) if a penalty charge of £XX for the release of the vehicle from the immobilisation device is so paid.

Removal, storage and disposal of vehicles

13. (1) Provided Regulation 27(1)(a) or (b) of the Enforcement Regulations is satisfied, an authorised person may remove a vehicle and deliver it to a custodian for storage.

(2) The custodian may dispose of the vehicle and its contents in the circumstances described in, and subject to the provisions of, Regulation 28 of the Enforcement Regulations.

(3) Where a vehicle has been removed and delivered into the custody of a custodian in accordance with paragraph (1) the Council or the custodian may (whether or not any claim is made under Regulation 30 or 31 of the Enforcement Regulations) recover from the person who was the keeper of the vehicle when the vehicle was removed—

(a) all outstanding charges under article 7;

(b) all penalty charges that are outstanding in relation to the vehicle;

(c) a penalty charge of £XXX for its removal;

(d) a penalty charge of £XX for each complete day or part of a day on which it has been held by the Council or a custodian; and

(e) if the vehicle has been disposed of, a penalty charge of £XX for its disposal.

Duration of scheme

14. This Scheme will remain in force indefinitely.

Transitional provisions and temporary non-chargeable vehicles

15. Annex 4 to this Scheme which contains transitional provisions and classes of temporary non chargeable vehicle has effect

Ten and five year plans for net proceeds

16.—(1) Part 1 of Annex 5 to this Scheme constitutes the general plan, under paragraph 10(1)(a) of Schedule 12 to the Transport Act 2000, for the application of the Council's share of the net proceeds of this Scheme during the opening ten year period.

(2) Part 2 of Annex 5 to this Scheme constitutes the detailed programme, under paragraph 10(1)(b) of Schedule 12 to the Transport Act 2000, for the application of the Council's share of the net proceeds of this Scheme during the opening five year period.

Article 1(1)(l) and (nn)

ANNEX 1

LIST OF THE PLANS

PART 1 – CLEAN AIR ZONE PLAN

PART 2 – CLEAN AIR ZONE BOUNDARY PLANS

ANNEX 2

NON-CHARGEABLE VEHICLES

Historic Vehicles

1. A vehicle is a non-chargeable vehicle if—

(a) it is an exempt vehicle for the purposes of the 1994 Act in accordance with paragraph 1A(1) of Schedule 2 to that Act; or

(b) it is a vehicle of Class M3 which the Council is satisfied would be treated as an exempt vehicle under paragraph 1A(1) of Schedule 2 to the 1994 Act but for the vehicle being used on a public road for hire or reward or for or in connection with a trade or business; or

(c) the Council is satisfied that, if a vehicle registered under legislation relating to the registration of vehicles in a country other than the United Kingdom had been registered under the 1994 Act, it would have fallen within paragraphs (a) or (b),

and particulars of the vehicle are for the time being entered in the register.

Military vehicles

2.—(1) A vehicle is a non-chargeable vehicle if—

(a) it belongs to any of Her Majesty's forces or is in use for the purposes of any of those forces; or

(b) the Council is satisfied the vehicle is used for naval, military or air force purposes and not registered under the 1994 Act, while it is being used on a road by a member of a visiting force or a member of a headquarters or organisation,

and particulars of the vehicle are for the time being entered in the register.

(2) In this paragraph "member of a visiting force" and "member of a headquarters or organisation" have the meaning given in paragraph 1(2) of Schedule 5 to the Road Vehicles (Registration and Licensing) Regulations 2002

(2) If the Council is satisfied that if a vehicle registered under legislation relating to the registration of vehicles in a country other than the United Kingdom had been registered under the 1994 Act, it would have fallen within paragraph (1), that vehicle is a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

Agricultural and similar vehicles

3.—(1) A vehicle which is an exempt vehicle for the purposes of the 1994 Act by virtue of it falling within any of the following paragraphs of Schedule 2 to that Act is a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register

(a) paragraph 20A (vehicles used between different parts of land)

(b) paragraphs 20B, 20C and 20D (tractors and certain agricultural vehicles);

(c) paragraphs 20E (mowing machines);

(d) paragraph 20F (steam powered vehicles);

(e) paragraph 20H (snow ploughs); and

(f) paragraph 20J (gritters).

