Birmingham Clean Air Zone Feasibility Study

Birmingham City Council

Distributional Impact Appraisal Report

(with Health Impact Assessment)

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Birmingham Clean Air Zone Feasibility Study

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Project Manager:	Stephanie Bywater
Author:	Jennifer Wade

Jacobs U.K. Limited

7th Floor, 2 Colmore Square
38 Colmore Circus, Queensway
Birmingham, B4 6BN
United Kingdom
T +44 (0)121 237 4000
F +44 (0)121 237 4001
www.jacobs.com

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Contents

List of Figures

List of Tables

Executive Summary

Background

Birmingham City Council commissioned a distributional impact appraisal, together with a health impact assessment, to identify how the impacts of a proposed Clean Air Zone (CAZ) would be distributed across Birmingham's diverse population and business communities. These impacts would include positive health benefits as well as financial impacts.

The impact appraisal has been conducted using a combination of appraisal techniques as set out in the Joint Air Quality Unit's (JAQU) 'Guidance on Options Appraisal' (2017) and the Department for Transport's Transport Analysis Guidance (TAG) Unit A4-2 'Distributional Impact Appraisal' (December 2015), supported with qualitative assessments drawing on available evidence and research on health, social equality and business impacts.

Birmingham City Council consulted on a charging CAZ where buses, coaches, taxis, private hire vehicles (PHVs), heavy goods vehicles (HGVs), light goods vehicles (LGVs) and cars that do not meet a minimum of Euro 6 diesel and Euro 4 petrol standards would be charged entry into central Birmingham from 2020 onwards. The purpose of this scheme is to achieve legal compliance on nitrogen dioxide (NO_2) concentrations in as short as time as possible. This is in the interests of public health since poor air quality is associated with a range of acute and chronic health conditions, and premature death. Vehicles which are compliant with the minimum standards would not be charged to enter central Birmingham. Additional licensing taxi conditions are proposed so that all taxis meet a higher standard (ultra-low emission vehicles – ULEV) standard from 2026. To make the CAZ more effective, a package of 'Additional Measures' has been included and considered as part of the appraisal. The Additional Measures included in the CAZ package that was consulted on included:

- All on-street free parking in CAZ becomes paid for.
- Banning traffic travelling northbound on Suffolk Street Queensway (A38) that exits onto Paradise Circus to then access Sandpits Parade and southbound traffic from Paradise Circus accessing the A38.
- Closing Lister Street and Great Lister Street at the junction with Dartmouth Middleway.

The final combination of Additional Measures to be put forward in the Full Business Case is subject to further air quality modelling and analysis to determine the efficacy of each measure. However, the impact assessment assumed all are in place as representative of the maximum impact the proposed CAZ could have on Birmingham.

The impact appraisal was reported as an appendix to the Outline Business Case, which was submitted in September 2018. This version of the report (Revision 2) has been partially updated to complete some analysis used to inform the targeting of mitigation.

Social and Equality Impacts

Income deprivation has been considered at lower super output level (LSOA)[1] relative to England and Wales, and relative to Birmingham. Compared to England and Wales as a whole, there are high levels of income deprivation within the CAZ and Birmingham in general. Owners of non-compliant vehicles resident within the CAZ and in close proximity to the CAZ (such as Nechells, Aston, Perry Barr, Tyburn, Soho and Sparkbrook) are potentially the worst affected financially by the proposed scheme, as due to their geographical location they would be least able to avoid entering and exiting the CAZ for everyday car journeys. There is a higher rate of non-compliant cars associated with areas of income deprivation. It should also be noted that there is a relatively high proportion of households within the CAZ that have no access to a car. The adverse impacts therefore would be distributed among those households that are dependent on car use and which have non-compliant

[1] LSOAs are small geographic areas which contain an average population of around 1,500 people.

vehicles. It is notable that low income households across Birmingham are also among those who would benefit most from the effects of the CAZ in terms of reduced journey times and reduced petrol consumption due to reduced congestion around the city centre as well as from the health benefits of the proposed scheme.

Other social groups potentially adversely affected by the CAZ proposals would be those dependent on community transport and taxis, as without mitigation these forms of transport could be adversely affected to the extent that their availability decreases. People vulnerable to these impacts would include the disabled, the elderly, women and children. It has therefore been recommended that these groups are targeted for mitigation.

There are some key community facilities within the CAZ whose users could be adversely affected by the combination of CAZ charges and parking charges. Examples would include staff and families of children in the Birmingham Children's Hospital, and congregants of those larger or more unique places of worship within the CAZ. These impacts could be mitigated through travel planning and ensuring convenient public transport is available at suitable times.

Business Impacts

The analysis has shown that some transport dependent businesses are more likely to have compliant fleets than others and so the impact of the CAZ would be distributed unequally across businesses., Taxi businesses would be faced with high upfront costs and few choices of response to the CAZ. Other types of business less able to afford the impacts of the CAZ appear to be private hire taxi companies, van companies with fleets that are owned by individuals rather than registered to the company, and SME HGV operators. A very high proportion of businesses within the CAZ are SMEs. Since all would be dependent on transport to some extent, any increase in costs from their suppliers as a result of entering the CAZ are likely to be passed on to these businesses, who in general would have less capacity to cope with increased costs than larger businesses.

Health Impacts

Health impacts would result from the reduction in air pollutants (particularly NO_2 and fine particles (PM_{10} and $PM_{2.5}$) as well as behavioural changes from switching to active modes of transport (walking and cycling) and improved environmental conditions. Impacts on life expectancy from exposure to air pollutants, hospital admissions for respiratory and cardiovascular problems and productivity (labour, human capital and natural capital), have been quantified and monetised using JAQU's impact pathway approach. This has identified that in the first year of the CAZ there would be £3.2m (adjusted to 2020 values) in benefit from reduced health impacts from air pollution, and a further £56m (adjusted to 2020 values) in environmental benefits (from reduced impact of NO_2 on ecosystems, reduced impacts of PM_{10} on building soiling and reduced impacts of ozone depleting substances on greenhouse gas related environmental effects). Analysis has shown that income deprived communities would proportionately receive higher health benefits than the population as a whole, meaning that the CAZ would help address a health inequality associated with the more deprived communities typically being exposed to more air pollution.

Spatial analysis of where the main air quality changes would occur have shown that there would be a 26% improvement in NO_2 pollution concentrations around schools and nurseries which are currently within the areas at greater risk of illegal levels of air pollution.

One of the aims of the CAZ is to nudge behavioural change, so that people use more active modes of travel where they can. Although it is not possible to quantify the likely level of change of the CAZ, across a population the increase in physical activity could contribute to significant improvements in overall public health.

Mitigation

It is proposed to target mitigation at those groups least able to cope with the changes brought by the CAZ. This would include taxi drivers faced with high upfront costs and limited choices of compliant vehicles; community transport; income deprived residents who live or work in the CAZ, key workers who work in the CAZ; disabled people, and SMEs. The types of mitigation under consideration include exemptions, discounts, sunset periods,

financial incentives to support businesses and enhanced infrastructure to support the transition to compliant modes of transport. Mitigation options are being consulted on and tested to check that they do not undermine the objectives of the CAZ. They would be subject to the availability of funding. The final mitigation package will be set out in the Full Business Case for the CAZ.

1. Introduction

1.1 Background

Birmingham City Council is one of five cities required by the UK government to introduce a scheme, such as a Clean Air Zone (CAZ), to achieve statutory nitrogen dioxide (NO_2) limit values in the shortest possible time.

In response, Birmingham City Council has considered various options for implementing a CAZ. Defra's CAZ Framework (Defra 2017) identifies two categories of CAZ:

- Non-charging CAZ – These are defined geographic areas used as a focus for action to improve air quality. This action can take a range of forms including, but not limited to, those set out in Section 2 of the Framework (for example emissions standards, awareness raising, optimising traffic management; improving business environment) but does not include the use of charge based access restrictions.
- Charging CAZ – These are zones where, in addition to the above, vehicle owners are required to pay a charge to enter, or move within, a zone if they are driving a vehicle that does not meet the particular standard for their vehicle type in that zone. The different types of charging CAZ identified by Defra are set out in Table 1.1.

Table 1.1 Defra Charging CAZ Classes

Defra CAZ class	Vehicles included
A	Buses, coaches, taxis and private hire vehicles (PHVs) (Euro 6/VI diesel and Euro 4 petrol)
B	Buses, coaches, taxis, PHVs and heavy goods vehicles (HGVs) (Euro 6/VI diesel and Euro 4 petrol)
C	Buses, coaches, taxis, PHVs, HGVs and light goods vehicles (LGVs) (Euro 6/VI diesel and Euro 4 petrol)
D	Buses, coaches, taxis, PHVs, HGVs, LGVs and cars (Euro 6/VI diesel and Euro 4 petrol) [Motorcycles and mopeds (optional) (Euro 3)].

Initial traffic and air quality modelling of a charging class C or class D Clean Air Zone (CAZ) demonstrated that these options would not meet compliance by 2020, and therefore a non-charging CAZ and charging class A and B options were discounted on the basis that they also would be insufficient. A package of Additional Measures including bans on different types of vehicles and other types of incentives were identified to test whether supplementing a class C or class D options with additional measures would achieve compliance. However, traffic and air quality modelling for a class C or class D CAZ with Additional Measures found that NO_2 concentrations would still not meet compliance by 2020. On the basis that none of the shortlisted options could achieve compliance by 2020, Birmingham City Council has selected a CAZ D with a 'High' rate of charge and including a package of Additional Measures as its preferred option.

This is on the basis that it is the option that would affect the greatest level of change and is therefore most likely to meet the critical success factor of air quality compliance in the shortest possible time. Further modelling is being undertaken to identify the point in time when compliance would be met. The package of Additional Measures that has been included in the modelled CAZ D 'High' with Additional Measures is set out in Box 1.

This distributional impact appraisal has therefore focused on the impact of the preferred option since that would affect the greatest amount of change and that the other shortlisted options have not been

found to be viable. Where data allows, some comparison has been made with other options in the appraisal (Appendix A), but the reporting in this document focuses on the effects of the preferred option. It has not been deemed proportionate to produce some of the modelling required to support full appraisal of shortlisted options, since these are not viable.

Box 1: Birmingham's Preferred CAZ Option

Birmingham's preferred CAZ option is a CAZ D (with a high charge) and Additional Measures. The proposed cordon for the CAZ would be within the inner ring road (A4540)

Figure 1.1 (Appendix B) shows the proposed location of the CAZ boundary and the Additional Measures.

The Additional Measures referred to above comprise of the following interventions:

- **All on-street free parking in CAZ becomes paid for.**
- **Banning traffic travelling northbound on Suffolk Street Queensway (A38) that exits onto Paradise Circus to then access Sandpits Parade and southbound traffic from Paradise Circus accessing the A38.**
- **Closing Lister Street and Great Lister Street at the junction with Dartmouth Middleway.**

The introduction of a CAZ would result in behavioural responses for vehicle users who currently travel to and from the area to be covered by the CAZ. The range of behavioural responses anticipated by the introduction of the CAZ is set out in Figure 1.2.

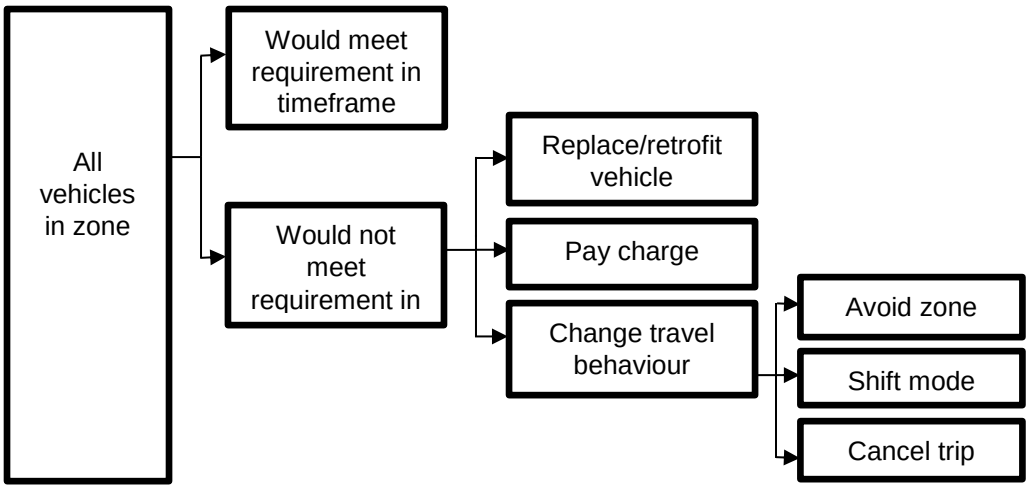


Figure 1.2 Behavioural Responses to the CAZ Charge

1.2 Purpose of Impact Appraisal

The UK Plan for Tackling Roadside Nitrogen Dioxide Concentrations (Defra/DfT July 2017) notes that NO_2 exceedances are highly localised and states that local authorities should seek to target measures to minimise their impact on local residents and businesses. Birmingham City Council has therefore commissioned an impact assessment to identify how the proposals for a CAZ would affect businesses

and local residents and where to target measures to minimise those impacts. This report brings together the findings of the assessment work and covers the following topics:

- Social and equality impacts;
- Business impacts; and
- Health impacts.

Although the results of the impact appraisal are set out under the broad topic headings of social and equality impacts; business impacts, and health impacts, it is important to recognise that the impacts and pathways to impact are interlinked as indicated by Figure 1.3.

An impact identified in one topic area, such as health, may also have an impact on another area, such as business, for example as a result of absenteeism of the workforce due to ill health. It therefore follows that where a measure is proposed to mitigate an adverse impact in one area, it may also mitigate an impact for another area. Chapter 8 outlines where multiple impacts may fall and where mitigation should be targeted as a result.

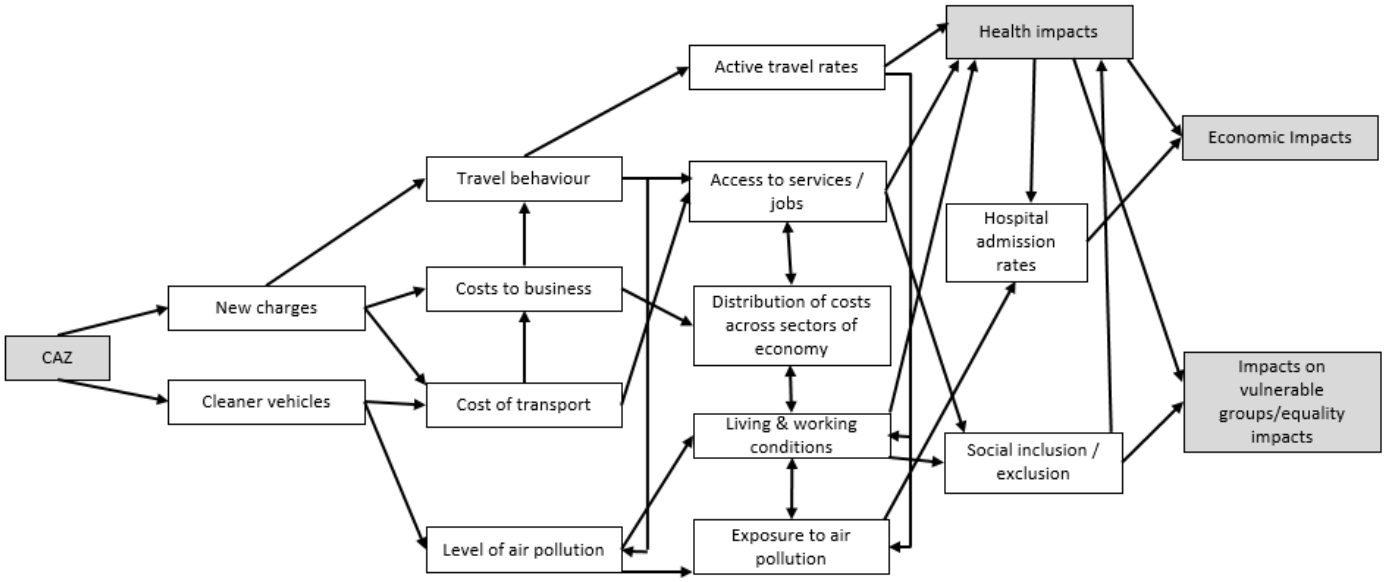


Figure 1.3: Links to Economic, Health and Social Equality Impacts

The assessment has been carried out through the application of various methods, including distributional impact appraisal in line with Defra's Joint Air Quality Unit (JAQU) *Guidance on Options Appraisal* (autumn 2017), which draws on the methods and approaches set out in Transport Analysis Guidance (TAG) unit *A4-2 distributional impact appraisal* (December 2015).

Whilst much of the analysis and modelling of options presented in the Outline Business Case uses average values as a summary statistic, the use of averages can mask the range of different responses that may depend on the characteristics of the person or business affected. Distributional impact appraisal looks at the differential impacts of the options between groups or businesses. The purpose is to identify whether a particular option unduly favours or disadvantages particular groups. This can inform measures to mitigate the impact of the option if required, or if the option should be amended.

1.3 Stage and Status of this Distributional Impact Appraisal Report

The first version of this report (Revision 1.1) was issued as an appendix to the Outline Business Case. The report has subsequently been updated to account of some additional analysis of some of the potential impacts, together with some information from the consultation that was undertaken for the Birmingham CAZ project

The development of mitigation proposals has taken place since the Outline Business Case as a separate workstream. This has taken into account distributional impacts as well as other types of impact such as broader economic and implementation issues, which are not part of the distributional appraisal. The final mitigation proposals, and their estimated costs, have now been taken into account as part of the Full Business Case reported for the proposed Birmingham CAZ.

This updated version of the report, Revision 2, has been issued as a background document for the Full Business Case. However, it should be noted that it has not been comprehensively updated since its purpose, to inform selection of the preferred option and where to target mitigation, has been served. It is therefore provided for information only.

1.4 Introduction to Social and Equality Impacts

The consideration of social distributional impacts helps Birmingham City Council to fulfil its public sector duty under the Equality Act 2010. The Equality Act 2010 requires public authorities to work to eliminate discrimination and promote equality in all their activities. Under Section 149 of the Equality Act a public authority has a duty to ensure that all decisions are made in such a way as to minimise unfairness, and do not have disproportionately negative impacts on people because of their protected characteristics or background. The protected characteristics are age, disability, gender reassignment, pregnancy and maternity, race, gender, religion or belief, sexual orientation and marriage/ civil partnership status. In addition to considering people with protected characteristics, the assessment of social impacts also considers income deprivation on the basis that these people may have less capacity to adapt to the measures being put forward to achieve NO_2 limit values.

1.5 Introduction to Business Impacts

The introduction of a CAZ would impose direct costs to businesses. These include businesses that are located within the CAZ, and transport service providers of people and goods into and out of the zone. How businesses and individuals decide to respond *"will depend on availability of funds to upgrade their non-compliance vehicle, or pay the charge, or flexibility to change behaviour in another way"* (Defra, 2016) (e.g. switch transport mode or re-route travel).

The proportion of SMEs which could be affected by the CAZ is a key issue. Owing to their size and the imposition of additional marginal costs, these businesses are less likely to easily absorb any extra costs incurred and would be the most vulnerable business category. The scale of this impact has been considered as part of the assessment to understand whether mitigation needs to be targeted at any specific areas or sectors. The implications on HGV, van and taxi businesses has been considered as these are transport related businesses most likely to be affected by charges associated with the CAZ. The implications for the wider West Midlands for HGVs and van businesses has also been considered.

1.6 Introduction to Health Impacts

The World Health Organisation (WHO, 2006) defines human health as *"a state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity*". This broad concept of health, which includes mental health and wellbeing, is applied in this assessment. Other key principles that have been applied in the assessment stem from the health map (Figure 1.4), adapted by Barton and Grant (2006), the Marmot review (2010) business case for action on health inequalities, and the Treasury Green Book guidance (HM Treasury, 2013) on valuing health benefits.

Health inequalities are increasingly being recognised by Government as a key issue to be tackled during development. The Marmot review (2010) presents a robust and well-evidenced business case for national and local action to address health inequalities. It looks at the differences in health and well-being between social groups and describes how the social gradient on health inequalities is reflected in the social gradient on educational attainment, employment, income and quality of neighbourhood.

The health map (Figure 1.4) developed by Barton and Grant (2006), shows a socio-economic model of health and health inequalities. People form the heart of the map, surrounding them are the layers of influence that, in theory, could be modified to facilitate optimum health.

Figure 1.4: The Determinants of Health and Well-being in Our Neighbourhoods (Barton and Grant, 2006)

2. Methodology

2.1 Approach

A three-step approach, in line with TAG unit A4-2, has been applied to the distributional impact appraisal. The three steps are:

1) Screening: The stage where the variety of impacts that the option may have are considered and particular impacts are prioritised for further analysis so that only the most relevant issues for the scheme are appraised to ensure proportionality.
2) Assessment: The stage where information is collected on the geographical area likely to be affected by the option and how different social and business groups are distributed within that geographical area.
3) Appraisal: The assessment of the extent of the impact of the option on the social or business groups identified.

The TAG guidance refers to various methods including quantitative analysis of statistics and modelling outputs, spatial analysis of geographical datasets and qualitative appraisal drawing on available information and research. The JAQU guidance acknowledges that in some cases a more 'light touch' appraisal is sufficient, rather than following the detailed guidance in TAG unit A4-2. The approach for this distributional impact appraisal has therefore been to screen for which types of impact are considered to be the most relevant to the influence of the CAZ, and then to determine what level of analysis is proportionate, taking into account the availability of data to inform the assessment and the sensitivity of the issue in the context of the Birmingham CAZ project.

2.2 Identification of Study Areas

The distributional impact appraisal takes account of different study areas depending on the impact variable being considered and likely spatial extent of the potential impacts resulting from the CAZ as informed by detailed traffic and air quality models that have been created covering the entire administrative boundary of Birmingham City Council. Relevant study areas or 'impact areas' for each type of impact are described below in the relevant topic area. Where relevant, the wider West Midlands has been considered, although most impact areas are relatively focused on Birmingham.

2.3 Key Terminology

The following key terminology is used throughout this report. Further terms are included in the glossary.

Table 2.1: Key Terminology

Term	Explanation
Grouping variables	The variables used to define different groups (e.g. level of income deprivation or business size).
Impact variables	The variables that change as a result of the option (e.g. air quality or affordability).
Differential impact	Impacts which vary according to the circumstances of groups that receive the impact. For example, some types of vehicle can be retrofitted to meet the CAZ standard whereas others cannot. Those that depend on vehicles that cannot be retrofitted would be affected differently as their choice of response to the CAZ is more limited.
Disproportionate impact	Impacts on a certain group which are out of proportion. For example, if a certain type of business would incur 50% of charges related to the CAZ but only make up 20% of business journeys in the CAZ, the impact would be disproportionate, as it would be expected to incur 20% of the charges if the option's impact were proportionate.
Transport User Benefit Appraisal (TUBA)	TUBA is a software which calculates the economic benefits to road users. TUBA compares the economic benefits of a 'Do Something' scenario (i.e. implementation of one of the shortlisted CAZ options) relative to the economic benefits of the Do Minimum scenario. These can include user charges, travel time and vehicle operating costs. Further details of TUBA appraisal for the shortlisted CAZ options are given in the Economic Appraisal Methodology Report (Report E1) appended to the Outline Business Case (OBC).
Lower level Super Output Areas (LSOAs)	LSOAs are small geographic areas which contain an average population of around 1,500 people.

2.4 Distributional Impact Assessment Criteria

The consideration of whether impacts are disproportionate is important to understand if one group is being unfairly disadvantaged or advantaged by the option over another group. In such cases it is necessary to understand how these impacts are occurring and whether it is acceptable or whether the option should be amended or mitigated. The following scale is used in the reporting of the distributional impacts.

Table 2.2 Distributional Impact Assessment Criteria

Assessment		Impact Description
✓✓✓	Large beneficial	Beneficial and the population impacted is significantly greater than the proportion of the group in the total population
✓✓	Moderate beneficial	Beneficial and the population impacted is broadly in line with the proportion of the group in the total population

Assessment		Impact Description
✓	Slight beneficial	Beneficial 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 and the population impacted is smaller than the proportion of the population of the group in the total population
✖✖	Moderate adverse	Adverse and the population impacted is broadly in line with the proportion of the population of the group in the total population
✖✖✖	Large adverse	Adverse and the population impacted is significantly greater than the proportion of the group in the total population

2.5 Social and Equality Impacts Appraisal Methodology

The distributional impact variables (as set out in TAG Unit A-2) considered most relevant to this broad topic were 'accessibility', 'personal affordability' and 'user benefits'. These are explained in Table 2.3.

Table 2.3: Impact Variables Included in Social and Equality Distributional Impacts Appraisal

Impact Variable	Explanation
Accessibility	Introduction of the CAZ charge may indirectly lead to a change in the availability of conventional public transport services (taxis and private hire vehicles) and specialist public transport services (for example community transport, school transport), which can affect how easy it is for people to access places of employment or study and to visit places of worship, friends and family or recreational facilities. Accessibility is linked to personal affordability in that sometimes the increased cost of a journey can either prevent people from making a journey or reduce the frequency at which they do so. Low income households, disabled people, women and children are all more vulnerable to changes in the availability of public transport as they are either more likely to use public transport (either conventional or specialised) and/or are less able to use another mode of transport such as walking or cycling.
Personal Affordability	Introduction of the CAZ charge would change the cost of travel by car or specialist transport services (for example community transport, school transport), which can affect how easy it is for people to access places of employment or study and to visit places of worship, friends and family or recreational facilities. Some groups of people are particularly vulnerable to increases in cost, including low income households and disabled people.
User benefits	In addition to the increase in cost of travel for people travelling by car for personal reasons as a result of paying the CAZ charge (as described against personal affordability), there would also be increases or decreases to the cost of journeys which are influenced by the distance and speed of travel. These factors include: • maintenance of the vehicle – factors such as oil consumption and tyre wear; • mileage related depreciation of car value; and • fuel consumption.

Impact Variable	Explanation
	These cost changes are termed 'user benefits;' although they relate to the beneficial and adverse impacts people travelling by car. User benefits also include time benefits, which is a monetised value given to forecast changes in the travel time of car journeys.

2.5.1 Method of Appraisal for Accessibility

The study area for accessibility takes account of Birmingham's population for the distribution of the different social groups across the city. It considers the main transport corridors within Birmingham and the identification of key destinations of relevance to the grouping variables in the scope of this impact assessment. Analysis of accessibility for the wider West Midlands has been undertaken to gain a fuller understanding of the distribution of impacts for people who travel to the CAZ from further afield than Birmingham.

The approach for the appraisal of distributional impacts on accessibility involved a qualitative assessment of how implementation of the shortlisted options may affect access to community facilities for those groups whose mobility limits the range of transport options available to them. The assessment method set out in section 8 of TAG unit 4.2 focussed on impacts on public transport accessibility, and whilst there may be some indirect effects on public transport travel times or timetables as a result of changes in traffic volumes, patterns following implementation of the scheme, no change to train or scheduled bus timetable, routes or fares are included in the proposals for the CAZ. There is potential that changes to public transport services would be made by operators in response to the CAZ to reflect changes in demand as an indirect effect of the CAZ but at this time no such plans have been made. The main impacts are likely to be related to the increased costs of travel by car or community transport. Therefore, the bespoke approach developed for this scheme was considered more proportionate.

Data sources used to inform the appraisal include:

- Ordnance Survey (OS) Addressbase Premium data (OS, 2016)
- Taxi and Private Hire Vehicle Statistics: England 2011 (Department for Transport, 2017a)
- Taxis, Private Hire Vehicles and their Drivers: England and Wales (Department for Transport, 2017b)

2.5.2 Method of Appraisal for Personal Affordability

In accordance with JAQU and TAG Unit 4.2 guidance (section 2.4), a quantitative appraisal of the distributional impacts on personal affordability has been undertaken using the outputs of the TUBA for each option. The TUBA model produced monetised outputs for geographical zones correlated with UK 2011 census merged wards, which were disaggregated to LSOA level according to the proportion of the total population of a ward or wards resident in the intersecting area of a given LSOA. It has been assumed that journeys undertaken during the morning peak in traffic flows originate from the driver's place of residence, and vice versa for those undertaken during the early evening peak.

Monetised outputs generated by the TUBA and included in the appraisal of personal affordability include:

- CAZ charges (as derived from operator revenue (local authority tolls) calculations)
- Fuel vehicle operating costs (i.e. changes in fuel consumption)
- Non-fuel vehicle operating costs (for example oil consumption, tyres, vehicle maintenance and mileage-related depreciation.

The quantitative assessment of personal affordability described above has been supplemented with a qualitative assessment of the impacts on specific social or business groups who may experience disproportionate or differential impacts over and above those defined by their geographical location or specific needs (for example mobility level).

2.5.3 Method of Appraisal for User Benefits

A quantitative appraisal of the distributional impacts on personal affordability has been undertaken using the outputs of TUBA for each option according to the process described in section 2.5.2.

Monetised outputs generated by TUBA and included in the appraisal of user benefits include:

- Fuel vehicle operating costs (i.e. changes in fuel consumption)
- Non-fuel vehicle operating costs (for example oil consumption, tyres, vehicle maintenance and mileage-related depreciation.
- Time benefits (a monetised value of forecast changes in travel time).

2.6 Business Impact Appraisal Methodology

2.6.1 Method of Appraisal for Business Impacts

Three study areas have been considered;

i. The CAZ itself for the consideration of impacts on SMEs. SMEs within the CAZ have been studied since these would be directly affected by the CAZ proposals.

ii. Birmingham City: The distribution of taxi and LGV ownership across the city has been considered to identify any spatial patterns and journeys into and out of the CAZ.

iii. West Midlands area. The wider area of the West Midlands has been considered in relation to the spatial distribution of LGV and HGV depots to account the regional distribution of suppliers and freight companies.

While the JAQU Guidance for Options Appraisal refers to TAG Unit A4.2 for detailed guidance on how to make an appraisal for each impact variable, there is no guidance for the appraisal of 'business affordability' in TAG Unit A4.2. Therefore, the principles of the 'personal affordability' approach were applied to understand if the impacts are distributed evenly across the LSOAs mapped for LGV ownership (Figure 2.1, Appendix B). The appraisal used costs to road users as based on the use of the DfT's Transport Users Benefit Appraisal (TUBA) program. The following types of cost were used:

- Fuel and non-fuel vehicle operating costs
- User charges
- Cost of upgrading vehicle

Further information on how these costs are derived is set out in the Economic Appraisal Methodology Report (E1) appended to the Outline Business Case. The TUBA model produced monetised outputs for geographical zones correlated with UK 2011 census merged wards, which were disaggregated to LSOA level according to the proportion of the total population of a ward or wards resident in the intersecting area of a given LSOA. The TUBA model output for operator revenue is directly proportional to the charge incurred for a particular journey or journeys between a defined origin and destination point, providing a proxy for the origin and volume of journeys that would attract a charge under the CAZ unless undertaken in a compliant vehicle. The TUBA model does not directly incorporate costs associated with upgrading or retrofitting vehicles, hence the operator revenue output has instead been used as a basis for identifying geographic areas where greatest costs to businesses

would be incurred as a result of the CAZ either through upgrading or retrofitting existing vehicles or paying the CAZ charges.

The appraisal initially considered the distribution of LGVs registered across the LSOAs as an indicator for the distribution of businesses which depend on vehicles (as per JAQU Options Appraisal Guidance section 6.2.2.). However, there are a number of limitations with this approach. For example;

- Many businesses depend on cars as well as other forms of vehicle, meaning the use of LGV is only a partially useful indicator for transport dependent businesses;
- Many vehicles are registered to addresses which are not the main location of use, for example they may be registered to a personal address or business headquarters but are in use elsewhere;
- Many businesses may not use their own vehicles but would nevertheless depend on the transport of their suppliers.

Due to lack of confidence in approach, further analysis was undertaken using the following sources of data:

- Traffic flow data (from ANPR data);
- DfT vehicle registration statistics;
- Government licensing statistics; and
- Results of business engagement reported in the Freight and Logistics Survey Report (Jacobs, January 2018).

Fleet analysis work was undertaken by Element Energy (June 2018). It should be noted that there were limitations in the business survey conducted for the Freight and Logistics due to a low survey response rate which has meant that no quantitative analysis of the responses has been made.

The appraisal reported below has therefore applied quantitative analysis where data has allowed and also drawn on qualitative analysis of various sources to build an understanding of the likely impacts of the CAZ on a range of business groups.

2.7 Health Impact Assessment Methodology

2.7.1 Study Area for Air Quality

The study area for air quality takes account of Birmingham's population and mapped areas of change in air pollution concentrations based on the air quality modelling.

2.7.2 Method for Appraisal for Air Quality - Impact Pathway Approach

It is recommended by Defra (2004) that a full impact pathway analysis is conducted when air quality impacts are valued at more than £50m using damage costs, or when air quality is the main objective of the proposal. Applying Defra's damage cost approach, the health and environmental benefits are estimated to be in the region of £38 million. Although this is below the £50m threshold recommended by Defra, the application of the impact pathway approach is appropriate for the proposed CAZ. The impact pathway approach is a more detailed way of valuing air quality changes. It values the impacts of proposed decisions (such as a CAZ) by estimating how the changes in concentrations of air pollutants affect a range of health and environmental outcomes.

The full impact pathway approach is outlined below:

1) Initial location-specific air quality modelling is undertaken to calculate the change in air quality emissions between a baseline scenario (i.e. when no interventions have taken place) and the modelled scenario (i.e. with the implementation of a CAZ).

2) The change in population weighted mean concentrations between the baseline and the modelled scenario are calculated. The population weighted mean concentration is the estimated average exposure of the population to different pollutants. This is weighted by population so that the concentration data in more populated areas are given a higher weight than those in less populated areas.

3) The health impacts are then quantified and monetised using a set of impact factors provided by JAQU. The impact factors capture the value in GBP per person of a 1 ugm^{-3} change in concentration of a pollutant. The impact factors represent the pathway between exposure to a pollutant and the ultimate health outcome. These are shown below in Table 2.4. Further detail on the health effects from these pollutants is provided in section 3.4.

Table 2.4 : Provisional Damage Cost Impact Factors (£/ug^{-3}/person) (2015 prices)

Pollutant	PM Chronic Mortality	NO_2 Chronic Mortality	PM Respiratory Hospital Admissions	PM Cardiovascular hospital admission	PM productivity	Building Soiling (PM_{10})	Ecosystem Impact (NO_2)	Ecosystem Impact (Ozone)
	(£/ug-3/person)					(£s per tonne emitted)		
PM_{10}	£16.20		£0.10	£0.06	£1.61	£543		
$N0_2$		£2.47					£61	-£35

2.7.3 Impact Pathway Pollutants for health pollutants

The provisional impact factors, provided by JAQU, are based on the recommended concentration response functions from the Committee on the Medical Effects of Air Pollutants (COMEAP). These are then monetised using the value of a life year and recommendations from a study by Chilton *et al* (2004). For the purposes of this assessment, the following impacts have been quantified:

- PM_{10} Chronic mortality – the impact on life expectancy of long-term exposure to average levels of pollutants in the air
- NO_2 Chronic mortality – the impact on life expectancy of long-term exposure to average levels of pollutants in the air
- PM_{10} Respiratory hospital admissions – emergency admissions to hospital due to pollution induced respiratory problems
- PM_{10} Cardiovascular hospital admissions – emergency admissions to hospital due to pollution induced cardiovascular problems
- PM_{10} Productivity – the impact on the efficiency with which an input is used in the production process e.g. labour, human capital, natural capital.

