Greater Manchester's Outline Business Case to tackle Nitrogen Dioxide Exceedances at the Roadside

Economic Case

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2.1 Introducing the Economic Case

2.1.1 The purpose of the Economic Case is to: explore the change that is likely as a result of the proposed Greater Manchester Clean Air Plan (GM CAP); describe the costs and benefits of this change; and identify the possible impacts on the people, businesses and economy of Greater Manchester. Each Option examined here includes a set of measures that include a Clean Air Zone, the analysis has considered the full GM CAP as a combined holistic plan and therefore results presented consider the full impact of all the measures in each option combined. At present, the proposals are in a draft stage and the detailed design is yet to be developed. A 'conversation' followed by formal consultation with stakeholders and the public later in 2019, supplemented by new research, analysis and technical design work will provide a better understanding of how the proposals will work. This Economic Case indicates the benefits of action, and highlights issues that will need to be addressed in the detailed scheme design and Full Business Case (FBC) stage.

2.1.2 Usually, an Economic Case drives the decision-making process; the proposal with the strongest ratio of costs to benefits is the preferred option and a scheme which does not appear to 'add up' is less likely to proceed. Here, the imperative to act is different: poor air quality is a public health emergency in Greater Manchester. Some of the costs of this health crisis can be quantified, but many more cannot – the lifelong impact of chronic ill-health pervades all aspects of people's lives and wellbeing. The drive to action is to save lives. Eight of Greater Manchester's local authorities are under a legal directive (Directive 2008/50/EC) to produce a Clean Air Plan that delivers compliance with EU Limit Values in the 'shortest possible time'; this directive does not allow for a standard cost-benefit analysis but demands that **where we can act, we must do so**. As the key driver for the adoption of a Clean Air Plan (CAP) is NO_2 compliance in the shortest possible time, every other criterion is secondary in the decision-making process.

2.1.3 The results presented here illustrate the total economic cost to the UK economy as far as this can be quantified at this stage, as well as the net effect on the Greater Manchester area. For this purpose, some impacts are captured and presented that would not appear in a standard economic appraisal, in order to better understand the gains and losses at a local level. Beyond this, it is clear that more work will be required at FBC to properly understand the impacts of the proposals on the local economy and identify the mitigations necessary.

2.1.4 It is vital that any action does not serve to worsen the prospects of Greater Manchester's poorest and most vulnerable residents. The proposed GM CAP should not worsen access to employment, or risk putting small local enterprises out of business. Where the appraisal presented here has identified causes for concern, action will be taken in the next phase of developing the proposals to identify what changes or mitigation Measures may be required. Greater Manchester's authorities will start a conversation with local residents and businesses to better understand how poor air quality affects them, how they view the Measures proposed, what impacts these Measures might have on them or their business, for example what support they need to help them upgrade their vehicles or change their behaviour.

2.1.5 A summary of the economic impacts is presented, followed by a high-level analysis of how these impacts will be felt across different groups in society (Distributional Impacts). The remainder of the chapter introduces the methodology underpinning the economic appraisal, as well as more detailed results, and concludes with key messages and next steps for refining the appraisal for the FBC.

2.2 Introduction

2.2.1 This chapter sets out the Economic Case for the preferred option and the economic appraisal undertaken for the three best-performing options to address NO_2 exceedances in Greater Manchester. As set out in the Strategic Case (Section 1.7), Option 8 has been assessed as delivering compliance with EU Limit Values in the same year as Options 5(i) and 5(ii), and imposes a lesser impact on businesses and people. Therefore, this Economic Case describes the costs and benefits of Option 8 as the proposed GM CAP and compares these to the other options that deliver compliance in the shortest possible time, Options 5(i) and 5(ii).

2.2.2 The Economic Case sets out how behaviour is likely to change as a result of the proposed GM CAP and what the impacts of this change could be on Greater Manchester's residents, workers and businesses. As the proposals are in an early stage of development, still subject to public consultation and considerable refinement, these impacts are not yet fully understood and should be considered as potential causes for concern which will be further investigated at FBC stage, with mitigations sought.

2.2.3 The Economic Case considers the likely impacts and costs of the GM CAP and includes appraisal of the following:

- distribution of air quality improvements across the Greater Manchester area;
- health and environmental benefits from the air quality improvements, and the distributional analysis of these, savings for health and social care services and the wider benefits of improved health;
- environmental benefits of reduced greenhouse gas emissions;
- costs to the public sector and impact on revenues;

- travel time savings arising from reduced congestion and the Distributional Impacts of these;
- impacts of mode shift including welfare loss; and the health benefits from increased active travel;
- costs imposed by cancelled trips by people who decide not to travel rather than pay a charge;
- costs and benefits of upgrading the vehicle fleet;
- costs imposed by user charges and the Distributional Impacts on affordability for people and businesses; and
- positive and negative impacts on the local economy.

2.2.4 The GM CAP should be treated as one package as it is considered essential that all components are delivered. Different aspects of the GM CAP complement and enhance each other and so removing part of the scheme could negatively impact another part. This is reflected in the approach to assessing the proposals, where all aspects have been modelled as a package. Component Measures have not been assessed individually due to the critical inter-dependencies of the various Measures.

2.2.5 This Economic Case has been produced in line with the Joint Air Quality Unit's (JAQU) guidance. This approach differs from standard transport appraisal.

2.2.6 A positive Net Present Value (NPV) is difficult to achieve given the short appraisal period of just ten years, and the fact that it is easier to fully quantify the costs (such as the costs of vehicle upgrade) than the benefits which depend on complex relationships between NO_2 concentrations and health outcomes. With this in mind, the Economic Case has been structured in order to itemise, quantify and where possible, monetise the impacts of the best-performing options in the recognition that none of the best-performing options achieve a positive NPV.

2.2.7 The monetised cost and benefits of the options have been calculated to assess the NPV and cost-effectiveness of each option, based on a ten-year appraisal period. In all instances, costs and benefits are assessed against a baseline scenario in which no action beyond the funded plans is taken. However, this should not be considered a true 'Do Minimum' scenario. There is a legal imperative to act. Failure to act, or to act effectively in order to deliver compliance in the shortest possible time, will leave Greater Manchester's local authorities in breach of the Ministerial direction.

2.2.8 A Distributional Impact (DI) appraisal of the GM CAP was undertaken to understand how positive and adverse impacts of the proposed GM CAP are distributed across specific social groups compared to the general population. An indicative Equality Impact Assessment (EQIA) has also been completed (see Appendix EX), however it is noted that further and fuller assessment of economic and equalities impacts will be required at FBC stage. There remains much we do not know about the possible impacts of the proposals, particularly on low income workers; key business sectors such as retail and leisure, transport and distribution; and on small local businesses. A programme of research, analysis, public and stakeholder engagement and a thorough integrated impact assessment has commenced and will be continued throughout 2019.

2.2.9 The economic and DI appraisals have been prepared in accordance with the JAQU Options Appraisal Guidance[1] (2017). However, the presentation and interpretation of results have been adapted to reflect local circumstances. A table showing where all the required components sit in the document is provided at the back of the Economic Case.

2.2.10 The remainder of this chapter is structured as follows:

- Section 2.3 sets out the purpose of the Economic Case;
- Section 2.4 describes the options being appraised as part of the Economic Case;
- Section 2.5 describes the behaviour change generated by the proposed GM CAP;
- Section 2.6 presents the economic impacts of the proposed GM CAP, including the Distributional Impacts analysis of the options;
- Section 2.7 provides summary tables of costs and benefits;
- Section 2.8 sets out the methodology applied in the quantification of economic impacts;
- Section 2.9 discusses the limitations of the analysis;
- Section 2.10 provides a summary of key conclusions and of the performance against the critical success factors.

2.3 Purpose of the Economic Case

2.3.1 The Economic Case serves two primary purposes. It supports the decision making for the preferred option from the three best performing options and identifies whether the preferred option offers Value for Money.

[1] Unpublished Guidance by JAQU to cities under Ministerial direction

2.3.2 In addition, it provides the evidence to inform the assessment in the Strategic Case of best-performing options against the relevant Critical Success Factors as part of the overall process of identifying the best-performing option (see Section 1.7 of the Strategic Case).

2.3.3 The role of the economic appraisal is therefore to describe the proposed GM CAP in terms of the total air quality benefit, wider social and economic impacts and the extent to which it offers good Value for Money within the parameters considered, and to compare this with the rejected best-performing options.

2.3.4 At this stage, a further purpose of the Economic Case is to identify questions and issues to be investigated as part of the FBC and through continued engagement with stakeholders.

2.4 Options for appraisal in the Economic Case

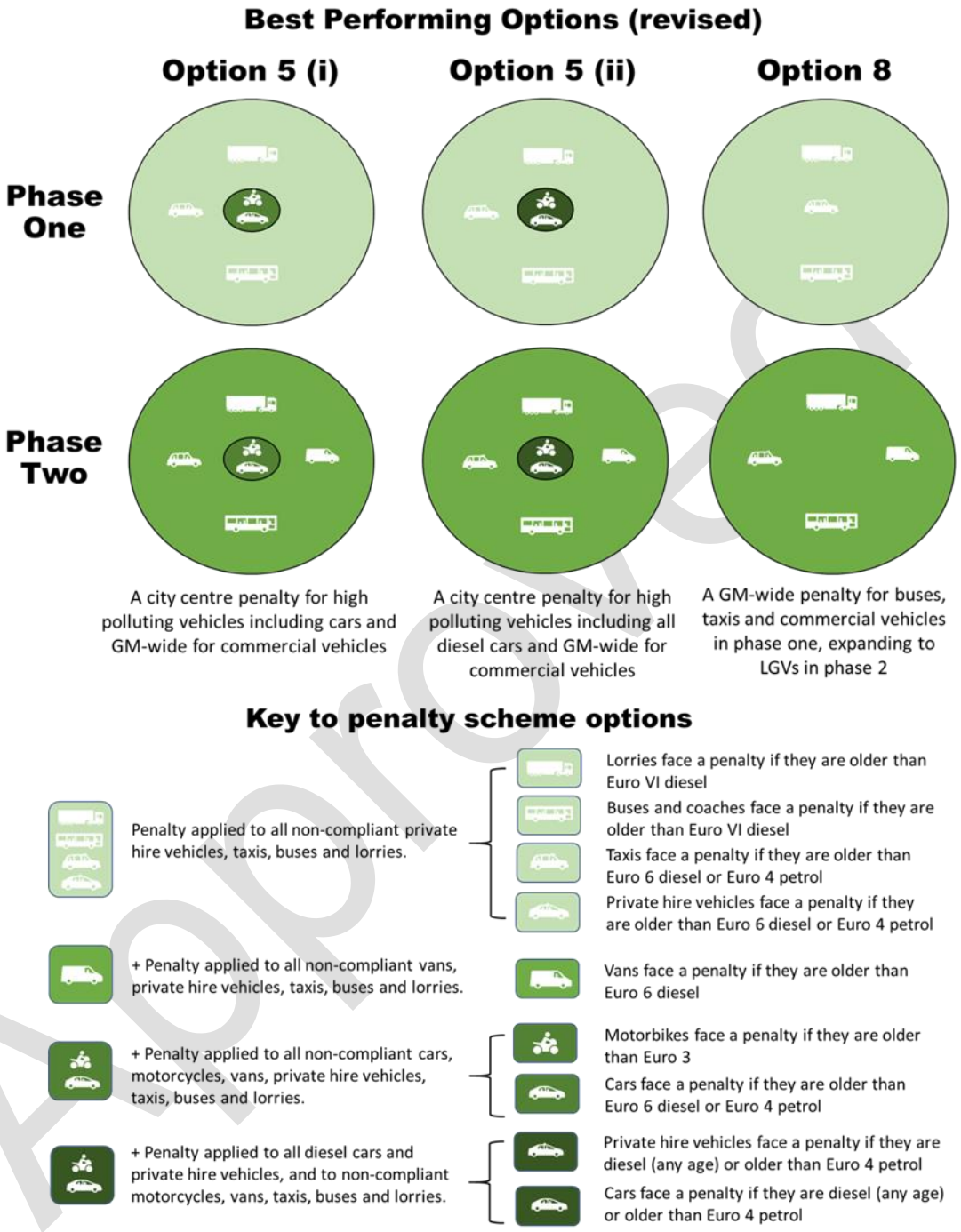
2.4.1 As set out in the Strategic Case (see Section 1.6.21 and 1.6.24) the three best-performing options that were taken forward for full appraisal can be summarised as follows:

- **Option 5(i):** a Clean Air Zone (CAZ) Category D[2] within the Inner Relief Route (IRR) to be delivered in Phase 1 alongside a CAZ Category B across Greater Manchester. In Phase 2, the CAZ across Greater Manchester extends to a Category C. The CAZ proposals are included alongside required Measures to communicate the message, promote cleaner vehicles and help people, businesses and bus operators upgrade.
- **Option 5(ii):** An enhanced CAZ Category D+ within the IRR such that all diesel cars and private hire vehicles would be subject to a penalty as well as non-compliant petrol vehicles and larger diesel vehicles older than Euro VI reflecting that even compliant diesel cars have higher emissions affecting air quality than their petrol equivalents. To be delivered in Phase 1 alongside a CAZ Category B across Greater Manchester. In Phase 2, the CAZ across Greater Manchester extends to a Category C. The CAZ proposals are included alongside required Measures to communicate the message, promote cleaner vehicles and help people, businesses and bus operators upgrade.
- **Option 8:** A CAZ Category B across Greater Manchester implemented as Phase 1. In Phase 2, the CAZ across Greater Manchester extends to a Category C. The CAZ proposals are included alongside required Measures to communicate the message, promote cleaner vehicles and help businesses and bus operators upgrade.

[2] See 'What is a Clean Air Zone?' in Strategic Case for details of categories

2.4.2 These are illustrated in Figure 2- 1 below.

Figure 2- 1: Best performing options included in full economic appraisal process



2.4.3 The Measures contained in each of the best-performing options are shown in Table 2- 1 below.

Table 2- 1: Best-performing options: Measures included in each option

	Measure	Option 5(i)	Option 5(ii)	Option 8
Communicating the message	Communications	✓	✓	✓
	Sustainable Journeys programme	✓	✓	✓
Promoting cleaner vehicles	Provision of 300 dual-headed Electric Vehicle (EV) charging points GM wide	✓	✓	✓
	Promotion of EV	✓	✓	✓
Helping business and bus operators upgrade	Clean Air Funds Upgrade Car	✓	✓	
	Clean Air Funds Upgrade Freight / Commercial vehicles	✓	✓	✓
	Clean Air Funds Upgrade Taxis and Private Hire Vehicles (PHV)	✓	✓	✓
	Clean Air Funds Upgrade Buses	✓	✓	✓
	Loan Finance	✓	✓	✓
Clean Air Zones	City Centre CAZ D	✓		
	City Centre CAZ D+		✓	
	CAZ B/C across GM	✓	✓	✓
	Discounts and exemptions for CAZ	✓	✓	✓

2.4.4 Modelling suggests that the earliest that compliance can be achieved is 2024, approximately three years earlier than would be expected without further action. All Options are predicted to deliver compliance in 2024 and will reduce human exposure to pollutants damaging to health over the lifetime of the Plan. It is also considered to be the most feasible and therefore the most likely to deliver these benefits at the lowest risk; and to incur the least economic cost. By not including any restrictions on cars in the CAZ and providing support to small businesses, sole traders and not-for-profit organisations, including taxi and private hire drivers, the risk of socioeconomic damage is significantly lower in Option 8 than the alternatives.

