Greater Manchester's Clean Air Plan to tackle Nitrogen Dioxide Exceedances at the Roadside

Note 6: GM CAP Behavioural Responses Review Note

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COVID-19 Pandemic Statement

This work has not considered the impact of the COVID-19 pandemic. Whilst we are continuing, where possible, to develop the Greater Manchester Clean Air Plan, the pandemic has already had an impact on our ability to keep to the timescales previously indicated and there may be further impacts on timescales as the impact of the pandemic becomes clearer.

We are also mindful of the significant changes that could result from these exceptional times. We know that the transport sector has already been impacted by the pandemic, and government policies to stem its spread. The sector's ability to recover from revenue loss, whilst also being expected to respond to pre-pandemic clean air policy priorities by upgrading to a cleaner fleet, will clearly require further thought and consideration.

The groups most affected by our Clean Air Plan may require different levels of financial assistance than we had anticipated at the time of writing our previous submission to Government.

More broadly, we anticipate that there may be wider traffic and economic impacts that could significantly change the assumptions that sit behind our plans. We have begun to consider the impacts, and have committed to updating the government as the picture becomes clearer over time.

We remain committed to cleaning up Greater Manchester's air. However, given the extraordinary circumstances that will remain for some time, this piece of work remains unfinished until the impact of the COVID-19 pandemic has been fully considered by the Greater Manchester Authorities.

This note contains early work on revised behavioural response estimates which is superseded by later work – see Note 37 and Report T4 for the latest assumptions.

1 Overview

1.1 This technical note will clarify the data and assumptions that underpin the behavioural response analysis being applied within the GM Clean Air Plan (CAP) project for the outline business case, and including additional data sources that could be incorporated as part of ongoing refinement of the CAP assumptions to inform the Full Business Case.

2 Behaviour Response Assumptions

2.1 London Ultra Low Emission Zone

2.1.1 Earlier versions of the Greater Manchester behavioural response models were based on data from the London Ultra Low Emission Zone (ULEZ) in accordance with JAQU guidance at the time. At the request of JAQU, later versions (Summer 2018 onwards) were changed to rely on data from the Bristol Clean Air Plan, as this was believed to be more applicable.

2.1.2 Details of the London ULEZ scheme are discussed in Section 3.4.

2.2 Bristol Clean Air Plan

2.2.1 Data from a web-based stated preference (SP) survey that was carried out to support the Bristol CAP was found to be more comparable to GM demographics in terms of income, employment, car availability and method of travel to work, and so the GM behavioural responses were rebuilt upon this data.

2.2.2 The Clean Air Zone (CAZ) proposed as part of the Bristol plan shared the same general format as the GM CAZ, requiring at least a Euro IV petrol engine or Euro VI diesel engine in order to be exempt from charges within the specified area.

2.2.3 The Bristol survey targeted drivers of noncompliant vehicles, and comprised two exercises;

- The first investigating the participants possible behaviour if a charge had been in place on their last journey in the proposed CAZ, and
- The second designed to find out if the respondent would continue to use their noncompliant vehicle if a CAZ were implemented, or if they would upgrade to a cleaner one to avoid charges.

2.2.4 The results of this survey were sense-checked, factored to account for the influence of trip frequency on respondents' behaviour, and weighted by trip purpose and fuel type in order to better fit the profile of the area. The statistical models produced through logistic regression methods were segmented by income, frequency and distance between home origin and the CAZ boundary.

2.3 Greater Manchester Clean Air Plan

2.3.1 The data from the two exercises in the Bristol survey was combined and used as the basis for the GM models. Similar methods were used to assess the behaviour responses, with some adjustments to the assumptions and weighting.

- The ‘Change Route’ and ‘Change Destination’ options were removed in all cases, as destination choice was not being tested, and re-routing opportunities are assumed to be captured within the GM SATURN model.
- ANPR data was used to tailor the proportions of compliant and noncompliant vehicles of each type across different parts of Greater Manchester to estimate compliant and non- compliant vehicle composition.
- The Bristol survey separated the responses by income, whereas the Manchester responses were classified by vehicle type, covering cars, LGVs, HGVS and Taxis, with the aggregated responses for each mode being weighted by income. Since the Bristol survey data does not make a distinction between vehicle types, and only surveyed car and LGV drivers, additional assumptions have been made for each mode and these are detailed below.
- The responses for car drivers were modelled using a combination of two methods, although private cars are not now intended to be charged under the proposed GM CAP. The proportion of drivers willing to pay the charge was modelled using trip cost elasticities that were calculated using GM SATURN average trip costs, fit to the weighted SP response data corresponding to a £7.50 charge. The proportion of drivers that would not pay the charge was then divided between the various options according to the weighted SP data alone.
- As the Bristol survey combined LGV and Car responses, LGV-specific responses were estimated by reweighting the SP data to account for the fact that LGVs are used for both business and personal trips, and each will have a difference response to the charging. Two additional factors were also considered to better define the LGV class; a higher upgrade cost to reflect the fact that vans tend to be more expensive than cars, and the ‘Change Mode’ response was removed for business trips by weighting in line with WebTAG guidance for business/non-business usage proportions. This response was still permitted for the non-business proportion of LGV responses.