2.7.4 Impact Pathway Pollutants for non-health (environmental) effects

Using the JAQU impact factors, it is also possible to quantify the effects on the environment, such as the effects of PM on building soiling and the associated costs involved in cleaning buildings in urban areas. For the purposes of this assessment, the following impacts have been quantified:

- Building Soiling (PM_{10}) – reduced soiling of buildings by combustion particulates (the soiling of buildings includes both residential dwellings and historic/cultural buildings and causes economic damages through cleaning costs and amenity costs)

- Ecosystem impact (NO_2) – reduced impact of NO_2 on ecosystems (impact of NO_2 results in increased nitrogen deposition and overloading by nitrogen favourable species, reducing plant diversity in natural and semi-natural ecosystems)

- Ozone ecosystem impact – negative effect on human and environmental health from depletion in the ozone layer resulting in greenhouse gas effects

2.7.5 Limitations

In this study, only NO_2 and PM_{10} are considered in detail. Given that there is likely to be substantial overlap between NO_2 and $PM_{2.5}$ when single-pollutant models are used in the same analysis (COMEAP 2015), this approach was considered proportionate for this assessment, and avoids any double counting.

Similarly, since ozone populated weighted mean concentrations are not available, these impacts have been monetised using the change in NO_x emissions. This is the approved approach recommended by JAQU for instances in which ozone emissions data is unavailable.

The impact factors applied in this analysis, as recommended by JAQU, have been derived based on the best available scientific information and medical evidence on the effects of pollutants on health and the environment. However, it is noted that the methodology used in this report is not without its limitations.

For example, there are a range of other positive health outcomes that are not included in Defra's impact pathway methodology. These include:

- cognitive decline and dementia, which have been linked to traffic-related air pollutants (Power et al., 2016);
- lower lung function in early life which has been associated to exposure during pregnancy (Morales et al., 2015);
- self-reported life satisfaction has been linked to NO_2 (after controlling for other economic, social and environmental factors) (Knight and Howley, 2017).

It is clear that the evidence on the health effects of traffic related air pollutants is continually evolving and that approaches to measuring health benefits will need to adapt as new evidence emerges.

2.7.6 Method of Appraisal - Income deprivation

The appraisal of distributional impacts on air quality relative to income deprivation broadly follows the method set out in section 4.4 of TAG Unit 4.2 except in that monetised health impact data has been used to determine which areas would receive most benefit if the preferred CAZ option were implemented and which, if any, would experience a disbenefit. Monetised health impacts data for the following measures have been developed based on impact factors provided by JAQU and in accordance with Defra guidance 'Impact pathways guidance for valuing changes in air quality' (Defra, 2013).

- NO_2 – chronic mortality
- PM_{10} and $PM_{2.5}$ – respiratory hospital admissions, cardiovascular hospital admissions and productivity

Values for each of the measures listed above have been derived on an LSOA basis for each option using the predicted change in weighted mean average NO_2, PM_{10} or $PM_{2.5}$ concentrations for the preferred CAZ option relative to the 'Do Minimum' and Office for National Statistics (ONS) mid-year population estimates for 2016 (ONS, 2016a).

2.7.7 Method of Appraisal – Behaviour Change

A brief qualitative assessment of the health impacts associated with changes in travel behaviour following implementation of the preferred CAZ option has been undertaken, informed by the projected shift towards active travel (walking and cycling) modes and anticipated changes in traffic patterns and flows within the study area. The introduction of a CAZ would increase the cost of travelling in and out of Birmingham centre for non-compliant HGVs, vans and cars, both as a result of the CAZ charge and through the loss of free parking within the CAZ area. It is anticipated that approximately 2% of journeys made by non-compliant cars would instead be undertaken by public transport, cycling or walking (see Outline Business Case for further information). Whilst public transport is not a form of active travel in itself, many public transport users walk or cycle to points of access as part of their overall journey.

2.7.8 Method of Appraisal – Severance and Accidents

The study area for these two types of impact variable has been determined by the traffic model and where areas of significant change have been identified (i.e. those areas where there is predicted to be a greater than 10% change in the flow of traffic or Heavy Duty Vehicle (HDV) composition).

Changes in traffic flows can lead to a significant impact on community severance when Annual Average Daily Traffic (AADT) traffic flows exceed 8,000 vehicles per day (Highways Agency, 1993). However, it is noted that there are limitations in using AADT. For example, a school route may require crossing a road where traffic is heavily 'peaked'. While the AADT may be below the 8,000 vehicles per day threshold, if the majority of this traffic flows at a time when the school route is most in use (for example traffic to a business park where peak flows may coincide with journey to school times), there is a likelihood that this would be sufficient to dissuade some journeys on foot by children and parents. The consideration of the AADT threshold has been used, but the assessment and appraisal has relied more on a qualitative review of the facilities present in the impact areas and the local conditions. The focus has been on considering whether vulnerable groups may be present who are more likely to experience severance or fear of accidents.

2.8 Consultation

Public consultation on the proposed CAZ was undertaken during the period 4th July 2018 to 17th August 2018. Drop in events were held at numerous locations across the Birmingham area, and consultation documents and questionnaires were also made available on Birmingham City Council's consultation website. The consultation questionnaire sought information regarding the frequency, mode and purpose for which residents and organisations within Birmingham travel into the CAZ and provided an opportunity for residents and organisations to provide feedback on the proposals and suggest mitigation. Following feedback from JAQU on Revision 0 of this report, information gained from the consultation responses has now been used to supplement the baseline context for social groups and businesses (sections 4.3.3 and 4.3.6) and has informed the appraisal of social and equality impacts and business impacts (e.g. section 6.2).

3. Screening for Relevant Issues

3.1 Screening for Distributional Impacts

This chapter presents the findings of the first step of the appraisal process; the screening stage. The JAQU Guidance on Options Appraisal identifies that the following impact variables are appraised as a minimum:

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

The JAQU guidance advises that local authorities should also screen for other relevant impacts beyond these minimum requirements. Therefore, the impact variables set out in TAG unit 4-2 were screened for relevance, taking into account

i. the anticipated behavioural responses to the CAZ and whether there is a potential distributional impact from these responses; and

ii. whether a significant change would occur as a result of the scheme.

The judgement of whether a significant change would occur has taken into account the degree of change the CAZ option would have on modelled traffic flows, speeds or volumes of HDV in line with section 1.3 of TAG unit A4-2. Where the use of these traffic related indicators suggests a significant change to the impact variable, a further judgement has been applied to determine whether it is proportionate to assess the impact variable further taking into account the context of Birmingham CAZ. In some cases, whilst the results of the traffic model have suggested a significant change to the impact variable, the need for further assessment has been screened out on the basis that it was not considered proportionate or appropriate for the context of this project. The rationale for what has been screened in, and what has been screened out is provided in Table 3.1.

Table 3.1 Screening of Distributional Impact Variables

Impact variables	Behavioural response					Screening Comment
	Replace or	Pay charges	Avoid zone	Shift mode	Cancel trip	
User benefits			•	•	•	The TUBA programme has been used for the CAZ options to inform the Economic Case. The outputs have shown that user benefits are positive for all the shortlisted CAZ options but it does not show whether these impacts are distributed evenly across income groups. The distribution of these user benefit impacts was therefore screened into the distributional impact appraisal to understand whether there is evidence would have particularly high benefits or disbenefits to a particular income group that may warrant mitigation.
Noise			•	•	•	From the traffic modelling outputs, some traffic network links have been identified where there would be an increase in total traffic flows of greater than 25% (see Figure 3.1, Appendix B) relative to the Do Minimum scenario (see Figure 3.2, Appendix B). However, on reviewing the locations of these links it was apparent that they were generally relatively short stretches of road (less than 300 m in length) within a wider network of links where no change or reductions in traffic were modelled. The affected streets were within areas of industry. Furthermore, average flows were predicted to be relatively low (less than 3,000 vehicles per day (Annual Average Daily Traffic)). It was not considered proportionate to appraise the distributional impacts of noise using the TAG Unit A-2 methodology since the consideration of traffic flows alone would not reflect the complexity of the noise environment of the urban study area which includes other sources of noise such as nearby industry, railways and bars. A qualitative approach has been undertaken instead to identify the characteristics of the population and facilities surrounding these areas of predicted impact. (Refer also to Health Impacts Screening below).
Air quality	•		•	•	•	The appraisal of distributional impacts of air quality changes from the CAZ is a minimum requirement of JAQU. Therefore, this has been screened in for further assessment. The distributional air quality impacts are reported in the Health Impacts section, which goes on to cover a range of health outcomes associated with changes in air quality.
Accidents				•	•	The traffic modelling indicates some links where traffic flows and/or changes in HDV content would change by more than 10% (see Figure 3.1, Appendix B) relative to Do Minimum Scenario (see Figure 3.2, Appendix B). The potential distributional impacts of accidents was therefore screened in. A qualitative approach has been undertaken to identify the characteristics of the population and facilities surrounding these areas of predicted impact.

Impact variables	Behavioural response					Screening Comment
	Replace or	Pay charges	Avoid zone	Shift mode	Cancel trip	
Severance				•	•	The traffic modelling indicates some links where traffic flows and/or changes in HDV content would change by more than 10% (see Figure 3.1, Appendix B) relative to the Do Minimum scenario (Figure 3.2, Appendix B). The potential distributional impacts of severance was therefore screened in. The potential distributional impacts of accidents was therefore screened in. A qualitative approach has been undertaken to identify the characteristics of the population and facilities surrounding these areas of predicted impact.
Security				•		No significant change in public transport waiting or interchange facilities is anticipated. There is potential that the behavioural response of modal shift may have an effect on perception of security among some groups, for example there is evidence for differential experiences of security on public transport for some groups, such as women and some ethnic minorities. However, it is not likely that there would be sufficient evidence to support analysis. A light touch consideration of security was deemed to be proportionate and was covered under accessibility impacts as closely linked to that impact variable.
Accessibility			•	•	•	This impact variable was screened in on the basis that it was a minimum requirement of JAQU and that differences in the ability to access some facilities may arise as a result of changes in public transport and community transport availability and fares and introduction of parking charges.
Affordability	•	•		•		This impact variable was screened in on the basis that it was a minimum requirement of JAQU. Changes to costs associated with private and public transport journeys are anticipated through requirement to pay charge/upgrade non-compliant vehicles/change mode and loss of free parking. Differences in ability to absorb these costs or change mode may arise, based on income distribution or size of business.

3.2 Relevant Grouping Variables

Taking into account the impact variables screened in, consideration was given as to the potential scope of grouping variables to be considered at the next stage (the assessment stage of the TAG process). In some cases, there is variance from the guidance set out in the JAQU Options Appraisal Guidance. For example, where the JAQU guidance considers only 'accessibility' to be in scope for the elderly and disability, we have also considered air quality to be within scope, since the elderly, and adults with long-term conditions, are also vulnerable to the effects of air pollution (particularly short term exposure to particulate pollution). Table 3.2 presents the results of this scoping consideration.

Table 3.2: Scope of Grouping Variables Relevant to Impact Variables

Grouping variables	Impact Variable Screened In							Summary of Relevance to Impact Variable
	User benefits	Air quality	Accidents	Security	Severance	Accessibility	Affordability	
Low income households	•	•	•		•	•	•	Lower income households are likely to have less capacity to adapt to impacts linked to the CAZ.
Children		•	•	•	•	•		Children and young people can be more vulnerable to air pollution, concerns over personal security and would be more sensitive to any changes in pedestrian access. They are also more likely to be affected by accessibility should there be changes to the provision of school, community or public transport.
The elderly		•	•	•	•	•		The elderly can be more vulnerable to air pollution, concerns over personal security and would be more sensitive to any changes in pedestrian access. They are also more likely to be affected by accessibility should there be changes to the provision of community or public transport.
Disabled people		•		•	•	•		The presence of a higher disability ratio may indicate a higher proportion of people sensitive to air quality due to long term illnesses. The disabled are also more likely to have concerns over personal security, severance and be dependent on community or public transport.
Women				•		•		Women are more likely to have concerns over personal security and accessibility as a higher proportion are less likely to have access to a car.
Black, Asian and minority ethnic				•				There are potential differential impacts on security as a consequence of some public attitudes which may affect transport

Grouping variables	Impact Variable Screened In							Summary of Relevance to Impact Variable
	User benefits	Air quality	Accidents	Security	Severance	Accessibility	Affordability	
(BAME) people								preferences. However, the scale of this issue is not known and is based on anecdotal evidence. Therefore, a light touch approach is taken in the assessment of accessibility.
Marriage and civil partnership								No differential impact has been identified for this group.
Pregnancy and maternity		•						There are health inequalities associated with pregnancy and air quality. This is addressed in the health impacts assessment.
Sexual orientation				•				There are potential differential impacts on security as a consequence of some public attitudes which may affect transport preferences. However, the scale of this issue is not known and is based on anecdotal evidence. Therefore, a light touch approach is taken in the assessment of accessibility.
Gender reassignment				•				There are potential differential impacts on security as a consequence of some public attitudes which may affect transport preferences. However, the scale of this issue is not known and based on anecdotal evidence. Therefore, a light touch approach is taken in the assessment of accessibility.
Religious groups				•		•		There are potential differential impacts on security as a consequence of some public attitudes which may affect transport preferences. However, the scale of this issue is not known and based on anecdotal evidence. Therefore, a light touch approach is taken in the assessment of accessibility.
SMEs							•	SMEs would have less capacity to adapt to financial pressures linked to the CAZ.
LGVs							•	Businesses dependent on transport would be more exposed to financial pressures linked to the CAZ.
HGVs							•	Businesses dependent on transport would be more exposed to financial pressures linked to the CAZ.
Taxis							•	Businesses dependent on transport would be more exposed to financial pressures linked to the CAZ.

3.3 Screening of Health Impacts

The key driver for action on air quality in Birmingham, through implementation of a CAZ, is the direct effect of poor air quality on human health. However, the implementation of transport policies and plans can also affect human health in a variety of indirect ways:

- Lifestyle changes by encouraging travel by means other than private car and encouraging walking and cycling;
- Effects on the local economy by changing access to employment;
- Promoting access to key services, particularly access to health facilities;
- Changes to the built environment to promote exercise through a healthy environment; and
- Impacts on accessibility to the countryside and local green spaces.

The screening of health impacts has sought to identify those health issues that could be most attributable to the environmental (air quality) and behavioural changes predicted from the implementation of the CAZ. The relevant issues screened into, or out of, the HIA are described in sections 3.4 and 3.5 respectively.

3.4 Relevant Health Issues Screened In

3.4.1 Deprivation

A Defra commissioned study in 2006 showed that there is a tendency for higher relative mean annual concentrations of NO_2 and PM_{10} in the most deprived areas of the country. In areas which exceed emissions standards, the correlation is stronger. The most vulnerable human receptors include young people and the elderly. A report published by the Royal College of Physicians finds that children living in high pollution areas are four times more likely to have reduced lung function when they become adults (Royal College of Physicians, 2016.).

3.4.2 Respiratory illness

The links between air quality emissions and health effects are well established. The main pollutants from vehicle emissions are particulate matter (PM) and nitrogen oxides (NOx), which are linked to effects on lung function and other respiratory problems.

Evidence shows high exposure to poor air quality (particularly PM and NO_X) in the short term can result in inflammation of the airways and increased incidence of shortness of breath and wheeze symptoms (Royal College of Physicians, 2016).

In the long term, exposure can affect lung function and increase mortality and hospital admissions for those with existing respiratory conditions such as chronic obstructive pulmonary disease (COPD) and asthma. There is also evidence to suggest that long-term exposure to poor air quality causes new-onset asthma in both children and adults and lung cancer (Royal College of Physicians, 2016).

Recently, evidence has shown links between Particulate Matter (PM) and chronic bronchitis; however, currently there is not sufficient evidence to establish causality. Therefore, this issue would be acknowledged during the assessment but not assessed quantitatively.

3.4.3 Cardiovascular Disease

Cardiovascular disease includes all the diseases of the heart and circulation including coronary heart disease, angina, heart attack, congenital heart disease and stroke (British Heart Foundation, 2017). Coronary heart disease is the leading cause of death in the UK (British Heart Foundation, 2015).

Evidence shows exposure to high levels of PM both in the short and long term can exacerbate existing cardiovascular disease and is associated with a range of cardiovascular effects such as heart failure and strokes.

3.4.4 Mortality

The link between chronic mortality and long term exposure to air pollution is well evidenced (COMEAP, 2017). Cohort studies looking at the effects of air pollution on health over several years have shown that the deaths from respiratory and cardiovascular causes, in combination with other factors, increase with long term exposure to air pollution. This occurs at both high and low levels of pollution and relates mostly to fine particulate matter, such as $PM_{2.5}$ (Public Health England, 2014).

3.4.5 Diabetes

Evidence suggests a link between air pollution and diabetes, especially type 2 diabetes mellitus. The association was stronger for traffic associated pollutants including NOx and PM (Royal College of Physicians, 2016).

3.4.6 Cognitive Decline and Dementia

There is emerging evidence to suggest that poor air quality affects both the developing and the ageing brain however this link needs to be explored further (Royal College of Physicians, 2016).

3.4.7 Mental Health

According to a growing body of evidence, air pollution can be associated with changes in behaviour within society, for example, spending less time outside, which can lead to more sedentary lifestyles and negative psychological effects on our mental health (Crowder, 2017). Additionally, it is well known that physical environments that promote good health can have a positive effect on reducing the socio-economic health inequalities of the area (Marmot Review, 2010).

3.4.8 Risks to the Unborn Baby

There is emerging evidence on the links between high levels of emissions and effects on the unborn child. Evidence shows that air pollution can affect the growth of the unborn baby and may be linked to premature birth or even still birth (Nezeeba Siddika et al., 2016). It is estimated that traffic-related air pollution exposure (particularly exposure to PM) of pregnant women accounts for more than one-fifth of all cases of low birth weight at term. Low birth weight is associated with low lung function, COPD, cardiovascular disease and early death in adulthood (Risnes et al, 2011, in Royal College of Physicians, 2016). Air pollution can also harm placental development, which affects the development of the unborn child and has been associated with several chronic diseases, including heart disease, obesity and type 2 diabetes. Poor foetal growth is linked to abnormal development of the kidneys, and to hypertension and kidney disease in later life (Luyckx et al., 2013 in Royal College of Physicians, 2016).

3.4.9 Obesity and Active Travel

Journeys by bicycle or on foot not only reduce emissions and improve air quality, but have the added advantages of improving health by helping reduce obesity, diabetes, coronary heart disease, stroke, road traffic accidents, and improving mental health (UK Alliance on Climate Change, 2016). A Birmingham CAZ has the potential to encourage a city wide transition towards active transport. A reduction in traffic, increased cycling and walking helps to both reduce air emissions, and improve air quality.

3.5 Health Issues Screened Out

3.5.1 Indoor Pollution

A report commissioned by the Royal College of Physicians (2016) considered the large potential effect on health of indoor sources of air pollution such as gas cookers, cleaning products and carbon monoxide. The report showed that several thousand's deaths per year in the UK could be attributed to indoor air pollution. Whilst consideration would be made to the potential health effects at built community facilities with limited ability to lessen interference from local emission sources such as hospitals and car homes (in line with TAG Unit 4.2), indoor air pollution falls outside the scope of this study, which focuses on mainly on traffic emissions.

3.5.2 Noise

Noise nuisance and vibration caused by road traffic can increase levels of stress, anxiety and aggression, increase the risk of hypertension and cardiovascular disease, and contribute to sleep disturbance and pyscho-physiological effects (WHO, 2011). Noise is also a key contributing factor of neighbourhood amenity with excessive noise reducing the quality of the local environment. This reduction in neighbourhood amenity can lead to avoidance of the street for social use and reduced levels of active travel, ultimately leading to impacts on physical and mental health (Mindell et al., 2011). Key receptors of noise impacts include residential properties, schools, hospitals, the elderly/children, care homes, open spaces, streetscapes and public rights of way.

The introduction of a clean air zone means there is potential for some change in fleet composition with older (generally louder engines) vehicles to be replaced with newer vehicles (generally quieter engines) that are subject to tighter noise limits in accordance with Regulation (EU) No 540/2014. Additionally, there is potential for some heavy vehicles to be replaced with multiple smaller vehicles in order to avoid the additional charge. However, these changes are not expected to result in a perceivable noise reduction. Further, establishing causal relationships between exposure to noise and health can be problematic as the effects of exposure vary between different types of noise sources and are also compounded by other factors. As such, noise effects are screened out, although the assessment of distributional impacts has considered where the main changes in traffic flows would occur and the characteristics of the population and facilities in that area. These locations would potentially experience change in levels of noise, as well as other traffic related impacts such as risk of accidents and community severance. A light touch qualitative consideration is given to noise in relation to these changes in traffic flows.

3.5.3 Climate Change

Climate adaption in urban areas now considers the impacts of urban heat islands as an important part of forming strategic climate change action plans. Urban heat islands are man-made areas which are significantly warmer than the surrounding countryside. This mainly occurs because the materials used in towns and cities e.g. tarmac and stone have different thermal properties allowing them to absorb more heat than the materials found in rural areas.

The impacts of Urban Heat Island (UHI) compounds intensify the impacts of climate change resulting in hotter summers and heatwaves, preventing night-time cooling.

Whilst there are many factors that contribute to UHI, transport is a major contributor. Vehicles generate a large amount of heat through their exhaust emissions, radiant heat and tyre-road surface friction. As there is a higher density of vehicles in urban areas, this significantly contributes to the UHI and its associated health effects.

The BUCCANEER (Birmingham Urban Climate Change and Neighbourhood Estimates of Environmental Risk) project, partnership between University of Birmingham, Birmingham City Council

and the Birmingham Health and Wellbeing Partnership, examined the effect of Birmingham's Urban Heat Island. Temperature modelling across the city has demonstrated increases of up to 4 degrees in the summer in the city centre compared to other areas and this has formed part of Birmingham climate change strategy (Birmingham City Council, 2011). Clean air zones, improved urban planning and investment in active transport can reduce the effects of the UHI, resulting in improvements to health, air quality and helping to meet climate change targets.

Assessment of the potential effects on the UHI in Birmingham is considered outside the scope of this assessment for reasons of proportionality in the assessment, but it is acknowledged that this is a potential area for further work.

3.5.4 Crime Reduction and Community Safety

In relation to community safety, being a victim of crime has an immediate physical and psychological impact. It can also have indirect long-term health consequences including disability, victimisation and isolation because of fear. Thoughtful planning and urban design that promotes natural surveillance and social interaction can help to reduce crime and the 'fear of crime', both of which impacts on the mental wellbeing of residents.

It is recognised that ANPR cameras and surveillance could potentially provide a deterrent for crime; however, given that CCTV has been found to reduce property and vehicle crime, but provide little deterrent for street crime in open areas, the potential for the CAZ to provide any additional deterrent to crime is considered unlikely (Gill and Spriggs, 2005). For this reason, this topic has been screened out of the HIA.

4. Assessment of Birmingham's Context

4.1 Introduction

This chapter reports step 2 of the appraisal process. It provides an assessment of the context of the relevant areas that could be affected by the CAZ in terms of the facilities present, the business context and the demographic profile of the communities which are present.

4.2 Birmingham's Population

4.2.1 Population Size

The Office for National Statistics (ONS) reports that Birmingham's resident population was 1,101,360 in 2014. This was an increase of nearly 10% since 2004. The constituency with the highest population is Ladywood which includes the proposed CAZ area in Birmingham city centre. Hall Green and Hodge Hill are the most densely populated, with 59 people per hectare, compared with 17 people per hectare in Sutton Coldfield (comprising the wards of Sutton Four Oaks, Sutton Trinity, Sutton Vesey and Sutton New Hall). The locations of more densely populated areas are a key consideration in understanding the level of exposure to air pollution from traffic sources.

4.2.2 Low income households

At ward level[2], Sparkbrook, Aston and Washwood Heath are the three most deprived wards within Birmingham, also ranking amongst the 5% most deprived wards in the country. Sutton Four Oaks, Sutton Vesey and Sutton New Hall are rated the top three least deprived wards within Birmingham. However, as shown in the table below, seven of the ten least deprived wards in Birmingham are these ranked within the 50% most deprived in England.

Table 4.1 The Ten Most Deprived and Ten Least Deprived Wards in Birmingham

Top 10 most deprived wards[2]		
Ward	**National Rank**	**National Quintile**
Sparkbrook	48	1
Aston	71	1
Washwood Heath	74	1
Nechells	81	1
Kingstanding	113	1
Lozells & East Handsworth	140	1
Shard End	148	1
Bordesley Green	172	1
Soho	183	1
Tyburn	266	1

Top 10 least deprived wards[2]		
Ward	**National Rank**	**National Quintile**
Sutton Four Oaks	5,835	4
Sutton Vesey	5,123	4
Sutton New Hall	5,038	4
Sutton Trinity	3,810	3
Selly Oak	2,435	2
Hall Green	2,277	2
Harborne	2,124	2
Bournville	1,803	2
Edgbaston	1,754	2
Oscott	1,527	1

[2] It should be noted that this is based on wards prior to the changes made to ward boundaries following the Local Government Boundary Review. New ward boundaries have been implemented in 2018 but up-to-date population and IMD datasets were not available for the new wards at the time of assessment.

At the LSOA level (Figures 4.1 and 4.2, Appendix B) deprivation is still clear across the city, particularly to the east of the city centre however, there are certain pockets of deprivation which were not as obvious at ward level. For example, despite being one of the 10 least deprived wards in Birmingham, looking from LSOA level shows high levels of deprivation within Edgbaston.

The CAZ mainly comprises of areas considered amongst the most deprived in England (quintile one for income deprivation as shown in Figure 4.1, Appendix B). The south east section and north section includes the most income deprived areas in England and Wales. There are areas within the Birmingham City Council's administrative area which are considered more deprived that those in the CAZ (Figure 4.1, Appendix B), however a section in the central northern part of the CAZ, the edge of the western part of the CAZ and in the southern part of the CAZ are high in income deprivation and include some of the most deprived areas within Birmingham. The centre section of the CAZ includes LSOAs ranked second least deprived areas within the Birmingham.

4.2.3 Households without Access to a Car

The CAZ mainly comprises of areas with a high proportion of households with no access to a car relative to the England distribution. The north west section of the CAZ has a slightly lower distribution of households with no access to a car relative to England as well as a small section in the south west (Figure 4.3, Appendix B). The CAZ mainly comprises of areas with a high distribution of households with no access to a cars relative to Birmingham also. The south and east of the CAZ has a high distribution of households with no cars. The sections within the CAZ which have a slightly lower distribution of households with no cars include a small section in the south, a small section in the north and a larger section in the west. However overall the CAZ has a high distribution in the top two quintiles for households with no access to a car relative Birmingham (Figure 4.4, Appendix B).

4.2.4 Children

The majority of the CAZ has a low proportion of people under the age of 16 by LSOA relative to distribution across England and Wales (Figure 4.5, Appendix B). Areas with the highest proportion of under 16s are within the south east part of the CAZ. There are also pockets with high proportions of under 16s north, south, and west, with a low proportion in a large part of the centre of the CAZ. This suggests that there may be areas within the CAZ and immediately surrounding the CAZ where changes in traffic and air quality incurred by the CAZ could disproportionately affect children, depending on where the changes occur and the types of facilities are present within those impact areas (see below in relation to accidents, severance, security, and accessibility).

4.2.5 Elderly People

The entire CAZ has a very low proportion of people over the age of 65 by LSOA relative to distribution across England and Wales and there is no variation in the proportion of people over the age of 65 within the CAZ (Figure 4.6, Appendix B). The areas with greater proportions of elderly people are in the Sutton Coldfield area in the northern part of Birmingham and the Northfield/Selly Oak areas to the south. This suggests that the elderly population is unlikely to be disproportionately affected by changes incurred within the CAZ.

4.2.6 Disabled people

The CAZ includes areas where there are a high proportion of disabled residents based on the comparative illness and disability ratio component of the Index of Multiple Deprivation (Figure 4.7, Appendix B). The central north section as well as the southern west part of the CAZ includes the highest proportion of disabled residents in the CAZ. There is only a small section within the centre with a low proportion of disabled residents.

The 2011 Census reported that 9% of the population of Birmingham (98,181 people) reported a long term health problem or disability that was significantly limiting their day-to-day activities. A similar percentage of the population reported their day-to-day activities were slightly limited by a health problem or disability.

The official labour market statistics state that the total number of people claiming disability living allowance in Birmingham is 43,920 (approximately 4% of the population).

4.2.7 Women

There is a very low proportion of female residents throughout the majority of the CAZ (Figure 4.8, Appendix B). There is a higher proportion of female residents in a small section in the southern part of the CAZ (Digbeth area) and one area, north east of the centre which includes a high proportion of female residents. This is in the vicinity of the Birmingham Children's Hospital and the high proportion of female residents is assumed to be due to the presence of key worker accommodation on the hospital site. Much of the remaining CAZ area has a low proportion of female residents by LSOA relative to distribution across England and Wales.

4.2.8 BAME people

Compared to England and Wales, much of Birmingham has a high proportion of its population that identifies as BAME (Figure 4.9, Appendix B). To show variation within the city therefore, the proportion of BAME population was mapped relative to the overall population in Birmingham (Figure 4.10, Appendix B). This shows a generally high concentration of Birmingham's BAME population to be within the central part of Birmingham, with the highest concentrations to the east (Hockley, Winson Green and Handsworth areas) and west of the CAZ (Sparkbrook, Small Heath and Bordesley Green areas). The areas with the lowest proportion of BAME population are the Sutton Coldfield area in the northern part of Birmingham and the Northfield/Selly Oak areas to the south, but these still comprise populations in the top 40% proportion of BAME population compared to England and Wales as a whole.

4.2.9 Religion

According to the 2011 census, Christianity was the highest represented religion in Birmingham with 46% of residents saying they were Christian. Whilst 22% of the population was Muslim and 19% had no religious beliefs.

The majority of people classifying themselves in one of the White or Black ethnic groups said that they were Christian, whereas the Muslim community was predominantly made up from the Asian population. In general, the Muslim population are concentrated closer to the city centre area with the Christian group generally further out towards the council boundary as detailed on Figure 4.11, Appendix B.

Within the proposed CAZ area there are 30 registered places of worship, including Roman Catholic, Presbyterian, Church of England, Greek Orthodox Churches, Synagogues, Mosques and Sikh Temples. Most are of a size that suggests their catchment is highly localised. However, Birmingham Central Mosque is an exception with a capacity of 20,000 and regularly attracts more than 4,000 worshippers for Friday services, suggesting that it attracts a significant number of visits from outside the CAZ area on a regular basis. Other places of worship with a significantly larger than average capacity (greater than 500 spaces) within the CAZ area include the Anglican, Greek Orthodox and Catholic Cathedrals, Camp Hill Seventh Day Adventist Church, Ladywood Seventh Day Adventist Church and Birmingham City Church.

4.3 Business Context in Birmingham

4.3.1 Economy

Birmingham is the UK's second largest city after London. As such, it is a major economic hub for the region and a major centre of employment.

The city has an economic output of £20 billion per annum (Birmingham Development Plan (BDP), 2017). In 2016, Birmingham[3] had a gross value added (GVA) per head of £23,330, this was higher than the West Midlands GVA per head of £22,144, but lower than the comparative figure for the UK which was £26,584 (ONS, 2016). Many high value economic activities are located in the city centre including professional and financial services; digital media; and environmental and medical technologies. The BDP recognises the strengths and challenges of the city economy, such as how to accommodate a projected population growth of 150,000 people by 2031 (BDP, 2017).

The number of jobs by sector in the CAZ and in the rest of Birmingham is shown in Table 4.2 (ONS, 2017).

Table 4.2 Birmingham Employment by Economic Sector and Location[4]

Key employment sectors	Employment within sector in the CAZ	% of employment within sector within the CAZ	Employment within sector in Birmingham (excluding the CAZ)	% employment within sector in Birmingham (excluding the CAZ)
Financial and insurance activities	14,000	64%	8,000	36%
Human health and social work activities	15,000	18%	67,000	82%
Accommodation and food service activities	12,000	38%	20,000	63%
Wholesale and retail trade5	19,000	26%	54,000	74%
Education	9,000	16%	47,000	84%
Public administration and defence	14,000	56%	11,000	44%
Other service activities	22,000	50%	22,000	50%
Information and communication	7,000	50%	7,000	50%
Real estate activities	5,000	63%	3,000	38%
Professional, scientific and technical activities	29,000	62%	18,000	38%
Manufacturing	7,000	18%	32,000	82%

[3] NUTS3 level
[4] Business Register and Employment Survey
[5] This key sector also includes repair of motor vehicles and motorcycles

Key employment sectors	Employment within sector in the CAZ	% of employment within sector within the CAZ	Employment within sector in Birmingham (excluding the CAZ)	% employment within sector in Birmingham (excluding the CAZ)
Construction	3,000	19%	13,000	81%
Transportation and storage	7,000	30%	16,000	70%
Total	**163,000**		**318,000**	

As indicated in Table 4.2, a significant proportion of the high value service jobs are located in the CAZ area. This includes jobs in 'finance and insurance activities', 'professional, scientific and technical activities', and 'other service activities'. For these sectors, on average over 50% of total jobs in Birmingham are located within the CAZ.

Over 80% of jobs in 'human health and social work activities', 'manufacturing' and 'construction' are located outside the CAZ. The manufacturing and construction business sectors are likely to require heavy vehicle (HGV) access.

From Table 4.2 it can be seen that 34% of all jobs in Birmingham are located within the CAZ. By comparison, the population of the CAZ is less than 5% of that for Birmingham.

4.3.2 Businesses and Business Size

Business size is a key factor that would determine how businesses are affected by the increased charges associated with a CAZ. Larger businesses would tend to be more resilient to any increased charges since they have more resources, and are able to spread costs over a larger customer base. Smaller businesses tend to be less resilient to a shifting economic landscape, due to, for example, limited options to diversify or increase productivity, and fewer cash reserves.

The type of business operation is also a key consideration when assessing potential economic effects of a CAZ. For the purpose of this assessment, businesses within the wholesale, retail trade and transport sectors are considered particularly susceptible to impacts from CAZ charging. This is based on the assumption that that these business operations are likely to be reliant on LGVs and HGVs, and could potentially be affected by CAZ charges relating to these classes of vehicles.