2.5 Behaviour change generated by the proposed GM CAP

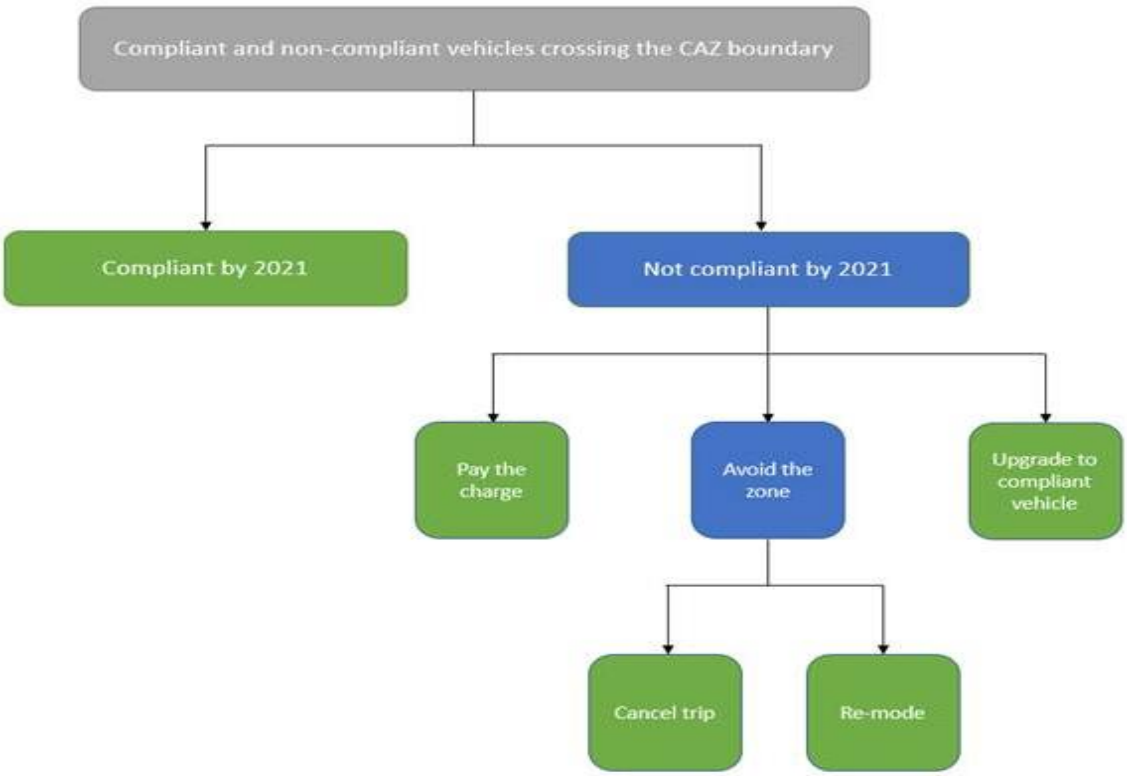
2.5.1 This section describes how drivers are predicted to respond to the proposals in the GM CAP and what behaviour change is generated. To establish the impact of the proposed GM CAP on traffic, the fleet and therefore emissions, estimates were produced of the possible behavioural response of transport users. The methodology for deriving these estimates is set out in the associated Technical Supporting Document, T4.

2.5.2 The nature of the proposals means that some but not all vehicles will face a daily charge for travelling in parts of Greater Manchester. The modelling has assessed what proportion of vehicles are likely to be non-compliant, and therefore 'in scope' for a charge, and how they might respond. This analysis has taken account of the impact of other proposed Measures including the retrofit/upgrade of buses and taxis, increased uptake of electric vehicles arising from investment in charging points, and financial support for the upgrade of vans. Only limited account has been taken at this stage for the proposed financial support for upgrade of other vehicles. The possible impact of discounts and exemptions has not been modelled at this stage. This means that the number of vehicles 'in-scope' is likely to be an over-estimate as some would benefit from discounts or exemptions.

2.5.3 For those vehicles that are 'in scope' for a daily charge, there are a number of possible responses, described below and shown in Figure 2- 2

- Continue to travel into, within or through the CAZ and pay the charge ('stay and pay').
- Change their behaviour to avoid travelling into, within or through the CAZ for example by travelling by a different mode or cancelling their trip. Some 'cancelled' trips would in fact move to a different destination, but the available model does not allow us to consider that option in this analysis.
- Upgrade to a compliant vehicle – this is assumed to be a newly purchased vehicle but note that another possible response is to swap to a compliant vehicle already owned (e.g. another vehicle in the household or in a commercial fleet). Again, the modelling tools and data available do not allow us to quantify this option.

Figure 2- 2: Flowchart of decision making for compliant and non-compliant vehicle drivers



2.5.4 The choice to upgrade is dependent both on the charge level – with higher charges leading to more change – and on the frequency of travel. Those who need to travel frequently in a charged zone are more likely to choose to upgrade their vehicle as it is more cost effective for them; conversely, those who travel infrequently are more likely to 'stay and pay' as the cost of upgrade would outweigh the cost of the charge. Note that the choices made are more complex than can be allowed for in the modelling – for example, the presence of a CAZ may mean that people make different choices when replacing their vehicle than they would have done otherwise, even where they are not substantially affected by the scheme, simply due to increased awareness of emissions factors and to give themselves the freedom to travel without incurring charges.

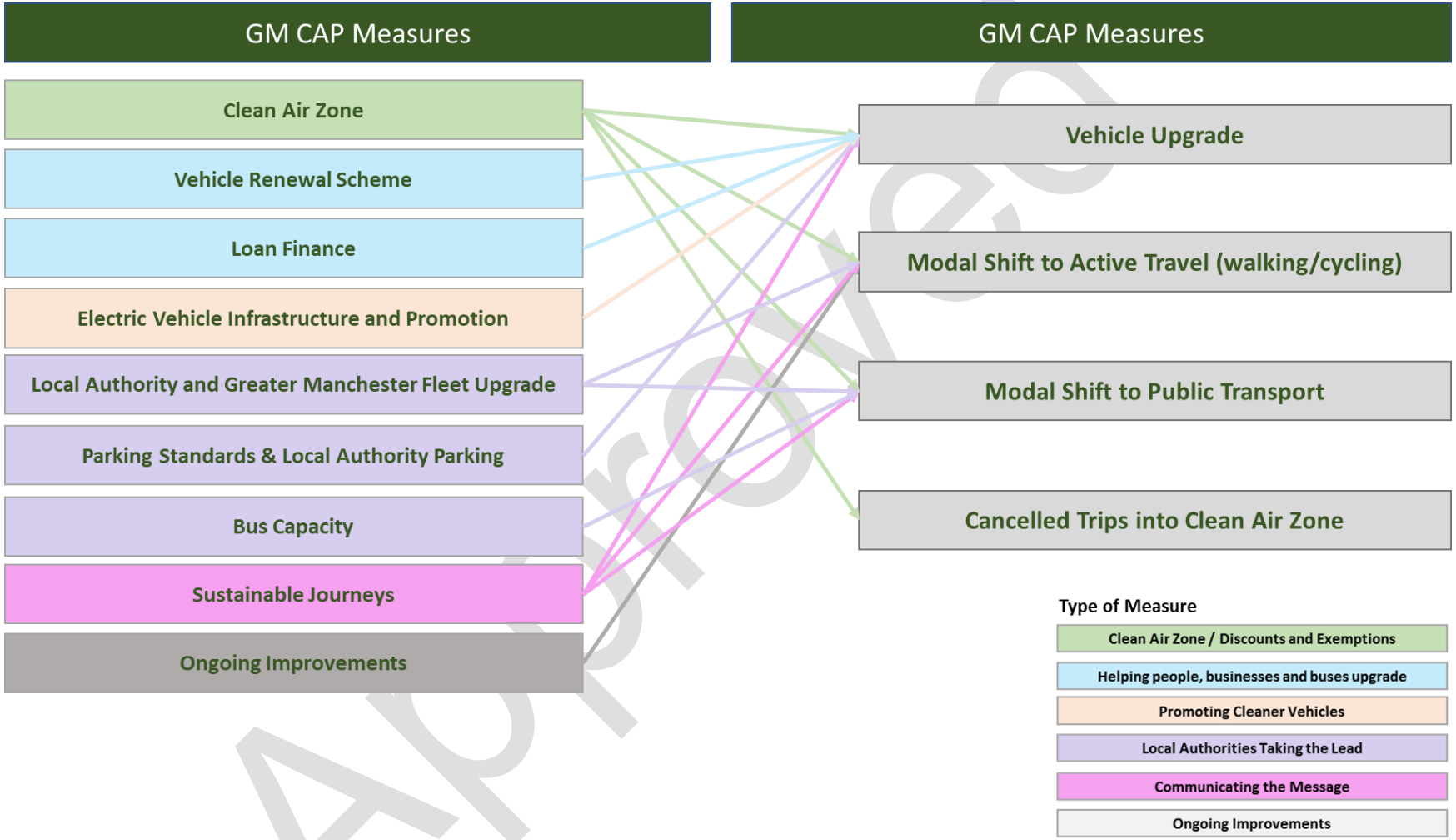
2.5.5 There is considerable uncertainty about the behavioural responses assumed for the purposes of this analysis, which is due largely to limited research and datasets. They are based upon surveys carried out in Bristol, re-weighted to reflect local characteristics. More data collection and analysis is required at FBC stage to improve the certainty of these forecasts. A more detailed discussion of the methodology and uncertainty is provided in Appendix E1. The assumed behavioural responses under-pinning the analysis presented in the remainder of this section are shown in Table 2- 2 and a more detailed description of the basis for these assumptions is included in the associated Technical Report, T4. Not that for private hire vehicles, a revised set of assumptions was introduced removing the 'change mode' and 'cancel trip' options. This was because the responses did not appear plausible. The behavioural change summary presented below is based upon the revised assumptions, but the economic appraisal draws on the original analysis. It is not considered likely that this makes a material difference to the conclusions, but the behavioural responses on private hire vehicles will be further investigated at FBC and revisions made to the assumptions as necessary.

Table 2- 2: Behavioural response per trip to the GM CAP by vehicle type (%)

Behavioral Response	Cars	Taxis	Private Hire Vehicles (PHVs)	Light Goods Vehicles (LGVs)	Heavy Goods Vehicles (HGVs)	Buses/ Coaches
Pay Charge	6.7%	0%	24.2%	9.6%	9.4%	0%
Change Mode	12.8%	0%	18.9%	7.5%	0.0%	0%
Cancel Trip	15.1%	0%	18.7%	7.5%	4.2%	0%
Upgrade Vehicle	65.4%	100%	38.2%	75.4%	86.5%	100%

2.5.6 The series of Measures proposed in the GM CAP interact with one another, acting as a package to deliver compliance in the shortest possible time. The impacts of the Measures and how they interact is shown in Figure 2- 3.

Figure 2- 3: Measures and Dependencies



How clean the Greater Manchester vehicle fleet will be without action: private vehicles

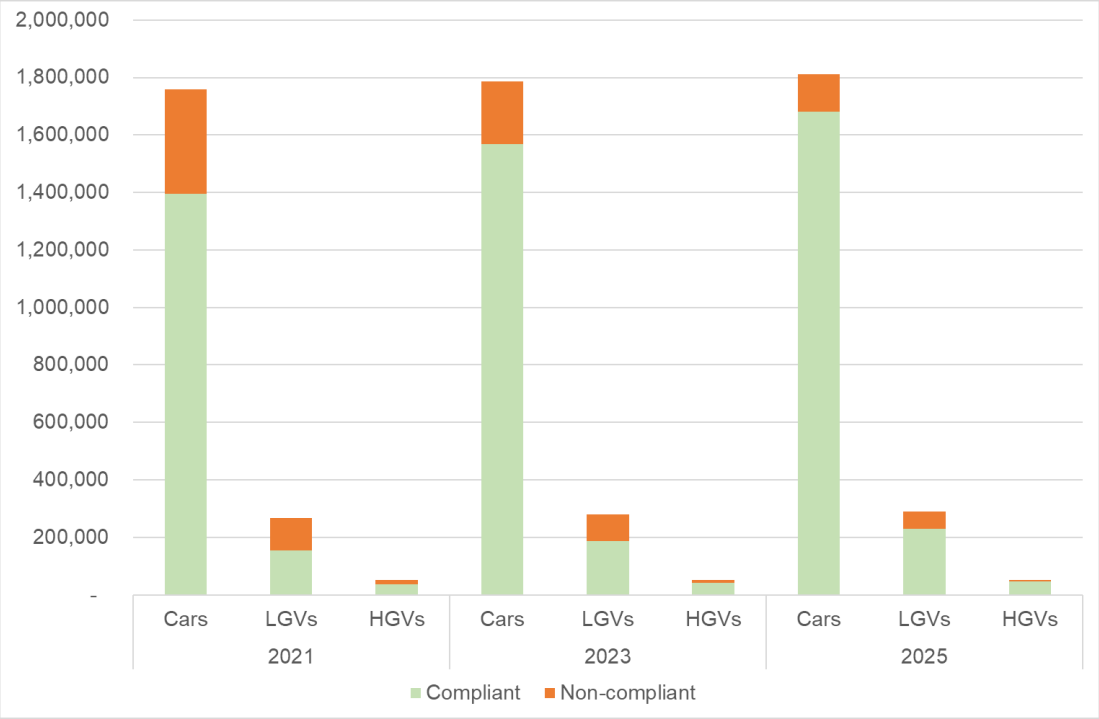
2.5.7 By 2021, forecasting suggests that around three quarters of the private vehicle fleet seen on the Greater Manchester road network will be compliant, including around 80% of cars, 70% of HGVs and private hire vehicles, and 60% of LGVs. Over time, vehicles will be replaced and the oldest vehicles will be disposed of, so that the fleet will gradually become newer and more compliant. Therefore, without further action, by 2025, around nine in ten vehicles will be compliant with the CAZ standards, including more than 90% of cars, HGVs and private hire vehicles, and around 80% of LGVs. Figure 2-4 shows changing compliance over time by vehicle type, based on transport model outputs, in a Do Minimum scenario.

2.5.8 As with any forecast, these estimates are based on a number of assumptions which have limitations. For example, there is some evidence that people are moving away from diesel cars, perhaps as a result of media coverage and changing tax rules. If diesel cars become less popular, the fleet may become cleaner and more compliant than expected. Conversely, however, sales of new vehicles have slowed, perhaps reflecting uncertain economic conditions. This could lead to slower fleet renewal than forecast, and thus an older, dirtier and less compliant fleet.

2.5.9 Furthermore, the forecasts do not take into account the impact of other clean air schemes nationwide. On an average day, the analysis suggests that around 20% of the non-compliant HGVs operating in Greater Manchester are from outside Greater Manchester. It has been assumed for analytical purposes that vehicles travelling longer distances (over 50 miles) will not change their behaviour as a result of the scheme and will always 'stay and pay'. This effect is due to the smaller impact on the overall generalised cost of the charge to a longer journey[3]. The complex national picture, where other cities are considering implementing Clean Air Zones to similar timescales, may mean that we have under-estimated the compliance level in the national fleet and over-estimated the number of non-compliant vehicles travelling from elsewhere into Greater Manchester and paying the charge. This would lead to better-than-forecast emissions and lower-than-forecast revenues for any scheme.

[3] See methodology report to Appendix T4 for further details

Figure 2- 4: Private vehicles in Greater Manchester by type and whether predicted to be compliant without implementation of GM CAP, by year



Impact of the GM-wide CAZ B in 2021 and CAZ C in 2023 on travel behaviour: private vehicles

2.5.10 Options 5(i), 5(ii) and 8 all propose a CAZ covering the whole of Greater Manchester, set at Category B in 2021 (including buses, taxis, HGVs and coaches) and expanding to Category C in 2023 (including LGVs and minibuses). This proposal would not affect cars. This section describes the impacts on vehicle ownership and trips of the GM-wide CAZ B/C in terms of private vehicles – cars (not subject to a charge), LGVs and HGVs.

2.5.11 Introducing a Category B CAZ across Greater Manchester from 2021 brings considerable benefits in terms of cleaning up the in-scope fleet, as shown in Figure 2- 5. In 2021, around 70% of the HGVs seen on Greater Manchester's roads are compliant without action; with the GM-wide CAZ B, a further quarter become compliant so that more than 95% of the HGVs travelling on Greater Manchester roads are predicted to be compliant with the GM-wide CAZ by 2021. In total, in 2021 just 3% of HGVs choose to stay and pay for their trip, with 1% cancelling their trip, as shown in Figure 2- 5. By 2025, the proportion of trips made by a non-compliant HGV and subject to a charge falls to just 1%. It is likely that most of those choosing to stay and pay are travelling in to the region infrequently from elsewhere, with local operators choosing to upgrade. Small local operators will be able to access support to upgrade through the proposed Clean Freight Fund.

2.5.12 Light Goods Vehicles are not affected by the CAZ in the first year, but do benefit from early Measures to help them upgrade their vehicles in advance of the introduction of the CAZ C in 2023. This is estimated to result in an increase of around 2% of LGVs upgrading in 2021, bringing an early emissions benefit and helping to ready the fleet. By 2023, when the GM-wide CAZ C is implemented, it is predicted that around two thirds of LGVs will be compliant in the Do Minimum scenario, with the CAZ C and Clean Freight Fund delivering a further upgrade of around 30%, thus the scheme should see around 95% of LGVs becoming compliant. In total, it is estimated that around 4% of LGV trips will be made by a non-compliant vehicle (and be subject to the penalty), with around 2% changing mode and 2% choosing to cancel their trip. Not all trips made by van are made for work purposes, and it is possible that discretionary personal trips by van may be more likely to change mode (to car, public transport, walking or cycling) or cancel.