- Taxi responses were estimated in two distinct categories: Hackney carriages and Private Hire Vehicles (PHVs). PHVs were considered in a similar fashion to the LGV responses, as they were assumed to share the same characteristics in terms of business and personal use, as well as increased upgrade cost due to the fact that taxis are larger than the average car, and typically have little to no re-sale value due to high mileage. Again, the 'Change Mode' response was removed for business related use; the WebTAG evidence on the purpose of LGVs was assumed to be applicable in the absence of a more relevant source. Hackney carriages were considered separately through the option assessment process and the response was modelled as a percentage upgrade for non-compliant vehicles, independent of charge.
- HGV responses were not included in the Bristol survey, so have been calculated using other sources. A combination of JAQU guidance (based on London Ultra-Low Emissions Zone SP data) and VTPI[1] research was used, alongside average HGV trip costs and times from SATURN.

3 Comparable Clean Air Plans

3.1 There are a number of comparable Clean Air Plans in the planning stages or already in place across the UK and Europe which could be used to strengthen and support the behaviour response evidence for the GM CAZ.

3.2 Most of the UK evidenced schemes below are study proposals similar to the GM CAP. The exception being the current London ULEZ, which replaced the T(toxicity)-charge in April 2019, but is proposed for expansion in October 2021. The European cities referenced all have schemes which are currently operating.

3.3 UK

3.3.1 All the UK schemes discussed in this section follow the same format as the proposed GM CAZ, whereby drivers of noncompliant vehicles must pay a charge to access the specified zone.

3.4 London Ultra Low Emission Zone

3.4.1 The London ULEZ SP study took the form of two stated preference surveys; the first aimed at drivers of non-compliant cars, small vans, LGVs and HGVs, and the second aimed at operators of LGV or HGV fleets. The survey recorded a range of demographic markers about the owner and their vehicle(s), the frequency and purpose of their travel within the ULEZ, and presented two stated preference exercises similar to those used in the Bristol CAP survey described in Section 2.2. The surveys gathered a total of 1,263 responses, with 1,197 deemed suitable for use in the statistical model calibration.

[1] VTPI – Victoria Transport Policy Institute (Research Organisation), Web link: https://www.vtpi.org/elasticities.pdf Date downloaded: 25/06/19

3.4.2 The statistical models were produced in a similar manner to the Bristol survey, described in Section 2.2, although in this case the data was segmented not only by income, frequency and home origin, but also by journey purpose. Frequency, purpose and income segmentations were also used on the subset of home origins that lay within the Greater London area.

3.5 Sheffield and Rotherham Clean Air Zone

3.5.1 A number of qualitative focus groups and stated intention surveys were undertaken by SYSTRA in Sheffield and Rotherham, aimed at drivers of private cars, PHVs, LGVs and black cabs. The quantitative surveys offered a range of potential responses to four CAZ charge levels between £5 - £20, as well as categorising the frequency of travel in central Sheffield or central Rotherham, where the scheme is expected to cover. The response proportions were calculated from the survey results of 512 respondents, consisting of 311 private car drivers, 101 LGV drivers, and 50 each of black cab and PHV drivers.

3.5.2 This study kept the results segmented by these vehicle types, and also gave particular consideration to geographic variations in frequency, making the distinction between internal (local trips), external (long distance 'through' trips) and cross-boundary trips.

3.6 Bath Clean Air Plan

3.6.1 In addition to the Bristol survey, Jacobs performed a second survey using the same methodology to support the Bath Clean Air Plan OBC. Both surveys are based off the London Ultra Low Emission Zone (ULEZ) SP survey format.