Table 4.3 shows the distribution of business sizes between Birmingham as a whole and the CAZ (Nomis, 2017), for all employment sectors, and for the three sectors identified for closer analysis (wholesale and retail trade and transportation and storage).

Table 4.3 Local Units by Business Size in Birmingham and CAZ[6]

Business size	All employment sectors			Wholesale and retail trade or transportation and storage		
	CAZ	Birmingham (excluding the CAZ)	Percentage of employment within the CAZ	CAZ	Birmingham (excluding the CAZ)	Percentage of employment within the CAZ
Micro (0 to 9)	10,105	26,900	27%	1,770	7,225	24%
Small (10 to 49)	1,760	4,000	31%	350	1,065	33%
Medium-sized (50 to 249)	415	975	30%	60	175	34%
Large (250+)	100	130	43%	15	30	50%
Total	**12,380**	**32,005**	**39%**	**2,195**	**8,495**	**26%**

The following key observations are made from the data in Table 4.3:

- In Birmingham (including the CAZ) there are almost 45,000 local units or businesses. The majority (99%) of these local units are categorised as Small and Medium Enterprises (SMEs), defined as businesses with fewer than 250 employees.
- 43% of 'Large' businesses in all sectors are based inside the CAZ, while this figure for wholesale and retail trade and transportation and storage sectors is 50%.
- More than 10,000 local units with up to nine employees (micro) are based in the CAZ.
- Of the 2,195 local units that are categorised in the wholesale and retail trade or transportation and storage sectors within the CAZ, 1,770 (equivalent to 81%) are micro.

Figure 4.12 (Appendix B) shows that relative to England and Wales, there is a very high proportion of SMEs within the CAZ. When mapped according to business size, relative to Birmingham's business counts at MSOA level (Figures 4.13 (Appendix B)) it can be seen that the three MSOAs with the highest counts of micro businesses (between 251 to 450) are located within the CAZ boundary. A high number are also located towards the south east of the CAZ. Similarly, for small businesses the three MSOAs with the highest counts are located within the proposed CAZ boundary (Figure 4.13 (b), Appendix B). Finally, Figure 4.13 (c) (Appendix B) shows that the highest number of medium sized businesses are located within the centre of the CAZ boundary. A high number of medium sized businesses (between 16-20) also exist in the north east of Birmingham. This is likely to be attributed to the location of the Fort Dunlop business park and shopping arcade within this MSOA.

4.3.3 Business Travel Patterns

Responses to the consultation with organisations held by Birmingham City Council in July/August 2018 indicated that most business vehicles within the CAZ are owned (69%), with a further 20% leased on short term contracts and 17% leased on short term contracts. The most popular business vehicles owned or leased by respondents are diesel vans (13.7%) and cars (13.7%). Around 35% of business respondents from across Birmingham currently have no CAZ compliant vehicles within their fleets, whereas approximately 24% of have fleets which are between 75 and 100% CAZ compliant.

[6] UK Business Counts – local units by industry and employment size band

The frequency of travel into the CAZ for businesses located within or in close proximity to the CAZ

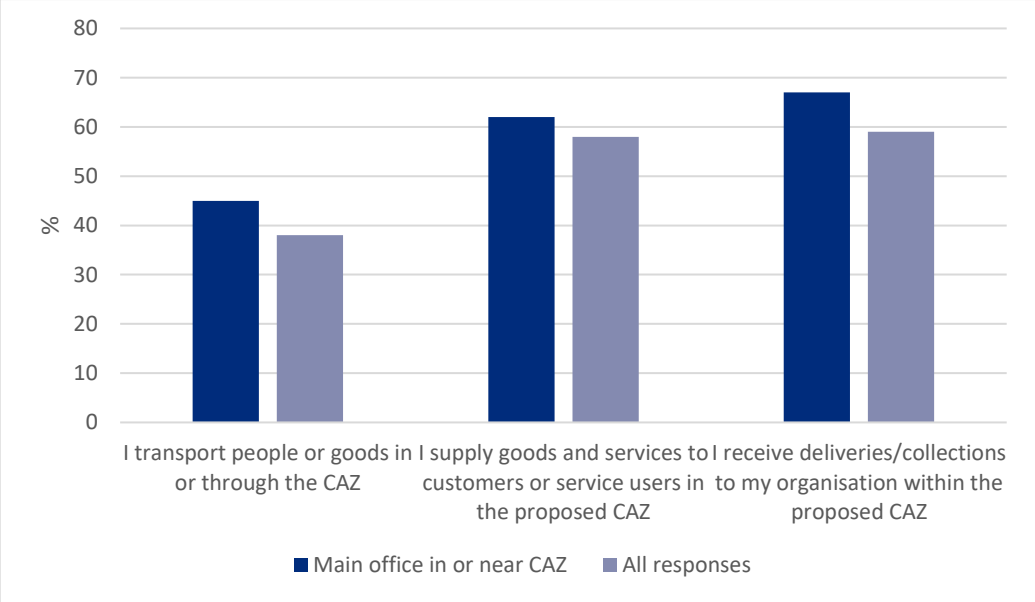


Figure 4.14 Proportion of Business Respondents who Regularly (more than 10 times per week) Travel or Receive Deliveries and Collections within the CAZ by Location

appears to differ little from the Birmingham average (see Figure 4.14). However, micro businesses

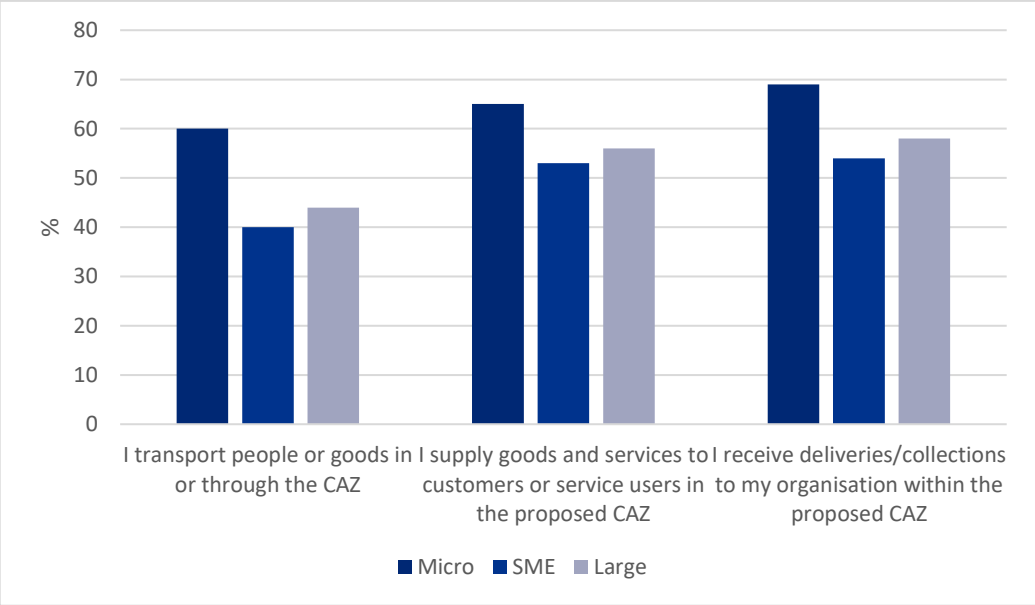


Figure 4.15 Proportion of Business Respondents who Regularly (more than 10 times per week) Travel or Receive Deliveries and Collections within the CAZ by Business Size

are more reliant on travel within the proposed CAZ than small, medium and large businesses (see Figure 4.15) and have lower levels of compliant vehicle ownership than small, medium and large businesses (see Figure 4.16). Micro businesses located within the CAZ are also more likely to receive frequent (more than once per week) deliveries or collections than small, medium and large businesses located within the CAZ (see Figure 4.15).

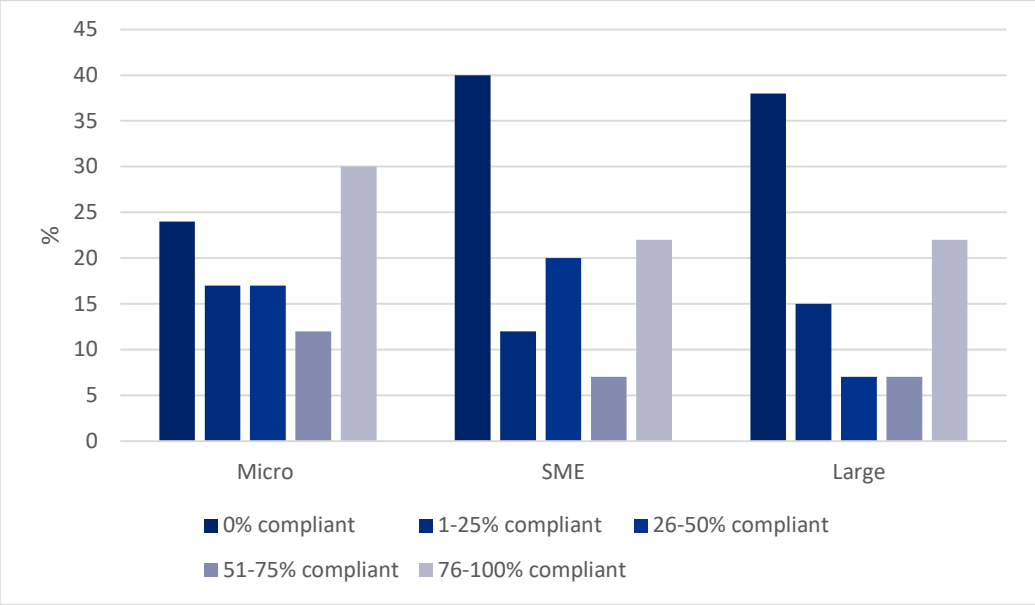


Figure 4.16 Business Fleet Compliance by Business Size

4.3.4 Transport

4.3.5 General

Cars, LGVs and HGVs

Vehicle licensing data for 2012 and 2016 are presented in Table 4.4 (Department for Transport (DfT), 2016).

Table 4.4 Registered Vehicles by Vehicle Category[7]

Area	Cars		LGVs		HGVs	
	2012	2016	2012	2016	2012	2016
Birmingham	551,674	627,794	87,789	110,639	4,163	4,210
Change between 2012-2016	14%		26%		1%	
Greater Birmingham	863,675	920,584	160,487	189,845	12,081	12,618
Change between 2012-2016	7%		18%		4%	
Great Britain[8]	28,722,453	30,850,440	3,280,615	3,781,984	460,616	493,638
Change between 2012-2016	7%		15%		7%	

[7] Vehicle Licensing Statistics – Table VEH0105
[8] Great Britain is used here, as data for the United Kingdom was only collected in 2016, and therefore is not comparable with 2012.

The following key observations are made from the data in Table 4.4:

- Over the period 2012 – 2016, car registrations in Birmingham increased by 14%.
- Over the period 2012 – 2016, LGV registrations in Birmingham increased by 26%, only 18% in Greater Birmingham, while the national average for the same period is 15%.
- Over the period 2012 – 2016, HGV registrations in Birmingham increased by only 1%, compared to Greater Birmingham of 4%.

Birmingham has a resident population of approximately one million, equivalent to 1.7% of Great Britain's population. Registered cars in Birmingham represent 2.0% of the total fleet of Great Britain. Considering the population of Birmingham and the number of registered cars in 2016 (Table 4.4), there is less than one car per head of the population (0.6 car per head of population).

The registered number of LGVS and HGVs in Birmingham are nearly 3% and 1% of the total Great British fleet respectively.

As outlined in section 1.4, SMEs are deemed to be the most vulnerable business sector to additional costs. Figure 2.1 (Appendix B) shows the distribution of LSOAs ranked by proportion of registered LGVs, overlying the MSOAs within quintile 1 for number of SMEs compared with the England and Wales average. It indicates that there are high proportions of LGVs registered within the northern part of the CAZ. However, this data should be treated with caution since it is likely that many vehicles will be registered to company addresses but used elsewhere so are not necessarily representative of numbers of vehicles likely to regularly cross the CAZ boundary.

A more reliable indicator of goods vehicles (HGVs and LGVs) activities in the CAZ area can be obtained from ANPR data. This shows that both HGV and LGV entries into the CAZ are relatively infrequent with over half entering the zone just once a week and only 6% of HGVs and 9% of LGVs entering the CAZ five times a week or more. The average annual daily total for vehicles crossing the CAZ cordon by compliance is shown in Table 4.5.

Table 4.5 AADT by Vehicle Type and Compliance

Key employment sectors	LGV	HGV
Compliant	13,067	4,588
Non-compliant	9,148	2,453
Total	22,214	7,042

This is broken down further by vehicle type in Table 4.6.

Table 4.6 Do-Minimum' Non-Compliant Cordon Crossing Trips (Average Annual Daily Trips)

Vehicles type	Frequency over the course of one week (1 = once a week, 7 = every day)						
	1	2	3	4	5	6	7
Car	21957	6768	3203	2458	2386	1285	733
Van	5288	1709	737	559	535	238	82
Taxi	1036	326	287	384	418	705	1654
Bus	771	338	243	173	260	232	179
Rigid	1292	353	172	111	96	43	17
Artic	308	36	14	5	3	1	1

However, 27% of non-compliant LGVs and 29% of non-compliant HGVs are transiting the zone and in future would use an alternative route.

Taxi and PHV Registrations

Table 4.7 shows data on the number of taxis and PHV within the Birmingham local authority and the surrounding authorities in 2017. Across Greater Birmingham there are a total of 9,148 registered taxis and PHV, with 5,405 (59%) being within the Birmingham area.

Table 4.7 Licensed Taxis and PHV Across the Local Authorities

Area	Taxis	Private hire vehicles	Total
Coventry	154	915	1,069
Sandwell	196	1,591	1,607
Solihull	166	1,970	2,136
Wolverhampton	173	4,469	4,642
Birmingham	1,224	4,181	5,405
Greater Birmingham	1,586	7,742	9,148

Coaches

Birmingham is host to several annual events throughout the year. There were 39.1 million visitors to the city in 2016 (Regional Observatory Marketing Birmingham, 2016), an increase of 16.6% over the last five years (Greater Birmingham Chambers of Commerce, 2017). According to a 2016 Visitor Survey the key conferences, events and festivals in 2016 that brought the most to the Birmingham economy include the Birmingham and Solihull Jazz and Blues Festival (£6.2 million), Edgbaston Cricket (£17.7 million) and the Christmas Markets (£399.8 million) (Regional Observatory Marketing Birmingham, 2016b). It is expected that coaches would be used to bring visitors to Birmingham for these events.

As Birmingham is well connected by road, many events can be accessed by coach, with a wide range of coach services calling at Digbeth Coach Station, close to Birmingham's city centre (Visit Birmingham, 2018). National Express, one of the largest bus groups in the UK, links Birmingham to over 500 locations in Europe, and 1,200 in mainland Britain (Visit Scotland, 2018). Typical return fares in 2018 from London to Birmingham using National Express or Megabus range from approximately £6.20 to £16, however single journeys can be achieved from as little as £1.50. Whilst these lower figures are likely not indicative of the average fare, they do highlight the fact that coach companies work on a low margin business model, which in turn indicates that these businesses operations would likely be affected by the CAZ charging.

Birmingham's Mode Share

Data on Birmingham's mode share is presented in Table 4.8 (Travel for West Midlands, 2016) for the four main modes of interest (bus, rail, metro and car).

The mode share information has been observed from cordon counts which surround Birmingham City centre and only apply to those trips with a destination within the city centre. The data are for inbound AM Peak (07.30-09.30) trips only.

Table 4.8 Number of Cordon Counts (Inbound AM Peak Trips Only)

Birmingham City Centre Cordon	2011		2013		2015	
	Count	Percent	Count	Percent	Count	Percent
Bus	25,749	28%	25,179	27%	25,315	26%
Rail	27,798	30%	27,506	29%	35,085	36%
Metro	1,687	2%	1,538	2%	299	0.3%
Car	37,256	40%	39,751	42%	35,658	37%

The following key observations are made from the data in Table 4.8:

- In 2015, the majority of the morning peak trips travelling to the city centre were made using public transport (primarily bus and rail).
- Mode share for metro was 0.3% in 2015 which is likely due to the cordon survey being undertaken between January and December, at which time Snow Hill Metro stop was closed for 6 weeks. This may also account for a portion of the increase in rail trips.
- Mode share for cars in 2015 was 37% a decrease of 4 percentage points from 2013.
- The use of rail for trips has seen the largest increase between 2011 and 2015 of 6 percentage points.

Car and General Traffic Trends

Figure 4.17 shows total traffic on major roads in Birmingham, measured in thousand vehicle miles (DfT, 2016).

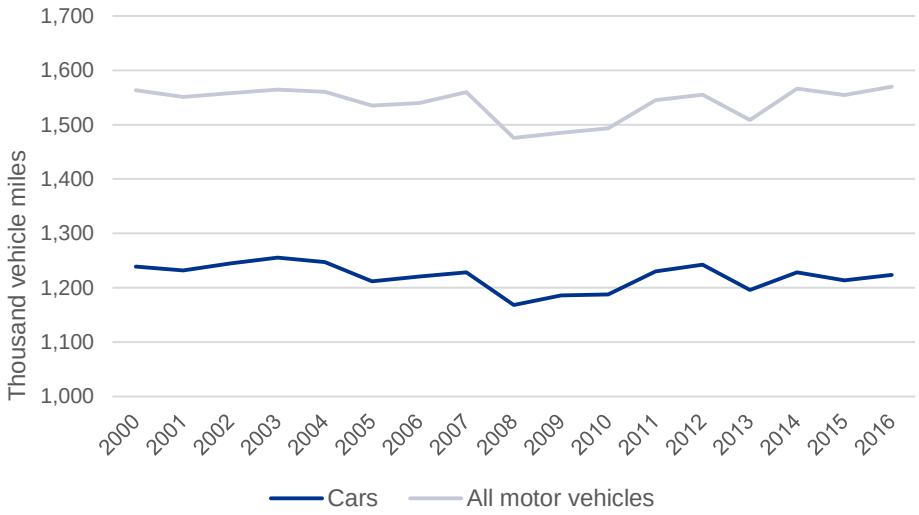


Figure 4.17: Vehicular Growth in Birmingham, 2000-2016

The following key observations are made from the data in Figure 4.17:

- While there are year-on-year variations in the traffic levels, total car miles in Birmingham in 2016 are comparable with the same traffic levels in 2000 (DfT, 2016).

- For all motor vehicles, the graph shows greater variations in volumes (particularly around the economic downturn in 2008), but 2016 traffic levels are also broadly comparable to those observed in 2000.

Figure 4.15 shows the average miles made by LGVs and HGVs between 2000 and 2016 (DfT, 2016). These trends in goods vehicles have been separated from the overall traffic volumes.

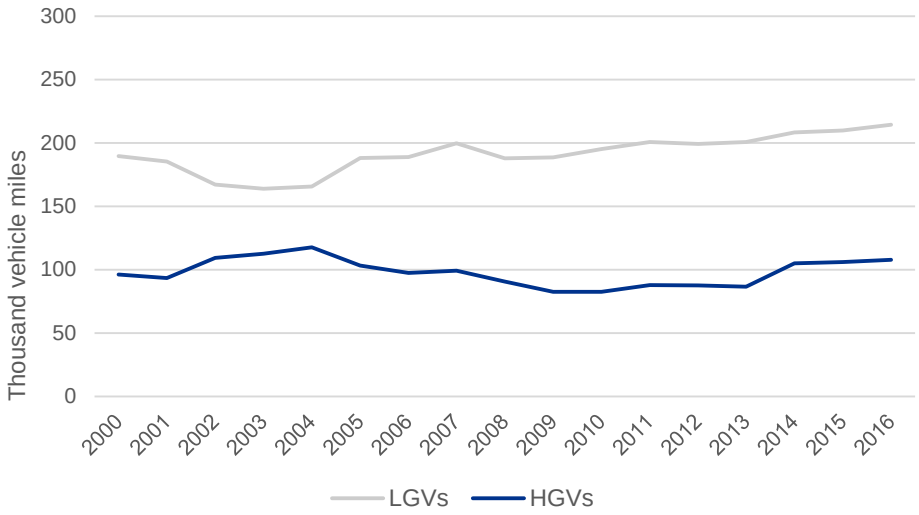


Figure 4.18: LGV and HGV Growth in Birmingham, 2000-2016

The following key observations are made from the data in Figure 4.18.

- LGVs have experienced notable traffic growth since 2008, although HGV traffic is broadly at the same level in 2016 as that seen in 2000.
- Since the economic recession of 2008, LGV traffic has grown consistently year-on-year. In 2016, LGV traffic is approximately 13% greater than that observed in 2000, which is the most significant growth of the two motorised modes.

Travel to Work Patterns

The Census 2011 data includes the location of usual residents and the method of travel to work (Nomis, 2011). Although the dataset is now seven years old, it provides a picture of the scale of the movements of people and information on their mode of transport, while travelling to work.

Table 4.9 presents the number of trips into the CAZ by those whose usual residence is in the rest of Birmingham and the number of trips from the CAZ by people who work in the rest of Birmingham. Data was aggregated for the CAZ and the rest of Birmingham (excluding CAZ) to show the total number of trips. Table 4.9 below shows the volume of movements observed by mode.

Table 4.9 Journey to Work Flows for CAZ/ Rest of Birmingham[9]

Mode	Rest of Birmingham into CAZ		CAZ into the rest of Birmingham		Total	
	Number of trips	Percentage of trips	Number of trips	Percentage of trips	Number of trips	Percentage of trips
Underground, light rail or tram	281	0%	22	0%	303	0%
Bus, minibus or coach	21,416	34%	1,624	30%	23,040	34%
Car / van driver or passenger	28,659	46%	2,348	43%	31,007	46%
Walking	2,523	4%	812	15%	3,335	5%
Train	7,871	13%	429	8%	8,300	12%
Bicycle	1,256	2%	142	3%	1,398	2%
Motorcycle, scooter or moped	305	0%	18	0%	323	0%
Taxi	335	1%	55	1%	390	1%
Total	**62,646**	**100%**	**5,450**	**100%**	**68,096**	**100%**

The following key observations are made from the data in Table 4.9:

- Almost half of all commuting trips are made by car and the rest by public transport;
- The majority of public transport trips are made by bus (34%).
- Nearly 63,000 movements were recorded from Birmingham to CAZ, while the same figure for CAZ to Birmingham is nearly 5,500. The total number of movements is just over 68,000.
- Considering only 'car/van drivers or passengers', there were 31,000 movements recorded in total for both flows.

Considering the physical size of the CAZ compared to the rest of Birmingham, 63,000 movements into the CAZ is a significant number of trips. Although it will partly reflect the use of the A4540 ring road, it also highlights the importance of the area to Birmingham for providing employment.

4.3.6 Travel Patterns

Responses received during the July/August 2018 consultation exercise for the proposed CAZ indicate that the most frequent reasons for travelling into the CAZ by car are commuting to a place of work or study, shopping and leisure/visiting friends or family, with fewer than one in five respondents reporting that they enter the CAZ for other purposes such as attending a place of worship, taking children to school or activities and medical appointments at a frequency of more than once per month. People who travel into the CAZ for shopping or leisure and social purposes typically travel into the CAZ at a frequency of once per month of less. Those who travel into the CAZ for commuting purposes typically travel into the CAZ five times a week or more.

[9] WU03EW – Location of usual residence and place of work by method of travel to work (MSOA level)

4.4 Context of Impact Areas

As set out in Table 3.1, the distributional impacts of air quality are screened into the assessment as a minimum requirement of JAQU, and therefore the areas of greatest potential changes in air pollution have been identified and their context is set out below. Changes in predicted traffic flows have indicated potential impact areas of relevance to potential distributional impacts of noise, severance and accidents. The context of these areas of greatest change in traffic flows has been assessed to further understand the potential for these distributional impacts and is set out in section 4.4.2.

4.4.1 Areas of Greatest Change in Air Quality (NO_2)

Under the 'Do Minimum' scenario, i.e. in the event that a CAZ is not implemented, a significant proportion of the study area is at risk of experiencing NO_2 concentrations which exceed the legal limit of 40 µg/m^3. The areas of Birmingham where average NO_2 concentrations are greater than 30 µg/m^3 (as indicated by the orange and red contours on Figure 4.19) are considered to be most risk of experiencing NO_2 concentrations which exceed the legal limit of 40 µg/m^3 NO_2.

As shown in Figure 4.19, highest average NO_2 concentrations (> 40 µg/m^3) occur within the city centre within the largely commercial areas which falls between and around Queensway and Park Street, more industrial areas to the north adjacent to Aston Expressway and also within southern residential areas of Digbeth and Deritend. There are also smaller isolated areas to the north of the city centre adjacent to the A38 and A47 within Nechells which are partly residential but mainly used for industrial purposes. Average NO_2 concentrations are still high, in excess of 30 µg/m^3, in the suburban residential area of Aston and the industrial areas in Bordesley. Residential areas north of the city centre in Nechells and Washwood Heath surrounding the route of the A38 and A47 also experience NO_2 concentrations in excess of 30 µg/m^3, as do some small residential areas to the south of the city centre in Selly Oak adjacent to the A38 (Bristol Road) where average NO_2 concentrations exceed 30 µg/m^3.

Those areas with highest (>40 µg/m^3) NO_2 concentrations have fairly high levels of income deprivation relative to the England and Wales distribution (see Figure 4.1, Appendix B), but are not considered deprived relative to the Birmingham distribution (see Figure 4.2, Appendix B) where they largely fall within the second least deprived quintile. However, those areas with average NO_2 between 30 and 40 µg/m^3 surrounding the city centre all have relatively high levels of income deprivation, with most falling within the most deprived quintile (one) for income deprivation relative to both the England and Wales distribution and Birmingham distribution (see Figure 4.1 and Figure 4.2 respectively, Appendix B). Within these areas are numerous community facilities of importance to groups who are particularly vulnerable or susceptible to changes in air quality such as children or those that are least able to make changes to avoid or minimise the negative impacts of poor air quality such as hospitals and care homes (see Figure 4.19).

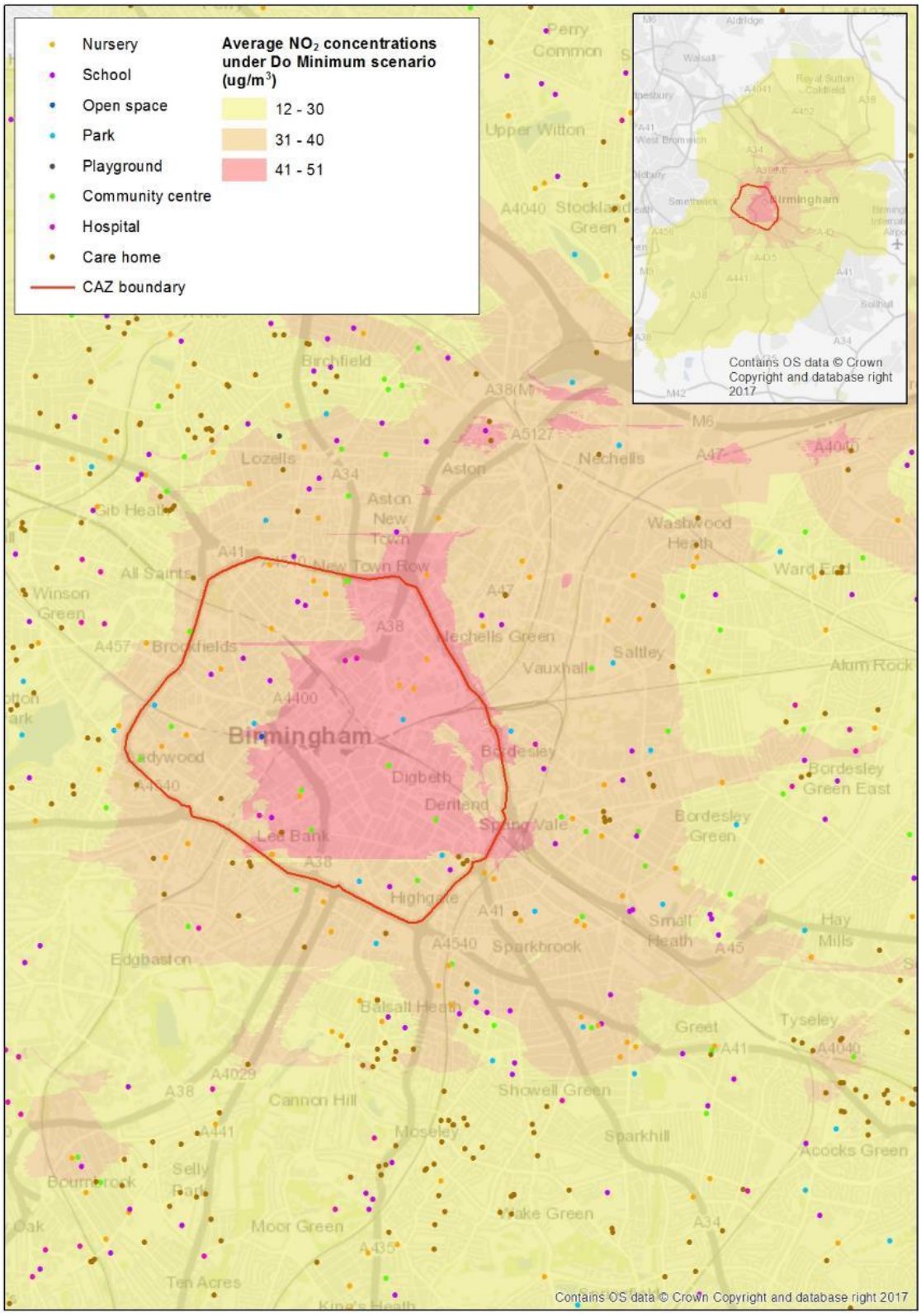


Figure 4.19 Key Impact Areas for Air Quality Related Effects of the CAZ

4.4.2 Areas of Greatest Change in Traffic Flows

Areas which are anticipated to experience greatest change in traffic flows if the preferred CAZ option were implemented, taken as an increase or decrease in 24-hour Annual Average Daily Traffic (AADT24) flows of 10% or greater, are also almost exclusively located within the proposed CAZ area with the exception of a couple of stretches of road within Edgbaston (see Figure 4.20).

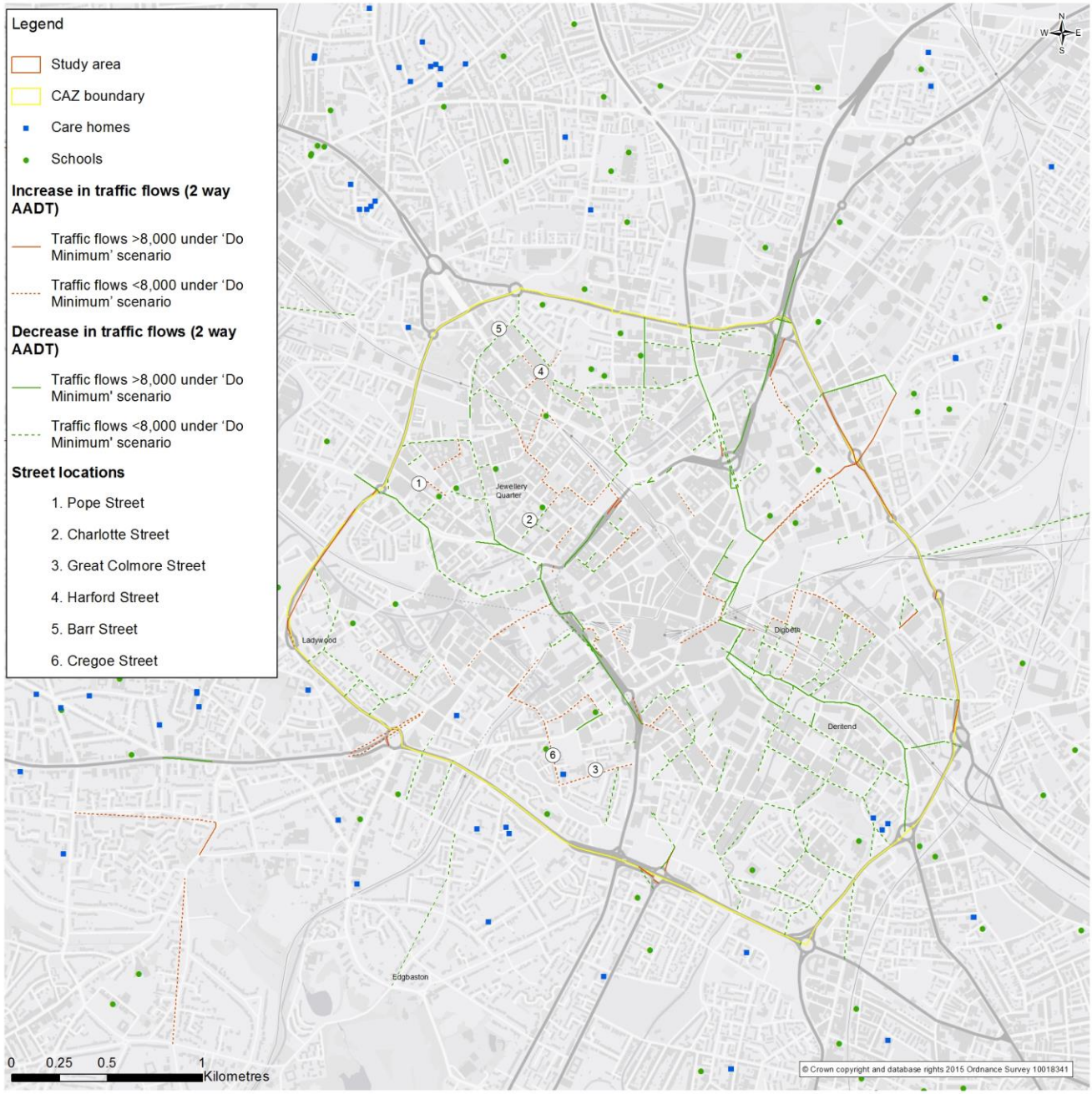


Figure 4.20 Key Impact Areas for Effects Relating to Changes in Traffic Flows

Assessment of Severance Context

The major roads bisecting the CAZ would largely experience decreases in traffic flows (Figure 4.20), including the A457 and A4400 between Spring Hill and Paradise Circus, the A38 between Paradise Circus and Holloway Circus, and short sections of the B4498, A38 and B4133 as they intersect the A4540 on the northern CAZ boundary and along Queensway Tunnel. In contrast, sections of roads where increases in traffic flows of greater than 10% are anticipated under the preferred CAZ option are mainly those circumnavigating the CAZ, including Ashtead Circus (and feeder roads including Dartmouth Middleway, Lawley Middleway, Nechells Parkway (A47) and Jennen's Road (B4114)) and Ladywood Middleway between the Hagley Road (A465) junction and Spring Hill (A475) junctions. There are also short stretches of road of less than 200 m in length towards to the east (Great Barr Street and northbound carriageway of Watery Lane Middleway immediately north of Bordesley Circus) and north of the city centre (Holliday Street and southbound slip road for Aston Expressway at Dartmouth Circus) and also along Harborne Road (B4124) in Edgbaston.