2.5.13 The GM-wide CAZ B in 2021 and CAZ C in 2023 does not affect cars. In 2021, it is anticipated that just under 80% of cars will be Euro 6 diesel or Euro 4 and newer petrol or low emission fuels, shown in Figure 2- 5. By 2023, this is expected to have increased to nearly 90% and by 2025 to nearly 95% with natural fleet renewal. Proposals to encourage sustainable travel choices and cleaner vehicles will provide additional benefits. It is anticipated that the Measures to promote electric vehicles could deliver an additional 75,000 electric cars and vans, delivering meaningful emissions reductions.

Figure 2- 5: Compliance benefits of a GM-wide CAZ B in 2021 and CAZ C in 2023, private vehicles travelling on the GM network, 2021, 2023, 2025

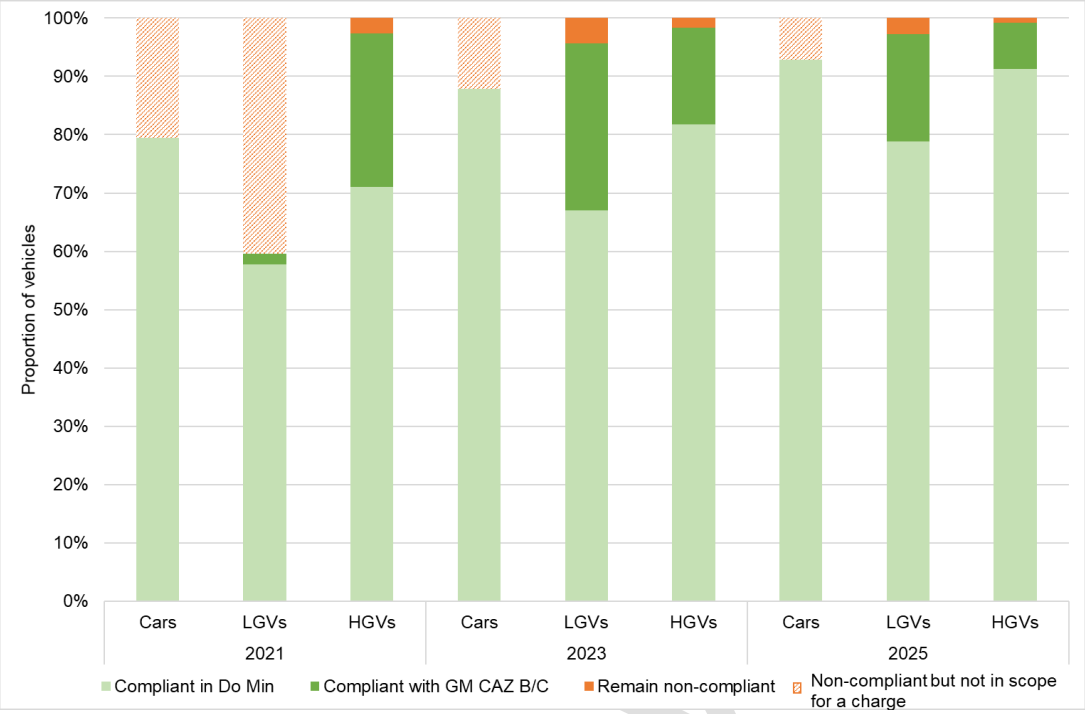
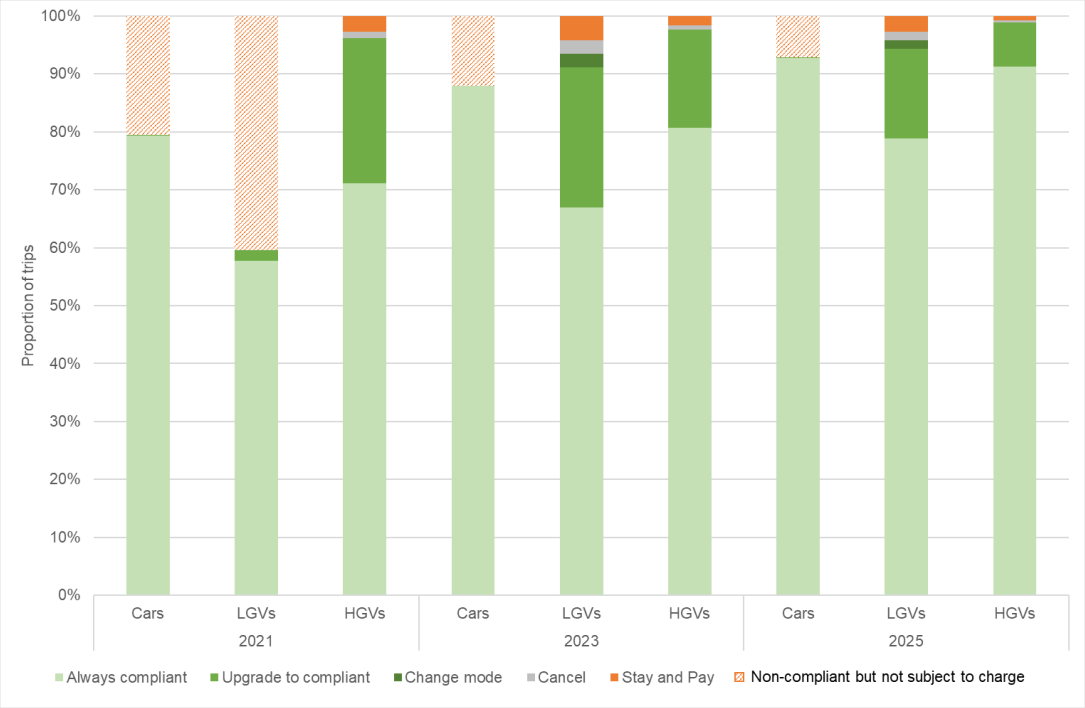


Figure 2- 6: Behaviour change resulting from a GM-wide CAZ B in 2021 and CAZ C in 2023, trips made on the GM network, 2021, 2023, 2025



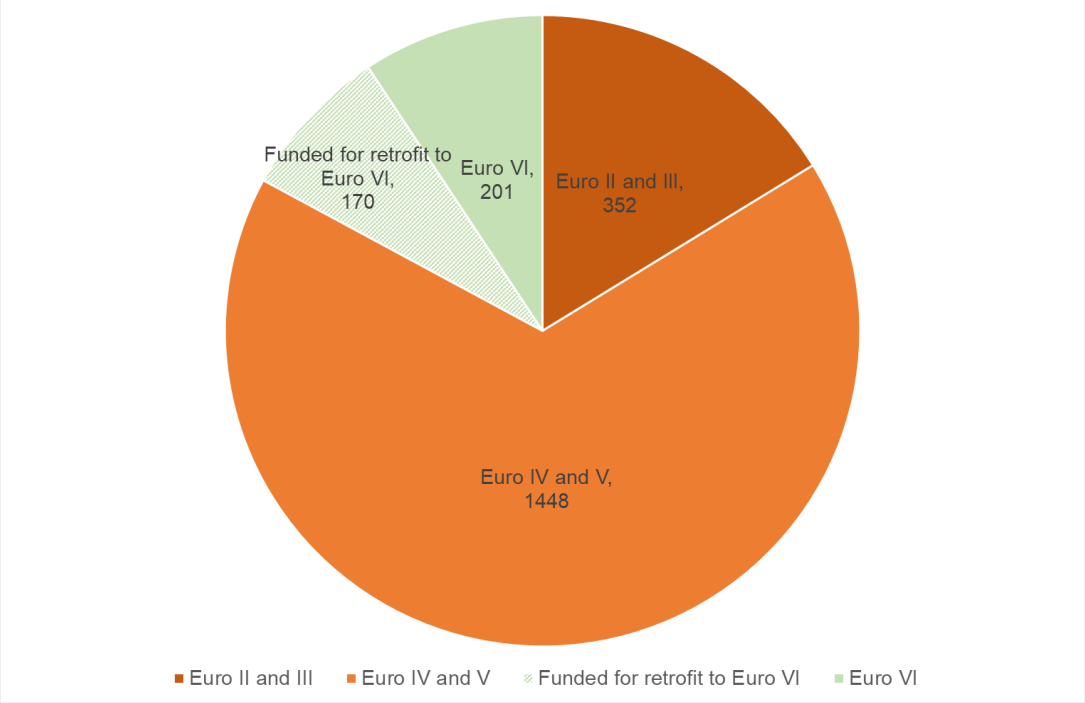
2.5.14 A source of uncertainty in the assumptions made is the possibility that operators will choose to change to a different vehicle type in order to avoid the penalty. So, for example, in 2021 HGV operators could switch to using vans which are unaffected by the scheme. This could have the unintended consequence of increasing total travel, as one HGV load would need multiple vans to transport it. Similarly, in 2023, some van drivers may find that it is cheaper to switch to a large car than upgrade their van. This could have the unintended consequence of increasing travel by older, dirtier diesel cars, which are not in scope for the scheme. Further work is required at FBC to identify the possible extent of vehicle-type switching that could be expected and to identify any mitigating measures. This would be monitored once the CAZ is in effect.

2.5.15 The GM-wide CAZ B would also affect coaches and minibuses, with non-compliant vehicle users required to pay the charge, upgrade their vehicle or change their behaviour. Currently, coaches are not included in Greater Manchester's traffic model and there is no suitable source of data on the volume of coach traffic on the local road network. There is also little information about who owns minibuses and what they are used for. Stakeholder engagement with the coach industry and minibus operators is underway to improve knowledge and better understand the possible impacts of the proposals. This will be supported by further analysis and data collection to support the FBC.

How clean the GM vehicle fleet will be, without action: buses and taxis

2.5.16 There are currently around 2,200 buses operating in Greater Manchester and across the boundary. Of these, around 2,000 are non-compliant, consisting of around 1,200 at Euro V, 400 at Euro IV and a further 350 at Euro II and III. TfGM has secured funding to retrofit approximately 170 buses, bringing the total number of compliant buses to around 370. TfGM and other Greater Manchester operators have also successfully bid for funds from the Ultra Low Emission Bus Scheme that will allow for the purchase of 70 new electric buses. However, the vast majority of the fleet is expected to remain non-compliant without action as bus replacement happens very slowly, at an estimated rate of around 7% per year.

Figure 2- 7: Public buses operating in Greater Manchester by Euro Standard, 2018[4]



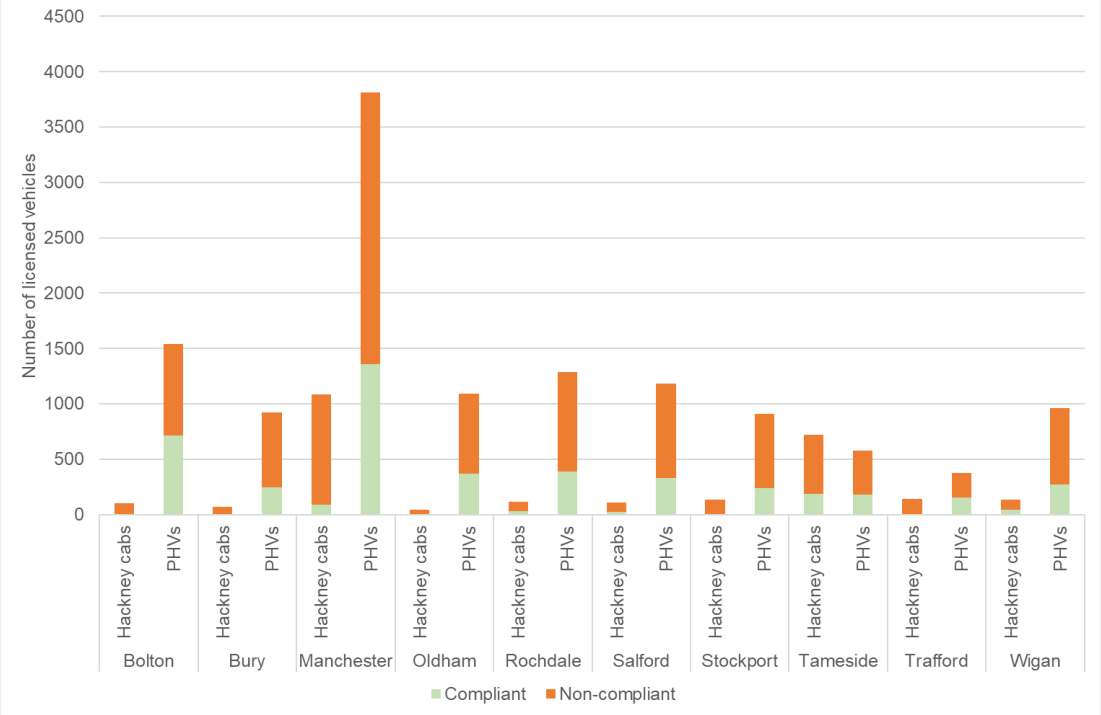
2.5.17 There are around 2,500 hackney carriages licensed in Greater Manchester (in 2018), of which the vast majority (85%) would not be compliant with the proposed GM-wide Clean Air Zone. In several authorities, the average age of a hackney carriage is approaching or over ten years old. Licensing rules vary across the region, with some authorities imposing age limits and some choosing not to do so; vehicle type requirements also vary across the region. By 2021, without the GM CAP, we could expect some natural fleet renewal but it is likely that most hackney carriages will remain non-compliant without action in 2021.

2.5.18 In 2018, there were just under 13,000 private hire vehicles licensed in Greater Manchester. Under current regulations, private hire vehicles are allowed to operate outside their licensed district and there is a growing trend of out-of-region licensing, with drivers choosing to license with authorities where standards may be less onerous and the licensing process is cheaper or easier for them. We do not have any information about the scale of the fleet that operates in Greater Manchester but is licensed elsewhere, or about the vehicles that they drive. It is proposed that any discounts and exemptions or financial support will only be offered to drivers and vehicles licensed with one of the ten authorities in the region.

[4] Data obtained via TfGM

2.5.19 Of the current private hire fleet licensed in Greater Manchester, around 8,500 vehicles were non-compliant in 2018, two thirds of the current licensed fleet. By 2021, it is estimated that just under three quarters of private hire vehicles seen on Greater Manchester's roads will be compliant, due to natural fleet renewal.

Figure 2- 8: Licensed hackney carriages and private hire vehicles in Greater Manchester, by compliance, 2018



Impact of the GM-wide CAZ B in 2021 and CAZ C in 2023 on travel behaviour: buses and taxis

2.5.20 The proposed GM CAP includes funds to retrofit or replace the Euro IV and V bus fleet and it is assumed that operators will upgrade the remaining older vehicles. As such, an assumption has been made for the purposes of modelling the scheme that all buses (100%) will be compliant by 2021 when the Greater Manchester-wide CAZ B goes live. Further work is required at FBC to better understand the feasibility of upgrading the bus fleet over this timescale. Efforts will be made to prioritise the programme such that vehicles operating in places with the highest concentrations are upgraded first where possible; although this is subject to co-operation from commercial bus operators and will not always be possible.

2.5.21 Similarly, the GM CAP includes funds to support hackney carriage drivers and operators to upgrade their vehicles, either through replacement or retrofit if possible. In the absence of better information, an assumption has been made that this support will be sufficient to ensure that all hackney carriages are compliant by 2021, when the CAZ B goes live. Further work is required at FBC to establish how realistic this assumption is, including stakeholder engagement with the taxi industry to understand what support would be required to help drivers and operators upgrade their vehicles. Upgrading a London-style hackney carriage is much more costly than upgrading a normal saloon car or people carrier so the cost implications will vary for drivers and operators across the region depending on the local licensing conditions.

2.5.22 For private hire vehicles, just under three quarters are expected to be compliant without action, and the GM-wide CAZ B adds a further 20%, so that just over 90% of private hire vehicles travelling on Greater Manchester's roads are predicted to be compliant by 2021 with the GM CAP (either Euro 6 diesel, Euro 4 or newer petrol, or low emission vehicles). The impact of the GM CAP on private hire vehicles in shown in Figure 2- 9.