(2) If the Council is satisfied, in respect of a vehicle registered under legislation relating to the registration of vehicles in a country other than the United Kingdom, that had the vehicle been registered under the 1994 Act it would have fallen within sub-paragraph (1), that vehicle is a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

Disabled vehicles

4. (1) A vehicle that is an exempt vehicle for the purposes of the 1994 Act by virtue of it falling within paragraphs 19 or 20 (vehicles for disabled people) of Schedule 2 to that Act is a non-chargeable vehicle.

(2) If the Council is satisfied, in respect of a vehicle registered under legislation relating to the registration of vehicles in a country other than the United Kingdom, that had the vehicle been registered under the 1994 Act it would have fallen within sub-paragraph (1), that vehicle is a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

Recovery vehicles

5. (1) A qualifying recovery vehicle is a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

(2) A vehicle is a qualifying recovery vehicle if—
(a) it is licensed as a recovery vehicle under paragraph 5 of Schedule 1 to the 1994 Act, or
(b) in respect of a vehicle registered under legislation relating to the registration of vehicles in a country other than the United Kingdom, the Council is satisfied that, had it been registered under the 1994 Act, it would have fallen to be licensed as a recovery vehicle under paragraph 5 of Schedule 1 to the 1994 Act.

Showman's vehicles

6. (1) A showman's vehicle is a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

(2) In this paragraph—
(a) "showman's vehicle" means any vehicle that—
(i) is registered under the 1994 Act and is a "showman's vehicle" or "showman's goods vehicle within the meaning of section 62 of the 1994 Act; or

(ii) is registered in a country other than the United Kingdom, in accordance with that country's rules governing the registration of such vehicles, in the name of a person following the business of a travelling showman and used solely by that person for the purposes of his business and no other purpose.

Diplomatic Vehicles

7. (1) During the designated diplomatic vehicles transitional period the Council will treat any vehicle—

(a) that is registered through the DVLA on either Diplomatic Vehicle Registration Plates or normal British plates and owned by Entitled missions or their entitled personnel and issued with the appropriate special registration document;

(b) that is liable to pay a charge imposed by article 7(2) of this Scheme; and

(c) particulars of which are for the time being entered in the register, as if it were a non-chargeable vehicle.

(2) In this paragraph "designated diplomatic vehicles transitional period" means the period beginning with the commencement date and ending on ………………20XX.

Specialist vehicles

8.—(1) A special vehicle is a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

(2) In this paragraph a "special vehicle" means

(a) a vehicle registered under the 1994 Act that falls to be treated as a "special vehicle" within the meaning of Part IV of Schedule 1 to the 1994 Act;

(b) a vehicle registered under legislation relating to the registration of vehicles in a country other than the United Kingdom in respect of which the Council is satisfied that, had it been registered under the 1994 Act, it would have fallen to treated as a "special vehicle" within the meaning of Part IV of Schedule 1 to the 1994 Act; or

(c) a vehicle of a type specified in an Order under section 44 of the Road Traffic Act 1988.

(d) a vehicle which is a designated Cash-in-transit or bullion vehicles being used for the delivery and collection of cash and other valuables.

Highway diversions

9. Where the Council is satisfied that a vehicle has been used on one or more designated roads solely as a result of an official diversion of traffic from a non-designated road onto a designated road that vehicle will be treated as if it were a non-chargeable vehicle.

Motorcycles

10.(1) a motorcycle is a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register

(2) In this paragraph, “motorcycle” means a motor bicycle or a motor tricycle but does not include an electrically propelled vehicle

Article 6

ANNEX 3

EMISSIONS STANDARDS FOR COMPLIANT VEHICLES

1.—(1) A vehicle meets the standards set out in Tables 1 and 2 if the Council is satisfied that—

(a) the vehicle is certified by the appropriate national approval authority as having been manufactured to satisfy the EC emissions standard specified for that vehicle in column (e) of the Table;

(b) the vehicle has been retrofitted so that the limit values for the emission of NOx specified for the vehicle in column (f) would not be exceeded during the appropriate test or tests specified in column (g) of the Table; or

(c) in respect of all other vehicles, the Council is satisfied that the limit values for the emission of NOx specified for the vehicle in column (f) would not be exceeded during the appropriate test or tests specified in column (g) of the Table.