Changes in traffic flows can lead to a significant impact on community severance when AADT traffic flows exceed 8,000 vehicles per day (Highways Agency, 1993). Increases and decreases in total traffic flows of greater than 10% on roads where flows exceed 8,000 AADT24 under the 'Do Minimum' scenario are almost all A roads and dual carriageways which are either not accessible to pedestrians or have controlled pedestrian crossings in place. Where this is not the case, for example along Great Barr Street and Holliday Road) the section of road affected is very short (<200 m in total). In this context, it is not considered that the changes in traffic flows would have a noticeable effect on severance (either beneficial or adverse) since the context of the pedestrian crossing points would not be altered.

Vulnerable people such as the elderly and children can be more sensitive to severance and therefore severance can be an issue for these groups in areas where traffic flows are less than 8,000 AADT. Stretches of road within the CAZ area where an increase in traffic flows of greater than 10% is predicted and which are located in close proximity to facilities used primarily by elderly people or children have therefore been assessed since these are where groups particularly vulnerable to severance are likely to be located. The identified stretches of road are listed below and shown on Figure 4.20.

- Pope Street in the Jewellery Quarter;
- Charlotte Street in the Jewellery Quarter;
- Great Colmore Street and Cregoe Street in Ladywood; and
- Harford Street and Barr Street in Gunsmiths Quarter.

These roads are single carriageway roads that do not have controlled pedestrian crossing points. However, total traffic flows along these sections of roads would remain very low, below 3,500 AADT24 in all cases, and traffic flows during peak times would also differ little from those anticipated under the Do Minimum scenario. It is also notable that there would be a consistent reduction in traffic flows in the Highgate and Deritend areas surrounding Calthorpe Academy, Ark St Albans school and Highgate Park, although again traffic flows are relatively low at these locations under both the Do Minimum scenario and the preferred CAZ option. The potential impact of severance, even for vulnerable groups, is not likely to change significantly between the Do Minimum and preferred CAZ scenarios because of the context, and is therefore not considered further in the DIA for reasons of proportionality.

Assessment of Accident Context

Certain groups are known to be at greater risk of experiencing transport related accidents, including children and older people (particularly as pedestrians or cyclists), young males and motorcyclists. As described above, the majority of roads which would experience changes in traffic flows of greater than 10% are within the proposed CAZ, which is an area with relatively low proportions of residents aged

under 16 or over 65. In addition, analysis of STATS19 (2014-2018) casualty data shows that these groups represent a relatively low proportion (7% and 3% respectively) of road traffic accident casualties that have occurred on roads where a greater than 10% change in traffic flows would occur relative to their representation within the population of Birmingham (approximately 24% and approximately 19% respectively), and there are no cluster spots for accidents relating to children (see Figure 4.21). There have been a number of accidents involving older people at Stratford Road and on Digbeth (see Figure 4.21), however older people are not overrepresented as a group in terms of road traffic accident casualties on these stretches of road.

The proportion of road traffic accident casualties involving motorcycles on stretches of road within Birmingham where traffic flows are anticipated to change by more than 10% (5.2%) is in line with the proportion of journeys undertaken by motorcycle on a national basis (approximately 4.2%). In addition, there are also no clear clusters of accidents involving either riders or passengers of motorcycles which would indicate particularly hazardous locations (see Figure 4.21). Clusters of accidents involving young male drivers can be seen within the CAZ area (see Figure 4.21) however young male drivers are not overrepresented as a group in these locations which are generally at the main junctions of the A4505 ring roads where accident rates are relatively high.

There is also a strong link between social deprivation and accidents rates within the UK. When income deprivation levels are considered relative to the England and Wales distribution, approximately 53% of LSOAs within Birmingham are ranked within quintile one for income deprivation yet 63% of road traffic accidents resulting in casualties occurred within these areas. However, when income deprivation levels are considered relative to the Birmingham distribution, approximately 36% of accidents within Birmingham occur within LSOAs ranked within quintile one for income deprivation but only 27% of road traffic accidents resulting in casualties occurred within these areas. The areas with highest levels of income deprivation relative to either the England and Wales and Birmingham distributions within the CAZ, such as Digbeth, Deritend, Ladywood and Atwood Green and in the St George's Park area, would largely experience reductions in traffic flows following implementation of the CAZ (see Figure 4.20).

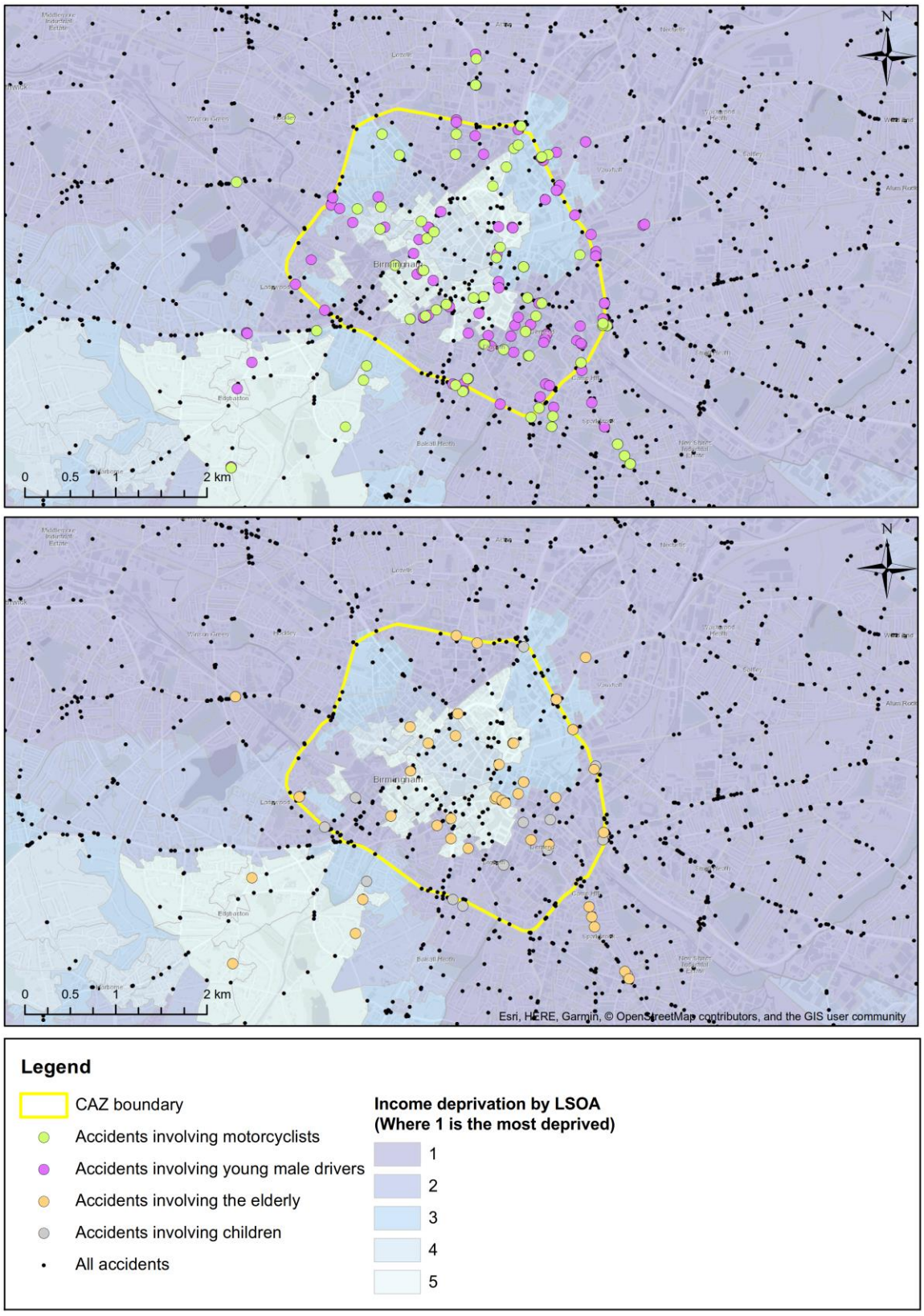


Figure 4.21 Distribution of road traffic accident casualties involving vulnerable groups

4.5 Summary of Context

The social context of the CAZ shows relatively low proportions of elderly, children and women, although there are pockets of higher concentrations associated with specific facilities. There are however high proportions of LSOAs within the CAZ with high levels of income deprivation and BAME communities. Key issues are therefore likely to relate to travel within the CAZ and the proportion of residents within the CAZ that have non-compliant vehicles who would not be able to avoid the zone.

In summary a very high proportion (99%) of businesses within the CAZ are SMEs making this type of business most likely to be affected by the proposals. In terms of traffic, LGVs make up the greatest growing portion of traffic. The mode share of journeys to work into the CAZ is dominated by car or van, with buses providing the next most popular means to get to work. Although only a small proportion of journeys to work are by taxi, analysis shows that taxis make up the most likely vehicles to undertake daily trips into the CAZ suggesting this business sector would be impacted by the proposals. The consideration of business impacts therefore focuses on SMEs, vans (LGVs), and taxis.

Assessment Conclusions and Scope of Appraisal

Analysis of the main impact areas – those areas where air quality changes or traffic flow changes would most likely occur as a result of the CAZ indicates that there are many facilities associated with vulnerable people that could be benefited by air quality changes. Therefore, this is considered further in the health impact assessment. However, the traffic flow changes are in relatively isolated locations, many of which have relatively low flows when considering the likely contribution to issues of severance, accidents and noise. Therefore, these issues are not considered further in the appraisal stage as it would not be proportionate.

5. Social and Equality Impacts

5.1 Introduction

The appraisal of distributional impacts on social groups considers how the scheme may affect accessibility, personal affordability, user benefits, severance and accidents for social groups who are identified as being either particularly vulnerable or susceptible to changes in these factors as a result of their geographical location or particular characteristics (such as age, mobility level or gender). A brief description of each of these impact variables is set out below.

- Accessibility: ease of access of public transport (buses, trains and taxis) used by local people to access their places of employment or study, services and social networks and accessibility of private or community transport used by groups unable to use conventional public transport services.
- Personal affordability: cost of travel for local people commuting to a place of work or education and undertaking journeys for social or leisure purposes via private vehicle. For this scheme, changes to personal affordability are linked to the costs associated with paying the CAZ charge for non-compliant vehicles and in operating a car (such as fuel and oil consumption, mileage related depreciation and tyre wear) that are considered critical to the decision of whether to undertake a particular journey or not.
- User benefits: experience of people commuting to a place of work or education and undertaking journeys for social or leisure purposes via private vehicle associated with journey times and the cost of operating a car as described above. In contrast to personal affordability, this impact variable considers time and money costs that affect a person's experience when travelling, but are likely not critical to the decision of whether to undertake a journey or not.

Air quality and noise are other impact variables known to have distributional impacts linked to social inequalities, and these are assessed either quantitatively or qualitatively within Chapter 7 -Health Impact Assessment.

5.2 Accessibility

5.2.1 Impacts on Disabled People

Private Vehicles

Disabled people with reduced mobility may be unable to make use of conventional public transport services or active transport modes (walking and cycling), and therefore more reliant on private cars for personal journeys than people who do not have reduced mobility. If the increased costs associated with these journeys (discussed further in section 5.3.2) are sufficient to deter disabled people with mobility problems from making these journeys then there would be a differential adverse impact on accessibility for this group.

Community Transport

Community transport is another important form of public transport for disabled people who are unable to make use of conventional public transport. The main community transport providers operating in the wider study area are Shencare Community Transport, Ring and Ride (under ATG Group) and Community Transport Birmingham. Shencare Community Transport provides door to door escorted passenger transport service for community groups, and supports many organisations within Birmingham including The Stroke Association and Midland Mencap. Community Transport Birmingham has 40 accessible and non-accessible minibuses which serves Birmingham and the surrounding areas and provide a range of services including transport to healthcare appointments, local bus services and transport for local community groups. Shencare Community Transport is a not-

for-profit organisation and Community Transport Birmingham is a charity which are partly or fully reliant on grant funding or voluntary donations. It is likely that other non-profit organisations also provide services similar to community transport.

Vehicles that are used solely for the transport of disabled people, and hence are registered as disabled passenger vehicles, are exempted from the CAZ charge. However, a proportion of community transport vehicles operating with the CAZ may not be registered as disabled passenger vehicles as they are also used to transport people who do not have a disability. The age profile of community transport vehicles is typically older than average, and hence more likely to be non-compliant. Non-profit organisations are unlikely to have the cash reserves to either pay the CAZ charge or upgrade to a compliant vehicle without increasing the cost of their services to end users and/or reducing the availability of services that they offer. This is because their vehicles tend to be older, and as services are run on a not-for-profit basis, organisations are unlikely to have the cash reserves to absorb the additional cost of compliance. There would be a disproportionate and differential adverse impact on users if there is an increase in cost to users or reduction in availability of such services as a result of the CAZ.

Taxis and Private Hire Vehicles (PHV)

A new Birmingham City Council policy proposed in 2018 would require all taxis (i.e. Hackney Carriages) and PHV registered within the area to be Ultra Low Emission Vehicles (ULEVs) by 2026, meaning that upgrading vehicles to the lowest minimum standard required for the 2020 licensing condition and CAZ compliance (Euro 4 for petrol vehicles or Euro 6 for diesel vehicles) would be an unattractive proposition for taxi and PHV drivers. The cost of upgrading to an ULEV standard Hackney Carriage taxi is significantly higher than the cost of upgrading to a Euro 4 (petrol) or Euro 6 (diesel) option, and it is anticipated that around 22% of Hackney Carriage drivers may choose to leave the taxi trade as a result of the implementation of the CAZ as those aged over 60 in 2020 may find it difficult to justify the capital expenditure required to obtain compliant taxi. It is not anticipated that the number of PHV active in the study area would decline, although fares are expected to increase in an effort to offset the costs incurred to drivers in upgrading their vehicles or paying the CAZ charge.

Taxis and PHV are an important form of transport for people unable to drive, use conventional public transport or use active travel modes due to disability. DfT data shows that in England the proportion of personal trips undertaken by taxi is on average three times higher for adults with mobility difficulties than those without (DfT, 2017a). A significant proportion of LSOAs within the CAZ and across the study area fall within the top two quintiles for disability (see Figure 4.7, Appendix B). All Hackney Carriages registered in Birmingham are wheelchair accessible, but none of the PHV are (DfT, 2017b). A reduction in the availability of taxis would therefore have a disproportionate and differential effect on disabled people.

5.2.2 Impacts on the Elderly

Private Vehicles, Community Transport, Taxis and PHV

People over the age of 65 are more likely to have a disability than any other age group. Around 42% of those aged over 65 and 75% of those aged over 80 have a disability as measured by Limitations on Activities of Daily Living which includes mobility related personal care tasks (Centre for Policy on Aging, 2016). A significant majority of those aged over 65 who have a disability acquired their impairment over the age of 50 (Disability Living Foundation). The disproportionate and differential impact on accessibility for disabled people as a result of the decreased availability and/or increased cost of travel via community transport services (noting that there are a number of community centres within the CAZ that provide services specifically for the elderly such as Birmingham Chinese Community Centre (B-CCC)) and taxis or PHVs are also relevant to older people.

5.2.3 Impacts on Children

School Transport

There are numerous primary and secondary schools located within the CAZ area as shown on Figure 5.1. Given the small size of the catchment areas within the city centre and availability of public transport modes, it is anticipated that in most cases the proportion of pupils transported to and from schools via a specific school transport minibus is low. There are three non-residential Special Educational Needs (SEN) schools (Calthorpe Academy, James Brindley School and Argent College) located within the CAZ area for which a high proportion of pupils are likely not to be able to use conventional public transport and are transported to and from school from a much wider catchment area. It is assumed that in most cases transport of SEN pupils is funded by the local authority or schools themselves and/or undertaken in vehicles registered in the disabled passenger vehicle tax class, and hence there would be no increase in cost of travel to the end user. Where this is not the case, then there would be a differential adverse impact on children attending these schools if introduction of the CAZ discourages or prevents families from supporting their attendance at the school.

Community Transport

There are also several community centres within the CAZ that have been identified as providing services used principally by children and which may require transport to and from the premises. These include St Martin's Youth Centre and community centres associated with schools in the CAZ area such as Al-Rasool School and St George's Academy (see Figure 5.1). As previously described community transport vehicles are typically older and liable to incur the CAZ charge. As community centres are typically funded either partially or fully by charitable donations, they are unlikely to have sufficient cash reserves to upgrade to a compliant vehicle. Therefore, they may have to either increase the cost or reduce the availability of their travel services as a result of the CAZ charge. This would have a differential adverse impact on children using these services.

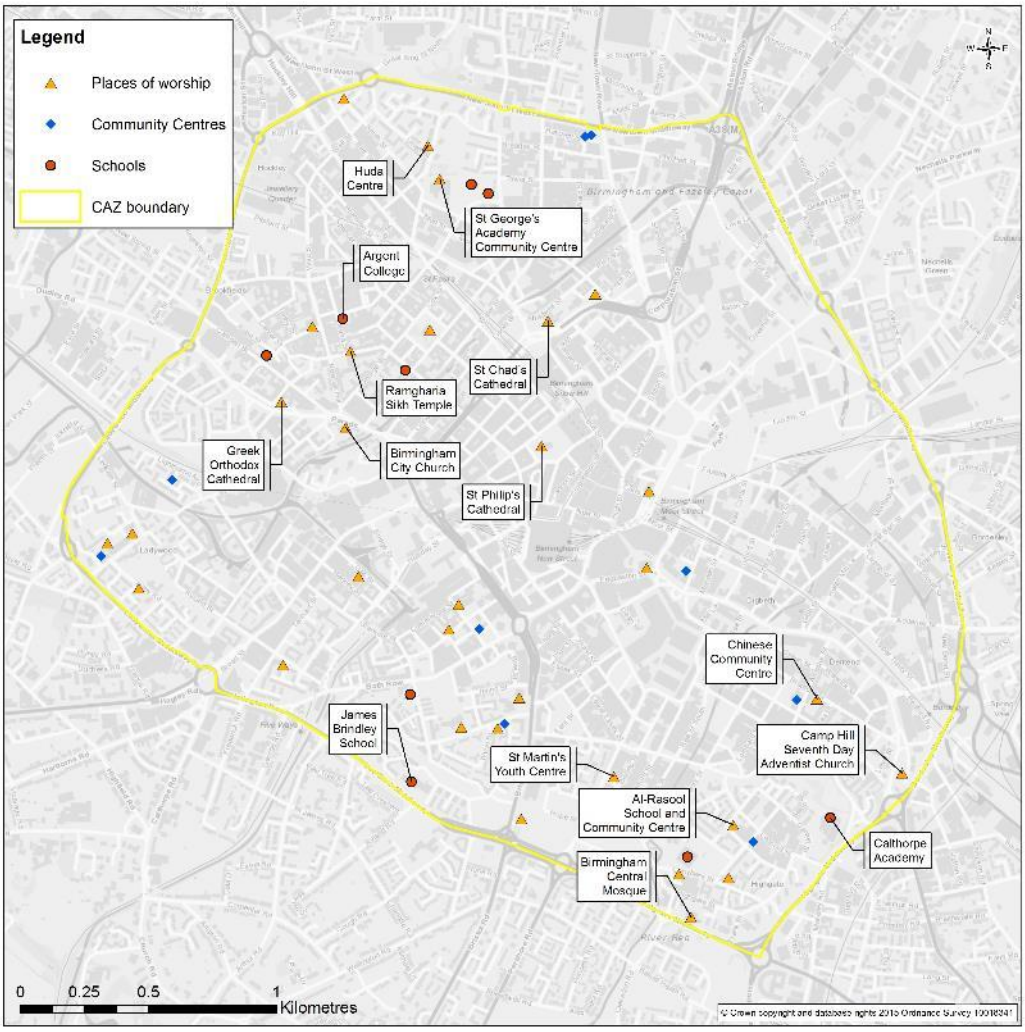


Figure 5.5.1 Places of Worship and Key Community Facilities within the CAZ

5.2.4 Impacts on Women

Private Vehicles

A study of public transport behaviour in London undertaken by Transport for London (TfL) in 2014 found that women are more concerned than men with regards to personal safety when using public transport (TfL, 2014), and a recent report by Sustrans found that fears surrounding personal safety are a key barrier to undertaking active travel journeys particularly when travelling at night (Sustrans, 2018). Whilst the majority of the CAZ and surrounding areas have relatively low proportion of women residents (see Figure 4.8, Appendix B). The increase in cost of travel by private vehicle associated with the introduction of a CAZ would therefore have a differential adverse impact on women due to their perceived negative experience of alternative travel options.

Taxis and PHVs

DfT data from 2017 shows that women are slightly more likely to use taxis and PHVs than men (Department for Transport, 2017). Whilst the LSOAs within the CAZ area and across central Birmingham largely fall within the fifth quintile for proportion of women residents (see Figure 4.8, Appendix B), indicating a relatively low proportion of women resident compared to the national (England and Wales) average distribution, it is anticipated that women travelling into the city centre

during anti-social hours for work or social purposes are likely to use taxis. Therefore, any changes in the availability of taxis and/or PHV or increases in fares would have a slightly disproportionate and differential adverse impact on women.

Table 5.1 Accessibility Appraisal Matrix

Social group	Appraisal	Comment
Disabled people	✖✖✖	Disproportionate and differential adverse impact on disabled people who are both more reliant on taxis, PHV and community transport services for their accessibility needs, and are less likely to be able to make use of active travel modes in preference to motorised transport.
Older people	✖✖	As described above against disabled people.
Children	✖✖	Differential impact on pupils who are unable to make use of public transport, and for whom transport is not funded by the Local Authority or school, if the increased cost of travel by car prevents or limits access to appropriate schooling.
Women	✖✖	Disproportionate and differential impact on women, who as a group are more frequent users of taxis and PHV and have a more negative perception or experience of alternative modes of public transport and active travel modes (walking and cycling).

5.3 Personal Affordability

5.3.1 Impacts on Low Income Households

Private Travel and Car Parking Charges

Quantitative analysis of the distribution of costs shows that whilst the proportion of costs incurred by LSOAs in each income deprivation quintile (based on England and Wales distribution) is in line with the proportion of the study area resident within each quintile (see Table 5.2 – full appraisal tables provided in Appendix A). However, when income deprivation is considered relative to the distribution within the study area then those LSOAs which are most deprived quintile (quintile one) would incur a disproportionately greater amount of the costs than more affluent quintiles, and vice versa for the LSOAs within the most affluent quintile.

Table 5.2 Personal Affordability - Distributional Impacts on Low Income Households

Income deprivation	Quintile					Comment
	1	2	3	4	5	
Relative to England and Wales distribution	✘✘	✘✘	✘✘	✘✘	✘✘	Costs would be evenly distributed across LSOAs from different income deprivation quintiles.
Relative to Birmingham distribution	✘✘✘	✘✘	✘✘	✘✘	✘	LSOAs within the most deprived quintile would bear a disproportionately greater amount of the costs that would be expected given the proportion of the population of the study area that are resident within this quintile, and vice versa for the least deprived quintile.

The preferred CAZ option would also have a disproportionate and differential adverse impact on residents of the CAZ and surrounding areas as due to the geographical nature of the scheme they have more limited ability to avoid entering and exiting the charging zone than residents of the wider Birmingham area and more limited ability to avoid paying parking charges.

In addition, it is notable that many of the areas within and adjacent to the CAZ that would incur the highest costs if the preferred CAZ option were implemented are also areas with high levels of income deprivation. As shown by Figure 5.2, areas which would incur the highest proportion of the costs (CAZ charges and vehicle operating costs) under the preferred CAZ option (dark blue areas) coincide with areas of high income deprivation relative to Birmingham (areas with light green hatching) and England and Wales (red hatching) distribution. This includes residents of the eastern areas of the CAZ and areas immediately to the north (within Nechells, Aston, Perry Barr and Tyburn), west (within Soho) and southeast (within Sparkbrook) of the CAZ. These areas are characterised by relatively high levels of income deprivation and low proportions of cars registered within the area that are currently compliant with CAZ standards (Euro 4 for petrol vehicles or Euro 6 for diesel vehicles) (see Figure 5.3, Appendix B), hence residents of these areas are both more vulnerable to cost increases and less likely or able to avoid incurring the CAZ charge.

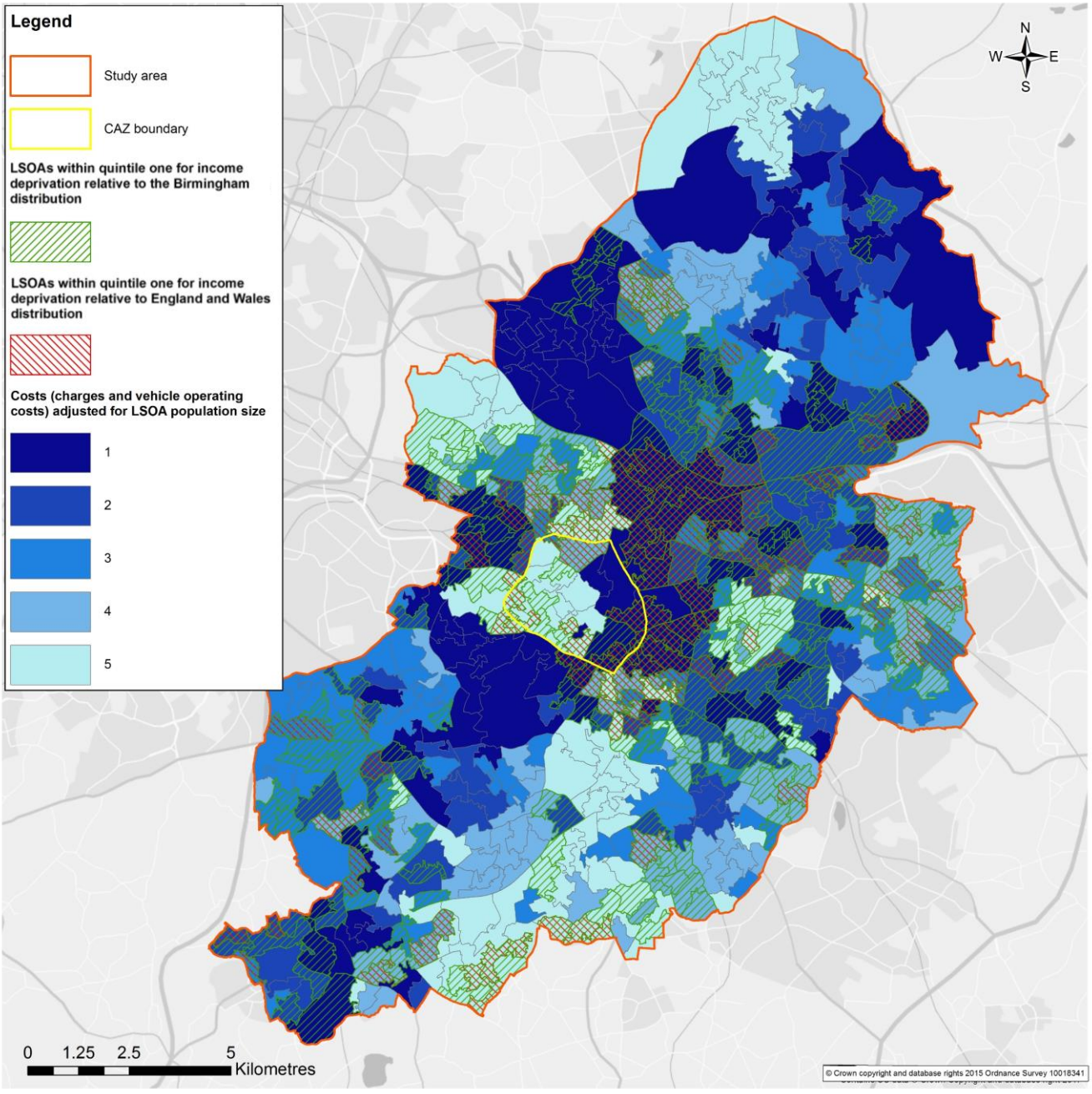


Figure 5.2 Distribution of Costs Associated with Implementation of Preferred CAZ Option Relative to Areas of Highest Income Deprivation

5.3.2 Impacts on Disabled People

Private Travel

Evidence form the London ULEZ project has been used to identify potential impacts on disabled drivers within Birmingham, on the assumption that some of the issues would be similar for both cities.

In 2011, the average age of a blue badge registered petrol vehicle entering the London Congestion Charge Zone was eight years (TfL CCZ data, 2011). Assuming the age profile of vehicles is the same

in 2020, approximately 16% of all petrol blue badge registered vehicles could be non-compliant when the CAZ comes into operation.

In 2011, the average age of a blue badge diesel vehicle was five years (TfL CCZ data, 2011). Assuming the age profile of vehicles is the same in 2020, approximately 45% of all diesel blue badge registered vehicles could be non-compliant, which is higher than the level of non-compliance across all vehicles.

The cost of replacing or retrofitting the vehicle for these people is less likely to be affordable on the basis that a person with disability is more likely to be on a low income (DwP, 2017) and that in general disabled people have higher living costs (Scope, 2018)

A proportion of blue badge holders will require vehicles adapted for wheelchair use. It is expected that the absolute number of non-compliant adapted vehicles would be lower than in the population as a whole, as the majority of wheelchair users rely on vehicles supplied through the motability scheme through which they receive VAT relief on substantially and permanently adapted vehicles. Motability leased vehicles are generally no more than three or four years old so the majority would be CAZ compliant (HMRC, 2014), however some wheelchair adapted vehicles (WAVs) can be leased for up to 7 years.

It is assumed that blue badge holders would be exempt from parking charges within the Birmingham City Council controlled on street parking that would become charged for as part of the CAZ additional measures.

5.3.3 Impacts on Children

Private Travel and Car Parking Charges

Birmingham Children's Hospital is located within the north east of the CAZ area, and provides specialist paediatric care for around 90,000 patients per year. The site is well served by public transport, and patients and visitors unable to use public transport can park either within a designated pay for offsite car park on Printing House Street or in nearby public pay for car parks. Guardians of long-stay patients (more than 30 days) can obtain free car parking permits for the designated off-site car park when available. The proposed CAZ charge under the CAZ D High scenario (£12.50 for cars) would therefore significantly increase the costs to guardians of patients unable to use public transport to access the hospital. There would be a differential impact on children as a social group if the cost of the CAZ charge were a deterrent to families accessing care, or to guardians visiting patients, at this specialist facility.

5.3.4 Impacts on People with Religious Beliefs

Private Travel and Car Parking Charges

Whilst there are numerous places of worship located within the CAZ area (see Figure 5.1), most are of a size that suggests their catchment is highly localised. However, Birmingham Central Mosque is an exception with a capacity of 20,000 and regularly attracts more than 4,000 worshippers for Friday services, suggesting that it attracts a significant number of visits from outside the CAZ area on a regular basis. Other places of worship with a significantly larger than average capacity (greater than 500 spaces) within the CAZ area include Camp Hill Seventh Day Adventist Church, Birmingham City Church and Singer's Hill Synagogue. St Phillip's Cathedral, Ramgharia Gudwara, St Chad's Roman Catholic Cathedral and Greek Orthodox Cathedral of the Dormition of Theotokos and St. Andreas may also draw congregants from the wider Birmingham area due to their more unique status within the local area. There may be a differential impact on religious groups if the introduction of the CAZ discourages or prevents congregants from attending their worship venue of choice.

Table 5.3 Personal Affordability – Distributional Impacts on Social Groups Defined by their Location or Specific Needs

Social group	Appraisal	Comment
Residents of the CAZ	✖✖	Differential adverse impact on residents of the CAZ who due to their location have more limited ability to avoid entering and exiting the CAZ, and therefore incurring the CAZ charge and parking charges.
Residents of Nechells, Aston, Perry Barr, Tyburn, Soho and Sparkbrook	✖✖✖	Differential adverse impact of residents of these LSOAs within these areas within or in close proximity to the CAZ who demonstrate greatest levels of desire to travel in and out of the CAZ area, but also have least ability to avoid incurring the CAZ charge or to absorb the additional costs.
Disabled people	✖✖✖	Differential adverse impact on disabled people who require wheelchair adapted vehicles and are not part of the motability scheme, as such vehicle are significantly more expensive than average cars.
Families with children who are patients at Birmingham Children's Hospital	✖✖	The CAZ charge could deter guardians of patients of this specialist medical facility, for which alternative comparable options are highly limited, from accessing care for their child or visiting patients.
Congregants of large places of worship within the CAZ	✖✖	The CAZ charge may dissuade or prevent congregants of those places of worship within the CAZ area whose congregation is drawn from the wider Birmingham area from attending their venue of choice.

5.4 User Benefits

5.4.1 Impacts on Low Income Households

There would be a beneficial impact on user benefits for all LSOAs within the study, relating to improvements in journey time and reduced fuel consumption and wear and tear on vehicles due to reduced traffic congestion (see Table 5.4 – full appraisal table provided in Appendix B). When income deprivation is considered relative to the study area distribution, LSOAs within the least deprived quintile (five) would receive a disproportionately greater amount of the total benefit than might be expected given the proportion of the study area population resident in these areas and LSOAs within the second most deprived quintile (two) would receive disproportionately less. When income distribution within the study area is considered relative to the national (England and Wales) distribution LSOAs falling within the most deprived (one) and least deprived (five) quintiles receive a disproportionately greater amount of the user benefits relative to the proportion of the population of the study areas resident in those areas, and those within quintile two and three would receive a disproportionately smaller amount.

Table 5.4 Summary of User Benefits Appraisal

Income deprivation	Quintile					Comment
	1	2	3	4	5	
Relative to England and	✓✓	✓	✓✓	✓✓	✓✓✓	Whilst all quintiles would experience a net benefit, LSOAs within quintile five would experience a disproportionately

Income deprivation	Quintile					Comment
	1	2	3	4	5	
Wales distribution						greater amount of the total benefit that would be anticipated given the proportion of the study area resident in that in quintile and residents of quintile two would receive disproportionately less.
Relative to Birmingham distribution	✔✔✔	✔✔	✔	✔	✔✔✔	Whilst all quintiles would experience a net benefit, LSOAs the most and least deprived quintiles would receive disproportionately greater amount of the total benefit that would be anticipated given the proportion of the study area resident in those quintiles and residents of quintiles two and three would receive disproportionately less.

5.5 Impacts for the West Midlands

5.5.1 Income Deprivation and Travel to Work Areas in the West Midlands

The implications for the metropolitan boroughs that make up the West Midlands (City of Birmingham, City of Coventry, City of Wolverhampton, Dudley, Sandwell, Solihull and Walsall) have been considered based on Travel to Work Areas (TTWA). TTWAs are derived from National Census data and approximate self-contained labour markets (i.e. areas where people both work and live), and relatively low numbers of commuters cross a TTWA boundary when travelling to work. There are four main TTWAs within the West Midlands, named Birmingham, Wolverhampton and Walsall, Dudley and Coventry (see Figure 5.4, Appendix B).