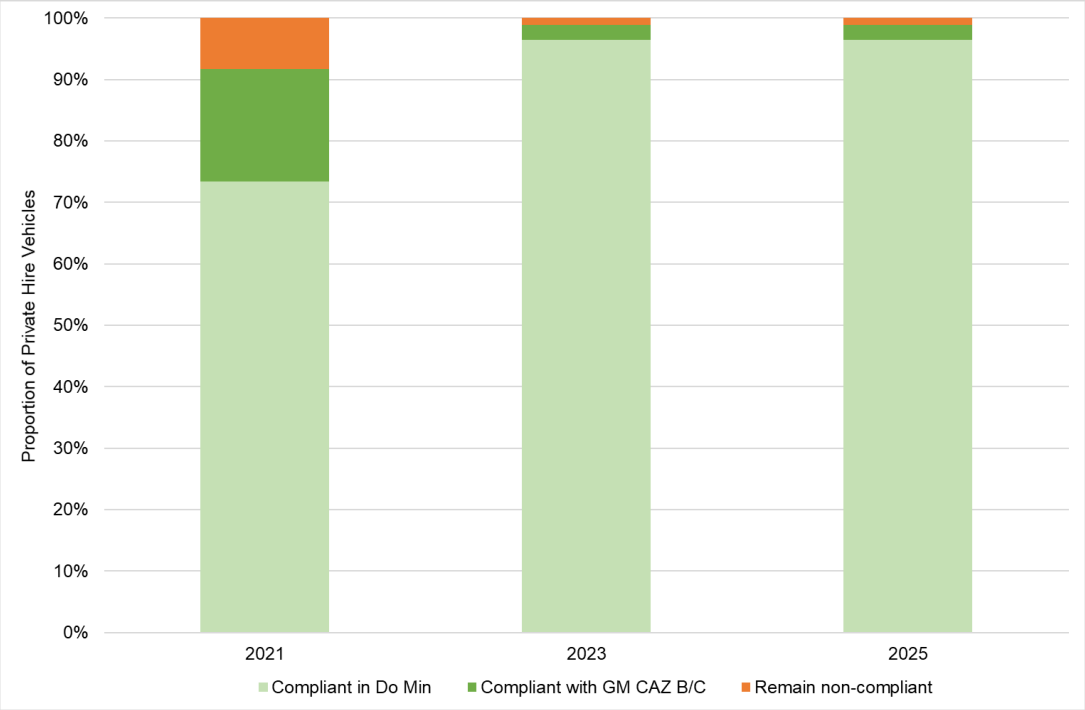
2.5.23 The proportion choosing to stay and pay the charge for their trip is estimated at 8% in 2021, falling to just 1% by 2023. An assumption has been made that trips will not be cancelled, as the passenger demand remains, but this may conceal churn within the market as some drivers/operators may find that it is not effective to continue, whilst new drivers/operators enter the market.

2.5.24 The analysis is based on the assumption that support will be provided to private hire drivers and operators to help them upgrade their vehicles. Further analysis and stakeholder engagement with the private hire industry and its customers will be undertaken to better understand what support would be required to help more drivers upgrade their vehicles, and reduce the number choosing to 'stay and pay' in the first year. A goal of the proposed GM CAP is to clean up the fleet rather than force people and businesses to incur charges and therefore more refinement is required to ensure this proposal delivers its goal.

2.5.25 Note that following the initial modelling carried out in autumn 2018, a change was made to the assumed behavioural responses of private hire vehicles within the model, to remove the option of changing mode or cancelling a trip, which was producing implausible results. The analysis presented above refers to modelling conducted using this new assumption. The assessment of costs and benefits is based upon the earlier modelling; tests have been carried out and this is not considered to have a significant impact on the results or conclusions. More work is required at FBC to test the validity of the assumptions made and better understand the private hire market and operations.

2.5.26 As stated earlier, a considerable source of uncertainty is that Private Hire Drivers can license themselves and their vehicles at a local authority outside of Greater Manchester, but operate wholly or mainly within Greater Manchester. Very little is known about how many people choose to do this at present and Greater Manchester understands that JAQU is currently producing a database of all licensed vehicles to support the implementation of CAZ schemes. Analysis of this database alongside local data will help illuminate this issue at FBC. It has been assumed that all support packages will only be available to drivers and operators licensed with a Greater Manchester local authority.

Figure 2- 9: Compliance benefits of a GM-wide CAZ B in 2021 and CAZ C in 2023, Private Hire Vehicles travelling on the GM network, 2021, 2023, 2025



Impact of a city centre CAZ D on travel behaviour: private vehicles

2.5.27 Options 5(i) and 5(ii) propose a CAZ within the IRR. In Option 5(i) this is a CAZ D to be implemented from 2021. In Option 5(ii), this is a CAZ D with all diesel cars and private hire vehicles considered non-compliant.

2.5.28 Note that the preferred Option for the GM CAP, Option 8, does not include any CAZ proposals that affect private cars.

2.5.29 The remainder of this section describes the impacts on vehicle ownership and trips of a CAZ D within the IRR in terms of private vehicles – cars, LGVs and HGVs. This is included for the purposes of comparison in the appraisal, in order to compare the impacts of Options 5(i) and 5(ii) and Option 8 on travel behaviour.

2.5.30 A CAZ D within the IRR would not bring any additional benefits in terms of the HGV fleet as all non-compliant HGVs are already in-scope for the region-wide scheme.

2.5.31 In 2021, LGVs are not in-scope for the region-wide scheme but would be in-scope for an IRR CAZ D in Options 5(i) and 5(ii).

2.5.32 Four percent of LGV trips in Greater Manchester have an origin and/or destination within the IRR and are in-scope for the CAZ D in 2021 under Options 5(i) and 5(ii). On an average day, it is estimated that around 29,000 van trips will be made in the IRR zone in 2021, 95% from within Greater Manchester. Of these, around four in ten (12,000) will be made by non-compliant vans without the GM CAP.

2.5.33 It is estimated that with a CAZ D, around 30% of van trips would upgrade, 3% would change mode, 3% would cancel their trips and around 5% would 'stay and pay' in 2021, with 60% already compliant and unaffected. This means that around 1,500 van trips into the IRR would incur a charge on an average day.

2.5.34 By 2023, all LGVs will be in scope for the GM-wide scheme.

2.5.35 Cars are not in scope for the region-wide scheme but would be affected by the CAZ D proposals in Options 5(i) and 5(ii). In total, there are around 1.1 million cars registered in Greater Manchester, based on DVLA data. Of these, it is estimated that around 200,000 (18%) will be non-compliant by 2021.

2.5.36 Around 4% of the c.4.5 million car trips in Greater Manchester on an average day have an origin and/or destination within the IRR and would be in-scope for a CAZ D in 2021 Options 5(i) and 5(ii). Around eight in ten will be compliant and able to travel unaffected.

2.5.37 It is estimated that with a CAZ D, around 12% of car trips would upgrade, 2% would change mode, 3% would cancel their trips and around 3% would 'stay and pay' in 2021, with 80% already compliant and unaffected. This means that around 5,000 car trips into the IRR would incur a charge on an average day.

The analysis does not take account of the possible impact of any discounts and exemptions, for example for residents of the zone. It also only takes a limited account of the benefits of any vehicle renewal scheme for cars, which would be part of any package of measures that also included a CAZ D. The goal of a CAZ D would be to help drivers travel more sustainably, either by upgrading to a compliant vehicle or by switching to public transport, cycling or walking. It is to be expected that a proportion of drivers would choose to 'stay and pay', either because they travel to the area infrequently or because they prefer to pay than change their behaviour. If the decision was made to progress with a CAZ D, further work would be required to better understand the extent to which drivers may be forced to pay because they cannot afford to upgrade their vehicle, and to identify what mitigations would be required to limit the extent and impact of this. At present, a GM CAZ D is not included in the preferred Option for the GM CAP.

2.6 Economic Impacts of the Proposed GM CAP

2.6.1 This section describes the costs, benefits and Distributional Impacts of the proposed GM CAP as they are currently understood, compared to the other options considered that could deliver compliance in the shortest possible time. This analysis will be further refined and strengthened throughout 2019. Where unacceptable negative impacts have been identified, mitigations will be sought through scheme refinements, discounts and exemptions, or supporting measures. In particular, note that the mitigating impacts of the proposed vehicle renewal schemes (Clean Air Funds) and of the range of discounts and exemptions likely to be applied, have not been quantified here so this is a worst-case scenario.

Health and Environmental Benefits of air quality improvements

2.6.2 As shown in Section 1.7 of the Strategic Case, Option 8 is the proposed GM CAP and is forecast to deliver compliance in the shortest possible time. Section 1.7 in the Strategic Case sets out the benefits to air quality brought by the proposed GM CAP and demonstrates that it delivers a route to compliance which substantially reduces human exposure. The reductions in NO_2 and Particulate Matter (PM) emissions bring real and significant benefits to health. These are set out below. As well as health, the GM CAP will lead to environmental benefits such as a reduction in building soiling[5] and ecosystem damage.

[5] The soiling of buildings includes both residential dwellings and historic/cultural buildings and causes economic damages through cleaning costs and amenity costs.

2.6.3 The quantified reduction in NO_2 and PM (tonnes) was monetised using JAQU's damage cost (converted from 2015 prices to 2018 prices) for NO_2 and PM and discounted using the 3.5% factor as recommended by the Government's Green Book. The monetised benefits of the GM CAP were extrapolated across the appraisal period, based on the proportion of non-compliant vehicles within the given year, relative to the opening year. The health and environmental benefits reduce year by year until 2030 to reflect the increasing rate of compliance. The damage costs capture the following monetised impacts:

- **Human health**: mortality, respiratory hospital admissions, cardiovascular hospital admissions, productivity losses
- **Environmental**: building soiling, ecosystem damage

2.6.4 Table 2- 3 presents the quantified and monetised benefits of the reduction in air pollution. The proposed GM CAP (Option 8) delivers monetised air quality benefits of £101m over the full appraisal period of 2021 – 2030.

Table 2- 3: Quantified and monetised air quality (AQ) benefits, £m, present value 2018 prices

	NO2 Tonnes Saved (2021)	NO2 Savings over Baseline (2021)	PM Tonnes Saved (2021)	PM Savings over Baseline (2021)	Monetised AQ Benefit (2021-2030)
Option 5(i)	1,491	20.1%	72	5.8%	£105m
Option 5(ii)	1,498	20.2%	72	5.8%	£106m
Option 8	1,419	18.6%	51	4.0%	£101m

2.6.5 Further analysis of the air quality impacts can be found in the Health and Environment Report which forms part of the Distributional Impacts full report (Appendix E3). In addition, the Distributional Impact analysis summarised in the next section provides an analysis of the key impacts including how air quality benefits are distributed across different social groups in Greater Manchester.

Air quality Distributional Impacts

2.6.6 The consideration of whether impacts are disproportionate is important to understand if one group is being unfairly disadvantaged or benefited by the option/package. 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, as recommended by DfTs Transport Analysis Guidance (TAG) Unit A4-2 'Distributional Impact Appraisal' (DfT, 2015), is used in the reporting of the Distributional Impacts.

2.6.7 As explained in the Distributional Impacts report, the WebTAG Distributional Impacts methodology refers only to 'winners' and 'losers', corresponding to improvements in, or worsening of air quality. Due to the nature of the Options proposed, all Options result in 'winners' exclusively across the study area (i.e. no Lower Layer Super Output Areas in Greater Manchester experiencing worsening air quality). The Distributional Impacts report provides a qualitative interpretation of these results, focussing on the areas with the 10% greatest improvements in air quality and the relation to key amenities of importance to the various social groups.

Table 2- 4: 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 line6 with the proportion of the group in the total population
✓	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

2.6.8 The analysis shows that, using the WebTAG methodology, moderate beneficial air quality impacts are distributed evenly across all income groups for both Option 5(i)/(ii) and Option 8. For children and the elderly, however, air quality benefits are not evenly distributed. For these two groups, air quality impacts favour residents in quintiles four and five (those with the lowest proportion of children/elderly people), where the impact is large beneficial. Those in quintile one (with the highest proportion of children/elderly), who may be considered the most vulnerable, experience slight beneficial air quality impacts.

[6] For the purposes of this assessment, 'broadly in line' refers to +/- 5% threshold between the percentage of net winners/losers and the share of the resident population in each group.

2.6.9 A simplified methodology has been applied in the OBC process and a fuller analysis will be required at FBC. When these results are available, more work will be required to consider whether any additional Measures could be effective in enhancing the benefits in areas with high populations of children and older people.

Health and environmental benefits

2.6.10 This section presents the findings of the preliminary analysis of health and environmental DI for the proposed GM CAP. The analysis is based on outputs of Transport for Greater Manchester's EMIGMA (Emissions Inventory for Greater Manchester) software, which provides the change in emissions in tonnes for NO_2 and PM_{10} for a Do Minimum scenario (2021) compared to each of the best performing Options under analysis (Option 5(i), Option 5(ii), and Option 8).

2.6.11 A summary of this assessment for the Greater Manchester area is presented as follows:

- for Option 8, the monetised health and environmental benefits in Greater Manchester are estimated at £15.0 million in 2021 and £12.8 million in 2025;
- for Option 5(ii), the monetised health and environmental benefits in Greater Manchester are estimated at £17.9 million in 2021 and £12.7m in 2025; and
- for Option 5(i), the monetised health and environmental benefits in Greater Manchester are estimated at £17.8 million in 2021 and £12.7m in 2025.

Health and social care savings

2.6.12 NO_2 and PM are known to cause harmful effects on human health, resulting in illnesses such as asthma, chronic heart disease and cardiovascular disease. In the context of health impact assessment, impacts are broadly divided into morbidity (living with a disease) and mortality (dying from a disease). Treating morbidities has knock-on effects for the National Health Service (NHS) and social care system through increased spending on inpatient visits, medication, General Practitioner (GP) costs etc. For instance, a chronic condition such as asthma requires multiple GP visits and/or hospital admissions.

2.6.13 It is not currently possible to quantify the scale of cost savings to health and social care services that would be delivered by the GM CAP, but it is reasonable to assume that these would be substantial.

Wider benefits of improved health: productivity and quality of life

2.6.14 Chronic ill health damages quality of life. The full effects of this on people's wellbeing cannot be meaningfully quantified but are clearly substantial and wide ranging. One example is that chronic ill health can lead to absences from work and education. The damage costs presented above to some extent capture productivity losses, thought to include workplace absence due to short-term episodic health events associated with cardiovascular and respiratory hospital admissions. However, the effect on children missing school days is not captured. There is evidence that school absences impact on pupils' attainment levels which result in long-term effects in terms of future earning potential.

Benefits of reduced greenhouse gas emissions

2.6.15 As well as air pollutants NO_2 and PM, the proposed GM CAP would also see a reduction in greenhouse gas (GHG) emissions primarily due to vehicles being upgraded to cleaner, more fuel-efficient models, and because some trips are cancelled or change mode to public transport or active travel in response to the schemes. There were concerns that measures to tackle Nitrogen Oxides (NO_x) emissions could cause GHG emissions to rise, by encouraging a shift from diesel to less efficient petrol engines. However, that concern has not materialised and all the preferred options in fact bring benefits in terms of reduced GHG emissions.

2.6.16 Table 2- 5 presents the total estimated reduction in GHG emissions and the total monetised benefits of reduced GHG emissions over the appraisal period. This was assessed based on the change in total vehicle kilometres driven, as well as the change in terms of fleet upgrades. The proposed GM CAP delivers £82m of benefits in terms of reduced GHG emissions.

Table 2- 5: Quantified and monetised benefits of reduced GHG emissions, £m, present value 2018 prices (2021-2030)

Options	Tonnes CO2e avoided (2021-2030)	GHG emission impact, £m (2021-2030)
Option 5(i)	1,391,000	£81m
Option 5(ii)	1,395,000	£82m
Option 8	1,399,000	£82m

Costs to the Public Sector

2.6.17 GMCA is assuming Central Government, via the JAQU Implementation and Clean Air Funds, will fund all costs relating to scheme implementation and will underwrite any net operational deficit, in so much as there is one, over the life of the scheme. The proposed GM CAP will not result in reduced spending on any other public services in Greater Manchester, nor will it negatively affect existing delivery plans.

2.6.18 The implementation costs comprise all the costs associated with establishing the GM CAP. This includes the costs of setting up each of the CAP measures, whose primary cost drivers are elaborated in the Financial Case.