(2) The Council will be satisfied that the vehicle has been retrofitted to meet the limit values referred to in paragraph (1)(b) if that vehicle has been certified as having been retrofitted in accordance with an approved retrofit scheme.

Table 1 — EURO 4/IV STANDARDS FOR POSITIVE IGNITION VEHICLES

(a) Row No.	(b) Vehicle Class	(c) Maximum mass of vehicle, where relevant (kg)	(d) Reference mass of vehicle, where relevant (kg)	(e) EC emissions standard	(f) Limit values for NOx	(g) Appropriate tests
(1)	M1	not exceeding 2,500		Euro 4	0.08 g/km	Type I
(2)	M1	exceeding 2,500	Not exceeding 1,305	Euro 4	0.08 g/km	Type I
(3)	M1	exceeding 2,500	exceeding 3,500 and not exceeding 1,760	Euro 4	0.10g/km	Type I
(4)	M1	exceeding 2,500	exceeding 1,760	Euro 4	0.11g/km	Type I

(5)	M2	Not exceeding 2,500		Euro 4	0.08g/km	Type I
(6)	M2	exceeding 2,500 and not exceeding 3,500	exceeding 3,500 and not exceeding 1,760	Euro 4	0.10g/km	Type I
(7)	M2	exceeding 2,500 and not exceeding 3,500	exceeding 1,760	Euro 4	0.11g/km	Type I
(8a)	M2	exceeding 3,500	not exceeding 2,840	Euro 4	0.11g/km	Type I
(8b)	M2	exceeding 3,500	Not exceeding 2,840	Euro IV	3.5g/kWh	ETC
(9)	M2	exceeding 3,500	exceeding 2,840	Euro IV	3.5g/kWh	ETC
(10)	N1 subclass (i)		not exceeding 1,350	Euro 4	0.08g/km	Type I
(11)	N1 subclass (ii)		exceeding 1,305 and not exceeding 1,760	Euro 4	0.10g/km	Type I
(12)	N1 subclass (iii)		exceeding 1,760	Euro 4	0.11g/km	Type I
(13a)	N2		Not exceeding 2,840	Euro 4		Type I
(13b)	N2		Not exceeding 2,840	Euro IV	3.5g/kWh	ETC
(14)	N2		exceeding 2,840	Euro IV	3.5g/kWh	ETC
(15)	M3, N3			Euro IV		ETC

Table 2 — EURO 6/VI STANDARDS FOR COMPRESSION IGNITION VEHICLES

(a) Row No	(b) Vehicle Class	(c) Maximum mass of vehicle, where relevant(kg)	(d) Reference mass of vehicle, where relevant (kg)	(e) EC emissions standard	(f) Limit values for NOx	(g) Appropriate tests
(1)	M1		not exceeding 2,610	Euro 6	0.08g/km	Type I
(2)	M1		exceeding 2,610	Euro VI	0.4 g/kWh (WHSC) and 0.46 g/kWh (WHTC)	WHSC and WHTC
(3)	M2		not exceeding 2,610	Euro 6	0.125g/km	Type I
(4)	M2		exceeding 2,610	Euro VI	0.4 g/kWh (WHSC) and 0.46 g/kWh (WHTC)	WHSC and WHTC
(5)	M3, N3			Euro VI	0.4 g/kWh (WHSC) and 0.46 g/kWh (WHTC)	WHSC and WHTC
(6)	N1		not exceeding 1,350	Euro 6	0.08g/km	Type I
(7)	N1 subclass (ii)		exceeding 1,305 and not exceeding 1,760	Euro 6	0.105g/km	Type I
(8)	N1 subclass (iii)		exceeding 1,760	Euro 6	0.125g/km	Type I
(9)	N2		not exceeding 2,610	Euro 6	0.125g/km	Type I
(10)	N2		exceeding 2,610	Euro VI	0.4 g/kWh (WHSC) and 0.46	WHSC and WHTC

					g/kWh (WHTC)	