The Birmingham TTWA includes areas of neighbouring local authorities, notably Bromsgrove, North Warwickshire, Lichfield, Tamworth and Redditch, and envelops the settlements of Tamworth, Fazeley, Solihull, Bromsgrove and Redditch (see Figure 5.5). The central area of the Birmingham TTWA, which largely corresponds to Birmingham City Council's administrative area, is comprised of areas with high levels of income deprivation (quintiles one and two) relative to the England and Wales distribution (see Figure 5.5, Appendix B). There are also smaller pockets of more income deprived areas to the far west (Great Barr and Sandwell areas, within Sandwell Metropolitan Borough), north (Tamworth and Fazeley) and south (Bromsgrove and Redditch) of the Birmingham TTWA. Income is strongly related to travel behaviour. People with low incomes tend to travel much shorter distances than those with high incomes. This is indicated by the National Travel Survey (Department for Transport, 2017) where the data for England show that distance travelled increases for each income quintile, such that the lowest income quintile travels the least distance to work, whilst the highest income quintile has the greatest distance travelled to work. The impact of the CAZ therefore would generally be felt less among income deprived with distance from central Birmingham since relatively few income deprived people in areas such as Redditch and Tamworth would be travelling into the CAZ. The south-eastern portion of Sandwell, which is in the Birmingham TTWA and contains a number of income deprived communities, is likely to be the most affected by and increased costs associated with the CAZ due to its relatively close proximity to the CAZ boundary (within 3 km).

5.5.2 Income Deprivation and Car Commuting Patterns within the West Midlands

TTWAs for specific modes of transport can vary in spatial extent from the main TTWAs discussed above. The TTWAs for commuters travelling by car (either as a driver or passenger) are generally slightly smaller in size than the main TTWAs. The Birmingham car user TTWA extends further north and east along the M6 corridor than the main TTWA to incorporate Litchfield and Walsall (see Figure 5.6, Appendix B). It also extends further east to include more of the Solihull borough adjacent to the M42. Areas with relatively high levels of income deprivation within the Birmingham car user TTWA are as described above for the main TTWA, with the addition of sizeable areas within and surrounding Walsall, Rugeley and Cannock. These areas identified as having high levels of income deprivation are also among those with highest numbers of cars that would not be compliant with the CAZ requirements (see Figure 5.7, Appendix B).

Figure 5.8 (below) shows the total number of people who commute into the proposed CAZ on a regular basis from each of the local authority administrative areas which fall within the West Midlands region and the proportion of the total working community that these people represent. Those areas with highest levels of commuters that would be affected by the CAZ, other than Birmingham, are Solihull and Sandwell. Approximately 4,500 people regularly commute from Solihull to the CAZ area and approximately 5,000 from Sandwell, representing 5 and 6% of the employed population respectively. In addition, a relatively low number but high proportion (approximately 5%) of the working population within Bromsgrove regularly commute into the proposed CAZ by car. Of these three locations, only Sandwell includes areas with relatively high levels (quintile one or two) of income deprivation. In contrast, whilst areas with high levels of income deprivation within Walsall, Redditch, Tamsworth, Lichfield, and Cannock Chase local authority areas are within the Birmingham car user TTWA, the absolute number of people who commute by car and proportion of employed people who travel into the CAZ for work from these areas is relatively low (around 3,000 or 3% or less, see Figure 5.8).

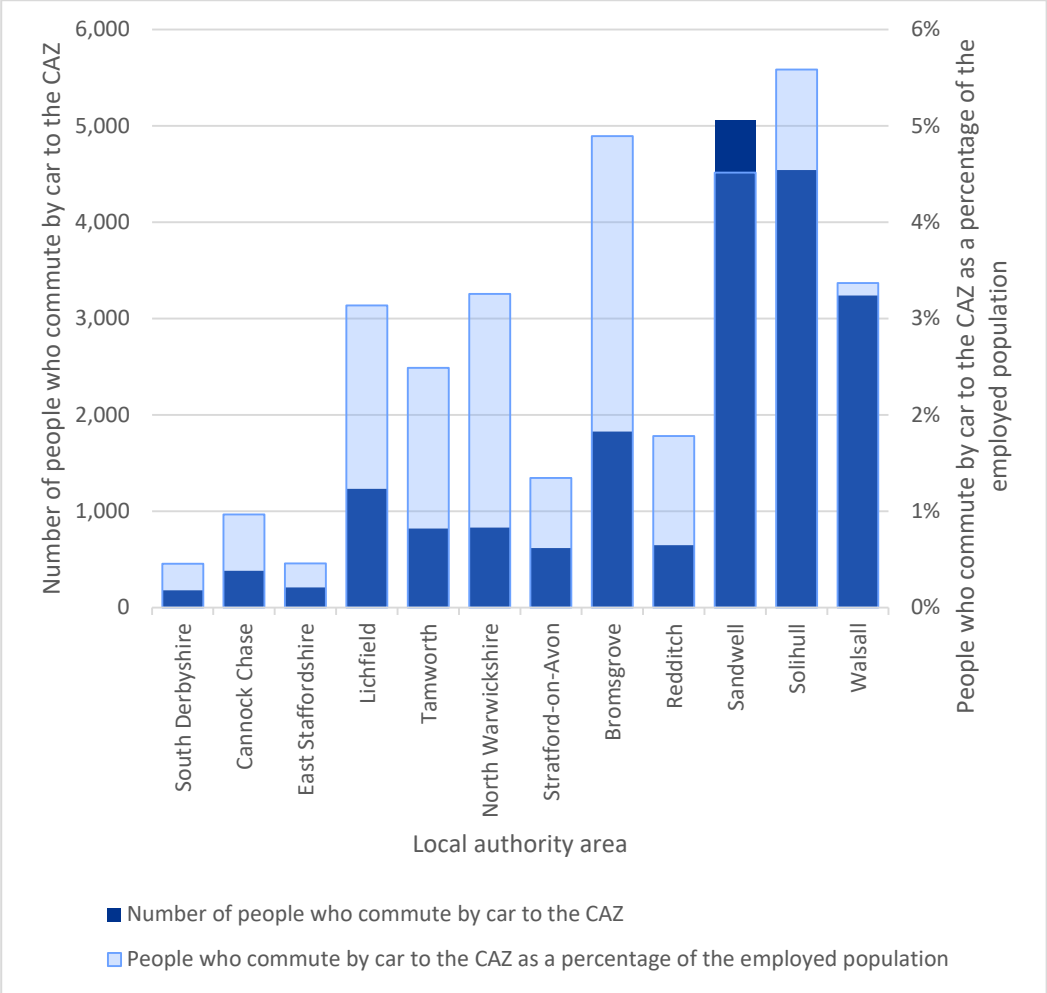


Figure 5.8 Trends in car commuting patterns into the CAZ from the wider West Midlands region

5.5.3 Conclusions for West Midlands

Analysis of commuting patterns and modes within the West Midland regions has identified that those areas within Sandwell which fall within the Birmingham car user TTWA have relatively high levels of income deprivation and that Sandwell has a relatively high proportion of the employed population currently commutes into Birmingham by car. Since this area also has a higher proportion of non-CAZ compliant cars registered, it is likely that this population would be most affected by the CAZ fees compared with other areas of the West Midlands.

There appears to be good access to the existing bus from this area, however there is no easy access to Birmingham city centre by rail. In addition, accessibility to the city centre for people who work unsociable hours may be limited by existing timetables, and cost may also be an issue.

5.6 Summary of Impacts on Social Groups

Low income households (particularly those resident within the CAZ and adjacent areas)

Low income households across Birmingham would bear a disproportionate amount of the increased costs associated with car travel for personal journeys. Those located within the CAZ and in close proximity to the CAZ (such as Nechells, Aston, Perry Barr, Tyburn, Soho and Sparkbrook) would be particularly affected as due to their geographical location they would be least able to avoid entering

and exiting the CAZ for everyday journeys. However, it is notable that low income households across Birmingham are also among those who would benefit most from in terms of reduced journey times and reduced petrol consumption (and vehicle maintenance costs due to reduced congestion around the city centre (termed user benefits).

Disabled people

Disabled people would be adversely affected by implementation of the CAZ through the potential reduction in availability of community transport and wheelchair adapted taxis, and also the potential increase in cost of community transport. As a group disabled people have a reduced range of transport modes available to them as they may not be able to use conventional public transport or active travel modes (walking and cycling), and so they are particularly vulnerable to reduction in availability of the previously mentioned services. They also have lower average household income, making them also particularly vulnerable to increases in the costs of the previously mentioned services.

Elderly people (aged over 65)

Impacts on older people would be largely as described above for disabled people due to the high proportion of older people who limited mobility and/or are on lower incomes.

Women

Women are more reliant on the use of taxis and PHV than other groups, and also have a more negative perception other transport options (such as buses and walking or cycling) due to safety concerns. Hence, there would an adverse impact on women as a group due to the increased cost of car travel and of PHVs and the decreased availability of taxis.

Children

Children would be adversely affected by any reduction in the availability of community transport servicing schools and community centres within the CAZ. They would also be adversely affected by the increased cost of community transport if this prevented them accessing schools and community centres within the CAZ, or if it prevented families of patients at Birmingham Children's Hospital from visiting them during their stay.

People with Religious Beliefs

Congregants of those larger or more unique places of worship within the CAZ (e.g. Birmingham Central Mosque, Camp Hill Seventh Day Adventist Church, Birmingham City Church and Singer's Hill Synagogue. St Phillip's Cathedral, Ramgharia Gudwara, St Chad's Roman Catholic Cathedral and Greek Orthodox Cathedral of the Dormition of Theotokos and St. Andreas) would be adversely affected if the increased cost of car travel dissuades them for attending their place of worship.

6. Business Impacts

6.1 Introduction

This chapter presents the predicted impacts of the CAZ D 'High' plus Additional Measures (the 'preferred CAZ option') on various types of businesses that depend on transport. It also includes a discussion of the types of impacts that may be felt by SMEs generally, since all businesses depend on transport to some extent.

6.2 Impacts on Business Affordability

6.2.1 Impacts on SMEs

The appraisal tables setting out the results of the distributional impact analysis that was undertaken following the principles of the JAQU Guidance for Options Appraisal are set out in Appendix A.2. However, there is a lack of confidence in the results, due to the limitations outlined in section 2.6, so has been discounted from the final appraisal.

Businesses within the CAZ have more limited ability to avoid entering or exiting the CAZ compared to businesses in the wider study area. Consultation response data suggests that a relatively high proportion (45%) of businesses located within or in close proximity to the CAZ transport people or goods in or through the CAZ on a regular (more than 10 times per week) basis, which is slightly higher than the proportion of businesses over Birmingham as a whole who do so (38%). Similarly, a slightly higher proportion of businesses located within or in close proximity to the CAZ stated that they supply goods and services to customers or services within the CAZ (62%) or received deliveries of collections to their organisation within the CAZ (67%) on a regular basis (more than 10 times per week) than for Birmingham as a whole (58 and 59% respectively). There are also a relatively high number of micro, small and medium enterprises within the CAZ, and consultation response data suggests that micro businesses are both more likely to travel or supply goods within the CAZ than small, medium or large businesses and less likely to own or lease compliant vehicles.

It is not possible to identify how impacts on supplier businesses outside the CAZ would be spatially distributed from the datacurrently available. ANPR data shows that both HGV and LGV entries into the CAZ are relatively infrequent with over half entering the zone just once a week and only 6% of HGVs and 9% of LGVs entering the CAZ five times a week or more, and behavioural response data suggests a significant percentage of these (around 30%) would change route to avoid the CAZ zone if a charge were introduced. In relation to the size of Birmingham's economy overall (around £25 billion a year) the general impact of the proposed scheme on business is around -£180m, but there would be a disproportionate and differential moderate adverse impact on the small number of SMEs based in the CAZ that operate their own vehicles and for SMEs in surrounding areas that frequently enter the CAZ.

6.2.2 Impacts on Commercial Van Owners

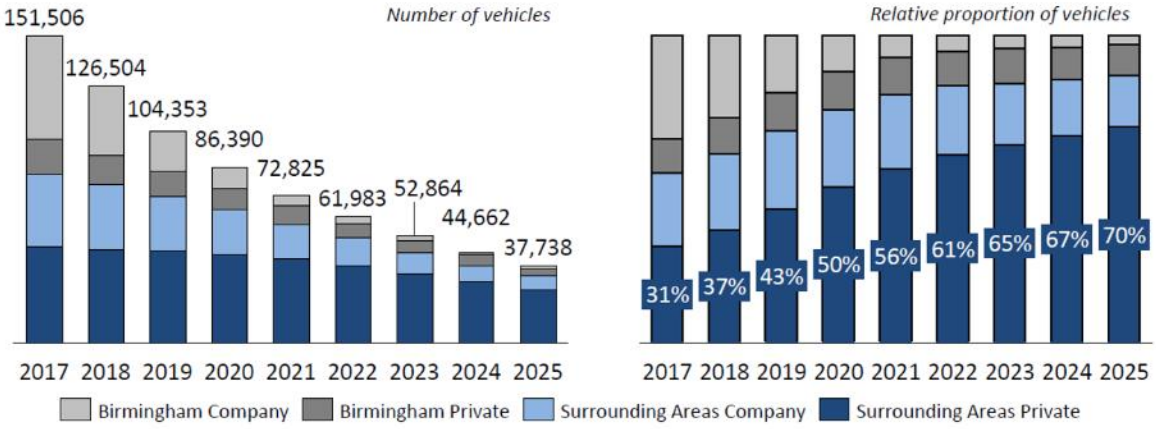
Consultation data suggests that diesel vans are the most common type of vehicle owned or leased by businesses within Birmingham. Fleet analysis shows that 68,336 of vans (58%) within Birmingham are currently not CAZ compliant. When the wider, West Midlands study area is taken into account, the figure is 79,500 vans (83%) which are currently not compliant. The average vehicle age within Birmingham is just over 4 years suggesting that over 80% of vans registered within Birmingham would be compliant by 2020[10]. For the wider area, the percentage expected to be compliant by 2020 drops to approximately 40% and that there is approximately a five-year time lag for fleets reaching compliance,

[10] It should be noted that not all vans registered within Birmingham will be operated within Birmingham. 52,000 vans were registered within one postcode in Birmingham, suggesting they are registered to a company headquarters and are operated nationally.

compared with Birmingham. However, although having a lower rate of compliance, it is anticipated that the impact overall would be less as many of these businesses would not need to enter the CAZ on a regular basis. ANPR data shows that LGV entries into the CAZ are relatively infrequent with over half entering the zone just once a week and only 9% of LGVs entering the CAZ five times a week or more. Behavioural response data suggests a significant percentage of these (around 30%) would change route to avoid the CAZ zone if a charge were introduced.

As can be seen from Figure 6.1, the rate of fleet turnover is much higher for company owned vehicles compared with privately owned vehicles. The impact of CAZ charges will therefore be disproportionately higher on businesses whose vehicles are employee owned or self-employed van owners.

Figure 6.1: Breakdown of non-CAZ Compliant Vans by Consumer Type for Birmingham and Surrounding Areas*



Source: Element Energy, 2018.

**Note this assumes that CAZ compliant vehicles are Euro 6 vehicles only. Euro 4 petrol vehicles are also CAZ compliant but these vehicles were not separately analysed as they only represent 2% of the 2017 stock.*

Element Energy undertook a total cost of ownership (TCO) analysis of the potential behavioural responses businesses may take to the CAZ. The responses and TCO depend on the category of van that the businesses use (i.e. small (car derived), medium or large). The analysis was based on the three options currently open to owners of non-CAZ compliant vans[11]:

Table 6.1 Options for Non-CAZ Compliant Van Owners

Option	Practical Decision Factors	Purchase Options
Continue to operate the vehicle and pay the CAZ charges.	The impact of this will depend on the frequency with which the van would need to enter the CAZ.	N/A
Purchase a CAZ compliant Euro 6 diesel vehicle or Euro 4 – 6 petrol vehicle	Available in all van types with a range of finance options available.	• Buy or lease • New or second hand
Purchase an electric van	Despite lower running costs there are several barriers:	• Buy or lease • Lack of second hand market

[11] There are currently no accredited retrofit technologies for vans. However, Wales has set a precedent in its Clean Air Framework to exempt LPG vehicles. Should an exemption for LPG conversions be made in England, this would offer a fourth option for van owners.

Option	Practical Decision Factors	Purchase Options

	• Low availability in each type of van category
	• High upfront cost
	• Charging infrastructure, which requires either:
	  ○ Installing depot charging facilities
	  ○ Access to overnight charging
	  ○ A public rapid charging network
		means vehicle will likely have to be purchased new

The analysis showed that purchasing a second-hand CAZ compliant van was cheaper than paying the CAZ charge for vehicles who travelled into the CAZ zone five or more times a week. The payback period for small and medium van diesel models was less than three years. For larger vans, with a higher purchase price, the payback period was longer (over three years). For all sizes of van, the economically best option would be to purchase a second-hand electric vehicle as these have lower overall running costs. However, the second-hand market is very limited for these types of vehicle.

The above analysis has identified that the majority of vans registered within Birmingham would be compliant and therefore not affected by the CAZ. The greatest impact is likely to be on employee owned vans where the rate of fleet turnover is typically slower, meaning they will account for a higher proportion of non-compliant vehicles in 2020. The impact of the CAZ will depend on the frequency of journeys a van owner will need to make into the CAZ. Although there is a higher rate of non-compliant vehicles in the authorities surrounding Birmingham, ANPR data indicates that a relatively small proportion of vehicles entering the CAZ do so five or more times per week. A significant percentage of these are likely to be able to re-route to avoid the CAZ.

6.2.3 Impacts on Taxis and Private Hire Vehicles

Birmingham City Council approved changes to taxi licensing arrangements in October 017. The proposed standards for taxis and private hire vehicles (PHV) are set out in Table 6.2, note these are the current proposals for future licencing conditions and they are subject to revision.

Table 6.2 New Taxi and PHV Licensing Requirements and Standards

Application	Existing Policy	From 2020	From 2021	From 2026	From 2030
New and replacement vehicles	There is a max. age of: • 14 years for taxis • 8 years for PHV Basic MOT emissions requirements are applicable to all vehicles.	Taxis: Euro 6 or ULEV PHV: Euro 6 (diesel) Euro 4 (petrol) or ULEV	All vehicles must be ULEVs	All vehicles must be ULEVs	All vehicles must be zero emission
Existing vehicles	No age limit for taxis or PHVs provided the exceptional condition test is passed. Basic MOT emissions requirements are applicable to all vehicles.	Euro 6 (diesel) Euro 4 (petrol) or ULEV	No taxis older than 14 years; No PHVs older than 8 years; Euro 6 (diesel),	All vehicles must be ULEVs	All vehicles must be zero emission

Application	Existing Policy	From 2020	From 2021	From 2026	From 2030
			Euro 5 (petrol) or ULEVs		

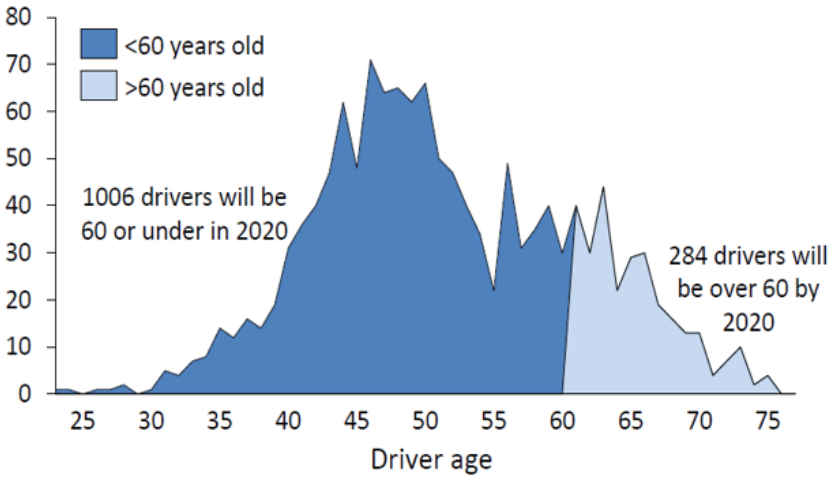
The above changes to taxi and PHV licensing conditions have been proposed to support the implementation of the CAZ. However, analysis undertaken by Element Energy (June 2018) has identified a number of implications of these licensing standards that put significant pressure on taxi operators.

Currently there are only seven Euro 6 vehicles in Birmingham's taxi fleet. A further 64 vehicles have been retrofitted as LPG vehicles[12]. Since LPG conversion is currently only an option for vehicles under 14 years old which are TX diesel models, only a further 69 vehicles are eligible for a conversion to LPG by 2020. On this basis, only 140 vehicles in Birmingham's current fleet would meet CAZ compliance (assuming the 69 further vehicles are converted to LPG). Birmingham City Council has conducted engagement sessions with the Hackney Carriage driver community, a popular option that many drivers are considering is to purchase a Euro 4 taxi and then retrofit the vehicle to make it compliant. This means, under the current licensing conditions, that 1,140 taxis (90% of the current fleet) would need to be replaced by 2020.

The options that taxi drivers with non-CAZ compliant vehicles have, are limited. Any Euro 6 vehicle purchased in 2020 would, under current proposals, only be able to be used for a maximum of six years due to the 2026 licensing condition that all vehicles must be ULEVs. However, there is limited availability of ULEV taxis currently on the market and they come at a high cost (in excess of £40,000 after an OLEV grant).

Analysis of the average age of Birmingham's licensed taxi drivers has identified that 284 would be aged over 60 by 2020 (see Figure 6.2).

[12] These were retrofitted with LPG engines with funding through the Clean Vehicle Technology fund from the Office for Low Emission Vehicles (OLEV), part of the Government's Department for Transport (DfT). This initiative was the NOx Reduction Champions Project – a partnership between Birmingham City Council, Autogas Ltd, Harborne Garage in Selly Oak, Element Energy and Vehicle Repowering Solutions (VRS).



HC fleet as of May 2018

Average	51 years
Median	50 years

Source: Element Energy, 2018.

Figure 6.2 Forecast of Birmingham's Taxi Drivers by Age in 2020

It is likely that many older drivers would choose to retire because they may feel that they would not be able to operate the new vehicle long enough to justify the upfront costs. Assuming most drivers will retire before the age of 70 and that they would want to use a vehicle for at least 10 years, it is estimated by Element Energy that over 250 drivers may choose to retire as a result of these measures. This will depend on the age of vehicles owned by these older drivers. As well as implications for the taxi business community, the potential loss of a sizeable portion of the taxi fleet has implications for some social groups, particularly disabled people, for whom there may be limited alternative transport available (refer to section 5.2.1).

For PHV drivers, the range of ULEVs available is greater than for taxi, and there are more models available at much lower upfront purchase costs. Whilst the 2026 licensing condition would cause a differential adverse impact on both taxi and PHV businesses (as ULEVs have higher upfront costs than Euro 6 diesel or Euro 4 petrol vehicles), the impact would be disproportionately more adverse for taxi drivers.

This distributional analysis has identified further, indirect impacts arising from the impacts on the taxi businesses. Analysis of the postcodes where taxis are registered reveals that approximately 88% of taxi drivers and 82% of PHV drivers are from areas with the highest proportion of BAME residents (Figures 4.9 and 4.10, Appendix B). Information from Birmingham City Council based on analysis of taxi licensing data showed that 90% of taxi drivers identified themselves as from BAME groups. There is also a strong prevalence of taxi drivers coming from the most income deprived LSOAs compared to the England and Wales average (Figures 4.1 and 4.2, Appendix B). Adverse impacts on taxi drivers will therefore disproportionately affect BAME people and their communities, as well as some of the most income deprived communities in England and Wales.

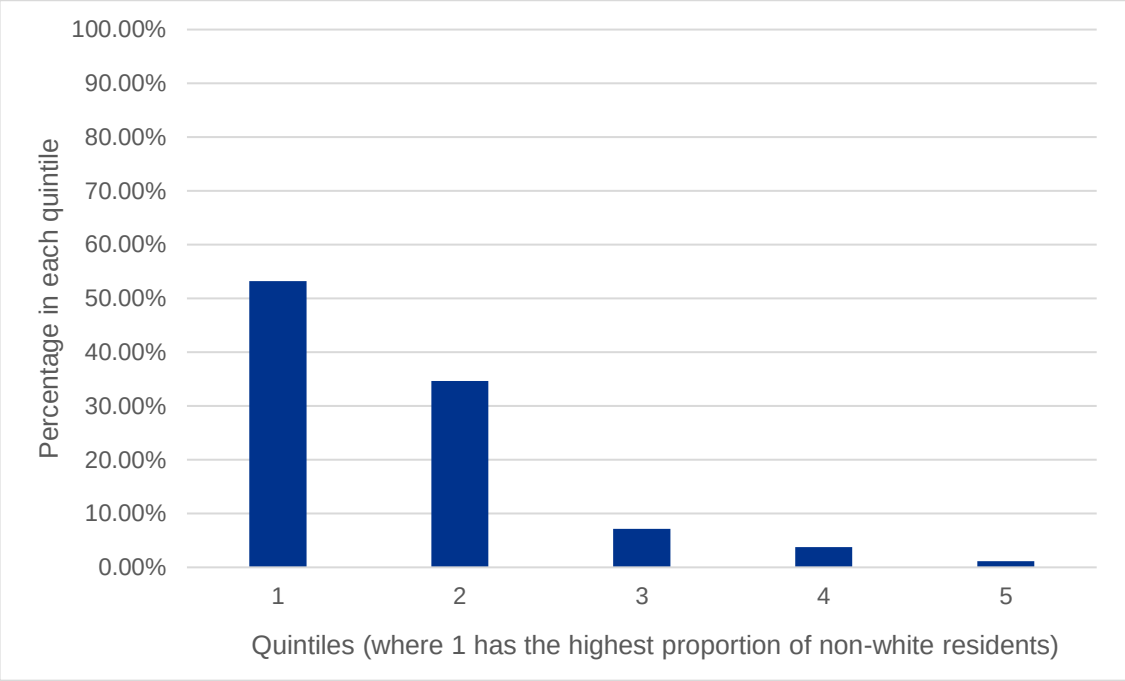


Figure 6.3: Share of Taxis Registered within each Quintile of BAME Community in Birmingham

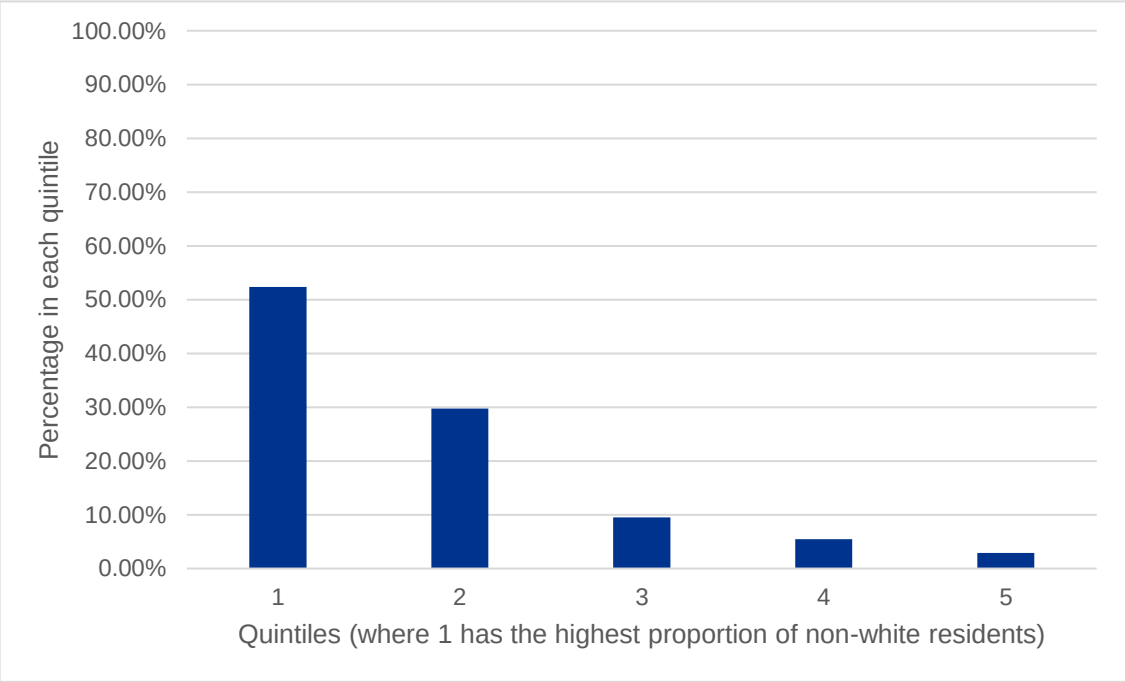


Figure 6.4: Share of Private Hire Vehicles Registered within each Quintile of BAME Community in Birmingham

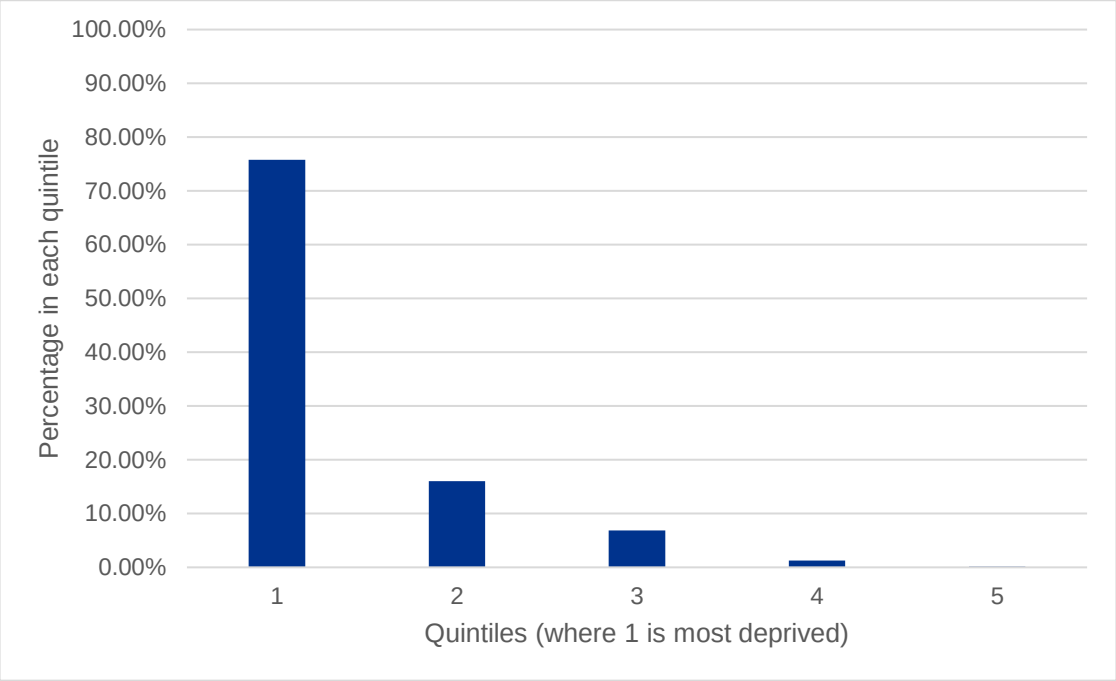


Figure 6.5: Share of Taxis Registered within each Quintile Deprivation in Birmingham Compared to the England and Wales Average

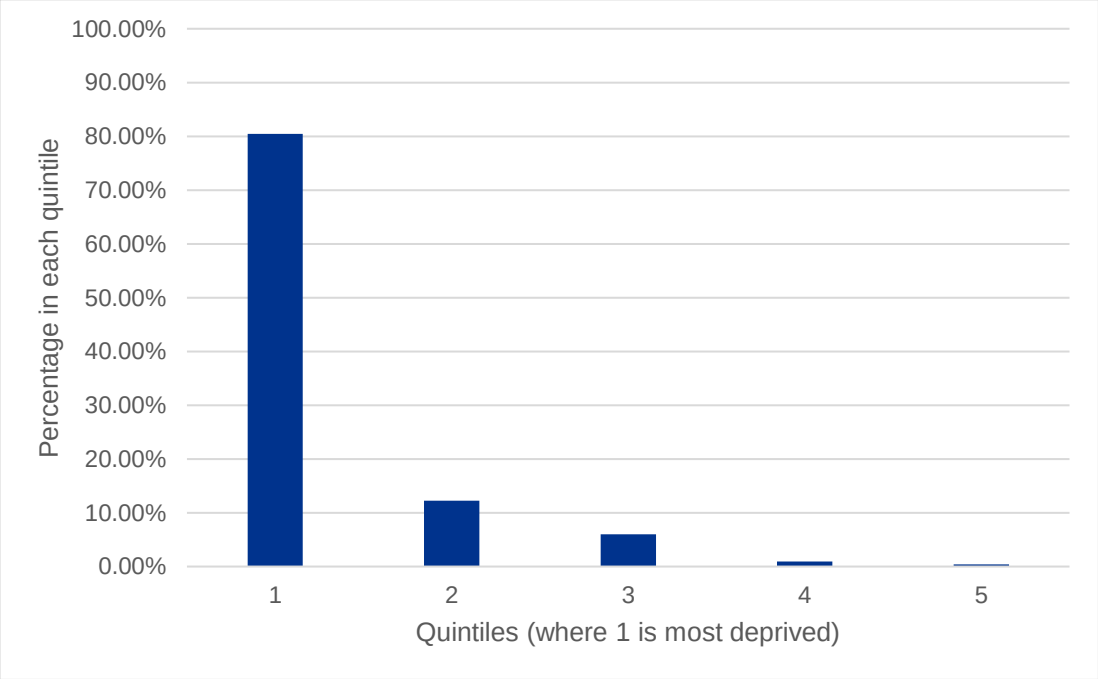


Figure 6.6: Share of Private Hire Vehicles Registered within each Quintile Deprivation in Birmingham Compared to the England and Wales Average

6.2.4 Impacts on HGVs

Fleet analysis of DfT HGV registration data by Element Energy (June 2018) has shown there are approximately 4,100 HGVs registered within Birmingham. HGVs in the over 18 tonne weight

categories (which comprise 47% of the UK HGV fleet), are typically involved in regional distribution and long haul activities and therefore will operate independently of where they are registered. It is therefore the local and urban delivery vehicles registered in Birmingham which are likely to also operate within Birmingham and therefore be susceptible to the effect of the CAZ.

The natural turnover of vehicles in the HGV fleet means that 59% of HGVs within Birmingham are expected to be CAZ compliant by 2020 (before any behavioural responses to the CAZ are considered).

However, by comparing government vehicle operator licensing statistics to the DfT data there is a large discrepancy and it is generally accepted that the DfT licencing statistics are not a fair reflection on the actual volumes of HGVs. The spatial distribution of HGV fleet depots across the West Midlands shows clusters of depots in Coventry and Wolverhampton to the west of Birmingham, and a further cluster in Birmingham City Centre (Figure 6.7). ANPR data suggests that only 6% of HGVs enter the CAZ five or more times a week, however, it is likely that those fleets based within Birmingham are among those most affected by the CAZ as they would be unable to route around the CAZ.