2.6.19 The operating and maintenance costs of the proposed CAP capture the ongoing cost of running the CAP over the appraisal period. Specifically, there are two Measures in the GM CAP that will incur operational and maintenance (O&M) costs post implementation: the CAZ, and EV infrastructure and promotion.

2.6.20 It is assumed that the CAZ infrastructure will be decommissioned two years after full compliance is forecast to be achieved in the Do Minimum scenario. This allows for an additional year of operations after the Do Minimum compliance date in 2027 and decommissioning in 2029.

2.6.21 The costs of the proposed GM CAP are presented in Table 2- 6. Note that costs have been discounted to present them in 2018 prices and are derived from those in the Financial Case. In total, the proposed GM CAP has an investment cost of £419m to support achieving compliance in the shortest possible time. More information about the costs of implementing, operating and maintaining the scheme can be found in the Financial Case.

2.6.22 Option 5(ii) is assumed for analytical purposes to be the same cost as 5(i). However, the costs of this option have not been developed in as much detail and it is anticipated to have higher costs than scheme 5(i). This is due to the implementation and operation of 5(ii) including the monitoring and processing of a vehicle Euro standard not included in JAQU's defined Clean Air Zone schemes.

2.6.23 Scheme costs include Optimism Bias (OB), this is calculated separately for individual cost element. The weighted OB for capital costs is 15% and for operating costs is 31%. See the Financial Case for detailed costs breakdowns.

Table 2- 6: Implementation cost of the options, £m, present value 2018 prices, discounted

	Option 5(i)	**Option 5(ii)**	**Option 8**
Total Implementation cost	£316m	£316m	£270m
Total O&M cost	£153m	£153m	£148m
Total Cost	**£469m**	**£469m**	**£419m**

Public Sector Revenues

2.6.24 The user charge payments of non-compliant vehicles opting to continue their journey into the CAZ is in effect received by the public sector as a revenue. As the user charges are simply treated as a transfer to the public sector, the cost to transport users and revenue to the public sector offset each other. The proposed GM CAP may generate other sources of public sector revenue, including potentially from parking permits and enforcement and from increased public transport fares. These potential sources of revenue have yet to be quantified.

2.6.25 For more information on the revenue to the public sector generated by the user charges, please refer to the Financial Case.

Travel time savings arising from reduced congestion

2.6.26 The introduction of the proposed GM CAP will deliver small-scale traffic reductions across the road network, resulting in slightly faster journey times. Annual Average Daily Traffic (AADT) is a standard measure of the average

2.6.27 number of vehicle trips on a road per day. This has been calculated for each modelled link and used (along with link length) to calculate the annual average daily vehicle kilometres.

2.6.28 The implementation of the proposed GM CAP is anticipated to reduce the growth in vehicle kilometres by 0.5% over the period 2021 to 2025 (2021 without GM CAP compared to 2025 with GM CAP). This is equivalent to a network-wide reduction of 275,000 vehicle kilometres per day.

2.6.29 The implementation of the proposed GM CAP will have an impact on the road network over a wide geographic area. Ignoring the effects of rerouting, there will be slightly reduced traffic across almost all roads within Greater Manchester, which will lead to widespread (if moderate) congestion relief.

2.6.30 In reality, traffic will reroute to take up the (newly available) road space, in order to reduce existing journey times. The benefits of this optimisation will be felt by almost all users (unlike in a traditional intervention where effects are typically localised). As such, it is anticipated that the implementation of the proposed GM CAP will have a positive impact on the current level of congestion felt along all key routes into Manchester, along with more modest benefits in other areas.

2.6.31 Whilst traffic and congestion are predicted to fall overall with the proposed GM CAP when compared to the without GM CAP (Do Minimum) scenario, for some users the choice to change their route to avoid the scheme may impose a cost on themselves and others. Changes in these costs have been estimated using Department for Transport's (DfT's) Transport User Benefit Appraisal (TUBA) software v1.9.11.

2.6.32 Table 2- 7 presents the travel time savings and vehicle operating costs for Options 5(i) and (ii), and Option 8. In total, the proposed GM CAP delivers travel time savings estimated at £136m in value, along with Vehicle Operating Cost (VOC) savings of £73m.

2.6.33 Please note, the travel time savings and VOC impact is assumed to be the same for Option 5(i) and Option 5(ii) as the transport model assumes the traffic network changes between the baseline (Do Minimum) and Do Something scenarios are the same. In reality, the Ultra-Low Emission Zone (ULEZ) within the IRR in Option 5(ii) would result in a higher number of trips cancelled or re-moded.

Table 2- 7: Travel time savings and VOC (from TUBA) £m, present value 2018 prices (2021-2030)

	Travel Time Savings	**Vehicle Operating Costs**	**Total £m (2021-2030)**
Option 5(i)	£210m	£89m	£300m
Option 5(ii)	£210m	£89m	£300m
Option 8	**£136m**	**£73m**	**£210m**

Distributional impact of accessibility improvements from faster journey times

2.6.34 Accessibility describes changes to the ability and ease of individuals or businesses to get to places of work, social networks and public amenities. This links with severance impacts which include barriers to accessibility and impacts on personal affordability which can also affect an individual's ability to access a key service or amenity.

2.6.35 As recommended by JAQU, the method of appraisal follows the guidance set out in the DfTs Transport Analysis Guidance (TAG) Unit A4-2 'Distributional Impact Appraisal' (DfT, 2015), applying the concept of 'quintiles' To identify societal groups who could be 'disproportionately' impacted, the population within the study area was divided into quintiles. For example, to assess income deprivation, the population was first divided into five equal parts depending on the level of income: the first quintile contains the top fifth of the population on the scale (i.e. the 20% of the population with high levels of deprivation), the second quintile represents the second fifth (from 20% to 40%) and the fifth quintile represents the 20% of the population with the lowest level of income deprivation. Once the population has been divided into quintiles, it is then possible to see which groups receive the highest share of the benefits.

2.6.36 The key findings of the accessibility Distributional Impacts assessment are presented as follows:

- For low income households, results are comparable for Options 5(i)/(ii) and Option 8, although Option 8 provides slightly better opportunities for enhancement than Option 5(i)/(ii). For Option 5(i)/(ii), moderate benefits are experienced evenly across all quintiles for low income households. For Option 8, moderate benefits are experienced across the majority of the population, with large benefits experienced by the 20-40% most income-deprived households (quintile 2).
- For children (under 16s), results are comparable for Option 5(i)/(ii) and Option 8, although Option 5(i)/(ii) provides slightly better opportunities for enhancement than Option 8. For Option 5(i)/(ii), benefits are experienced by all under 16s, although the spread of benefits is uneven. Large benefits are experienced in quintile 1 and quintile 3, slight benefits in quintile 2, and moderate benefits in quintile 4 and quintile 5. For Option 8, benefits are experienced by all under 16s, with large benefits experienced by areas with the highest concentration of under 16s compared to other areas (quintile 1).
- For the elderly population, results are comparable for Option 5(i)/(ii) and Option 8, although the benefits are more evenly spread for Option 8. For Option 5(i)/(ii), the areas with relatively low levels of elderly residents (quintile 4) receive the greatest share of the benefits. For Option 8, moderate benefits are experienced evenly across all quintiles.
- For disabled people, results are comparable for Option 5(i)/(ii) and Option 8, although Option 5(i)/(ii) provides slightly better opportunities for enhancement than Option 8. For both options, the areas with the most disabled residents receive the greatest share of the benefits.
- For women, results are comparable for Option 5(i)/(ii) and Option 8. For Option 5(i)/(ii), the areas with the fewest female residents (quintile 5) receive the greatest share of the benefits. For Option 8, moderate benefits are experienced across the majority of the population, with large benefits experienced by quintile 4.
- For Black, Asian and Minority Ethnic people, the results are the same for both options, with moderate benefits experienced evenly across all quintiles.

2.6.37 The appraisal of accessibility Distributional Impacts is supplemented by further analysis of potential severance effects, looking at community facilities along corridors and single roads that are expected to experience an increase in traffic flow. The key findings of the assessment of potential severance impacts are presented as follows:

- For Option 5(i)/(ii), the potential for community severance impacts has been identified along 96 roads/corridors. Along these roads/corridors, a total of 69 education facilities and 52 medical/healthcare facilities were identified.

- For Option 8, the potential for community severance impacts has been identified along 82 roads/corridors. Along these roads/corridors, a total of 63 education facilities and 47 medical/healthcare facilities were identified (Appendix E3).
- Results of Option 5 and Option 8 are broadly comparable, with slightly less potential severance effects anticipated for Option 8 compared to Option 5(i).
- Further monitoring of traffic flows at key education and healthcare locations would be recommended to ensure that any potential community severance effects can be properly managed.

Impact of Mode Shift: Welfare Loss

2.6.38 Greater Manchester aims to reduce car dependency and increase the sustainable travel mode share to 50% of all trips by 2040. Mode shift from the car to public transport and active travel is therefore in line with Greater Manchester's strategic goals and brings wider benefits for society.

2.6.39 Nevertheless, it is recognised that by imposing mode shift on drivers of non-compliant vehicles, those drivers are not able to travel by their preferred mode and there is some welfare loss associated with this. This is based on the assumption that the new action is less favoured than their current choice, otherwise they would have been doing it anyway. It may well be, however, that this loss is overstated. Habit is a strong driver of transport choices and some users may find that their alternative mode is in reality equally satisfactory or even better than the car.

2.6.40 Table 2- 8 presents the monetised impacts of welfare losses for those switching their mode of travel, presented in present value 2018 prices. Further details of the methodology are in the EAMR (Appendix (E1). The proposed GM CAP causes an assumed consumer welfare cost impact estimated at £17m as a result of the mode shift generated.

2.6.41 Note that Option 8 does not affect cars. Therefore, the welfare costs described for Option 8 are those imposed on LGV drivers only. In comparison, Options 5(i) and 5(ii) impose welfare costs on LGV and car drivers.

Table 2- 8: Consumer welfare impact, £m, present value 2018 prices, discounted

Options	Welfare Impact* £m (2021-2030)
Option 5(i)	−£36m
Option 5(ii)	−£36m
Option 8	**−£17m**

** Negative value indicates disbenefit*

2.6.42 Please note, the appraisal assumes that the option of switching mode of travel is only applicable to cars, PHVs, and LGVs. It is assumed that HGVs are unable to switch mode. For the purpose of the appraisal it is assumed that 100% of taxis would be compliant and therefore no taxi journeys change mode.

2.6.43 Changing mode from car to public transport would change the costs of travel for users, spending less on car travel and potentially more on public transport fares. It is not possible to determine at this stage whether the net effect would represent an increase or reduction in the cost to transport users.

Impact of Mode Shift: public transport supply and crowding

2.6.44 Mode shift generated by Option 5(i) has been modelled on the committed 2025 public transport network. The modelling has been carried out by adding predicted extra public transport trips to the 2025 NTEM forecast demand, with the increased demand in each modelled time period being as follows:

- AM Peak: 1.8%
- Interpeak: 2.4%
- PM Peak: 1.7%

2.6.45 On the rail network, the proposed GM CAP is predicted to increase boardings by 2% in the morning peak (which has the highest demand), tipping one service from just under 'crush capacity' to just over. Note that the modelling assumes that services operate with capacities as scheduled, and therefore the real-world impacts of this increased demand would be more severe if trains run less frequently or with lower capacities than timetabled.

2.6.46 On Metrolink, the proposed GM CAP is predicted to increase boardings by 1.3% in the morning peak but this will not cause any further services to reach crush capacity. The model tests include extra capacity due to the introduction of 27 additional trams, due to be introduced between 2020 and 2021.

2.6.47 On the bus network, the proposed GM CAP is predicted to increase boardings by 2.2% in the morning peak hour, but this is not expected to cause crowding problems. The increased demand for bus services may encourage operators to increase service provision on some routes and may improve the viability of other routes thus protecting service provision.

2.6.48 Increased demand for public transport services will increase revenues which can be invested in service improvements.

Impact of Mode Shift: Health Benefits from travelling more actively

2.6.49 The modal shift of non-compliant vehicle owners from private car, LGV and PHV use to walking or cycling will improve the general health of those making active travel choices. The increased health benefits as a result of the induced modal shift was estimated using the World Health Organisation's Health Economic Assessment Tool[7], presented in Table 2- 9.

2.6.50 The proposed GM CAP delivers health benefits of £18m PV 2018 prices over the appraisal period. Trips by public transport also typically involve more walking than car trips and research shows that active and public transport commuters have a lower BMI than those who commute by car. Therefore, the full health benefits of mode shift from the car are likely to have been under-estimated here.

Table 2- 9: Active Travel Health Benefits, £m, present value 2018 prices, discounted

Options	Health Benefits £m (2021-2030)
Option 5(i)	£31m
Option (ii)	£31m
Option 8	**£18m**

Costs Imposed by Cancelled Trips

2.6.51 Some users will choose not to travel, or to change the destination of their trip in order to avoid paying a charge. These users will incur a welfare loss, which to some extent can be quantified. In reality, it is difficult to distinguish between trips which represent a genuine loss – because the user is no longer able to do something they wanted or needed to do – compared to those trips which have been in some way re-organised or replaced with another equally satisfactory activity.

2.6.52 Table 2- 10 presents the monetised impacts of welfare losses for those cancelling trips, presented in present value 2018 prices. The proposed GM CAP imposes costs of £39m as a result of trips no longer made.

Table 2- 10: Consumer welfare impact, £m, present value 2018 prices

Options	Welfare Impact* £m (2021-2030)
Option 5(i)	−£59m
Option 5(ii)	−£59m
Option 8	**−£39m**

** Negative value indicates disbenefit*

[7] https://www.heatwalkingcycling.org/#homepage

2.6.53 Note that cancelled trips may well have a wider societal cost than to the individual, through lost economic activity or reduced social interaction. The wider risks and costs of trips being cancelled or moved to a different destination will be explored more fully in 2019. In reality, the effects of Option 8 are felt by businesses rather than private households and so the impact of cancelled trips may be a loss of economic opportunity.

Costs and Benefits of Upgrading the Vehicle Fleet

2.6.54 The cost of upgrading borne by a non-compliant vehicle owner is estimated through the consideration of the following:

- Cost of upgrade – Welfare loss estimated by multiplying the number of vehicles upgrading by the difference in depreciation with the new (or used) vehicle, using the Rule of Half.
- Loss of asset value – Loss of value estimated by considering the residual value of the vehicles assumed to be scrapped.
- Transaction Cost – The cost involved in searching for a new vehicle. Estimated by multiplying the number of vehicles upgrading by the weighted transaction cost (derived from the "National data inputs for Local Economic Models").
- Fuel Switch Cost or Saving – Estimated by multiplying the number of vehicles switching fuel type, by the fuel cost and the average annual mileage. Note that this does not currently take account of the shift to electric vehicles encouraged by the investment in electric charging infrastructure, which would lead to reduced fuel costs.

2.6.55 A more thorough explanation of the methodologies used is included in the Economic Appraisal Methodology Report (EAMR) (Appendix E1). These costs are offset against the benefits provided by the proposed vehicle renewal funds and the proposed Clean Bus Fund.

2.6.56 The number of vehicles forecast to upgrade due to the GM CAP has been estimated using the baseline fleet composition data, Automated Number Plate Recognition (ANPR) data and the upgrade response.

2.6.57 Table 2- 11 presents the impact of upgrades to vehicle owners. The proposed GM CAP imposes a total cost as a result of vehicle upgrades of £10m. This encompasses an imposed cost or disbenefit of £127m, mitigated by £117m of proposed funding to support the upgrade of vehicle fleets in Greater Manchester.

Table 2- 11: Impact of upgrade* for non-compliant vehicle owners, £m, present value 2018 prices (2021-2030)

Options	Welfare loss	Benefits from Vehicle Renewal Fund and Clean Bus Fund	Fuel switch	Transaction cost	Loss of asset value	Total
Option 5(i)	−£168m	£149m	−£13m	−£0.7m	−£85m	−£119m
Option 5(ii)	−£202m	£149m	−£106m	−£1.3m	−£85m	−£247m
Option 8	**−£87m**	**£117m**	**−£0.7m**	**−£0.1m**	**−£40m**	**−£10m**

** positive value indicates benefit, negative value indicates cost*

Benefits of a Cleaner Fleet of Buses and Taxis in Greater Manchester

2.6.58 A cleaner fleet of buses and taxis operating in Greater Manchester would deliver a cleaner, better quality environment and would be more appealing to users. This may promote mode shift and reduce dependency on the private car. The GM CAP may be considered as the 'catalyst' for bus and taxi operators to take a significant step in investing in cleaner, more fuel-efficient vehicles, and be the turning point for driving older and unsuitable vehicles out of the market altogether.