Article 15

ANNEX 4

TRANSITIONAL PROVISIONS AND

TEMPORARY NON-CHARGABLE VEHICLES

Emergency service vehicles

1.—(1) A vehicle which is a non-chargeable vehicle for the purposes of the 1994 Act by virtue of it falling within any of the following paragraphs of Schedule 2 to that Act is a non-chargeable vehicle—

(a) paragraph 3A (police vehicles)

(b) paragraphs 4 and 5 (fire engines etc.)

(c) paragraph 6 (ambulances) and NHS patient Transport Ambulances

(d) NHS Patient Transport ambulances

(e) Blood and Transplant vehicles

Residents' vehicles

2.—(1) A vehicle which is a qualifying resident's vehicle is a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

(2) During the resident's vehicles transitional period the Council will treat a qualifying resident's vehicle as if it were a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

(3) In this paragraph "resident's vehicles transitional period" means the period of one year beginning with the commencement date.

(4) A vehicle is qualifying resident's vehicle if it is a relevant vehicle of Class M1 or Class N1 other than a commercial vehicle, a taxi or a private hire vehicle, and the Council is satisfied that—
(a) the registered keeper of the vehicle is a qualified resident and the address of the registered keeper shown on the vehicle registration document is the same as that of the premises referred to in subparagraph (5);
(b) the registered keeper of the vehicle is the employer of a qualified resident or the vehicle is hired by or leased to the qualified resident by their employer, and the Council is satisfied by the production of such evidence as it may reasonably require that the vehicle is kept for the exclusive use of the qualified resident and members of the qualified resident's household residing at the same address as the qualified resident; or
(c) the registered keeper of the vehicle is a company that has leased or sold the vehicle to the qualified resident, and the Council is satisfied by the production of such evidence as it may reasonably require that the vehicle is kept for the exclusive use of the qualified resident and

members of the qualified resident's household residing at the same address as the qualified resident.

(5) In this Scheme "qualified resident" means an individual in respect of whom the Council is for the time being satisfied, by the production of such evidence as it may reasonably require, that the individual's only or main residence is at premises situated in the Clean Air Zone.

(6) Where a qualified resident ceases to reside at the premises in relation to which the Council was satisfied that the requirement in sub-paragraph (4) was met but resides at other premises in the Clean Air Zone, that person shall cease to be a qualified resident unless that person has notified the change of residence to the Council and the Council is satisfied that the requirement in sub-paragraph (4) is met in relation to those other premises.

Community transport vehicles

3.—(1) A community transport vehicle is a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

(2) During the community transport vehicles transitional period the Council will treat a qualifying community transport vehicle as if it were a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

(3) In this paragraph—
(a) “community transport vehicles” means a vehicle of Class M2 or M3 that is being used pursuant to a community transport permit;
(b) “community transport permit” means a permit granted under section 19(3), 19(4), 19(5) or 22(2) of the Transport Act 1985.
(c) “community transport vehicles transitional period” means the period of one year beginning with the commencement date

Those travelling into the Clean Air Zone for work

4. (1) During the CAZ workers transitional period the Council will treat a qualifying CAZ worker’s vehicle as if it were a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

(2) In this paragraph “CAZ workers transitional period” means the period of one year beginning with the commencement date.