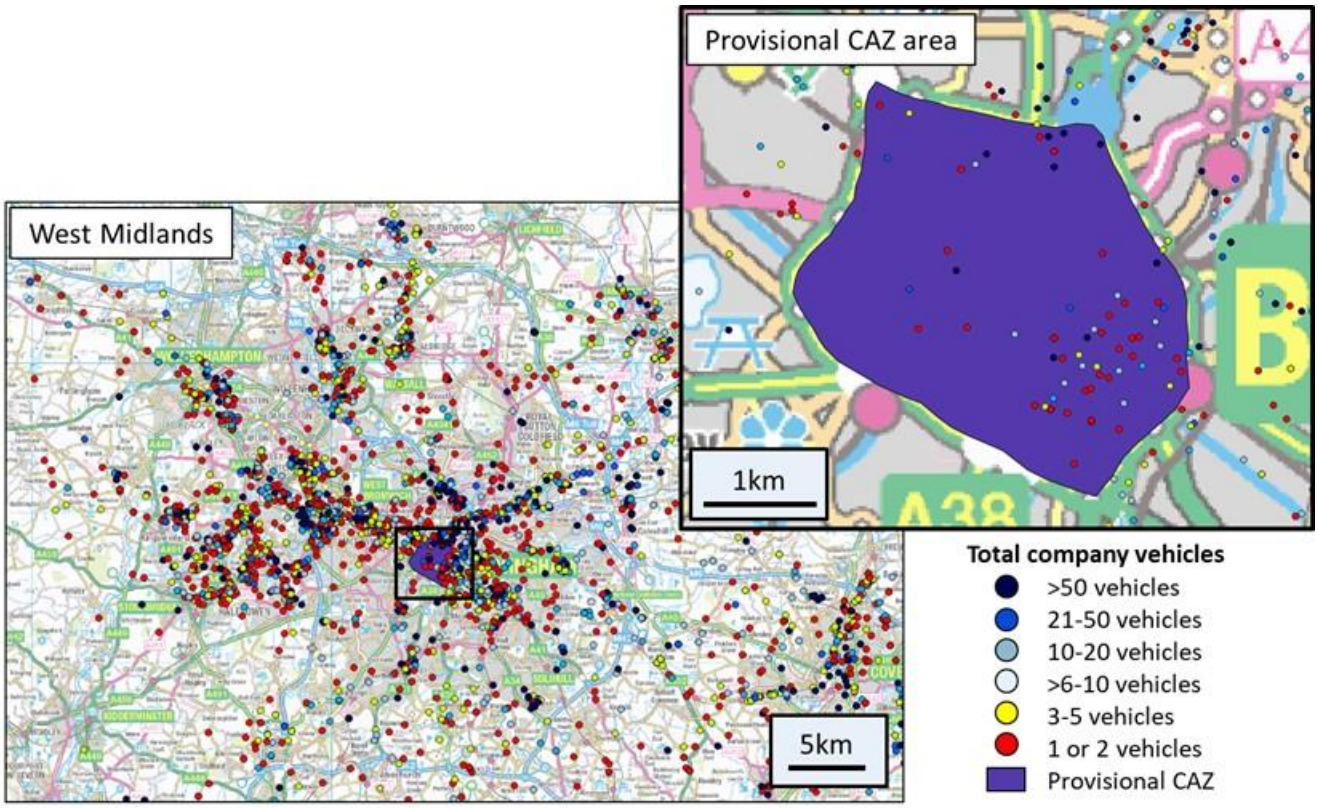


Figure 6.7 Locations of HGV Fleet Depots across West Midlands with Size of Total Company Fleet *(Source: Element Energy 2018, analysis of vehicle operator licensing data).*

By using location and company fleet size as proxy to estimate a company's ability to respond to CAZ charges, Element Energy's analysis of government licensing statistics has indicated that there are approximately 1,459 companies which are small operators (i.e. having 5 or fewer vehicles in their fleet) operating in Birmingham. These businesses are most at risk of CAZ charges as their small fleets means they lack the flexibility to redistribute their vehicles to areas outside of the CAZ and they are likely to find the CAZ charges prohibitively expensive if they make journeys into the CAZ on a frequent basis. There is currently no market offering for a retrofit solution for HGVs and small operators may lack the capital for the upfront purchase of new CAZ compliant vehicles (typical costs range from

£42,000 for a 7.5 tonne vehicle, to £70,000 for a 16 -18 tonne vehicle, and to £106,000 for a 44 tonne vehicle).

TCO analysis by Element Energy for three classes of HGV (7.5 tonne, 18 tonne and 32 tonne) concluded that in all three categories of HGV, operators would be better off purchasing a CAZ compliant vehicle (new or second hand) than paying the CAZ charge on a 5 day per week basis. However, if entry into the CAZ is infrequent (one day per week), then paying the CAZ is preferable. Since the APNR data has shown that over half of HGVs enter the CAZ one day or less per week, it is likely that a sizeable proportion of operators of current non-compliant HGVs, would pay the charge in 2020 in preference to changing their vehicle. However, natural fleet turnover would mean that by 2025, approximately 90% of HGVs would be CAZ compliant (based on DfT licensing data).

Forecasts derived from ANPR data show that in a 'Do minimum' scenario where the CAZ is not implemented, 7,042 HGVs would enter the CAZ daily with 2,453 of these expected to be non-compliant. Of these 68% are predicted to enter the CAZ only once a week.

Although the data suggests that negative impacts will be limited to a relatively small number of vehicles, those that are affected could face severe impacts if their business operations require frequent entry onto the CAZ and if they do not have the capital to upgrade to a compliant vehicle.

6.2.5 Overview of Implications for West Midlands Region

The economic implications of the CAZ on the wider West Midlands region are mostly related to accessibility for workers travelling from elsewhere to the CAZ, and for businesses reliant on transport that need to access the CAZ on a regular basis. The implications of accessibility for people travelling to work are considered in section 5.2 of this report.

6.2.5.1 HGV sector

Work by Element Energy, which has involved the analysis of vehicle registrations provided by the Department for Transport, suggests that while Birmingham itself has a high number of HGVs registered within it, there are also high numbers of vehicles registered in Sandwell, Coventry, Solihull and Walsall, with Sandwell having the highest number of registrations for the West Midlands Region.

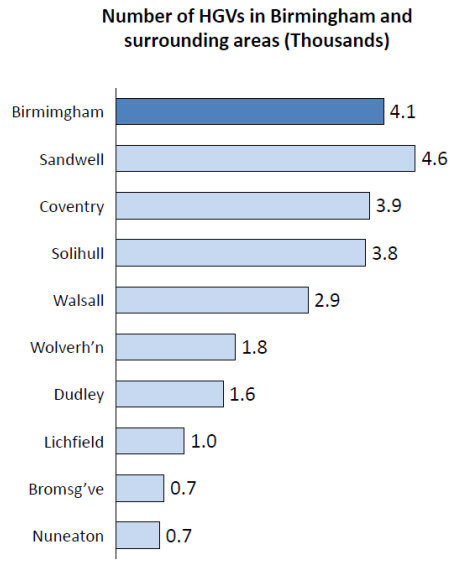


Figure 6.8 Number of HGVs in Birmingham and Surrounding Areas (Thousands) [Source: Element Energy analysis of DfT HGV licensing statistics]

Analysis of the age and standards of these HGVs registered in Birmingham and surrounding areas reveals that a greater proportion of vehicles than the national average are currently compliant with the CAZ, and that the level of compliance is greater for vehicles registered in the surrounding areas of the West Midlands than for Birmingham itself (Figure 6.9). Element Energy has estimated that the natural turnover of vehicles would mean that while 59% of HGVs registered in Birmingham would be CAZ compliant by 2020, the proportion rises to 67% for the surrounding areas in the West Midlands (Figure 6.10). This is a baseline projection, before any behavioural change associated with the CAZ is taken into account.

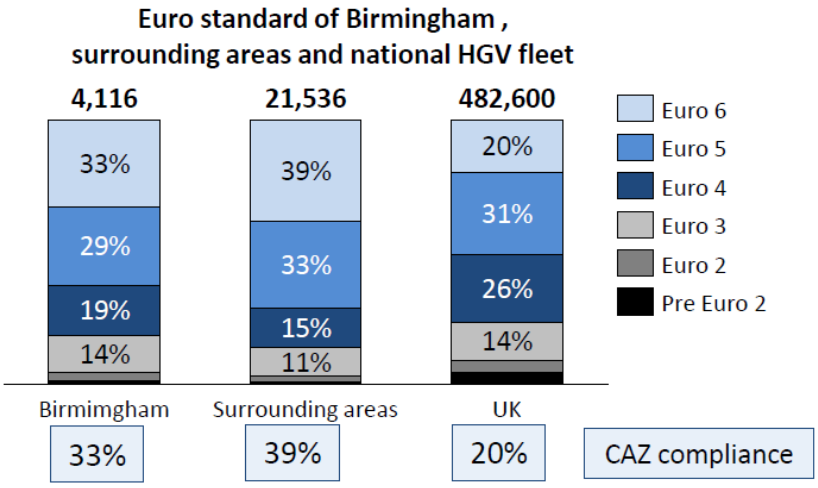


Figure 6.9 Euro Standard of HGV Fleet (Birmingham, Surrounding Areas of West Midlands, and UK) *[Source: Element Energy, 2018]*

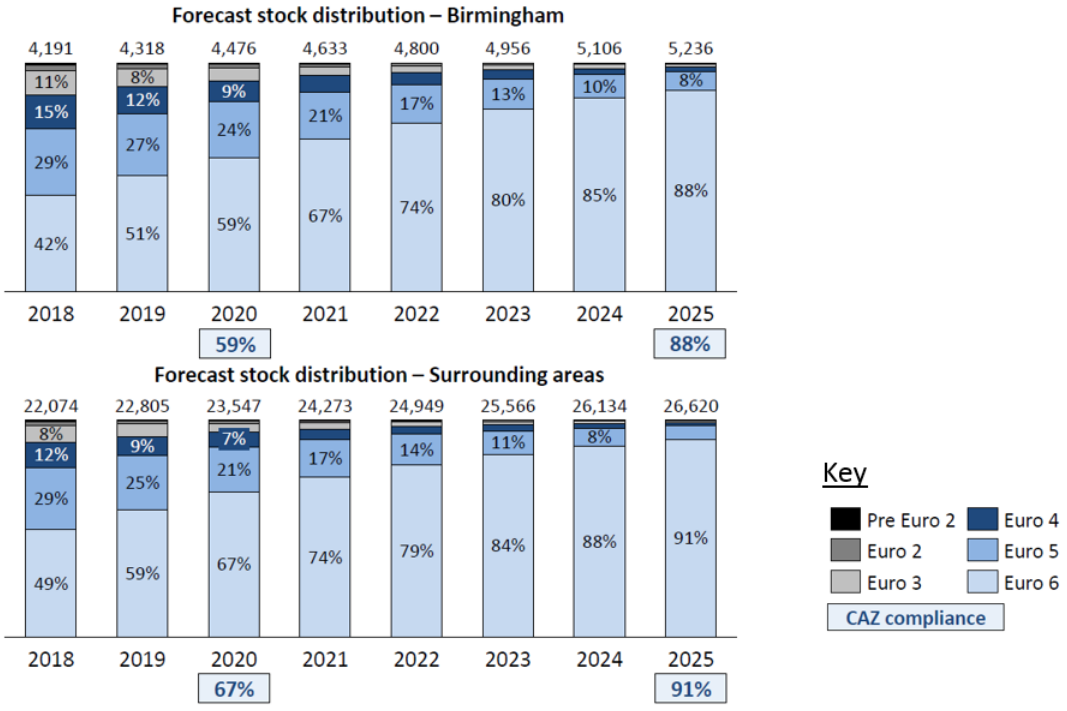


Figure 6.10 Projected Euro Standard of HGV Fleet to 2025 (Birmingham, Surrounding Areas of West Midlands, and UK) *[Source: Element Energy, 2018]*

Based on the above evidence, it is considered that the influence of the CAZ on HGV businesses would be less pronounced for the wider West Midlands than for Birmingham. This is because there is a greater likelihood that HGVs in the wider West Midlands would be CAZ compliant by 2020, and therefore not subject to the CAZ charge. Furthermore, there would be a lower proportion of HGV operators that would need to access central Birmingham anyway.

6.2.5.2 Van/LGV sector

The Element Energy study of van registrations shows a different context from HGVs in terms of the distribution of compliant and non-compliant vehicles between Birmingham and the surrounding West Midlands area. Both Solihull and Birmingham have very high numbers of vans registered. For Solihull the number of vans registered per head of population is 4 times higher than the average for West Midlands. For Birmingham there are 52,000 vehicles registered to one postcode (likely a company headquarters). As previously identified, there is a limitation in using vehicle registrations, since a vehicle may be registered to a particular address but used elsewhere. Element Energy excluded Solihull from further analysis due to its very high number of registrations, which would likely distort the results.

The analysis shows that there is a higher proportion of the non-compliant vans registered in the areas surrounding Birmingham (i.e. the wider West Midlands) than Birmingham itself (Figure 6.11). Currently, approximately 83% of vehicles registered in Coventry, Sandwell, Dudley, Walsall, Wolverhampton, Nuneaton, Lichfield and Bromsgrove are not compliant.

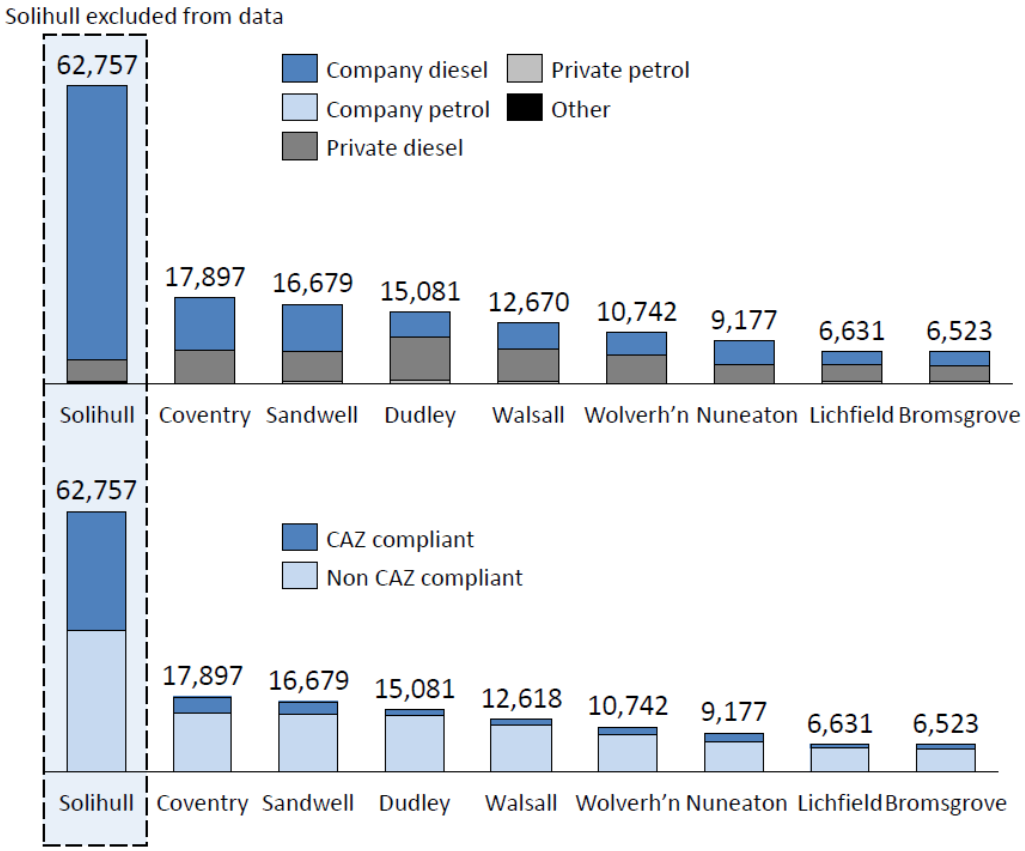


Figure 6.11 Number and Compliance of Vans Registered in local authorities surrounding Birmingham *[Source: Element Energy analysis of DfT licensing statistics, 2018]*

On this basis, businesses with vehicles registered outside of Birmingham are more likely to incur charges if they enter the CAZ. However, it is unlikely that businesses in the wider West Midlands would be affected to the same extent of Birmingham based businesses as the frequency with which they would need to enter the CAZ is likely to be lower.

6.3 Summary of Impacts on Business Affordability

The analysis has shown that some transport dependent businesses are more likely to have compliant fleets than others and so the impact of the CAZ would be less felt. However, taxi businesses will be faced with high upfront costs and few choices of response to the CAZ. Other types of business less able to afford the impacts of the CAZ are private hire companies, van companies with fleets that are privately owned, and small HGV operators. Potential mitigation for businesses most adversely affects is discussed in chapter 8.

Table 6.3: Summary of Impacts on Business Affordability

Business Group	Impact	Comment
SMEs (general) based within CAZ	✘	Although only a minority of businesses within the CAZ will own or operate their own vehicles, virtually all businesses will be dependent on road transport, for example for deliveries. Some of these increases in costs from suppliers may be passed on to businesses and SMEs will typically be less able to absorb these increases.
LGV/Van dependent businesses within CAZ (with company owned vehicles)	✘	The majority of the company owned van fleet is expected to be CAZ compliant by 2020 due to the high turnover of fleet. However, for businesses that remain with a fleet of non-compliant vehicles the impacts are potentially severe.
LGV/Van dependent businesses within CAZ (with privately owned vehicles)	✘✘	There is a higher proportion of non-compliant vans which are privately owned than company owned, meaning there would be a differential impact on this group. However, a relatively low proportion enter/exit the CAZ five or more times per week, this will be especially true of private vans as they will not be compelled to enter the CAZ for business purposes.
LGV/Van dependent businesses with vehicles registered outside of CAZ	✘	There is a higher proportion of non-compliant vans registered in areas surrounding the CAZ. However, a relatively low proportion enter/exit the CAZ five or more times per week and of these, a number will be able to re-route and avoid the zone.
Taxis	✘✘✘	90% of Birmingham's fleet will need to be replaced by 2020 but there is little incentive to upgrade to Euro 6 since the vehicles would need to be ULEV by 2026, and there are currently very few ULEV models available and all have high upfront costs.
Private Hire Vehicles	✘✘	Drivers will be faced with higher costs than private cars, but there are more models of ULEV available at lower prices than for the taxi market.
HGV operators serving Birmingham (small operators)	✘✘✘	Smaller fleets mean these operators are less able to redistribute vehicles to avoid the charge, and they may lack capital for upfront costs of vehicle replacement. These represent a relatively high proportion of HGV businesses.
HGV operators serving Birmingham (large operators)	✘	The impact on large operators is likely to be lower as these operators are likely to be able to redistribute the fleet and are also likely to replace their fleet more frequently.

7. Health Impacts

7.1 Introduction

As set out in the introduction, the key driver for action on air quality in Birmingham is the direct effect of poor air quality on human health. Measures that significantly reduce exposure to harmful concentrations of NO_2 and particulates will lead to improvements in health for the population in and around the study area.

7.2 Air Quality Impacts on Health

7.2.1 Overall health and environmental impacts

For the purposes of this study, the impact pathway methodology has been applied to assess the health benefits of two scenarios, CAZ D 'High' and CAZ D 'High' with Additional Measures, compared to the 2020 'Do Minimum' scenario. Health benefits were calculated for each Lower Super Output Area (LSOA) within the Birmingham Authority region. Table 7.1 summarises the monetised health benefits of each scenario across the Birmingham Council district.

Table 7.1: Monetised Health Impacts (£) for 2020

Pollutant pathway	CAZ D 'High' compared to 'Do Minimum'	CAZ D 'High' plus Additional Measures compared to 'Do Minimum'
PM_{10} Chronic Mortality	£839,000	£1,000,000
NO_2 Chronic Mortality	£1,970,000	£2,130,000
PM_{10} Respiratory hospital admissions	£5,260	£6,300
PM_{10} Cardiovascular hospital admissions	£3,220	£3,850
PM_{10} Productivity	£83,600	£100,000
Total Health Impact	**£2,900,000**	**£3,250,000**

Table 7.1 shows that the overall health benefit to Birmingham is in the region of £3m. This is the benefit in a single year (2020) compared to the 'Do Minimum' scenario. The majority of this benefit is derived from reduced rates of Chronic Mortality associated with NO_2, followed by reduced rates of PM_{10} Chronic Mortality. Avoided cardiovascular hospital admissions associated with exposure to $PM_{2.5}$ results in the lowest health benefit. Overall, the CAZ D High plus Additional Measures scenario creates approximately £350,000 more benefit than the CAZ D High scenario.

The impact pathway approach also allows for the monetisation of non-health impacts. Table 7.2 shows the overall environmental benefit to Birmingham with the implementation of the two CAZ scenarios compared to the 'Do Minimum' scenario.

Table 7.2 Monetised Environmental Impacts (£) for 2020

Pollutant pathway	CAZ D 'High' compared to 'do minimum'	CAZ D 'High' plus Additional Measures compared to 'do minimum'
Building Soiling (PM_{10})	£28,100,000	£33,700,000
Ecosystem Impact (NO_2)	£48,600,000	£52,600,000
Ecosystem Impacts (Ozone)	-£28,300,000	-£30,600,000
Total Environmental Impact	**£48,500,000**	**£55,700,000**

Table 7.2 shows that the overall environmental benefit to Birmingham is between £48m and £56m depending on the scenario being addressed. This is the benefit in a single year (2020) compared to the 'do minimum' scenario. The majority of this benefit is derived from the positive impact of reduced NO_2 emissions on ecosystem functioning. Similarly, the positive impact on reduced building soiling results in benefits of around £33m for Birmingham.

The combined impact of health and non-health (environmental) factors can be seen in Figure 7-1.

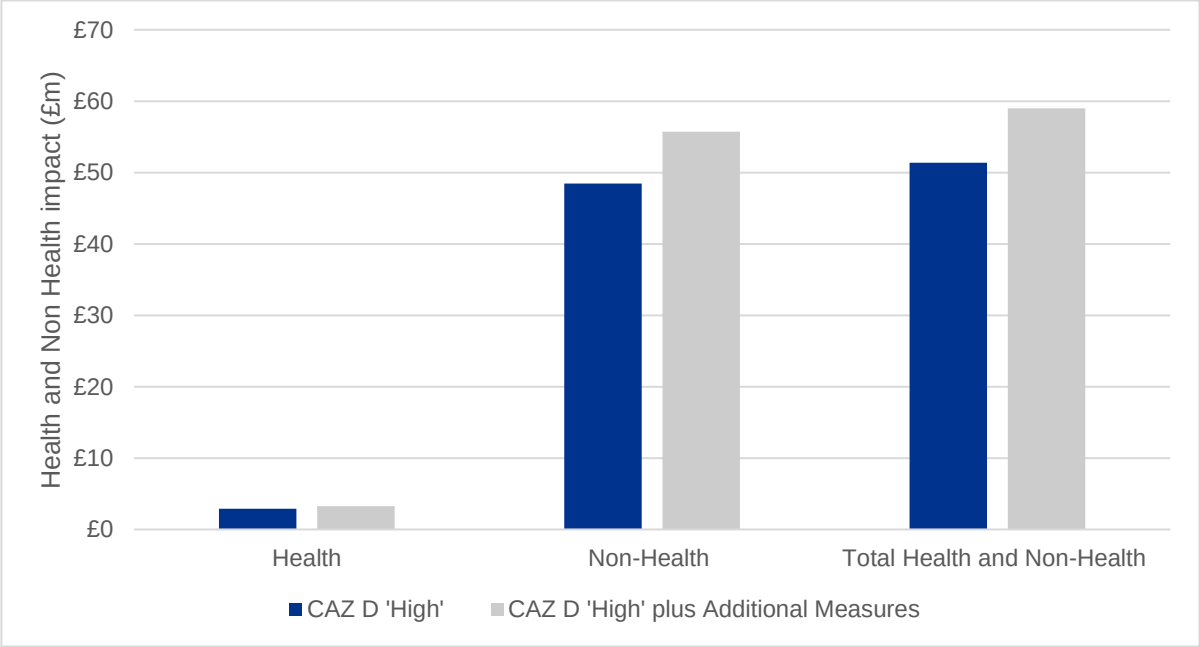


Figure 7.1 : Monetised Health and Non-Health Impacts (£)

Figure 7.1 shows the combined benefit of the health and non-health outcomes for Birmingham. The figure shows that the majority of the benefit is derived from non-health outcomes such as building soiling and ecosystem effects. In a CAZ D 'High' scenario, the combined benefit is in the region of £51m. This increases to approximately £59m in the CAZ D 'High' plus Additional Measures scenario.

7.2.2 Social Groups and Community Facilities Vulnerable to Air Quality Impacts

A qualitative assessment of the distributional impacts on children has been undertaken following the method set out in section 4.4 of TAG Unit 4.4. Average NO_2 concentrations at locations of importance to children, including schools, nurseries, playgrounds, parks and areas of open space under the 'Do Minimum' scenario and the preferred CAZ option have been compared, focussing on locations where

average NO_2 concentrations exceed 30 µg/m^3 which are considered most at risk of experiencing NO_2 concentrations in exceedance of the legal limit of 40 µg/m^3. Changes in NO_2 concentrations at facilities which are also important to local communities (such as community centres), which area less able to lessen interference from local emission sources (such as hospitals and care home) has also been considered. The spatial distribution of facilities of importance to children and facilities important to local communities which are more vulnerable to poor air quality that are considered at most risk of experiencing NO_2 exceedances under the preferred CAZ option relative to the distribution of income deprivation within the study area has also been considered.

7.2.3 Impacts on Low Income Households

As reported in section 3.4.1, deprivation and air quality related health outcomes are closely linked. A report published by the Royal College of Physicians found that vulnerable groups, including poorer people, are more likely to live in polluted areas and are therefore more likely to experience health problems caused by air pollution (Royal College of Physicians, 2016).

There would be an overall beneficial health impact within the study area under the preferred CAZ option and all other options, however the magnitude of benefit would be greatest under the preferred CAZ option. When income distribution is considered relative to England and Wales, residents of those LSOAs which fall within quintile one for income deprivation would experience a disproportionately greater amount of the benefits associated with reductions in atmospheric concentrations of all three pollutant types (NO_2, PM_{10} and $PM_{2.5}$) than those within less deprived quintiles, and residents of LSOAs within quintile three would receive a disproportionately smaller amount of the benefit associated with reductions in NO_2 atmospheric concentrations (see Table 7.3). Residents of LSOAs which fall within quintiles one for income deprivation relative to income distribution within Birmingham (the most deprived LSOAs) would experience a disproportionately greater amount of the benefits associated with reductions in atmospheric NO_2 concentrations than might be expected given the proportion of the study area population residing in these areas, with residents of LSOAs falling within quintile three receiving a disproportionately smaller amount (see Table 7.3). Health benefits associated with reductions in atmospheric PM_{10} and $PM_{2.5}$ concentrations would be evenly distributed across the income deprivation quintiles.

Table 7.3: Distributional Impacts of Air Quality – Low Income Households

	Pollutant	Quintile				
		1	2	3	4	5
Relative to income deprivation across the England and Wales	NO_2	✓✓✓	✓	✓✓	✓✓	✓✓
	PM_{10}	✓✓	✓✓	✓✓	✓✓	✓✓
	$PM_{2.5}$	✓✓	✓✓	✓✓	✓✓	✓✓
Relative to income deprivation across Birmingham	NO_2	✓✓✓	✓✓	✓	✓✓	✓✓
	PM_{10}	✓✓✓	✓✓	✓✓	✓✓	✓✓
	$PM_{2.5}$	✓✓✓	✓✓	✓✓	✓✓	✓✓

7.2.4 Impacts on Children

Figure 7.2 shows NO_2 concentrations across the modelled area under the 'Do Minimum' (ie if no CAZ were implemented) relative to the locations of facilities of importance for children aged under 16 including schools, nurseries, playgrounds, parks and areas of open space. Those facilities that fall within areas where NO_2 concentrations are greater than 30 µg/m^3 (as indicated by the orange and red contours) are considered to be most at risk of experiencing NO_2 concentrations which exceed the legal limit of 40 µg/m^3 NO_2.

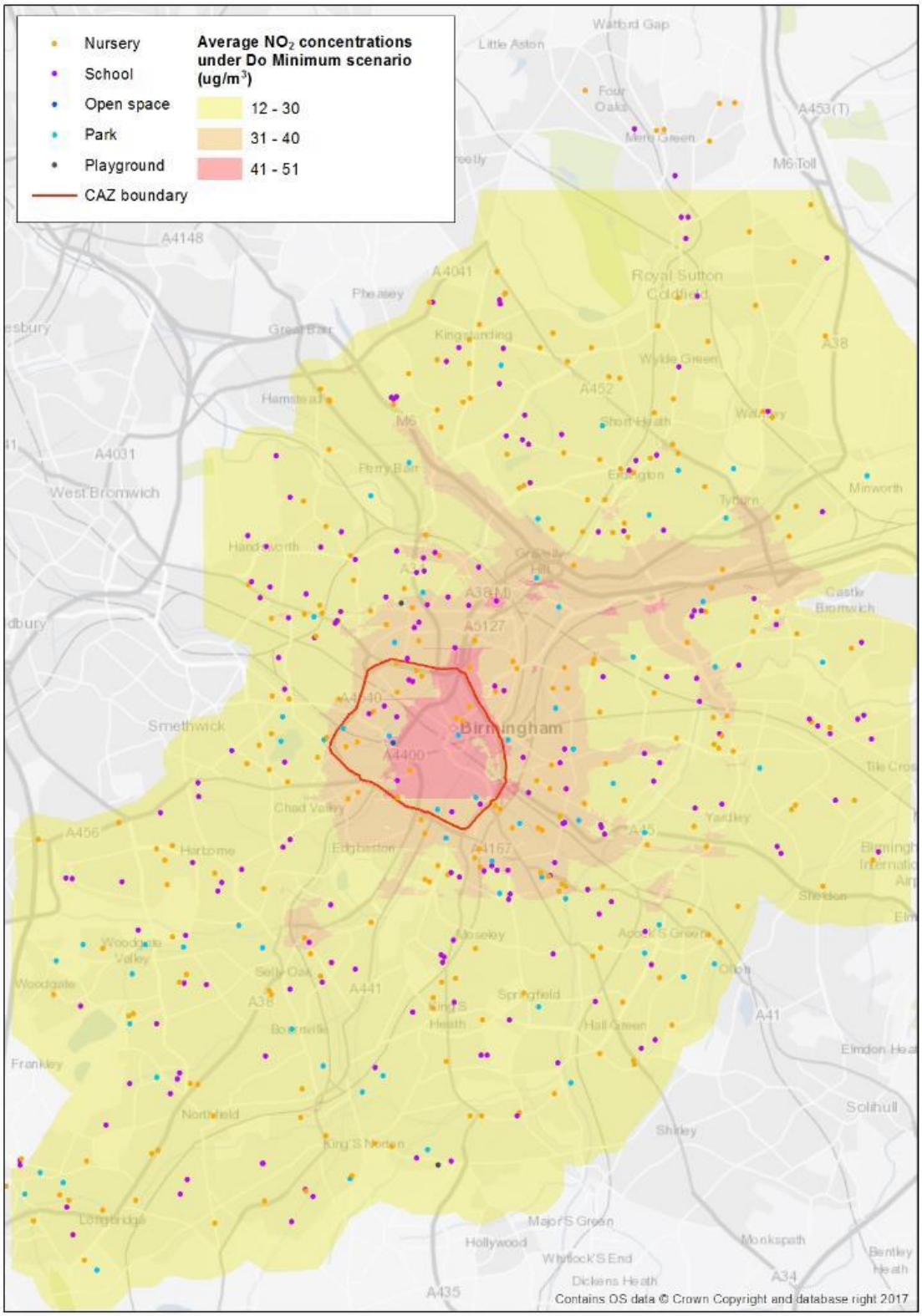


Figure 7.2: Average NO_2 Concentrations Under Do Minimum Scenario Relative to Locations of Facilities of Importance to Children

All facilities of importance within the air quality modelling area for the preferred CAZ option would

experience a decrease in NO_2 concentrations to some degree. Figure 7.3 shows the degree of increase or decrease in NO_2 concentrations modelled following implementation of the preferred CAZ option relative to locations of facilities of importance to children as described above. As shown in Figure 7.3 the greatest decreases in average NO_2 concentrations are generally seen within the CAZ areas itself and surrounding major arterial roads as they extend out of the CAZ, which is also where average NO_2 concentrations are highest under the Do Minimum scenario (see Figure 7.1).

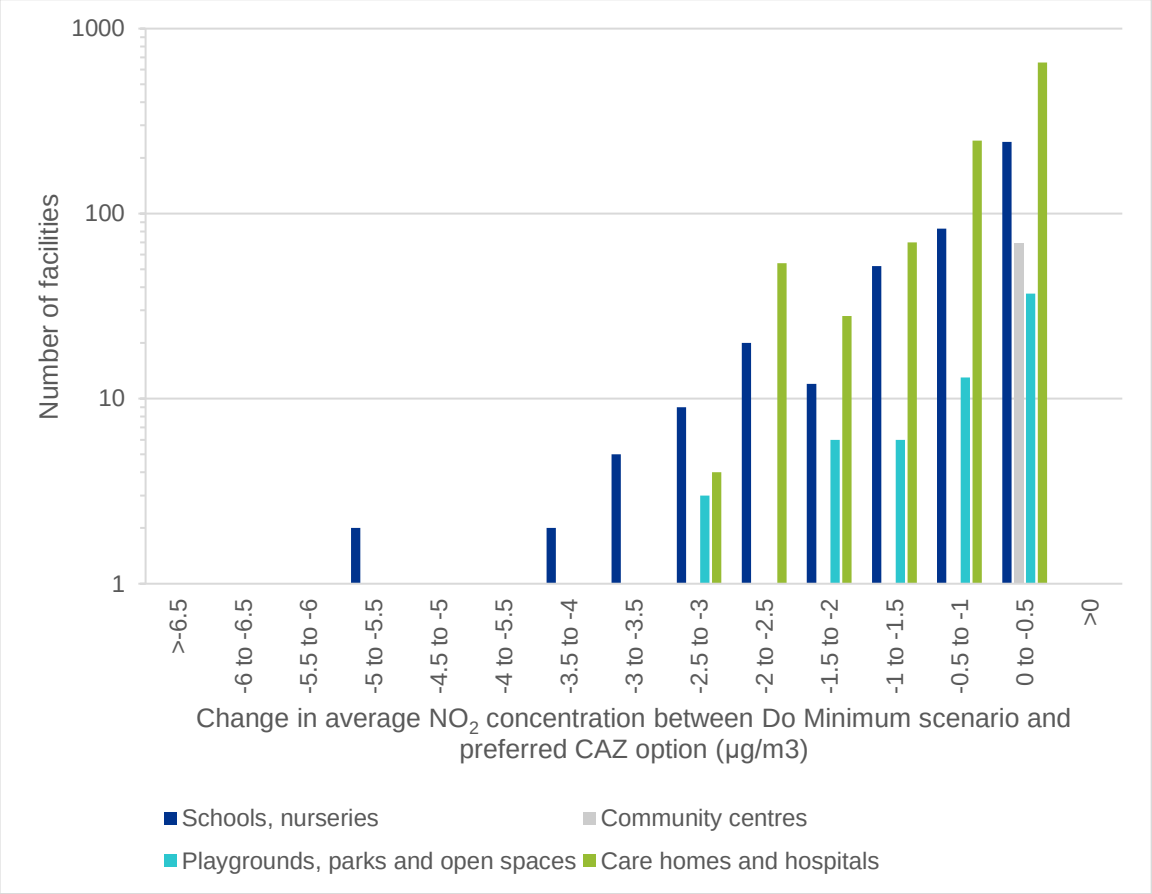


Figure 7.3 Change in NO_2 Concentrations at Key Facilities Under Preferred CAZ Option

Around one quarter of the facilities of importance to children that are identified as being at highest risk of NO_2 exceedances (i.e. average NO_2 concentrations are greater than 30 µg/m^3) under the Do Minimum scenario would no longer fall within areas with average NO_2 concentrations in excess of 30 µg/m^3 (as shown in Table 7.4). The locations of these facilities are shown on Figure 7.4. As shown by Figures 7.5 and 7.6, those educational and recreational facilities where the decrease in NO_2 concentrations under the preferred CAZ option brings the average NO_2 concentrations below 30 µg/m^3 are almost exclusively located within areas that are within quintile one for income deprivation relative to the England and Wales distribution, and mainly also within quintile one for income deprivation relative to the study area distribution.