Wider Benefits to Businesses of Upgrading their Fleet: Achieving Corporate Social Responsibility

2.6.59 A large number of businesses now include specific objectives and targets in relation to emissions levels and cleaner vehicle technology[8]. The proposed GM CAP offers an opportunity for businesses to manage their risk by operating in ways which are more environmentally friendly, supported by the public sector through a programme of sustainable travel initiatives and funds to help them upgrade their fleets.

[8] Transport for Greater Manchester's Freight and Logistics Transport Strategy

Costs Imposed by User Charges

2.6.60 Although the proposed GM CAP aims to induce non-compliant vehicle owners to upgrade or alter their behaviour to meet compliance, some users will choose to 'stay and pay', making their journey as normal and paying the charge. The reasons that users choose to stay and pay will be diverse. For some, it will be a trip they make infrequently, and therefore it would not be worth considering upgrading their vehicle. For others, the charge will simply not be high enough in comparison with the wider cost or value of their trip to induce them to change. Others may have no option than to pay because they cannot afford to upgrade their vehicle, or because a compliant vehicle is not a viable option for some reason, or because they do not have an alternative option available.

2.6.61 The user charges and penalty charges incurred are considered a financial cost to transport users and as a revenue to the public sector. They are therefore not included in the Economic Appraisal and do not contribute to the NPV. They are shown here for context.

2.6.62 Table 2- 12 presents the forecast user charges over the appraisal period (2021 to 2030), based on the assumed set charges outlined in Table 2- 17 and converted to present value 2018 prices for economic appraisal purposes. The proposed GM CAP is predicted to generate user charges of £234m.

Table 2- 12: Total User Charges, £m, 2021-2030, discounted

	Option 5(i)	**Option 5(ii)**	**Option 8**
Total User Charges, £m	£249m	£249m	£234m

Distributional Analysis of the Affordability of Costs Imposed by the GM CAP on residents

2.6.63 The Distributional Analysis of Affordability considers:

- **Personal Affordability**: the 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 the GM CAP, changes to personal affordability are linked to the costs associated with either paying the clean air charge for non-compliant vehicles or upgrading to a compliant vehicle where required, and in operating a vehicle (such as fuel and oil consumption, mileage-related depreciation and tyre wear) that are considered critical to the decision of whether to undertake a journey.
- **User benefits**: the 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, user benefits consider time and money costs that affect a person's experience when travelling, which are not likely to be critical to the decision of whether to undertake a journey.

2.6.64 Table 2- 12 presents an overview of the Distributional Impact Appraisal of Affordability. Colour coding in the table refers to the assessment matrix presented in Table 2- 4.

Table 2- 13: Distributional Impact Appraisal of Affordability Matrix: Option 5(i)(ii

	1 (Most Deprived)	2	3	4	5 (Least Deprived)	Are the impacts distributed evenly?	Key impacts
Personal Affordability - Income deprivation (England and Wales)	✓✓	✓✓	✓✓	✓✓	✗✗✗	No	The share of increased user costs experienced by the lowest income households in quintiles 1, 2 and 3 is in line with the share of the population in these areas. When compared to the distribution across England and Wales, those in quintile 5 receive a score of large adverse, compared to slight beneficial when mapped in comparison to Greater Manchester only. Differences exist within quintile 4, which receives a score of moderate beneficial when mapped against England and Wales and a score of large beneficial when mapped in comparison to Greater Manchester only.
Personal Affordability - Income deprivation (Greater Manchester)	✓✓	✓✓	✓✓	✓✓✓	✓	No	
Personal affordability – Disabled	It is recognised that people with a disability are less likely to drive and more likely to be dependent on public transport (including taxis and PHVs), community transport that offers door to door usage, or lifts from family and friends ((DfT, 2018a)[9]. Similarly, disabled people typically have lower average household income and the cost of upgrading wheelchair-adapted private vehicles is higher, making them particularly vulnerable to increases in the costs of private transport services and private car travel (Crisp *et al*., 2018)[10].						
User benefits Income deprivation (England and Wales)	✓	✓✓	✓✓	✓✓	✓✓	No	

[9] DfT (2018a). The Inclusive Transport Strategy: achieving equal access for disabled people. Available from: https://www.gov.uk/government/publications/inclusive-transport-strategy/the-inclusive-transport-strategy-achieving-equal-access-for-disabled-people [Accessed 19/11/18].

[10] Crisp et al., (2018). Tackling transport-related barriers to employment in low-income neighbourhoods. Joseph Roundtree Foundation. Available at: https://www.jrf.org.uk/report/tackling-transport-related-barriers-employment-low-income-neighbourhoods [Accessed 03/12/2018]

	1 (Most Deprived)	2	3	4	5 (Least Deprived)	Are the impacts distributed evenly?	Key impacts
User benefits Income deprivation (Greater Manchester)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	When compared to the distribution across Greater Manchester, user benefits are equally distributed across all income groups with all groups receiving a score of moderate beneficial. When compared to the distribution across England and Wales, those in quintile 1 receive a score of slight beneficial.
Business affordability – small and medium-sized enterprises	Business affordability impacts are assessed qualitatively.						
Business affordability – LGVs	Business affordability impacts are assessed qualitatively.						

Note: 1 = Most Deprived, 5 = Least Deprived

Table 2- 14: Distributional Impact Appraisal of Affordability Matrix – Option 8

	1	2	3	4	5	Are the impacts distributed evenly?	Key impacts
Personal affordability – Income deprivation (England and Wales)	✓	✓✓	✓✓	✓✓✓	✓✓	No	When compared against the distribution across England and Wales, the share of decreased user costs (user benefit) experienced by the lowest income households in quintile one is in line with the share of the population in these areas. In quintile four, there is a large beneficial impact. When compared to the distribution across Greater Manchester, user benefits are equally distributed across all income groups (moderate beneficial impacts).
Personal affordability – Income deprivation (Greater Manchester)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	
Personal affordability – Disabled	It is recognised that people with a disability are less likely to drive and more likely to be dependent on public transport (including taxis and PHVs) and community transport. Disabled people typically have lower average household income making them particularly vulnerable to increases in the costs of private transport services and private car travel (Crisp *et al*., 2018)[11]. As there is no charging of private vehicles under the conditions of Option 8, there would be no requirement for wheelchair-adapted private vehicles to be upgraded. Similarly, disabled people receiving lifts from family and friends would not be affected.						
User benefits Income deprivation (England and Wales)	✓	✓✓	✓✓	✓✓	✓✓	No	When compared to the distribution across Greater Manchester, user benefits are equally distributed across all income groups with all groups receiving a score of moderate adverse. When compared to the distribution across England and Wales, those in quintile one receive a score of slight adverse.
User benefits Income deprivation (Greater Manchester)	✓✓	✓✓	✓✓	✓✓	✓✓	Yes	

[11] Crisp et al., (2018). Tackling transport-related barriers to employment in low-income neighbourhoods. Joseph Rowntree Foundation. Available at: https://www.jrf.org.uk/report/tackling-transport-related-barriers-employment-low-income-neighbourhoods [Accessed 03/12/2018]

	1	2	3	4	5	Are the impacts distributed evenly?	Key impacts
Business affordability – small and medium-sized enterprises	Business affordability impacts are assessed qualitatively, described in the following section.						
Business affordability – LGVs	Business affordability impacts are assessed qualitatively, described in the following section.						

Personal affordability

2.6.65 The personal affordability DI analysis considers the monetary cost of travel for local people commuting to a place of work or education, and/or undertaking journeys for social or leisure purposes, using their own private vehicle.

2.6.66 The analysis takes into account changes in VOC as well as any applicable CAZ charges. Where congestion reduction effects open up new routes this can lead to changes in driving distances or allow driving at more efficient speeds, resulting in decreased vehicle operating costs.

2.6.67 For Option 8 in 2021, user costs decrease for non-business car and LGV users across all income groups due to reductions in vehicle operating costs.

2.6.68 For Option 5(i)/(ii) the reductions in vehicle operating costs across Greater Manchester outweigh CAZ charges within the IRR for personal trips so that there is an overall decrease in user costs for all income groups.

User benefits

2.6.69 User benefits considers the travel time and vehicle operating cost savings for users. As the options considered would only have minimal impacts on re-routing, the distribution of impacts is expected to be broadly similar for both Option 5(i)/(ii) and Option 8. The analysis indicates moderate beneficial impacts for all income levels.

Impact on local businesses and the economy

2.6.70 The DI analysis also considers the impact on Business Affordability. The introduction of CAZs in Greater Manchester would impose direct costs on businesses through increased transportation costs associated with either paying the clean air emissions charge for non-compliant vehicles or upgrading to a compliant vehicle where required, and/or procurement costs. The analysis of business affordability focuses on impacts on small and medium-sized enterprises (SMEs) and LGVs.

Business Affordability of the GM CAP: SMEs

2.6.71 The business profile of Greater Manchester is broadly in line with the national averages for each business type: 84.6% micro, 12.4% small, 2.6% medium and 0.4% large. Businesses across Greater Manchester would experience adverse affordability impacts from the implementation of the GM CAP.

2.6.72 For all Options, increased costs would be likely for those businesses that rely on HGVs and LGVs and for sole traders operating an in-scope vehicle. Freight vehicles registered to a private individual, rather than a company, are more likely to be non-compliant at present and the rate of fleet turnover is typically slower, meaning they will account for a higher proportion of non-compliant vehicles in 2021. These impacts will be mitigated to some extent by the proposed Clean Freight Fund and any loan finance scheme, which will offer financial support to help small businesses and sole traders upgrade their vehicles. The potential role of discounts and exemptions is also being explored, and will be investigated more fully at FBC and through stakeholder engagement.

2.6.73 Similarly, most taxi and private hire drivers and operators are sole traders or small businesses. It is unclear the extent to which drivers will be able to pass on the costs of the charge or of upgrade to their customers. The impacts will be mitigated to some extent by the proposed Clean Taxi Fund and any loan finance scheme, which will offer financial support to help upgrade or retrofit taxis and private hire vehicles. More support may be offered to those required to operate a London-style taxi and other specialist vehicles, reflecting the higher cost of these vehicles. The potential role of discounts and exemptions is also being explored, and all support measures will be investigated more fully at FBC and through stakeholder engagement.

2.6.74 Micro, small and medium businesses are less likely to own HGVs, but may rely on HGV services, which may become more expensive. It is unclear to what extent businesses in different sectors will be able to pass on the costs of any charges or upgrades to their customers, and therefore where the impacts are most likely to be felt. More work will be undertaken at FBC to explore this question.

Business Affordability of a CAZ D within the IRR: SMEs

2.6.75 Options 5(i) and 5(ii) impose additional costs on businesses, by bringing forward the implementation of charges for LGVs to 2021 within the IRR, and imposing a charge on non-compliant cars travelling into, within or through the IRR zone.

2.6.76 The number of LGVs registered within the IRR, relative to the number of SMEs, is only small, suggesting that only a small proportion of SMEs within the IRR own or have vehicles registered inside the charging zone. However, it is assumed that almost all businesses inside the IRR would be reliant on road transport and therefore the CAZ could increase the cost of doing business within the zone and make it more difficult to access suppliers.

2.6.77 Options 5(i)/(ii) will also increase the cost of travel to work for those dependent on a car and unable to upgrade their vehicle. This could lead to the potential displacement of workers to outside of the IRR to avoid the charge. If SME employees within the IRR cannot afford to pay the charge, this could lead to a loss of workers for the company who would then face the cost of recruitment.

2.6.78 The proposed GM CAP, Option 8, does not affect cars and does not propose an IRR scheme, and therefore these impacts are avoided.

2.7 Summary Tables of Costs and Benefits

2.7.1 This section brings together all the quantified costs and benefits to calculate the Net Present Value (NPV) of the proposed GM CAP and the rejected best-performing options over the appraisal period (2021-2030). NPV is calculated as the Present Value Benefits (PVB) minus the Present Value Costs (PVC): (NPV = PVB – PVC). Table 2- 15 presents the summary of the monetised benefits and costs of the options.

Table 2- 15: Summary of the total costs and benefits of the proposed GM CAP best-performing options, £m, present value 2018 prices

	Impact	Option 5(i)	Option 5(ii)	Option 8
Health and Environmental Impacts (positive value indicates a benefit, negative a disbenefit)	NO2 reduction	£52m	£52m	£52m
	PM reduction	£54m	£54m	£49m
	GHG emission reduction	£81m	£82m	£82m
User costs and benefits (positive value indicates a benefit, negative a disbenefit)	Health benefits of active travel	£31m	£31m	£18m
	Welfare loss (trips re-moded)	−£36m	−£36m	−£17m
	Welfare loss (trips cancelled)	−£59m	−£59m	−£39m
	Vehicle fleet upgrade Includes cost of upgrade, loss of asset value, transaction cost and fuel switch costs, less any financial subsidy from the funding measures	−£119m	−£247m	−£10m
	Congestion effects on travel time	£210m	£210m	£136m
	Congestion effects on vehicle operating costs	£89m	£89m	£73m
Present Value Benefits		**£304m**	**£176m**	**£344m**
Costs to the Public Sector (positive value indicates a cost, negative a saving)	Implementation Cost	£316m	£316m	£270m
	Operating and Maintenance	£153m	£153m	£148m
Present Value Costs		**£469m**	**£469m**	**£419m**
Net Present Value		**−£166m**	**−£293m**	**−£74m**

2.7.2 The outcome of the economic analysis shows that the NPV for all three options is negative, i.e. the costs outweigh the benefits. However, this is to be expected. There is a legal imperative to act and the analysis here clearly defines the option which is able to meet the requirements with the minimum adverse economic impact.

2.7.3 Option 8, the proposed GM CAP, presents the best NPV of −£74m, followed by Option 5(i). The variance between Option 8 and Option 5(i) is primarily due to lower vehicle fleet upgrade costs in Option 8, while Option 8 is still able to generate comparable benefits in most areas. This vehicle fleet upgrade cost is discussed in more detail in section 2.6.

2.7.4 In terms of air quality benefits, all three options deliver very similar reductions. Whilst Option 5(ii) would be expected to deliver more air quality benefits than Option 5(i), the difference is somewhat underestimated in the results presented above due to model capability limitations, as further explained in Section 2.9.

2.7.5 For Options 5(i) and 5(ii) the largest economic disbenefit comes from the cost of vehicle upgrades. It should be noted that there is an underlying assumption that the GM CAP will include vehicle scrappage. This implies that some vehicle users will upgrade their non-compliant vehicles at an earlier date than would have otherwise happened. However, rather than trading in the vehicle (retaining the depreciated asset value), it is assumed that the vehicles are scrapped. This avoids displacing non-compliant, polluting vehicles to other areas of the UK and is therefore advantageous from an air quality perspective because it removes those vehicles from the roads altogether. However, it does result in high economic cost.

2.7.6 Removing the costs/revenue to the public sector, it is possible to explore the effects (benefits, disbenefits and costs) on the residents and businesses of Greater Manchester as well as the wider public[12], as presented in Table 2- 16 below.

2.7.7 This analysis helps to illustrate whether the GM CAP is achieving its goal at the lowest imposed cost and offering the greatest benefits. Option 8 achieves compliance in the shortest possible time, meeting the core requirement of the GM CAP. It does so while bringing £410m of quantified benefits to Greater Manchester, as well as the very significant unquantified benefits to health, and at the lowest imposed cost of the three options. In total, the GM CAP delivers at least £344m of net benefits to Greater Manchester's residents and businesses.

[12] Impacts on the wider public include benefits, disbenefits and costs incurred by occasional visitors/those travelling from outside Greater Manchester.