(3) A vehicle is a “qualifying CAZ worker’s vehicle” if it is a relevant vehicle of Class M1 or Class N1other than a taxi or private hire vehicle and the Council is satisfied that—
(a) the registered keeper of the vehicle is a qualified CAZ worker and the address of the registered keeper shown on the vehicle registration document is the same as that of the premises referred to in sub-paragraph (4)(a);
(b) the registered keeper of the vehicle is the employer of a qualified CAZ worker or the vehicle is hired by or leased to the qualified CAZ worker by their employer, and the Council is satisfied by the production of such evidence as it may reasonably require that the vehicle is kept for the exclusive use of the qualified CAZ worker and members of the qualified CAZ worker's household residing at the same address as the qualified CAZ worker; or

(c) the registered keeper of the vehicle is a company that has leased or sold the vehicle to the qualified CAZ worker, and the Council is satisfied by the production of such evidence as it may reasonably require that the vehicle is kept for the exclusive use of the qualified CAZ worker and members of the qualified CAZ worker's household residing at the same address as the qualified CAZ worker.

(4) An individual is a "qualified CAZ worker" if the Council is for the time being satisfied, by the production of such evidence as it may reasonably require, that:
(a) the individual's only or main residence is at premises situated outside the Clean Air Zone;
(b) the individual's income does not exceed a maximum hourly rate of £12.45; and
(c) the individual's income for the tax year ending on 5 April 2021 was no greater than £24,000.

(5) In this paragraph—
(a) "income" means—
(i) "earnings" within the meaning of section 62 of the Income Tax (Earnings and Pensions) Act 2003 ("the 2003 Act");
(ii) earned income derived from carrying on a trade profession or vocation; and
(iii) any other taxable income not falling within sub-paragraphs (i) and (ii), excluding any chargeable gain computed in accordance with Part II of the Taxation of Chargeable Gains Act 1992;
(b) section 29 of the 2003 Act shall apply for the purposes of determining whether, in relation to an employee within the meaning of section 4 of the 2003 Act, earnings are "for" a particular tax year.

(6) Where a qualified CAZ worker ceases to reside or work at the premises in relation to which the Council was satisfied that the requirements in sub-paragraph (4) were met but resides or works at other premises that person shall cease to be a qualified CAZ worker unless that person has notified the change of residence or business premises to the Council and the Council is satisfied that those requirements are met in relation to those other premises.

(7) At no time may more than one qualifying CAZ worker's vehicle be entered in the register in relation to any one individual who is a qualifying CAZ worker.

Commercial vehicles subject to finance agreements

5. (1) During the financing transitional period the Council will treat any commercial vehicle—
(a) that meets the conditions specified in sub-paragraph (2); and
(b) particulars of which are for the time being entered in the register,
as if it were a non-chargeable vehicle.

(2) The conditions referred to in sub-paragraph (1)(a) are that the Council is satisfied, by the production of such evidence as it may reasonably require, that—
(a) the owner of the vehicle had on or before 25th February 2021 entered into a contractual arrangement for financing the purchase or leasing of the vehicle concerned; and
(b) one or more payments pursuant to that contractual arrangement are due on or after the commencement date;
(c) the vehicle is—

(i) a commercial CAZ vehicle within the meaning of paragraph 3 of this Annex; or
(ii) regularly kept overnight in the Clean Air Zone for the primary purpose of carrying on a business in the Clean Air Zone.

(3) In this paragraph—
(a) “financing transitional period” means the period beginning with the commencement date and ending on the earlier of—
(i) the date on which the payment for the purchase of the vehicle concerned is completed and the contractual arrangement referred to in sub-paragraph (2) ceases to apply; and
(ii) the date falling one year after the commencement date;
(b) “owner” includes a lessee of a vehicle, a person using a vehicle pursuant to a hire purchase agreement, and such other forms of use or ownership as the Council may specify on its website.

Visitors to specified hospitals

6.—(1) During the specified hospital visitor’s transitional period the Council will treat a specified long term hospital visitor’s vehicle as if it were a non-chargeable vehicle. In this paragraph “long term” means if they are long term visitors i.e. visiting the hospital more than 3 times within a one- week (7 day) period.

(2) In this paragraph “specified hospital visitor’s transitional period” means the period of one year beginning with the commencement date.

(3) A vehicle is a specified long term hospital visitor’s vehicle on any charging day if—
(a) it is a private vehicle;
(b) the Council is satisfied that it is used on the charging day concerned for the purposes of—
(i) transporting a patient to or from a specified hospital; or
(ii) visiting an inpatient in a specified hospital; and
(c) particulars of the vehicle are entered in the register before the end of the second charging day following the charging day concerned.