Table 7.4 Improvement in Number of Facilities of Importance to Children at Risk of NO2 Exceedances

Facility type	Number within areas at highest risk of NO_2 exceedances under Do Minimum scenario	Number within areas at highest risk of NO_2 exceedances under preferred CAZ option	% improvement between Do Minimum and preferred CAZ option
Schools and nurseries	99	73	26%
Parks, playgrounds and areas of open space	19	15	21%

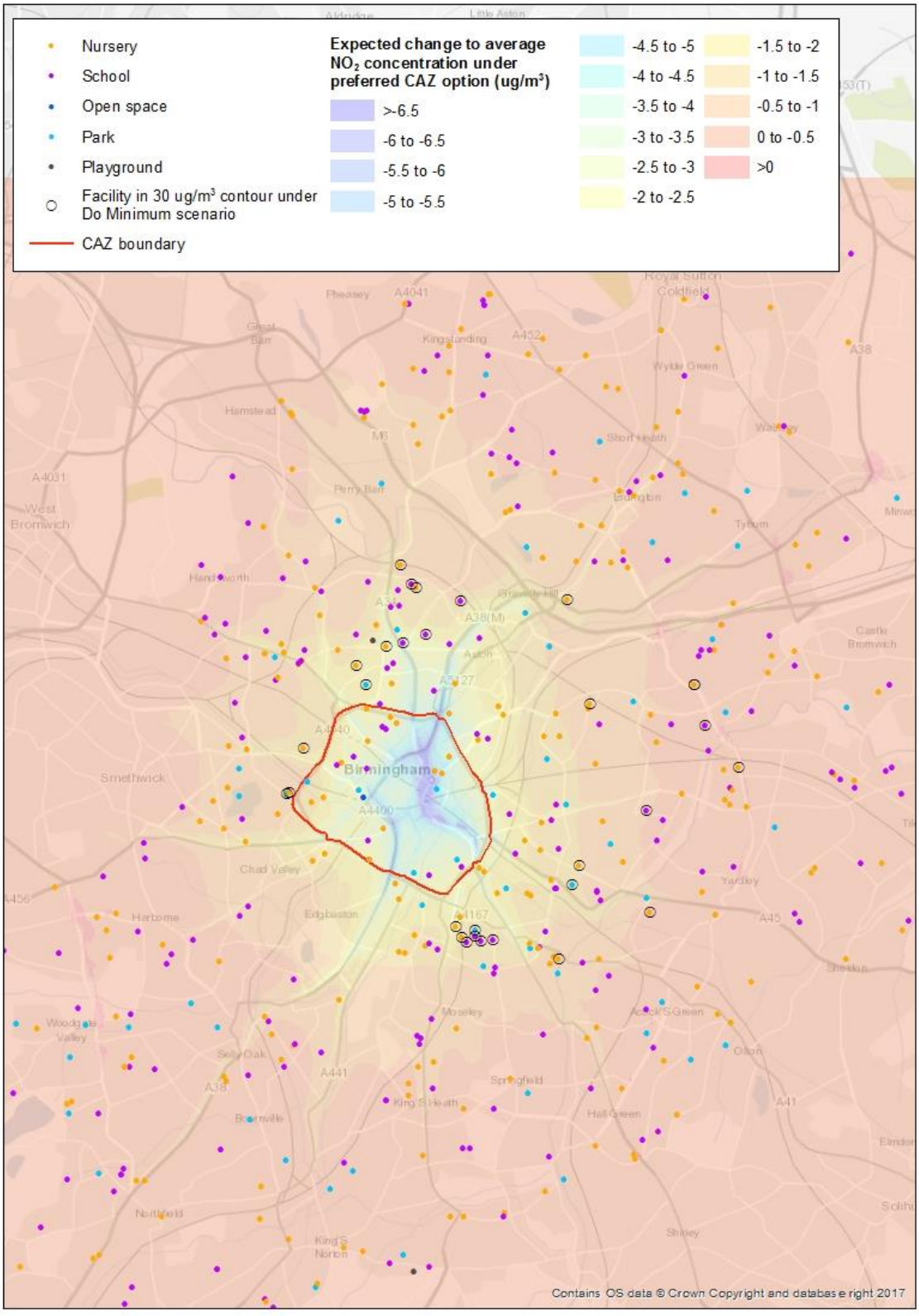


Figure 7.4 Change in NO_2 Concentrations Between Do Minimum Scenario and the Preferred CAZ Option Relative to Locations of Facilities of Importance to Children

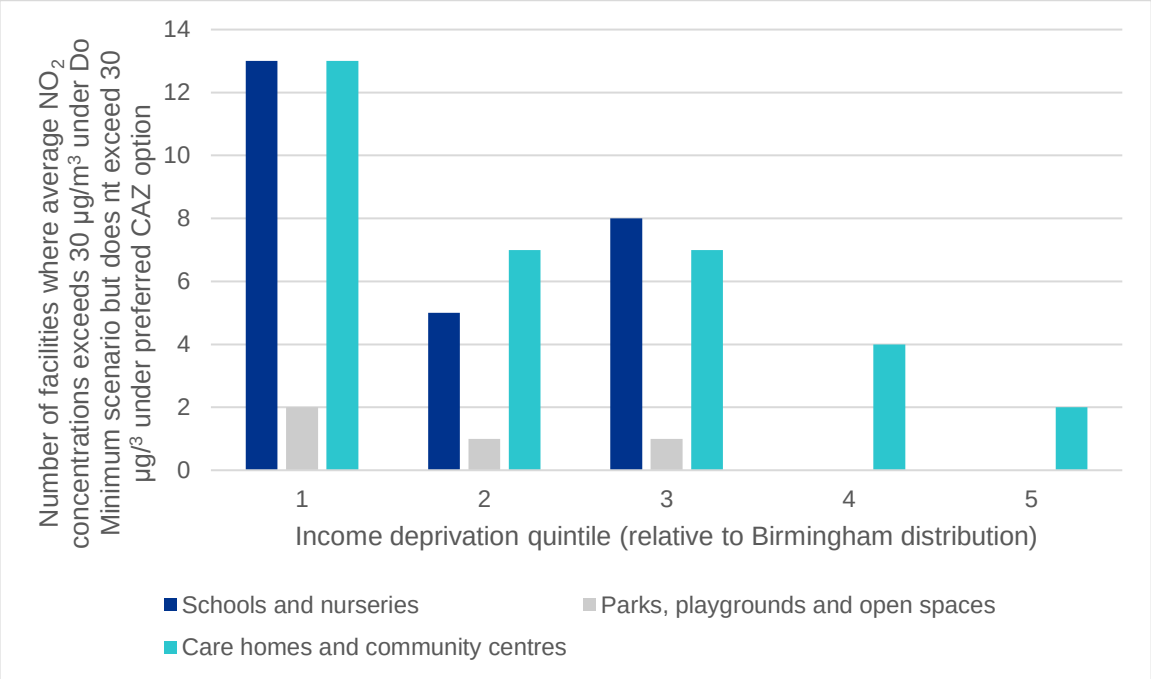


Figure 7.5 Facilities Experiencing Improvement in Air Quality by Income Deprivation Quintile (Relative to Birmingham Income Deprivation Distribution)

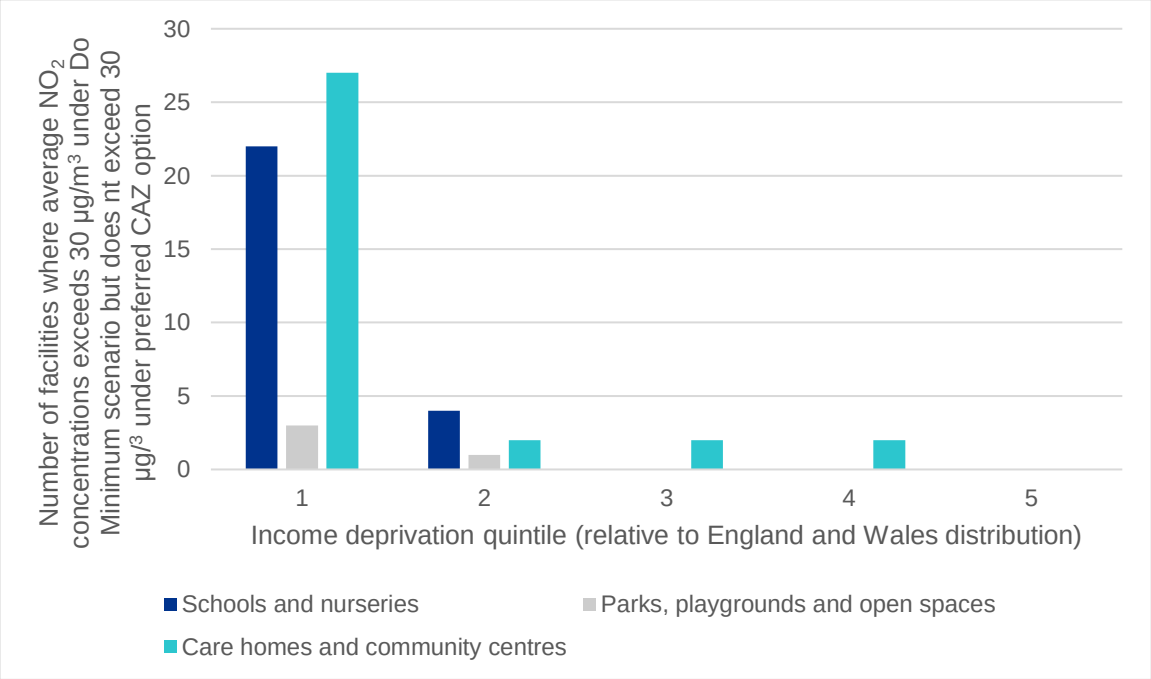


Figure 7.6 Facilities Experiencing Improvement in Air Quality by Income Deprivation Quintile (Relative to England and Wales Income Deprivation Distribution)

7.2.5 Impacts on Other Vulnerable Groups

Figure 7.7 shows NO_2 concentrations across the modelled area under the Do Minimum scenario relative to the locations of facilities that are of importance to both children and the wider community (community centres) or that have limited or lessened ability to lessen exposure for their occupants such as hospitals and care homes. Again, as shown in Figure 7.3 all facilities of this type located within the study area would experience a decrease in average NO_2 concentrations under the preferred CAZ option. The degree of decrease NO_2 concentrations is generally relatively small (<3 µg/m^3), however the study area wide changes are sufficient that a notable proportion of facilities are no longer within areas where average NO_2 concentrations exceed 30 µg/m^3 (see Expected Change to Average NO2 Concentrations under Preferred CAZ Option

Table 7.5) including Queen Elizabeth Hospital, Edgbaston. Again, these areas are largely located outside of the CAZ area (see Figure 7.8) and within areas that fall within the most deprived quintile for income deprivation relative to the England and Wales distribution (see Figures 7.5 and 7.6).

7.2.6 Limitations of Analysis

The air quality models used to inform this assessment do not cover the full study area (Birmingham City Council administrative area) as this was not deemed necessary, with LSOAs to the far north of the study area excluded from the analysis. It should also be noted that air quality can differ considerably over very short distances and periods of time, and therefore whilst facilities located in areas where average NO_2 levels are below 30 µg/m^3 are at lower risk of experiencing NO_2 exceedances this does not mean that exceedances could not occur at these locations, and the converse is true for those located in areas where average NO_2 levels are below 30 µg/m^3. Furthermore, there is no safe level of air pollution as tolerance levels vary by individuals.

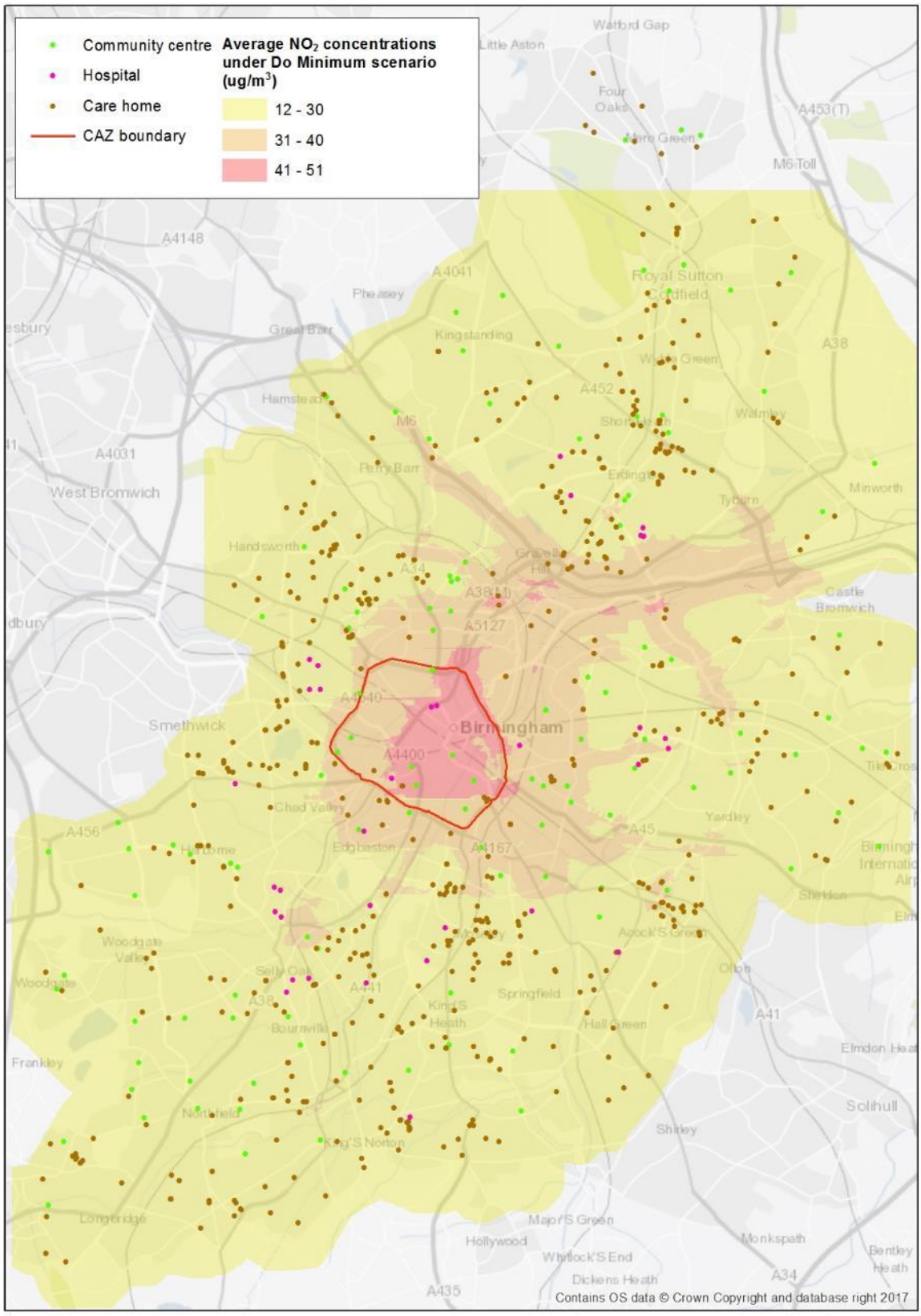


Figure 7.7 Average NO_2 Concentrations Under Do Minimum Scenario Relative to Locations of Community Centres, Care Homes and Hospitals

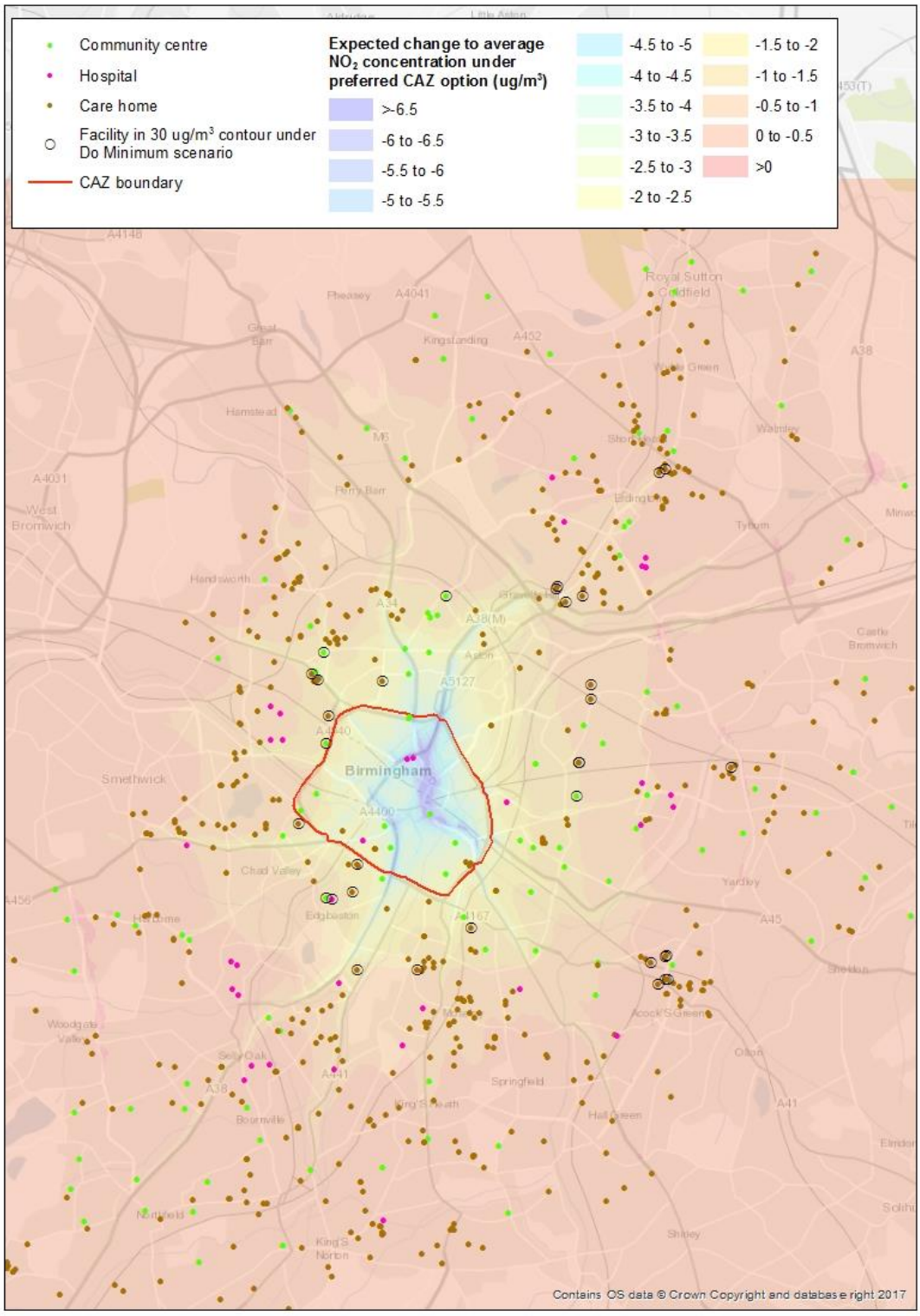


Figure 7.8 Expected Change to Average NO_2 Concentrations under Preferred CAZ Option

Table 7.5 Improvement in Number of Community Centres and Vulnerable Facilities at Risk of NO2 Exceedances

Facility type	Number within areas at highest risk of NO_2 exceedances under Do Minimum scenario	Number within areas at highest risk of NO_2 exceedances under preferred CAZ option	% improvement between Do Minimum and preferred CAZ option
Care homes	124	96	23%
Hospitals	6	5	17%
Community centres	29	24	17%

7.2.7 Behavioural Change Impacts

Relationship Between Traffic Patterns, Travel Modes and Health

Daily physical activity is hugely important for maintaining health (Department of Health, 2011), and inactivity directly contributes towards one in six deaths in the UK (Lee et al., 2012). It is estimated that physical inactivity costs the UK approximately £7.4 billion per year when the impact on NHS, social care, sickness absence from work and other factors are taken into account (Public Health England 2016). The costs to business of absenteeism and presenteeism (working whilst sick can cause productivity loss and further poor health) are significant. In 2014 the cost of absences was approximately £14 billion (Confederation of British Industry, 2013), of which approximately £5 billion can be attributed to physical inactivity (Sustrans, 2017). The costs of presenteeism may be even more (Centre for Mental Health, 2011).

For most people, the easiest forms of physical activity are those that can be built into daily life, for example by using walking or cycling as an alternative to motorised transport for everyday journeys such as commuting to work or school (Department of Health, 2011). Traffic speeds and volumes are known to influence how individuals choose to travel, with higher volumes of walking and cycling where traffic is less and vice versa (Appleyard, 1981). Active forms of travel, such as walking and cycling, are associated with a range of health benefits. These include improved mental health, reduced risk of premature death and prevention of chronic diseases such as coronary heart disease, stroke, type 2 diabetes, osteoporosis, depression, dementia and cancer (British Medical Association, 2012). Research also suggests that countries with highest levels of active travel generally have amongst the lowest obesity rates (Bassett et al., 2008).

High traffic volumes and speeds can reduce opportunities for positive contacts with other residents in a neighbourhood, contributing towards increased social isolation and reduced community cohesion (Appleyard, 1981; Hart and Parkhurst, 2011). Individuals who are socially isolated are more likely to make use of public services due to lack of support networks and have increased likelihood of developing certain health conditions such as depression and dementia (Social Finance, 2015). They are also more likely to be physically inactive (Appleyard, 1981), which is again linked to increased likelihood of developing certain diseases as discussed above. People experiencing high levels of social isolation have significantly higher mortality levels than those with low or average levels of isolation (Steptoe et al., 2013). It has been estimated that better community cohesion could save the UK around £53 million per year (Public Health England, 2017).

Health in Birmingham

The health of the people in Birmingham is generally worse than the national average as evidenced by several markers. Life expectancy is lower than the national average, and is heavily influenced by neighbourhood area. The city experiences higher rates of death than the national average from preventable diseases such as coronary heart disease, stroke and certain cancers, as well as high

levels of diabetes amongst its residents. All of these can be improved by increased levels of physical activity (Birmingham City Council, 2015). The proportion of people who are overweight or obese is also higher than the national average, as is the proportion of people with severe mental illnesses. In contrast, the proportion of adults who regularly undertake physical activity is relatively low (Public Health England, 2017).

Impact on Physical Activity

An increase in the number of journeys made on foot or cycle would be expected to have a beneficial impact on public health. The proportion of non-compliant car journeys anticipated to be shift mode to public transport, walking or cycling (2%) appears small, but when considered against the population of Birmingham (over one million) the number of journeys and people affected are likely not insignificant. As discussed in section 5.3.1, areas with high income deprivation and low levels of compliant cars and also high levels of traffic flows to and from the CAZ area are largely located on the northern and eastern areas of the CAZ and immediately surrounding areas (Figure 5.2). The characteristics of these areas (high income deprivation and close proximity to the CAZ) suggest that journeys from these areas would be clear candidates for modal shift to public transport or active transport (walking and cycling) modes. It is also notable that most roads that would have reduced traffic flows under the preferred CAZ option are located within the CAZ area itself (see Figure 3.1. Appendix B). Whilst these reductions are not sufficient to be considered significant for the purposes the assessment of distributional impacts on severance (as discussed in section **Error! Reference source not found.**), they would contribute towards improvements in public health in conjunction with other Birmingham City Council initiatives that aim to encourage people to walk or cycle in preference to using a car, particularly for short journeys. The redistribution of traffic flows away from residential roads within the city centre and towards the A4540 may also help contribute towards improved social cohesiveness and reduce social isolation, particularly within the city centre. Whilst impacts of this nature cannot currently be quantified or monetised, the CAZ would be important in contributing towards other Birmingham City Council initiatives in initiating a step change in the approach and mentality surrounding active travel with consequential improvements in public health both within the city centre and the wider Birmingham area.

7.2.8 Summary of Main Impacts

The preferred CAZ option is anticipated to have a benefit to public health, with the overall benefit (as calculated via monetised health monetised health impacts associated with chronic mortality, respiratory and cardiovascular hospital admissions and productivity) being in the region of £3 million in 2020. Areas of high income deprivation would benefit most from the air quality improvements associated within implementation of the preferred CAZ option. This is evidenced both through the spatial distribution of monetised health impacts previously mentioned and also by the spatial distribution of facilities of importance to children and facilities that are particularly vulnerable to poor air quality that currently considered to be at highest risk of NO_2 exceedances that would no longer fall into this category if the preferred CAZ option were implemented. The scheme would also have further indirect benefits to public health through the incentive that the increased cost of travel by car would provide for Birmingham residents to switch travel modes to public transport (bus or train), cycle or walk for those shorter everyday journeys when taken in conjunction with other Birmingham City Council initiatives around public transport improvements and active travel. An improvement in physical activity levels within Birmingham due to increased active travel journeys would also benefit public health (both physical and mental), potentially providing a positive feedback loop for health and reductions in vehicular emissions of air quality improvements that would also benefit the environment.

8. Key Findings and Proposed Mitigation

8.1 Key Impacts of the CAZ

8.1.1 Disproportionate Adverse Impacts

The introduction of a charging CAZ will have an adverse impact on anyone who does not have a compliant vehicle and who normally uses that vehicle to enter the CAZ. However, the distributional impact appraisal has identified some groups who are more likely to have non-compliant vehicles and who have less capacity to avoid the CAZ and/or cope with the costs associated with compliance. These are considered to be disproportionately affected as they have a greater proportion of impacts compared with social or business groups as an average.

- Accessibility for disabled people – as a consequence of the more limited transport choices available to some disabled people. This could be compounded where there are impacts on community transport providers or taxi providers since disabled people as a group have more dependency on these forms of transport.
- Affordability for income deprived people – particularly those in wards of Nechells, Aston, Perry Bar, Tyburn, Soho and Sparkbrook, where there are relatively high rates on income deprivation coupled with relatively high proportions of non-compliant vehicles
- Affordability for taxi drivers – as a consequence of the new taxi licensing proposals accompanying the CAZ and higher costs and limited availability of ULEV taxis suitable for taxi use.
- Affordability for HGV and LGV fleets – SMEs with non-compliant fleets which must regularly enter the CAZ for business purposes will have to either pay a significant amount in CAZ charges or upgrade their vehicle involving high capital costs, often unaffordable for small businesses.

While the above impacts are considered to fall disproportionately on those social groups, there are predicted to be adverse impacts on a number of different groups. The ability of individuals within these groups to adapt to the changes of the CAZ will vary according to their specific circumstances. Section 0 considers potential mitigation. Mitigation has been recommended where there are likely to be disproportionate impacts, or where it is considered there may be a strong case to target a particular group.

8.1.2 Benefits of the CAZ

The CAZ would have beneficial impacts on public health, both directly via improvements in air quality across Birmingham and indirectly through the nudge effect on physical activity levels and consequential impacts on health. Areas with high levels of income deprivation would benefit most from the improvements in air quality and would also benefit from improved journey times and reduced vehicle operating costs (associated with fuel usage and vehicle maintenance) due to reduction in traffic flows within and surrounding the CAZ. There may also be health benefits in the wider area as an uptake in cleaner vehicles prompted by the CAZ would mean more journeys by cleaner vehicles being undertaken across the wider area generally.

8.2 Potential Mitigation

The following mitigation has been identified as possible measures that could be undertaken to alleviate some of the impacts of the CAZ on those groups most adversely affected by the proposals. The final mitigation proposals will be developed following consultation and further analysis to ensure that the objectives of the CAZ are not compromised. In addition to the mitigation below, help for community facilities and businesses within the CAZ with travel planning and public transport

improvements is also recommended to support those who currently use cars but could use alternative modes. For example, where people would face new parking charges due to the Additional Measures.

8.2.1 Impacts on Taxi Operators

The distributional impact assessment has identified that taxi (Hackney Carriage) operators would be particularly affected by the new licensing conditions brought in to support the CAZ due to the high purchase cost of new ULEV taxis and the limited options currently available. Over time the operational costs of running an electric vehicle are cheaper than for diesel, so in the longer term the impact would reduce. Without mitigation there is a risk that many would leave the profession. This would have knock-on consequences for BAME and low income communities, since a very high proportion of taxi drivers are from communities with high proportion of BAME residents and income deprived residents. Since taxi in Birmingham are all wheelchair accessible, whereas currently none of the private hire taxis are, a reduction in this type of vehicle will have an adverse impact on disabled people who may depend on them for access. It is therefore recommended that taxis are targeted for mitigation due to the combination of direct and indirect impacts arising from the proposed CAZ.

Financial incentives could potentially be offered to assist drivers in purchasing a new vehicle. Taking into account that licensing conditions require all new or replacement vehicles to be ULEVs from 2021 the mitigation should be targeted at new ULEV taxis. Additionally, Element Energy has identified an LPG retrofit as the optimal option cost wise for those with an eligible vehicle and recommend a provision for this within the mitigation measures. Further work is required to understand the likely level of uptake different types of financial scheme may have, and to ensure that the proposals are within state aid rules.

Table 8.1: Potential Financial Schemes to Mitigate Impacts on Taxi Drivers

Potential Financial Scheme	Comment
Purchase aid	A grant could assist with upfront purchase costs. This could only apply where existing grants from the Office for Low Emission Vehicles (OLEV) are not available. It is likely that this would only partially mitigate high upfront costs of an electric vehicle.
Incentive package	A financial incentive package could be developed to provide assistance to drivers with their operational costs, so that they have less of a financial burden in the first few years while they are paying back the cost of a new vehicle. Options could include waiving taxi licence fees or access fees (for example to Birmingham New Street Station); provision of free public electric charging; funding vehicle testing fees and/or insurance.
LPG retrofit fund	Money could be provided to contribute to the installation of LPG retrofit technology to make non-compliant vehicles compliant and thus able to operate within Birmingham.
Electric vehicle lease scheme	A number of vehicles could be bulk purchased and leased back to drivers at a favourable rate of repayment. It is likely that a scheme to assist all drivers would be prohibitively expensive, but it may be feasible to develop a targeted scheme based on pre-determined conditions.

8.2.2 Impacts on Community Transport

The potentially differential and disproportionate costs for community transport operators could be mitigated through either a discount on the CAZ charge or an exemption. Mitigation for community transport providers is considered appropriate on the basis that these are often provided by small

operators and local charities that provide important access to health and social care, employment, education and training for people who may otherwise be isolated.

8.2.3 Impacts on Income Deprived Local Residents and Key Workers

It is recommended that mitigation is targeted at income deprived residents who live or work within the CAZ and key workers who frequently work within the CAZ. Mitigation could also be targeted at income deprived who work in the CAZ. People on low incomes are potentially more likely to work unsocial hours with more reliance on travel by car. Residents within the CAZ would not have the choices open to other residents in Birmingham of avoiding the zone when they are in their vehicle. The distributional analysis has assessed that residents in the most deprived LSOAs in Birmingham will bear disproportionately greater costs. The analysis has also identified that there is a higher proportion of non-compliant vehicles registered in those areas with the highest levels of income deprivation, meaning drivers from these areas are more likely to have to pay the charge. Many key workers, for example NHS staff who work at the Birmingham Children's Hospital, may work night shifts and have more limited transport options. Since key workers provide essential services, it is recommended that they are considered for targeted mitigation.

Potential mitigation for these groups of people would take the form of a discount on the charge and a sunset period to allow residents with sufficient time to change their vehicles to compliant models. Consideration should also be given to the availability, amenity and affordability of public transport, particularly at night. An additional mitigation measure that should be considered is the provision of funding to help individuals transition to alternative forms of travel. This could take the form of a mobility credit; whereby low-income residents are provided an annual credit to use on the West Midlands transport system. This could either be provided with or without a condition on the individual scrapping their non-compliant vehicle and there is also an option of providing a cash payment to contribute towards the purchase of a compliant vehicle.

8.2.4 Impacts on SMEs

The greatest concern reported among business representatives is the 2020 deadline which provides limited time for businesses to prepare and adapt. The total costs to businesses of either complying with the CAZ or paying the charge is estimated to be around £180m in the first year, which will fall disproportionately on SMEs, particularly those based in the CAZ that operate their own vehicles and for SMEs in surrounding areas that frequently enter the CAZ. These costs will diminish over time as the proportion of vehicles becomes more compliant. Some of the potential measures that could help to mitigate impacts of the CAZ are set out in Box 2. It is unlikely that a one size fits all approach will work with businesses due to the variety of types of business and their needs. For example, while consolidation centres may work for some types of business, certain businesses such as law firms have large numbers of unique deliveries throughout the day.

Box 2: Potential Measures to Support Businesses

Non-financial Measures

These are examples of measures that could support businesses with the transition to compliant forms of transport, including overcoming barriers from lack of awareness of options.

- **Continue to roll out alternative fuel infrastructure, such as rapid charge EV charging points**
- **Develop network of consolidation centres/micro-consolidations centres (last mile deliveries)**

- **City Centre electric cart delivery service (from consolidation centres/micro-consolidation centres), for example, use of electric cargo bikes**
- **Supporting awareness raising targeted at SMEs to ensure they understand the types of compliant vehicles available and associated running costs and infrastructure, what financial support is available**

Financial Measures

These are examples of potential financial measures that could be consulted on. Some of these measures would be subject to the availability of government grants and funding (for example successful applications to the Clean Air Fund) and state aid rules.