Table 2- 16: Summary of the total costs and benefits incurred by Greater Manchester, present value 2018 prices

Impact	Option 5(i)	Option 5(ii)	Option 8
NO2 reduction	£52m	£52m	£52m
PM reduction	£54m	£54m	£49m
GHG emission reduction	£81m	£82m	£82m
Health benefits of active travel	£31m	£31m	£18m
Congestion effects on travel time	£210m	£210m	£136m
Congestion effects on vehicle operating cost	£89m	£89m	£73m
Total beneficial effects	£517m	£518m	£410m
Welfare loss (trips re-moded)	−£36m	−£36m	−£17m
Welfare loss (trips cancelled)	−£59m	−£59m	−£39m
Vehicle upgrade Includes cost of upgrade, loss of asset value, transaction cost and fuel switch costs, less any financial subsidy from the funding measures	−£119m	−£247m	−£10m
Total costs/disbenefits	−£214m	−£342m	−£66m
NPV	**£303m**	**£176m**	**£344m**

2.7.8 Figure 2- 10 illustrates the costs and benefits of the preferred option (Option 8)

Figure 2- 10: Visual chart of the economic impact of Option 8, £m, present value 2018 prices

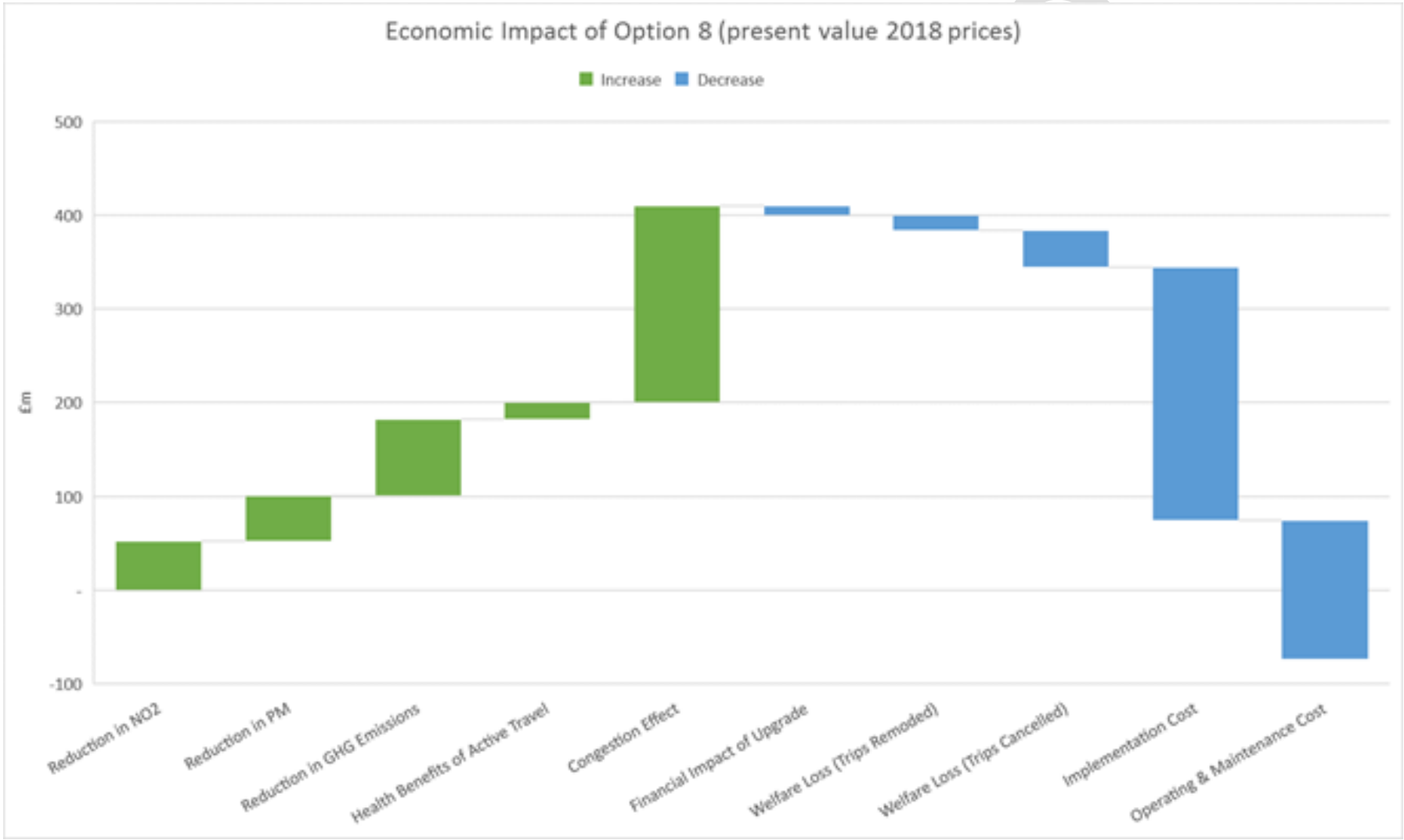
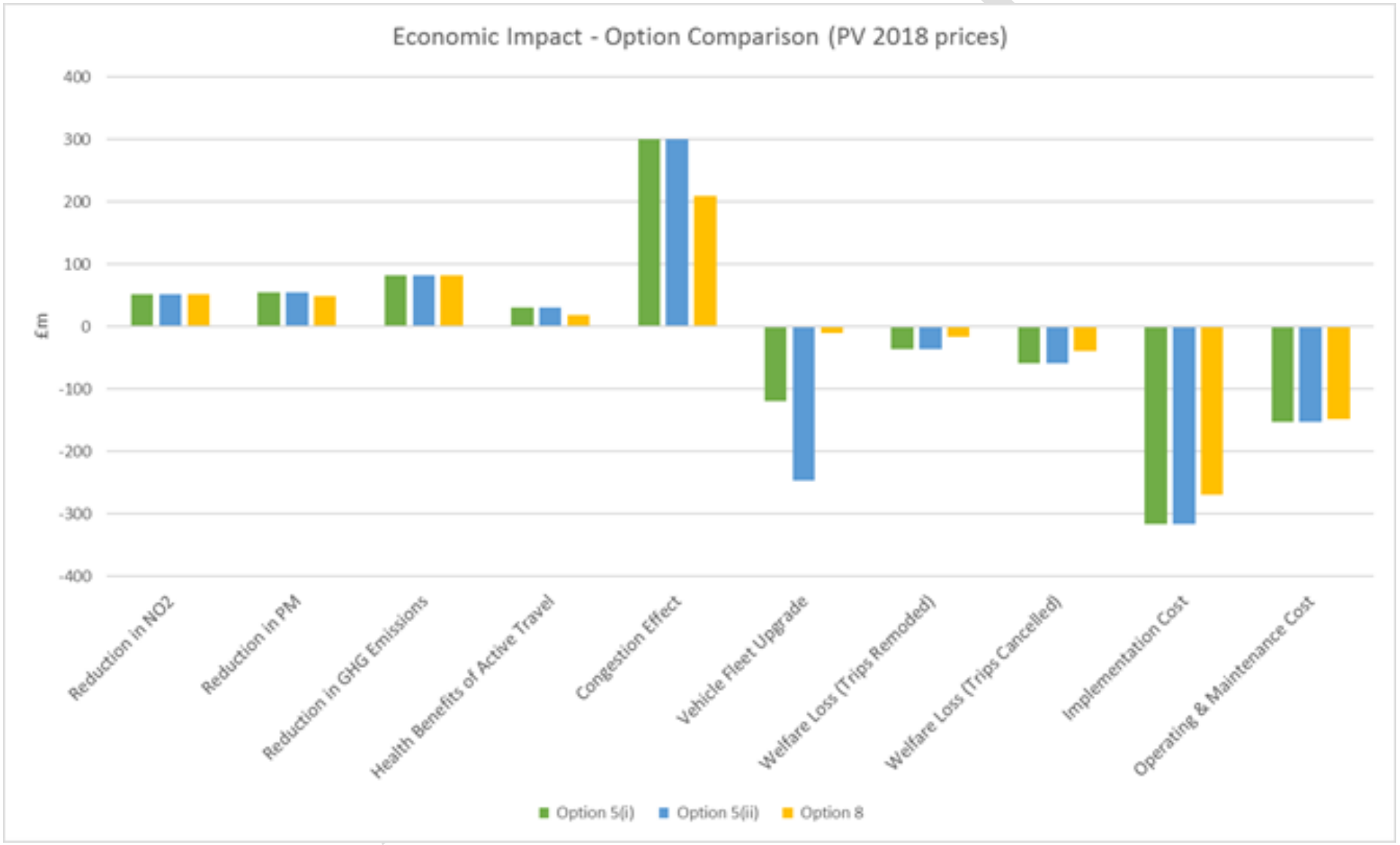


Figure 2- 11: Economic Impact of Options 5(i), 5(ii) and 8



Non-monetised impacts

2.7.9 There are a number of impacts of the GM CAP that have not been monetised in the appraisal, either due to limitations in the valuation methodologies and/or to the availability of data to support the analysis. Some of these gaps are highlighted here in order to underline the strategic reasoning for the intervention.

2.7.10 As discussed in the Strategic Case, the impacts of air pollution are far-reaching. The damage costs used to value the reduction in NO2 and PM emissions, and the avoided health and social costs, attempt to capture productivity losses associated with episodic illness. This refers to the impact of lost work days on the economy. In children, however, episodes of ill health result in absence from school which is shown to reduce pupil attainment. Those children achieving lower qualifications will go on to have lower earning potential with subsequent reductions in economic productivity.

2.7.11 The avoided health costs also do not capture the wider health impacts of poor air quality; for example, those who live and work in areas with poor air quality are less likely to spend time outside. This contributes to physical health (reducing opportunities for physical exercise) as well as mental health.

2.7.12 It should also be noted that the costs and benefits of changes in travel behaviour associated with the GM CAP are only partially captured. They do not cover the change in (real) costs to the transport user in switching from car to public transport, nor do they capture the public transport revenue from those trips re-moded.

2.7.13 The scale of these non-monetised impacts is unknown; however, it is likely that these additional impacts not captured could have a material effect on the NPV results.

2.7.14 The Distributional Impacts report includes a non-monetised qualitative analysis of the impacts on accessibility, air quality and affordability on different social and business groups including children, the elderly, disabled people, low income families, SMEs, LGVs and taxi operators.

2.8 Methodology of the Economic Appraisal

2.8.1 This section sets out an overview of the methodology adopted for the economic appraisal, the core assumptions applied, and the key impacts assessed. A full explanation of the methodology is in the Economic Appraisal Methodology Report (EAMR) (Appendix E1).

Monetised Costs and Benefits

2.8.2 The economic appraisal incorporates many of the key costs and benefits associated with the proposed GM CAP options within the available timeframe and modelling capabilities. There are a number of impacts which remained unquantified at this stage; a description of these and a discussion of the likely scale is presented in Section 2.7.

2.8.3 Table 2- 17 presents the scope of the monetised costs and benefits and how they have been assessed. For further detail on the methodology underpinning the appraisal, refer to the EAMR (Appendix E1)

Table 2- 17: Monetised Economic Impacts of the GM CAP

Impact	Benefits/Cost	Description	Methodology
Health and environmental impacts	Air quality (NO2 and PM)	The impact of the reduction in NO2 and PM emissions in terms of avoided health and environmental damage.	The change in emissions (tonnes) of NO2 and PM is modelled using outputs from the transport model to provide an indication of the level of change across Greater Manchester. The NO2 and PM savings are then monetised using damage costs (per tonne saved) recommended by JAQU.
	GHG emissions	The impact on GHG emissions as a result of the change in vehicle fleet and network effects.	The change in CO2 emissions is estimated based on the difference in total vehicle kilometres, extracted from the transport model. The change in emissions is then monetised using the CO2 non-traded values from the DfT WebTAG.
Changes in travel behaviour	Health benefits	The health benefits gained from those switching from cars to walking and cycling.	The health benefits associated with increased walking/cycling are calculated using the World Health Organisation's Health Economic Assessment Tool. For more details of the methodology, please refer to https://www.heatwalkingcycling.org/#homepage
	Welfare loss (trips re-moded)	The welfare loss of those opting to re-mode their trips, i.e. switching from car travel to public transport and/or active travel.	This impact assumes that there is a disbenefit to users in choosing an alternative to their original course of action. The loss of welfare from changing travel behaviour is estimated using the Rule of Half for trips foregone (cancelled), and trips re-moded (i.e. change to public transport). This implies that the value of the disbenefit falls somewhere between £0 and the price of the charge (or else users would have simply paid the charge and made their original journey as planned). The midpoint is taken to be the average disbenefit and multiplied by the number of trips foregone, or re-moded, to determine the overall welfare loss.
	Welfare loss (trips cancelled)	The welfare loss of those opting to cancel their trip altogether.	

Impact	Benefits/Cost	Description	Methodology
Vehicle fleet upgrade	Welfare loss	The welfare loss of having to purchase a new/used compliant vehicle earlier than planned.	The welfare loss associated with vehicle upgrade induced by the GM CAP is estimated based on the difference between the purchase price of a compliant vehicle and the deprecation value of the non-compliant vehicle that is traded in. The Rule of Half is applied to account for the consumer welfare loss to account for the fact that the user will experience some benefit in having a newer vehicle beyond the fact that it is merely compliant.
	Loss of asset value	The loss in asset value for those choosing to scrap (End of Life) as opposed to trade in their older, non-compliant vehicles.	Based on the estimated number of vehicles being scrapped, the average loss of asset value (after the GM CAP implementation) of each vehicle type and Euro standards have been estimated using JAQU's depreciation rate assumption.
	Transaction cost	Vehicle owners choosing to upgrade their non-compliant vehicle earlier than planned, are likely to incur a cost in having to locate a vehicle to their taste.	The transaction cost has been estimated using JAQU's average transaction cost per vehicle type and Euro standards.
	Fuel switch cost	Vehicle owners upgrading to a compliant vehicle may choose to upgrade to a different fuel type, for example a diesel car owner could upgrade to a compliant petrol car. The switch in fuel type leads to a change in running costs.	The total vehicle kilometres by non-compliant vehicle owners upgrading to a different fuel type is estimated based on the average vehicle kilometres travelled per vehicle. The average fuel consumption (of petrol vs diesel) is calculated, based on values provided by DfT WebTAG, and then the total fuel cost is estimated based on the average fuel price per litre consumed. The fuel switch cost is estimated by subtracting the Do Something fuel cost (i.e. the fuel type they switch to) from the Do Minimum fuel cost (i.e. the original fuel type).

Impact	Benefits/Cost	Description	Methodology
	Financial subsidy	Non-compliant vehicle owners choosing to upgrade early may receive financial support via the proposed Vehicle Renewal Fund (Car, Freight and Taxi Funds) and the Clean Bus Fund. This would offset some of the welfare loss from upgrading.	The financial relief which offsets the welfare loss associated with upgrading was estimated by the financial model, taking into the account the number of vehicles upgrading and the maximum financial subsidy offered per applicant via the funding measures, Vehicle Renewal Fund and and Clean Bus Fund.
User charges	Financial cost of paying the CAZ emissions penalty	The cost to non-compliant vehicle owners opting to continue travelling into the CAZ and pay the daily emissions penalty.	The number of individual vehicles paying the charge was estimated based on the number of trips forecast to pay the charge by the traffic model, and the average number of trips per vehicle. The proposed CAZ charges are then assigned to each individual vehicle forecast for each year of the appraisal period. It should be noted that the user charges assumed were for the purpose of modelling only and are subject to change following stakeholder consultation.
Congestion effect	Travel time impact	Due to the nature of the GM CAP, there may be an impact on traffic flow. For example, if more non-compliant vehicle owners opt to avoid the CAZ boundary, this may result in fewer vehicles crossing and moving within the CAZ boundary, leading to travel time savings.	The congestion effects are modelled using DfT's TUBA software. The input of TUBA is generated by the transport model.
	Changes in vehicle operating cost	Vehicles may see a difference in vehicle operating costs as a result of travel time savings or costs and an increase or decrease in fuel consumption	

Impact	Benefits/Cost	Description	Methodology
Cost to the public sector	Implementation cost	The up-front cost of implementing the GM CAP.	Assumptions on the implementation costs and how they were derived can be found in the Financial Case.
	O&M	The ongoing cost of operating and maintaining the GM CAP.	Assumptions on the O&M costs and how they were derived can be found in the Financial Case.
	Revenue	Revenue generated by the CAZ charge payments.	The user charges which are incurred as a cost to transport users are reflected as revenue (income stream) to the public sector.

Behavioural Response

2.8.4 To best capture the behavioural response of vehicle owners in Greater Manchester, the approach adopted has deviated from the national behavioural responses provided by the JAQU guidance (with the exception of HGVs). The national assumptions are based on the London ULEZ scheme, whereas the assumptions incorporated here are based on the stated preference survey undertaken for the Bristol CAP and adjusted to better reflect the situation in Greater Manchester.

2.8.5 A stated preference survey may be required as part of the FBC stage aimed at Greater Manchester residents and businesses, which would then inform the modelling and economic appraisal for the FBC, improving the accuracy and reliability of the results.