(4) An application to enter particulars of a specified hospital visitor’s vehicle on the register shall be made by such means and accompanied by such details relating to the specified hospital, the vehicle and its use the as the Council may reasonably require.

(5) In this paragraph—
(a) “private vehicle” means any vehicle other than a taxi, a private hire vehicle, a bus or a coach;
(b) “bus” means a vehicle used for carrying passengers for hire or reward and operated pursuant to a
licence granted under section 14 of the Public Passenger Vehicles Act 1981;
(c) “coach” means any vehicle of Class M2 or Class M3 other than a bus, taxi or private hire vehicle,
used for carrying passengers for hire or reward; and
(d) “specified hospital” means one of -
(i) the Bristol Royal Infirmary
(ii) the Bristol Heart Institute
(iii) the Bristol Royal Hospital for Children
(iv) the Bristol Haematology and Oncology Centre

(v) St Michael's Hospital
(vi) the Bristol Dental Hospital
(vii) the Bristol Eye Hospital
(viii) the Central Health Clinic

Blue Badge Holders

7. (1) During the blue badge transitional period the Council will treat any qualifying blue badge vehicle as if it were a non-chargeable vehicle.

(2) A vehicle is a qualifying blue badge vehicle on any charging day if –
(a) it has been specified by the Council pursuant to an application under sub-paragraph (3) or (4);
(b) it is a compression ignition vehicle that the Council is satisfied meets the emissions standards for temporary non-chargeable vehicles set out in paragraph 4 (3) of this Annex
(c) it is being used for the transport of a disabled person and has a blue badge displayed in compliance with regulation 12 and regulation 13, 14, 15 or 16 of the Disabled Persons (Badges for Motor Vehicles)(England) Regulations 2000; and
(d) particulars of the vehicle are entered in the register on the charging day concerned or the next working day following that charging day.

(3) An eligible person may apply to the Council to specify a vehicle in relation to the blue badge held by that person for any charging day or days and, subject to sub-paragraph (5) to specify a different vehicle in place of a specified vehicle

(4) An eligible organisation may apply to the Council to specify a vehicle in relation to any blue badge held by that organisation for any charging day or days and, subject to sub-paragraph (5) to specify a different vehicle in place of a specified vehicle

(5) Unless a vehicle has been specified pursuant to an application under sub-paragraph (3) or (4) for a particular charging day or days, it remains specified for all charging days until a different vehicle has been specified in place of it

(6) An application under sub-paragraph (3) or (4) shall be made by such means as the Council may accept and be accompanied by such information as the Council may reasonably require

(7) In this paragraph –
(a) "blue badge" means any badge issued to an individual or institution under section 21 of the Chronically Sick and Disabled Persons Act 1970 or under section 14 of the Chronically Sick and Disabled Persons (Northern Ireland) Act 1978;
(b) "blue badge transitional period" means the period beginning with the commencement date and ending after one year ;
(c) "eligible organisation" means any organisation issued with and holding a blue badge
(d) "eligible person" means any person issued with and holding any blue badge

Home to School Transport

8. —(1) During the specified transitional period the Council will treat a specified home to school transport vehicle as if it were non-chargeable vehicle.

(2) A home to school transport vehicle is a non-chargeable vehicle provided particulars of the vehicle are for the time being entered in the register.

In this paragraph—

(a) "home to school transport vehicle" means a bus, minibus or coach that is being used to transport a child or children to or from a school or educational setting;
(b) "specified transitional period" means the period of one year beginning with the commencement date.

Patients attending hospital appointments at a specified hospital

9.—(1) During the specified patient attendee's transitional period the Council will treat a specified patient attendee's vehicle as if it were a non-chargeable vehicle.

(2) In this paragraph "patient attendee's transitional period" means the period of one year beginning with the commencement date.