- **Continuation of plug-in grants (e.g. OLEV grant) to support businesses with the transition to ultra-low emission vehicles**
- **Low cost loans for vehicle conversion or replacement**
- **Financial support to contribute towards the operational costs of owning a ULEV vehicle, for example providing free charging on BCC's upcoming public charging network**
- **Temporary exemptions or discounts for business vehicles registered to businesses which enter the CAZ on regular basis (e.g. twice or more times per week). This could be restricted to a maximum of two vehicles per company**
- **Temporary exemptions or discounts for LGV owners who are locked into lease or finance agreements that started before June 2018. This should be extended until the end of the lease contract**
- **Additional financial grant for HGV fleets to support their transition to compliant vehicles. This could contribute towards a new or second hand vehicle purchase or alternatively assist with the cost of an accredited retrofit solution (if one becomes available within the timeframe of the CAZ)**

8.3 Summary of Impacts and Proposed Mitigation

A summary of the findings of the distributional impact analysis and proposed mitigation is provided in Table 8.2.

Table 8.2 Summary of Distributional Impacts and Proposed Mitigation

Social or business group (general)	Specific geographical location (if applicable and differs from study area) or other differentiating characteristic	Impacts			Suggested mitigation (where applicable)
		Variable	Impact	Commentary	
Social groups					
Low income households	Across study area (Birmingham wide)	Personal affordability	✖✖✖	Low income households across Birmingham would bear a disproportionate amount of the increased costs associated with car travel for personal journeys. Many will choose to avoid entering the CAZ however some will need to enter the CAZ for work. Many key workers, for example NHS staff who work at the Birmingham Children's Hospital, may work night shifts and have more limited transport options. Since key workers provide essential services, it is recommended that they are considered for targeted mitigation.	It is recommended that mitigation is targeted at key workers who frequently work within the CAZ. People on low incomes are potentially more likely to work unsocial hours with more reliance on travel by car. Potential mitigation for these groups of people would take the form of a discount on the charge and a sunset period to allow sufficient time for key workers to change their vehicles to compliant models. Consideration should also be given to the availability, amenity and affordability of public transport, particularly at night. Additional financial support could be provided in the form of mobility credits or assistance with the purchase of a compliant vehicle with an option to make this support conditional on the individual scrapping their non-compliant vehicle. The parking charges proposed as Additional Measure could be restricted to the day only, so that they do not impose costs on those working in the night-time economy.
		Health (Air quality)	✔✔✔	Residents of LSOAs which fall within quintiles one for income deprivation relative to income distribution within England and Wales would experience a disproportionately greater amount of the benefits associated with reductions in atmospheric NO_2 concentrations than might be expected given the proportion of the study area population residing in these areas, and those within quintile one for income deprivation relative to the Birmingham distribution would experience a disproportionately greater amount of the benefits associated with all NO_2, PM_{10} and $PM_{2.5}$.	
	Within CAZ and surrounding areas	Personal affordability	✖✖✖	Low income households in the most deprived quintile would bear a disproportionately greater amount of the costs given the proportion of the population of the study area that are resident within this quintile. Many of the areas within and adjacent to the CAZ that would incur the highest costs if the preferred CAZ option were implemented are also areas with high levels of income deprivation. Those low-income households located within the CAZ and in close proximity to the CAZ would be particularly worst affected as due to their geographical location they would be least able to avoid entering and exiting the CAZ, for everyday journeys therefore incurring the CAZ charge and parking charges. The analysis has also identified that there is a higher proportion of non-compliant vehicles registered in the areas with the highest levels of income deprivation, meaning drivers from these areas are more likely to have to pay the charge.	It is recommended that mitigation is targeted at income deprived residents who live within the CAZ. Residents within the CAZ would not have the choices open to other residents in Birmingham of avoiding the zone when they are in their vehicle. Potential mitigation for these groups of people would take the form of a discount on the charge and a sunset period to allow residents with sufficient time to change their vehicles to compliant models. Consideration should also be given to the availability, amenity and affordability of public transport. It is also recommended that this group is included in any financial package as described above.
		Health (Air quality)	✔✔✔	As shown in Figure 7.4, the CAZ and surrounding areas would experience the greatest reduction in NO_2 concentrations within the study area.	
Disabled people	Across study area	Personal affordability	✖✖✖	Disabled people have lower average household income and the cost of upgrading wheelchair adapted private vehicles is higher, making them also particularly vulnerable to increases in the costs of community transport, taxis and private car travel.	The distributional analysis has identified a likelihood that there would be disproportionate adverse impact on disabled people, since there is a higher rate of non-compliant vehicles in 'disabled' tax class diesel cars. Furthermore, there is a disproportionate impact on owners of diesel powered wheelchair adapted vehicles since the cost of these adaptations is expensive, so these types of adapted vehicles tend to be kept or leased by their owners for longer than non-adapted vehicles. Some disabled people are less able to use other forms of
		Accessibility	✖✖✖	Disproportionate and differential adverse impact on disabled people who are both more reliant on taxis and community transport services for their accessibility needs and are less likely to be able to make use of active travel modes in preference to motorise transport. Disabled people would be adversely affected by implementation of the CAZ through the potential	

Social or business group (general)	Specific geographical location (if applicable and differs from study area) or other differentiating characteristic	Impacts			Suggested mitigation (where applicable)
		Variable	Impact	Commentary	
				reduction in availability of community transport and wheelchair adapted taxis, and also the potential increase in cost of community transport and private vehicle travel.	transport, for example public transport or cycling, and are therefore more dependent on car use. It is therefore recommended that mitigation is targeted at these groups. Potential mitigation would involve support for people on low-incomes and extended sunset periods for wheelchair adapted vehicles. The mitigation measures below for community transport and older people, also apply to disabled people.
Elderly people (over 65s)	Across study area	Accessibility	✖✖	A high proportion of elderly people have limited mobility and therefore would be adversely affected by implementation of the CAZ through the potential reduction in availability of community transport and taxis, and also the potential increase in cost of community transport and private vehicle travel.	Some of the mitigation measures suggested for disabled people will apply. Older people are also more likely to use community transport. The potentially costs for community transport operators could be mitigated through either a discount on the CAZ charge or an exemption. Mitigation for community transport providers is considered appropriate on the basis that these are often provided by small operators and local charities that provide important access to health and social care, employment, education and training for people who may otherwise be isolated.
Children	Across study area	Accessibility	✖✖	Where transport is not provided by the school or local authority, then there would be a differential adverse impact on children attending special educational needs schools if introduction of the CAZ discourages or prevents families from accessing these schools. There are also several community centres within the CAZ that have been identified as providing services used principally by children and which may require transport to and from the premises. Children would be adversely affected by any reduction in the availability of community transport servicing schools and community centres within the CAZ. They would also be adversely affected by the increased cost of community transport if this prevented them accessing schools and community centres within the CAZ, or if it prevented families of patients at Birmingham Children's Hospital from visiting them during their stay.	The mitigation measures above for community transport also apply to children. There may be a case for exemptions for frequent visits into the CAZ for family members visiting children in the hospital or where children have regular appointments.
		Health (Air quality)	✓✓	There would be a 26 % reduction in the number of schools and 21 % reduction in the number of other facilities frequently used by children (playgrounds, parks and areas of open space) where average NO_2 concentrations in excess of 30 µg/m^3 under the preferred CAZ option.	N/A
Women	Across study area	Accessibility	✖✖	Adverse differential impact on women, who as a group are less likely to have access to a car, are more frequent users of taxis and have a more negative perception or experience of alternative modes of public transport and active travel modes (walking and cycling).	Mitigation for taxis (below) will assist this group, as would improvements to amenity and availability of public transport.
Faith groups	Across study area	Affordability	✖✖	Congregants of those larger or more unique places of worship within the CAZ (e.g. Birmingham Central Mosque, Camp Hill Seventh Day Adventist Church, Birmingham City Church and Singer's Hill Synagogue. St Phillip's	Travel planning could help to improve awareness of transport options to get to these places of worship. Support for people on low incomes would also help a proportion of people within faith groups.

Social or business group (general)	Specific geographical location (if applicable and differs from study area) or other differentiating characteristic	Impacts			Suggested mitigation (where applicable)
		Variable	Impact	Commentary	
				Cathedral, Ramgharia Gudwara, St Chad's Roman Catholic Cathedral and Greek Orthodox Cathedral of the Dormition of Theotokos and St. Andreas) would be adversely affected if the increased cost of car travel dissuades them for attending their place of worship	The outline design process has enabled the City Council to ensure that the car park for the Central Mosque will not be affected by the CAZ charges as it is accessed directly from the Ring Road.
Business groups					
SMEs	Across study area	Affordability	✖	A very high proportion (99%) of businesses within the CAZ are SMEs making this type of business most likely to be affected by the proposals. Although only a minority of businesses within the CAZ will own or operate their own vehicles, virtually all businesses will be dependent on road transport, for example for deliveries. Some of these increases in costs from suppliers may be passed on to businesses and SMEs will typically be less able to absorb these increases.	These are examples of measures that could support businesses with the transition to compliant forms of transport, including overcoming barriers from lack of awareness of options. • Continue to roll out alternative fuel infrastructure, such as rapid charge EV charging points • Develop network of consolidation centres/micro-consolidations centres (last mile deliveries) • City Centre electric cart delivery service (from consolidation centres/micro-consolidation centres), for example, use of electric cargo bikes. • Supporting awareness raising targeted at SMEs to ensure they understand the types of compliant vehicles available and associated running costs and infrastructure and what financial support is available.
LGV/van dependent businesses	Within the CAZ (with company owned vehicles)		✖	Although the majority of the company owned van fleet is expected to be CAZ compliant by 2020 due to the high turnover of fleet, those with non-compliant vehicles are at financial risk if they cannot accommodate the additional capital costs to upgrade their fleet in their business plans.	These are examples of potential financial measures that could be consulted on. Some of these measures would be subject to the availability of government grants and funding • Continuation of plug-in grants (e.g. OLEV grant) to support businesses with the transition to ultra-low emission vehicles • Low cost loans for vehicle conversion or replacement • Temporary exemptions or discounts for business vehicles registered to businesses which enter the CAZ on regular basis (e.g. twice or more times per week). This could be restricted to a maximum of two vehicles per company. • Provide funding to support the operational costs of ULEV vehicles. • Temporary exemptions or discounts for LGV owners who are locked into lease or finance agreements that started before June 2018. This should be extended until the end of the lease contract. • Private van owners could be included in any measures targeted at low-income vehicle owners.
	Within the CAZ (with privately owned vehicles)		✖✖	There is a higher proportion of non-compliant vans which are privately owned than company owned, meaning there would be a differential impact on this group. However, a relatively low proportion enter/exit the CAZ five or more times per week.	
	Vehicles registered outside the CAZ		✖	There is a higher proportion of non-compliant vans registered in areas surrounding the CAZ. However, a relatively low proportion enter/exit the CAZ five or more times per week and of these, a number will be able to re-route and avoid the zone.	
Taxis	Registered in Birmingham		✖✖✖	90% of Birmingham's fleet will need to be replaced by 2020 but there is little incentive to upgrade to Euro 6 since the vehicles would need to be ULEV by 2026, and there are currently very few ULEV models available and all have high upfront costs. It is likely that many older drivers would choose to retire because they may feel that they would not be able to operate the new vehicle long enough to justify the upfront costs. Assuming most drivers will retire before the age of 70 and that they would want to use a vehicle for at	Without mitigation there is a risk that many taxi drivers would leave the profession. This would have consequential impacts for BAME and low-income communities, since a very high proportion of taxi drivers are from communities with high proportion of non-white residents and income deprived residents. Since taxis in Birmingham are all wheelchair accessible, whereas currently none of the private hire taxis are, a reduction in this type of vehicle will have an adverse impact on

Social or business group (general)	Specific geographical location (if applicable and differs from study area) or other differentiating characteristic	Impacts			Suggested mitigation (where applicable)
		Variable	Impact	Commentary	
				least 10 years, it is estimated that over 250 drivers may choose to retire as a result of these measures.	disabled people who may depend on them for access. It is therefore recommended that taxis are targeted for mitigation due to the combination of direct and indirect impacts arising from the proposed CAZ. Financial incentives could potentially be offered to assist drivers in purchasing a new vehicle. Taking into account that licensing conditions require all new or replacement vehicles to be ULEVs from 2021 the mitigation should be targeted at new ULEV taxis. Further work is required to understand the likely level of uptake different types of financial scheme may have, and to ensure that the proposals are within state aid rules. Potential financial schemes to mitigate impacts on taxi drivers: • Targeted scrappage scheme (encourage a shift from old diesel taxis to ULEV) • Purchase aid (grant to assist with upfront costs) • Incentive package (e.g. waiving taxi license fees or access fees, free public electric charging, funding vehicle testing fees and/or insurance) • Electric vehicle lease scheme (a number of vehicles bulk purchased and leased back to drivers at a favourable rate of repayment).
	Registered in Birmingham		**	There are more models of ULEV available at lower prices than for the taxi market.	
HGV operators serving Birmingham	Small operators		***	There are approximately 1,459 companies which are small operators (i.e. having 5 or fewer vehicles in their fleet) operating in Birmingham. These businesses are most at risk of CAZ charges as their small fleets means they lack the flexibility to redistribute their vehicles to areas outside of the CAZ and they are likely to find the CAZ charges prohibitively expensive if they make journeys into the CAZ on a frequent basis. There is currently no market offering for a retrofit solution for HGVs and small operators may lack the capital for the upfront purchase of new CAZ compliant vehicles. Smaller fleets mean these operators are less able to redistribute vehicles to avoid the charge, and they may lack capital for upfront costs of vehicle replacement. These represent a relatively high proportion of HGV businesses.	Some of the measures that could support HGV operators. • Low cost loans for vehicle conversion or replacement • Financial assistance to contribute to either a compliant vehicle or retrofitting a non-compliant vehicle with an accredited technology (if available) • Temporary exemptions or discounts for business vehicles registered to businesses which enter the CAZ on regular basis (e.g. twice or more times per week). This could be restricted to a maximum of two vehicles per company.
Wider West Midlands					
Low income groups who enter the CAZ on a regular basis	Income deprived residents of Sandwell who commute to CAZ by car	Affordability	***	Sandwell has relatively high levels of income deprivation as well as a relatively high proportion (6%) of its working population that regularly commutes to the CAZ area by car. Due to its close proximity (within 3km) to the CAZ it is likely that income deprived people in Sandwell would be disproportionately affected compared with those in other districts in the wider West Midlands. This is because income deprived people typically travel shorter distances to work than those on higher incomes and a greater proportion of Sandwell's residents are more likely to have non-compliant cars.	Potential mitigation could include: • Support for low income households who need to enter the CAZ regularly • Working with public transport operators to ensure that there are sufficient services (at appropriate times and fares) to provide good alternative transport options for commuters in the wider West Midlands, particularly Sandwell

9. Glossary

AADT	Annual Average Daily Traffic The total volume of vehicle traffic of a highway or road for a year divided by 365 days.
ANPR	Automatic Number Plate Recognition A surveillance technology which uses optical character recognition on camera images to read a vehicle's number plate.
BAME	Black, Asian and minority ethnic.
CAZ	Clean Air Zone A Clean Air Zone is an area where targeted action is taken to improve air quality. Clean Air Zones aim to reduce all types of air pollution, including nitrogen dioxide and particulate matter, so that people breathe in less of all these pollutants.
DfT	Department for Transport
Differential impact	Impacts which vary according to the circumstances of groups that receive the impact. For example, some types of vehicle can be retrofitted to meet the CAZ standard whereas others cannot. Those that depend on vehicles that cannot be retrofitted would be affected differently as their choice of response to the CAZ is more limited.
Disproportionate impact	Impacts on a certain group which are out of proportion. For example, if a certain type of business would incur 50% of charges related to the CAZ but only make up 20% of business journeys in the CAZ, the impact would be disproportionate, as it would be expected to incur 20% of the charges if the option's impact were proportionate.
Grouping variables	The variables used to define different groups (e.g. level of income deprivation or business size).
Taxis	The term 'taxi' is relatively modern. It was first used in legislation in the Transport Act 1980, where section 64(3) defines a taxi in the same terms as a 'hackney carriage'. Most of the legislation and case law still refers to taxis as 'hackney carriages' There are two trades providing driver and car hire: taxis (hackney carriages), and private hire vehicles (PHVs or 'minicabs'). The main difference between the two is that taxis ply for hire from taxi ranks and can be hired in the street whereas private hire vehicles must be pre-booked electronically, by telephone or calling in person at an office.

HDVs	Heavy-Duty Vehicles Trucks, buses, and coaches
HGVs	Heavy Goods Vehicle Heavy goods vehicles are those with a total weight above 3,500 kg. (vehicle + load). A heavy goods vehicle is a large vehicle intended for the transportation of heavy loads. Drivers of these vehicles must have a special training and license.
Impact variables	The variables that change as a result of the option (e.g. air quality or affordability).
JAQU	Joint Air Quality Unit The joint unit between the Department for the Environment, Food and Rural Affairs (Defra) and the Department for Transport (DfT) delivers national plans to improve air quality and meet EU limits.
PHV	Private Hire Vehicle A private hire vehicle (PHV) was described in the original 1998 Act as a 'vehicle constructed or adapted to seat fewer than nine passengers which is made available with a driver to the public for hire for the purpose of carrying passengers'.
LGVs	Light Goods Vehicle Four wheel vehicles constructed for transporting goods. Must have a gross weight of 3.5 tonnes or less.
LPG vehicles	Liquid Petroleum Gas LPG vehicles are generally converted from petrol-fuelled cars, either by the original manufacturer or by an aftermarket converter. For practicality LPG vehicles tend to be bi-fuel, meaning that they can run on either petrol or the gaseous fuel. LPG vehicles tend to fall between petrol and diesel in CO_2 performance due to the lower carbon and higher energy content by mass of the fuel.
OLEV	Office of Low Emission Vehicles The UK Government department that works across government to support the early market for ultra-low emission vehicles.
Options	The short-listed options under consideration by Birmingham City Council to achieve NO_2 compliance. The shortlisted options have each been considered as part of the distributional impact appraisal.

SME	Small and Medium-sized Enterprise The usual definition of small and medium sized enterprises (SMEs) is any business with fewer than 250 employees. Micro-businesses are business with 0-9 employees, small are businesses with less than 50 employees and medium sized businesses are those with less than 250 employees.
SOA (LSOA and MSOA)	Super Output Area SOAs were designed to improve the reporting of small area statistics and are built up from groups of output areas (OA). There are statistics for lower layer super output areas (LSOA) and middle layer super output areas (MSOA). LSOA have a population between 1000 -3000 and households of 400-1200. MSOAs have a population between 5000 – 15,000 and from 2000 – 6000 households.
TCO	Total Cost of Ownership Total Cost of Ownership (TCO) is an analysis meant to uncover all the lifetime costs that follow from owning certain kinds of assets. Asset ownership brings purchase costs but owning also brings costs due to installing, deploying, using, upgrading, and maintaining the same assets.
TUBA	Transport Users Benefit Appraisal program. TUBA software performs transport scheme economic appraisals in accordance with the Department for Transport's transport appraisal guidance.
UHI	Urban Heat Island An urban heat island is a man-made area that's significantly warmer than the surrounding countryside - especially at night. Heat islands exist because the land surface in towns and cities, which is made of materials like Tarmac and stone, absorbs and stores heat. That, coupled with concentrated energy use and less ventilation than in rural areas, creates a heating effect.
ULEV	Ultra-Low Emission Vehicles The collective term for battery electric vehicles, plug-in hybrid vehicles, range-extender electric vehicles and hydrogen fuel cell electric vehicles.

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Appendix A. Appraisal Tables

A.1 Social Impacts

Table A.1.1 Personal Affordability Appraisal Table - Income Deprivation Relative to England and Wales Distribution

	Option	Quintile					Total
		1	2	3	4	5	
Total increase in user charges (ΣLSOAs)	CAZ C High	120,576	37,244	29,624	6,082	12,410	205,936
	CAZ D High	524,178	240,623	182,550	50,896	19,913	977,500
	CAZ C High + AM	113,819	44,203	33,777	5,637	6,608	204,044
	CAZ D High + AM	759,942	256,135	205,016	58,484	46,232	1,325,808
Total decrease in user charges (ΣLSOAs)	CAZ C High	-	-	-	-	-	-
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	-	-	-	-	-	-
	CAZ D High + AM	-	-	-	-	-	-
Share of user charge increase (%)	CAZ C High	58.6	18.1	14.4	3.0	6.0	100
	CAZ D High	51.5	23.6	17.9	5.0	2.0	100
	CAZ C High + AM	55.8	21.7	16.6	2.8	3.2	100
	CAZ D High + AM	57.3	19.3	15.5	4.4	3.5	100
Share of user charge decrease (%)	CAZ C High	-	-	-	-	-	-
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	-	-	-	-	-	-
	CAZ D High + AM	-	-	-	-	100	100
Share of population in study area	All	54.4	17.7	14.9	6.4	6.6	100
Assessment	CAZ C High	xx	xx	xx	xx	xx	-
	CAZ D High	xx	xxx	xx	xx	xx	-
	CAZ C High + AM	xx	xx	xx	xx	xx	-
	CAZ D High + AM	xx	xx	xx	xx	xx	-

Table A.1.2 Personal Affordability Appraisal Table - Income Deprivation Relative to Birmingham Distribution

	Option	Quintile					Total
		1	2	3	4	5	
Total increase in user charges (ΣLSOAs)	CAZ C High	60,214	37,570	34,988	43,962	29,202	205,936
	CAZ D High	197,549	191,394	220,035	267,878	141,301	977,500
	CAZ C High + AM	49,242	38,807	41,591	50,017	24,388	204,044
	CAZ D High + AM	338,468	242,226	275,404	287,609	182,101	1,325,808
Total decrease in user charges (ΣLSOAs)	CAZ C High	-	-	-	-	-	-
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	-	-	-	-	-	-
	CAZ D High + AM	-	-	-	-	-	-
Share of user charge increase (%)	CAZ C High	29.2	18.2	17.0	21.3	14.2	100
	CAZ D High	19.4	18.8	21.6	26.3	13.9	100
	CAZ C High + AM	24.1	19.0	20.4	24.5	12.0	100
	CAZ D High + AM	25.5	18.3	20.8	21.7	13.7	100
Share of user charge decrease (%)	CAZ C High	-	-	-	-	-	-
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	-	-	-	-	-	-
	CAZ D High + AM	-	-	-	-	-	-
Share of population in study area	All	19.4	20.4	19.9	20.2	20.1	100
Assessment	CAZ C High	xxx	xx	xx	xx	x	-
	CAZ D High	xx	xx	xx	xx	x	-
	CAZ C High + AM	xx	xx	xx	xx	x	-
	CAZ D High + AM	xxx	xx	xx	xx	x	-

Table A.1.3 User Benefits Appraisal Table - Income Deprivation Relative to England and Wales Distribution

	Option	Quintile					Total
		1	2	3	4	5	
Total benefits (ΣLSOAs)	CAZ C High	1,998	1,367	1,203	-	-	4,568
	CAZ D High	878,953	197,779	178,586	82,780	320,002	1,658,100
	CAZ C High + AM	-	-	-	2,981	20,899	23,880
	CAZ D High + AM						
Total disbenefits (ΣLSOAs)	CAZ C High	-	-	-	125	365	490
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	2,131	4,259	5,064	-	-	11,454
	CAZ D High + AM						
Share of user benefits (%)	CAZ C High	43.7	29.9	26.3	-	-	100
	CAZ D High	53.0	11.9	10.8	5.0	19.3	100
	CAZ C High + AM	-	-	-	12.5	87.5	100
	CAZ D High + AM	18.6	37.2	44.2	-	-	100
Share of user disbenefits (%)	CAZ C High	-	-	-	25.5	74.5	100
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	18.6	37.2	44.2	-	-	-
	CAZ D High + AM	-	-	-	-	-	-
Share of population in study area	All	54.4	17.7	14.9	6.4	6.6	100
Assessment	CAZ C High	✓	✓✓✓	✓✓✓	xxx	xxx	n/a
	CAZ D High	✓✓	✓	✓✓	✓✓	✓✓✓	n/a
	CAZ C High + AM	x	xxx	xxx	✓✓	✓✓✓	n/a
	CAZ D High + AM						n/a

Table A.1.4 User Benefits Appraisal Table - Income Deprivation Relative to Birmingham Distribution

	Option	Quintile					Total
		1	2	3	4	5	
Total benefits (ΣLSOAs)	CAZ C High	2,186	-	209	1,598	1,133	5,126
	CAZ D High	406,196	300,557	216,356	235,027	499,963	1,658,100
	CAZ C High + AM	-	4,390	-	-	24,936	29,327
	CAZ D High + AM	430,899	333,971	173,487	250,964	521,985	1,711,306
Total disbenefits (ΣLSOAs)	CAZ C High	-	68	-	-	-	68
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	2,869	-	7,627	-404	-	16,901
	CAZ D High + AM	-	-	-	-	-	-
Share of user benefits (%)	CAZ C High	42.6	-	4.1	31.2	22.1	100
	CAZ D High	24.5	18.1	13.0	14.2	30.2	100
	CAZ C High + AM	-	15.0	-	-	85.0	100
	CAZ D High + AM	25.2	19.5	10.1	14.7	30.5	100
Share of user disbenefits (%)	CAZ C High	-	100	-	-	-	100
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	17.0	-	45.1	37.9	-	100
	CAZ D High + AM	-	-	-	-	-	-
Share of population in study area	All	19.4	20.4	19.9	20.2	20.1	100
Assessment	CAZ C High	✓✓✓	xxx	✓	✓✓✓	✓	n/a
	CAZ D High	✓✓✓	✓✓	✓	✓	✓✓✓	n/a
	CAZ C High + AM	xx	✓✓✓	xxx	xxx	✓✓✓	n/a
	CAZ D High + AM	✓✓✓	✓✓	✓	✓	✓✓✓	n/a

A.2 Business Impacts

Table A.2.1: Business Affordability (SMEs)

	Option	Quintile					Total
		1	2	3	4	5	
Total increase in user charges (ΣLSOAs)	CAZ C High	282,851	50,095	41,619	64,265	60,449	499,279
	CAZ D High	587,038	361,515	388,076	407,744	233,329	1,997,703
	CAZ C High + AM	1,150,460	372,379	85,606	397,335	228,618	2,534,398
	CAZ D High + AM	987,503	796,175	369,074	380,043	122,771	2,655,566
Total decrease in user charges (ΣLSOAs)	CAZ C High	-	-	-	-	-	-
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	-	-	-	-	-	-
	CAZ D High + AM	-	-	-	-	-	-
Share of user charge increase (%)	CAZ C High	57	10	8	13	12	100
	CAZ D High	29.7	18.3	19.6	20.6	11.8	100
	CAZ C High + AM	45.4	14.7	15.2	15.7	9.0	100
	CAZ D High + AM	37.2	30.0	13.9	14.3	4.6	100
Share of user charge decrease (%)	CAZ C High	-	-	-	-	-	-
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	-	-	-	-	-	-
	CAZ D High + AM	-	-	-	-	-	-
Share of SMEs in study area	All	52	19	13	10	7	100
Assessment	CAZ C High	xx	x	xx	xx	xx	-
	CAZ D High	x	xx	xxx	xxx	xx	-
	CAZ C High + AM	x	xx	xx	xxx	xx	-
	CAZ D High + AM	x	xxx	xx	xxx	xx	-

Table A.2.2: Business Affordability (LGVs)

	Option	Quintile					Total
		1	2	3	4	5	
Total increase in user charges (ΣLSOAs)	CAZ C High	321,776	101,390	38,413	19,043	18,656	499,279
	CAZ D High	903,985	337,396	347,255	213,246	175,821	1,997,703
	CAZ C High + AM	1,335,968	377,302	384,642	216,710	219,776	2,534,398
	CAZ D High + AM	1,214,862	450,089	485,384	274,467	230,766	2,655,566
Total decrease in user charges (ΣLSOAs)	CAZ C High	-	-	-	-	-	-
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	-	-	-	-	-	-
	CAZ D High + AM	-	-	-	-	-	-
Share of user charge increase (%)	CAZ C High	64	20	8	4	4	100
	CAZ D High	46	17	18	11	9	100
	CAZ C High + AM	52.7	14.9	15.2	8.6	87	100
	CAZ D High + AM	46	17	18	10	9	100
Share of user charge decrease (%)	CAZ C High	-	-	-	-	-	-
	CAZ D High	-	-	-	-	-	-
	CAZ C High + AM	-	-	-	-	-	-
	CAZ D High + AM	-	-	-	-	-	-
Share of LGVs in study area	All	86	5	4	3	2	100
Assessment	CAZ C High	x	xxx	xx	xx	xx	-
	CAZ D High	x	xxx	xxx	xxx	xxx	-
	CAZ C High + AM	x	xxx	xxx	xxx	xxx	
	CAZ D High + AM	x	xxx	xxx	xxx	xxx	-

A.3 Health Impacts

Table A.3.1 Air Quality Appraisal Table - Income Distribution Relative to England and Wales Distribution

	Option	Quintile					Total
		1	2	3	4	5	
Total increased costs (ΣLSOAs)	CAZ C High	No data available					
	CAZ D High	0	0	0	0	0	0
		0	0	0	0	0	0
		0	0	0	0	0	0
	CAZ C High plus AM	No data available					
	CAZ D High plus AM	0	0	0	0	0	0
		0	0	0	0	0	0
		0	0	0	0	0	0
Total decreased costs (ΣLSOAs)	CAZ C High	No data available					
	CAZ D High	1,216,770	226,926	229,218	63,206	231,609	1,967,729
		546,796	131,270	122,007	34,434	96,677	931,185
		476,351	108,840	107,486	29,178	82,226	2,898,914
	CAZ C High plus AM	No data available					
	CAZ D High plus AM	1,317,447	247,373	250,500	69,751	245,562	2,130,632
		663,143	152,230	145,618	42,505	112,498	1,115,993
		540,224	122,979	124,930	34,696	91,454	914,282
Share of increased costs (%)	CAZ C High	No data available					
	CAZ D High	-	-	-	-	-	-
		-	-	-	-	-	-
		-	-	-	-	-	-
	CAZ C High plus AM	No data available					
	CAZ D High plus AM	-	-	-	-	-	-
		-	-	-	-	-	-
		-	-	-	-	-	-
Share of decreased costs (%)	CAZ C High	No data available					
	CAZ D High	61.8	11.5	11.7	3.2	11.8	100

	Option	Quintile					Total
		1	2	3	4	5	
		58.7	14.1	13.1	3.7	10.4	100
		59.2	13.5	13.4	3.6	10.2	100
	CAZ C High plus AM	No data available					
	CAZ D High plus AM	61.8	11.6	11.8	3.3	11.5	100
		59.4	13.6	13.1	3.8	10.1	100
		54.8	17.6	14.7	6.1	6.8	100
Share of population in study area	CAZ C High	54.8	17.6	14.7	6.1	6.8	100
	CAZ D High						
	CAZ C High plus AM						
	CAZ D High plus AM						
Assessment	CAZ C High	No data available					
	CAZ D High	✓✓✓	✓	✓✓	✓✓	✓✓	n/a
		✓✓	✓✓	✓✓	✓✓	✓✓	
		✓✓	✓✓	✓✓	✓✓	✓✓	
	CAZ C High plus AM	No data available					
	CAZ D High plus AM	✓✓✓	✓	✓✓	✓✓	✓✓	n/a
		✓✓	✓✓	✓✓	✓✓	✓✓	
		✓✓	✓✓	✓✓	✓✓	✓✓	

- Data presented in black reflects monetised impacts for NO_2 mortality
- Data presented in red reflects monetised impacts for PM_{10} mortality, respiratory hospital admissions, cardiovascular hospital admissions and productivity.
- Data presented in blue refers to PM2.5 mortality, respiratory hospital admissions, cardiovascular hospital admissions and productivity.

Table A.3.2 Air Quality Appraisal Table - Income Deprivation Relative to Birmingham Distribution

	Option	Quintile					Total
		1	2	3	4	5	
Total increased costs (ΣLSOAs)	CAZ C High	No data available					
	CAZ D High	0	0	0	0	0	0
		0	0	0	0	0	0
		0	0	0	0	0	0
	CAZ C High plus AM	No data available					
	CAZ D High plus AM	0	0	0	0	0	0
		0	0	0	0	0	0
		0	0	0	0	0	0
Total decreased costs (ΣLSOAs)	CAZ C High	No data available					
	CAZ D High	632,225	392,503	275,295	287,384	380,322	1,967,729
		250,585	190,144	160,106	150,048	180,301	931,185
		224,198	161,543	135,124	129,566	560,623	2,898,914
	CAZ C High plus AM	No data available					
	CAZ D High plus AM	681,889	425,576	301,474	313,290	408,404	2,130,632
		308,656	228,397	187,773	178,693	212,474	1,115,993
		246,524	187,981	155,309	150,045	174,423	914,282
Share of increased costs (%)	CAZ C High	No data available					
	CAZ D High	-	-	-	-	-	-
		-	-	-	-	-	-
		-	-	-	-	-	-
	CAZ C High plus AM	No data available					
	CAZ D High plus AM	-	-	-	-	-	-
		-	-	-	-	-	-
		-	-	-	-	-	-
Share of decreased costs (%)	CAZ C High	No data available					
	CAZ D High	32.0	20.0	14.1	14.7	19.2	100
		27.7	20.5	16.8	16.0	19.0	100

	Option	Quintile					Total
		1	2	3	4	5	
		27.9	20.1	16.8	16.1	19.1	100
	CAZ C High plus AM	No data available					
	CAZ D High plus AM	32.0	20.0	14.1	14.7	19.2	100
		27.7	20.5	16.8	16.0	19.0	100
		27.0	20.6	17.0	16.4	19.1	100
Share of population in study area	All	21.0	20.7	20.0	18.9	19.4	100
Assessment	CAZ C High	No data available					
	CAZ D High	✓✓✓	✓✓	✓	✓✓	✓✓	n/a
		✓✓✓	✓✓	✓✓	✓✓	✓✓	
		✓✓✓	✓✓	✓✓	✓✓	✓✓	
	CAZ C High plus AM	No data available					
	CAZ D High plus AM	✓✓✓	✓✓	✓	✓✓	✓✓	n/a
		✓✓✓	✓✓	✓✓	✓✓	✓✓	
		✓✓✓	✓✓	✓✓	✓✓	✓✓	

- Data presented in black reflects monetised impacts for NO_2 mortality
- Data presented in red reflects monetised impacts for PM_{10} mortality, respiratory hospital admissions, cardiovascular hospital admissions and productivity.
- Data presented in blue refers to $PM_{2.5}$ mortality, respiratory hospital admissions, cardiovascular hospital admissions and productivity.

Appendix B. Oversize Figures