Traffic Modelling

2.8.6 At the time of development, the traffic and air quality modelling were based on the fleet composition provided by the ANPR data over a one-week time period and therefore may not be representative of general travel patterns. One of the ways this could be improved is to incorporate the fleet composition based on registered vehicles in Greater Manchester sourced from the DVLA. This would provide a more reliable estimate of the number of compliant and non-compliant vehicles that are likely to make frequent journeys within Greater Manchester. New ANPR surveys are underway to validate these assumptions.

2.8.7 Additionally, the transport and air quality modelling is subject to further refinement, incorporating feedback from the planned public engagement, as well as further development of the measures. The assumptions underpinning the current model will be updated and refined, improving the reliability and accuracy of the modelling results. For example, for Option 5(ii), it has been assumed for modelling purposes that Euro 6 diesel car owners entering the IRR cordon would either pay the charge, or upgrade to a compliant vehicle (i.e. switch to petrol or an Ultra-Low Emission Vehicle (ULEV)). This assumption reflected what was possible with the tools and data available, but clearly in reality a more complex range of responses would occur. The implications of this are that both the costs and benefits are likely to have been under- or over-estimated.

Air Quality Modelling

2.8.8 The limited capacity of the air quality modelling to assess the complex nature of the proposed GM CAP in the time available means that changes in NO_2 and PM have been quantified using the damage cost approach which relies on the change in total (gross) emissions. This does not reflect the change in ambient concentration levels over the appraisal period which ultimately drive improved health outcomes.

2.8.9 Further, the air quality benefits are likely to be significantly underestimated as they are based on traffic changes within the CAZ cordons. This means that the total NO_2 and PM savings are only calculated for trips wholly contained within the CAZ boundary and do not include trips which have an origin or destination outside of the CAZ.

2.8.10 Additionally, the air quality impact of Option 5(ii) is underestimated as the modelling does not assume any diesel Euro 6 car trips to be cancelled or re-moded. Realistically, we would expect to see a substantial proportion of diesel trips cancelled or re-moded, especially for those that do not enter the CAZ frequently and have reasonable accessibility to public transport.

Guidance

2.8.11 The methodology of the economic appraisal has been based on various guidance reports, mainly the JAQU Guidance for CAZ Options Appraisal (Defra 2017), the Greenbook: Central Government Guidance on Appraisal and Evaluation (HM Treasury, 2018) and DfT WebTAG (last updated May 2018).

2.8.12 Furthermore, Greater Manchester has taken a collaborative approach throughout the development of the CAP, seeking advice and guidance from JAQU and obtaining approval for methodological decisions throughout the project.

2.8.13 The economic appraisal is based on the JAQU guidance for CAZ Options Appraisal but, as recommended by JAQU, the approach and assumptions underpinning the appraisal have been adjusted specifically for Greater Manchester. The economic appraisal incorporates as many monetised costs and benefits associated with the GM CAP options as possible given the available timeframe and modelling capabilities.

Transport and Air Quality Modelling

2.8.14 The economic modelling undertaken is reliant on the traffic modelling and the air quality modelling. The traffic modelling was completed using the traffic assignment software - Simulation and Assignment of Traffic to Urban Road Networks (SATURN), which models the change in traffic assignment after the implementation of the GM CAP (i.e. Do Something scenario), compared to the baseline scenario (i.e. Do Minimum scenario). The SATURN output then feeds into the Air Dispersion Modelling System (ADMS) model, which calculates the change in concentration of the pollutants NO_x and PM across Greater Manchester. Aside from the opening year, the years 2023 and 2025 were modelled for the following purposes:

- Year 2023 – to model the impact of the CAZ transition for van/minibus from the IRR to Greater Manchester cordon; and
- Year 2025 – to confirm the year of compliance.

2.8.15 However, given the restricted timeframe, the economic appraisal only incorporates the modelled years 2021 and 2025. The economic appraisal may be updated and could incorporate the modelled year 2023 at a later stage.

2.8.16 Going forward, the transport, air quality, and subsequently the economic, modelling will be modified and updated to incorporate the following:

- further development of the measures;
- feedback from the public and stakeholder engagement;
- DVLA data for improved accuracy and reliability of the baseline fleet composition used for the analysis; and
- general refinement and improvement of the models.

2.8.17 The modelling assumes charge levels of £100 a day for non-compliant HGVs, buses and coaches and £7.50 a day for all other in-scope vehicles. These charges are assumed for modelling purposes only; a decision about charge-levels will depend upon further analysis, stakeholder engagement and public consultation. It has been assumed that the charges do not differ across the different cordons and it has been assumed that a non-compliant vehicle will be charged once per day, regardless of how many times the CAZ boundary is crossed.

2.8.18 Note that the CAZ charges described in Table 2- 18 are assumptions applied for the purpose of economic modelling. The CAZ charges have not been determined and will be subject to public and stakeholder consultation, as well as further analysis.

Table 2- 18: Clean Air Zone Charges assumed for modelling purposes, £, 2021 prices

Vehicle Type	CAZ Charge assumed for modelling purposes, £
Car	£ 7.50
Taxis & PHVs	£ 7.50
Vans (LGV)	£ 7.50
HGVs, Buses & Coaches	£100.00

Economic Assumptions

2.8.19 The following economic assumptions were adopted for the option appraisal:

- opening year is 2021;
- modelled years are 2021 and 2025;
- appraisal period runs from 2021 to 2030;
- all figures are presented in 2018 prices;

- economic impacts are adjusted to 2018 prices using the Gross Domestic Product (GDP) deflator series (source: DfT WebTAG Databook May 2018);
- number of working days is 253 days;
- discount rate is 3.5%, as recommended by DfT's TAG unit A1.1 Cost Benefit Analysis (November 2014); and
- optimism bias (OB) is applied to the implementation, operating and maintenance costs based on the Government Green Book Guidance (see the Financial Case for further detail).

2.9 Limitations of the Modelling and Recommended Further Analysis

2.9.1 In interpreting these results it is important to note the following:

- the analysis is limited by the impacts which are able to be quantified and monetised. There are multiple benefits associated with improving air quality that are only partially captured or not captured at all (see Section 2.7 for a discussion of non-monetised impacts); and
- the economic appraisal is driven in large part by the traffic modelling and the assumptions underpinning it, particularly around the assumed travel behaviours as a result of the CAP. This is subject to ongoing research and will be further refined at FBC stage.

Limitations and Caveats

2.9.2 In interpreting these results it is important to note the following:

- the analysis is limited by the impacts which are able to be quantified and monetised. There are multiple benefits associated with improving air quality that are only partially captured or not captured at all (see Section 2.7 for a discussion of non-monetised impacts); and
- the economic appraisal is driven in large part by the traffic modelling and the assumptions underpinning it, particularly around the assumed travel behaviours as a result of the CAP. This is subject to ongoing research and will be further refined at FBC stage.

2.9.3 The modelling includes a simplifying and conservative assumption that all LGV users are driving for non-business and commuting purposes. That is, they are making personal non-work-related journeys referred to in the modelling as 'other' journeys. This is clearly not the case but is conservative because the benefit of improved journey times would be larger if the business value of time was used. This assumption will be reviewed at FBC and may be revised in future if better data becomes available.

2.9.4 The distributional impact analysis also ignores business users as it assumes their choices are not affected by the charge. In reality many of those paying the LGV charge in particular are likely to be small businesses or sole traders.

2.9.5 Default purpose splits are used for all vehicle types, which may over/underestimate the actual trip purposes on specific routes.

2.9.6 No income segregation is included with the assignment model, which may affect the calculation of the Distributional Impacts as it is not possible to see specific re-routing or affordability impacts for lower income groups.

2.10 Summary of the Economic Analysis

Conclusions

2.10.1 The economic appraisal of the GM CAP evaluates the economic costs and benefits of the three shortlisted options, Option 5(i), Option 5(ii) and Option 8. Option 8 is proposed as the GM CAP, as set out in Section 1.7 of the Strategic Case.

2.10.2 As the proposed GM CAP does not impose a charge on private cars, the impacts on private residents are positive: they will experience improved air quality and related health benefits. Residents will benefit from investment in electric vehicle charging infrastructure and promotion, programmes to support sustainable journeys, and from a newer, cleaner bus and taxi fleet.

2.10.3 In summary, the proposed GM CAP, Option 8, delivers a total quantified health, air quality and environmental benefit of £201m. Beyond the readily quantifiable benefits, the GM CAP would substantially reduce health and social care costs, reduce persistent absences from work and school, and improve the quality of life of those suffering from chronic conditions worsened by poor air quality. Residents in all parts of Greater Manchester will benefit from these improvements, with the greatest improvements found in those places where air quality is worst.

2.10.4 The GM CAP, Option 8, also delivers travel time savings valued at £136m, through small-scale but widespread reductions in traffic and congestion; alongside associated reductions in vehicle operating costs of £73m.

2.10.5 The costs of complying with the GM CAP fall largely on businesses, sole traders and the public sector. In total, the GM CAP imposes an estimated cost of £66m in terms of the costs of upgrading vehicles sooner than anticipated, and the welfare loss of changing mode or cancelling trips. This is a crucial consideration and has shaped the proposals for significant financial support to businesses to upgrade non-compliant vehicles.

2.10.6 It is intended that the help to upgrade provided by the Clean Freight and Taxi Funds is targeted at smaller operators who would otherwise struggle to afford to upgrade their vehicles. The goal is to maximise fleet upgrade and minimise the number of local operators who ‘stay and pay’. More work is required to fully define these schemes, but the aim is to provide an air quality benefit and limit the costs imposed on small businesses, taxi and private hire licence holders, and sole traders. Any discounts and exemptions are also likely to be targeted at this group, as well as at specialist vehicles, the emergency services and charitable and not-for-profit organisations.

2.10.7 Analysis and stakeholder engagement suggests that larger fleets tend to be made up of newer vehicles, with the oldest vehicles disproportionately likely to be privately owned, presumably by sole traders and very small operators. It is reasonable to assume that the business decisions, costs and benefits to the smallest businesses are more interwoven with family and household circumstances than those of larger enterprises. Thus the distinction between the impacts on businesses and residents is blurred. Residents who are self-employed or run a small business in affected industries may experience disbenefits beyond those captured here.

2.10.8 The cost to the public sector of implementing and operating the GM CAP is estimated at £419m. In summary, taking the benefits and imposed costs, and the cost to implement and operate the GM CAP into account, the Net Present Value of the GM CAP is −£74m. Whilst negative, Option 8 is the best performing of the three Options considered here by quite some way: the equivalent NPV is −£166m for Option 5(i) and −£293m for Option 5(ii).

2.10.9 If only the benefits and imposed costs are considered, ignoring the operational and implementation cost to the public sector, the GM CAP brings benefits valued at £410m to the residents and businesses of Greater Manchester, compared to imposed costs of £66m, a net benefit of £344m.

2.10.10 Fundamentally, the purpose of the Economic Case within a business case is to answer the question: is this the right thing to do? As discussed earlier, in this instance, inaction is not an option – there is a legal imperative to act, and specifically to take all action possible to deliver compliance in the shortest possible time. As established in the Strategic Case, the Option 8 delivers compliance in the shortest possible time, by 2024, and delivers considerable reductions in NO_x emissions and NO_2 concentrations prior to compliance being achieved. By proceeding with Option 8, Greater Manchester will meet the overarching objective of the Clean Air Plan process and meet its legal requirements.

2.10.11 The analysis presented above demonstrates furthermore that Option 8 delivers:

- compliance in the shortest possible time and very similar monetised air quality and emissions benefits as the other Options;
- the highest net benefits to the people and businesses of Greater Manchester of any Option;
- the best NPV of any Option; and
- avoidance of negative Distributional Impacts on affordability, on low income workers dependent on a car, and on the city centre economy and particularly the retail and leisure sector that result from a CAZ D.

2.10.12 Some concerns remain about the impact on small businesses and sole traders, but a package of measures, discounts and exemptions is proposed to support this group and help them comply with the scheme. More work will be carried out at FBC to better understand the support needed and to target effort and funds where they can be most effective in delivering air quality benefits and mitigating socioeconomic impacts.

2.10.13 Whilst every effort has been made to use the best data and tools available in this assessment, there remains much that we don't know and many sources of uncertainty in the analysis and conclusions drawn. Sensitivity testing has been conducted to better understand the uncertainty inherent in this analysis, and the extent to which it affects the validity of the conclusions; this is described in the associated Sensitivity Testing Technical Report. Additional research, analysis and modelling will be conducted at FBC, supported by engagement with stakeholders and industry experts. This should ensure that a more certain and fuller assessment, including Economic and Equalities Impact Assessments, can be presented at FBC. A more detailed discussion of uncertainty and possible next steps is provided in the supporting Analytical Assurance Statement.

A discussion on Value for Money

2.10.14 Value for Money is normally assessed by considering the extent to which the monetised benefits (and unquantified benefits) outweigh the costs. The key decision in most cases is whether action is preferable to inaction, i.e. is this scheme worth doing? There are two key differences here. Firstly, inaction is not an option. There is a legal imperative to act where it is possible to do so, and that this action must be sufficient to achieve compliance in the shortest possible time. Therefore, the question is not 'is it worthwhile to act?' but 'is this the best course of action, of the options available?' This is a more complex question to answer as it is not possible or reasonable to assess every possible course of action, or combination of actions. GM has used the evidence and tools it had available to develop a series of ambitious but feasible packages that seek to use all the measures considered deliverable and effective within the timescale to achieve our goal. We believe the GM CAP represents the best course of action to achieve compliance in the region in the shortest possible time.

2.10.15 The second key difference is that the quantified benefits used in appraisal are better suited to schemes designed to deliver transport benefits. The core purpose of the GM CAP is to improve human health. The substantial reductions in NO_2 concentrations sooner than would be experienced without action, as well as reduced particulate matter emissions, will deliver real benefits for the people of Greater Manchester. But it is very difficult to put a value on this saving. We cannot know for sure how many lives will be saved, or how many visits to hospital or absences from work or school avoided, but we know it is many. We cannot put a value on the misery prevented, but it has value. A cleaner, healthier Greater Manchester will be better for everyone, making the region a more appealing place to live, work, visit and do business, but we cannot meaningfully quantify this. So we are better able to quantify the costs than the benefits of our scheme and cannot properly describe whether it represents 'Value for Money' using traditional methods.

2.10.16 One alternative method that can be usefully employed is to consider the efficiency with which the money spent on the different options reduces the level of NO_2 – where a greater volume of NO_2 reduction per pound spent represents a more efficient outcome and better Value for Money.

2.10.17 The primary aim of the GM CAP is to achieve compliance whereby NO_2 concentrations are below the EU Limit Value. It would be possible to implement a CAP which delivers compliance in terms of concentration levels but does not result in a significant change in total emissions. Every tonne of NO_2 emitted is damaging; and so this sort of efficiency analysis should take into account the total emissions savings relative to the costs incurred in delivering those savings – not just the exceedances reduced.

2.10.18 Table 2- 19 presents the abatement cost of NO_2 (£ per tonne) across all of the best-performing options. Note that abatement cost here refers to financial costs (implementation, operation and maintenance costs) only. Although the financial costs would include revenue savings, for the purpose of the analysis, the revenue savings have been excluded, therefore the abatement cost of NO_2 is very likely to be underestimated.

Table 2- 19: Abatement costs of NO_2 per tonne, present value 2018 prices

Policy	Total NO2 savings (tonnes) 2021-2030	Total Cost/NO2 savings (Appraisal period discounted)
Option 5(i)	10,912	£43,000 per tonne
Option 5(ii)	10,973	£42,700 per tonne
Option 8	11,274	£37,200 per tonne

2.10.19 Option 8 achieves an abatement cost of £37,200 per tonne. This can be compared to the marginal abatement costs for road transport interventions presented in *Abatement cost guidance for valuing changes in air quality*[13] (Defra, 2013) which presents values ranging from approx. £24,000 to £79,000 per tonne, with an average price of £47,000 per tonne (2011 prices – approximately 11% lower than current prices) depending on the intervention.

2.10.20 Based on these values all the potential interventions provide an efficiency greater than the average of the schemes presented, and so provide a greater than average Value for Money.

Appendices

Appendix E1 – Economic Appraisal Methodology Report (EAMR)
Appendix E2 – The Economic Model
Appendix E3 – Distributional Impacts Report
Appendix EX – Equality Impacts Statement (EQIA)

13 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/197898/pb13912-airquality-abatement-cost-guide.pdf