(3) A vehicle is a patient attendee's vehicle on any charging day if—
(a) it is a private vehicle;
(b) the Council is satisfied that it is used on the charging day concerned by a patient attendee for the purposes of travelling to or from a specified hospital for the purpose of attending a hospital appointment (or in the case of child patient attendees used for the purpose of transporting such patient attendee to or from a specified hospital for the purpose of attending a hospital appointment)
(c) particulars of the vehicle are entered in the register before the end of the second charging day following the charging day concerned.

(4) An application to enter particulars of a patient attendee's vehicle on the register shall be made on the day of attendance at the hospital reception by entry of the vehicle details on the permitted vehicle list for the day, by such means and accompanied by such details relating to the specified hospital, the vehicle and its use as the Council may reasonably require.

(5) In this paragraph—
(a) "private vehicle" means any vehicle other than a taxi, a private hire vehicle, a bus or a coach;
(b) "bus" means a vehicle used for carrying passengers for hire or reward and operated pursuant to a licence granted under section 14 of the Public Passenger Vehicles Act 1981;
(c) "coach" means any vehicle of Class M2 or Class M3 other than a bus, taxi or private hire vehicle,
(d) "specified hospital" means one of—
(i) the Bristol Royal Infirmary
(ii) the Bristol Heart Institute
(iii) the Bristol Royal Hospital for Children
(iv) the Bristol Haematology and Oncology Centre
(v) St Michael's Hospital
(vi) the Bristol Dental Hospital

(vii) the Bristol Eye Hospital
(viii) the Central Health Clinic

Article 16

ANNEX 5

PART 1

THE COUNCIL'S GENERAL PLAN FOR APPLYING ITS SHARE OF THE PROCEEDS OF THIS SCHEME DURING THE OPENING TEN YEAR PERIOD

It is proposed that the Scheme will commence on 20XX. This plan therefore covers the ten year period from 20XX to 20XX.

The revenue generated by the Scheme will in the first place be used to cover the cost of operation, including the maintenance of cameras, installation of signage, and engagement of operational staff etc. It is not intended that the Scheme should generate substantial net proceeds after covering these costs. Government policy is that the level of any charges should not be set as a revenue raising measure and the purpose of the Scheme is not to generate revenue but to encourage the use of cleaner vehicles and discourage use of more polluting vehicles. The more vehicles that are compliant with the Scheme standards, the less revenue the Council will make from charges and any penalty charge notices.

In the event that net proceeds are generated from the Scheme over the opening ten year period, these proceeds would be applied, in such proportions as may be decided by the Council, to directly or indirectly facilitate the achievement of the Council's local transport policies in accordance with the following high level spending objectives, set out below:

- Supporting the delivery of the ambitions of the Scheme and promoting cleaner air by offering packages for non-compliant vehicles to upgrade or retrofit their vehicles to meet the standards required by the Scheme;
- Supporting active travel and incentivising public transport use;
- Supporting green infrastructure along the most polluted roads where public exposure is the highest.

PART 2

THE COUNCIL'S DETAILED PROGRAMME FOR APPLYING ITS SHARE OF THE PROCEEDS OF THIS SCHEME DURING THE OPENING FIVE YEAR PERIOD

The Council's detailed programme for applying any net proceeds during this period will depend on:

- The level of net proceeds generated;
- How quickly compliance with Scheme standards are achieved across the various sectors (and the identification of which sectors will still require support to meet those standards);

- What other work will already have been implemented via other means and what the demand for further support is;
- How long the Scheme stays in place and when compliance with relevant air quality standards will be achieved.

The funding objectives are set out below

Objective 1

The funding will be awarded on a priority basis and in considering the prioritisation the following factors will be considered:

- Impact on air quality
- Value for money

Objective 2

Enabling vehicles which are subject to the exemptions or transitional arrangements set out in this Order to upgrade or retrofit where possible in order to meet the Scheme emissions standards.

Objective 3

The third objective will be to increase the use of active transport, public transport and low emission vehicles.

Article 1(1)(nn)

ANNEX 6

PLANS ILLUSTRATING THE CLEAN AIR ZONE