3.7 Birmingham Clean Air Zone

3.7.1 SP surveys carried out for the London ULEZ were analysed and interpreted as part of the Birmingham CAP proposals development. The data was reweighted for Birmingham demographics in terms of trip frequency, income levels and upgrade costs. In addition, a consultation carried out by Birmingham City Council provided some insight into short-term behaviour responses, although no statistical estimation was included in this.

3.8 Bradford Clean Air Zone

3.8.1 In support of the Bradford Clean Air Zone two surveys were performed; the first designed for drivers of private cars and LGVs registered to an individual, and the second designed for business owners of LGVs and HGVs. The surveys gathered personal and vehicle demographic data, as well as information regarding vehicle replacement plans, frequency of access to the CAZ and journey purpose. This was followed by two stated intention questions describing scenarios in which various charges were either already in place on the respondent's last journey, or were to be implemented in 2022.

3.9 Europe

3.9.1 There are a number of Clean Air Plans in effect across Europe, although the majority of them use a system of restricted access instead of the mode-based charge proposed in the Greater Manchester plan. These types of schemes are of limited use in informing the GM CAP, as the behaviour responses are not directly comparable.

3.10 Milan Area C

3.10.1 There are several concurrent low emission zones and environmental regulations in effect in Milan, with the 'Area C' component being the most relevant to the GM CAZ. In addition to restricting access based on engine type, there is also a charge in place for all permitted vehicles, with reduced costs for residents and some types of business trips. Currently, only electric and hybrid vehicles are exempt from any charge, although hybrid vehicles will be subject to normal charges from October 2019.

3.10.2 Vehicles entering Area C have been monitored continually since the schemes inception in January 2012, and a full dataset (including Euro engine classifications) is available through the City of Milan website[2].

3.11 Berlin

3.11.1 Berlin, alongside other German cities including Cologne and Leipzig, operates on a national vehicle classification system. Only vehicles meeting the Class 4 standard (Diesel Euro IV or petrol Euro I) can travel in these zones.

3.12 Stockholm

3.12.1 There are two key components to the Stockholm clean air plan. Firstly, there is a Low Emission Zone in place that only permits access to Euro VI vehicles, as well as Euro V vehicles and HGVs that have been registered recently. The second component is a variable congestion charge that is enforced throughout the day (0630 – 1830), with peak times demanding higher charges. This affects all vehicles regardless of emissions.

[2] https://areac.amat-mi.it/it/areac/

3.13 Supporting the Greater Manchester Clean Air Plan

3.13.1 The Sheffield study shows the most potential in further informing GM CAP. All four of the vehicle types considered in this study are assessed separately, and show distinct behaviour profiles. This can provide data to support the GM response models, particularly for LGVs and taxis, although the data pertaining to cars is inferior to the data from the Bristol survey in terms of both sample size and as it is only based on stated intention survey methods rather than stated preference. In addition, there are several other caveats concerning the applicability of the Sheffield responses, as set out below.

3.13.2 The exact scale of the Sheffield and Rotherham CAZ is not currently known, although the survey considered a situation in which only the city centres were included. As such, the scope of the scheme presented to the respondents is significantly smaller than the region-wide GM CAZ. The availability of different response options could vary significantly between the two schemes as a result, and this must be kept in mind when applying these response proportions to the GM demographics without further investigation. One particular consideration is that the size of the GM CAZ means drivers within the zone will see the vast majority of their trips affected, and therefore responses for high-frequency trips are most appropriate. The Sheffield response data aligns with the GM modelling in this respect, as a high-frequency trip profile was applied to taxis (and other vehicle types showed no significant variation in responses).

3.13.3 In contrast to the range of charges considered in the GM and Bristol CAP research, the Sheffield survey only assessed responses relating to £5, £10 and £20 charges for all vehicles, as well as a fourth option with a £10 charge and a subsidy for electric vehicles. Despite this limitation, interpolation between these data points could still provide a more robust response model than is currently in place, particularly for taxis, which are currently based on limited assumptions. It is also worth noting that the data indicates that there are diminishing returns on the effectiveness of the CAZ charge in terms of motivating vehicle upgrade. When faced with these high charges, there is a significant proportion of drivers that will neither upgrade nor pay the charge, and hence will be driven away from conducting business in the area (Tables A1 and A2).

3.13.4 The Bath and Birmingham studies are of less use in informing the GM CAP. Both of these, as with the Bristol survey, are based heavily on data from the London ULEZ scheme, meaning that the underlying assumptions will be largely similar to the ones already in use and the majority of adjustments made in these studies will be area-specific and not applicable to Greater Manchester.

3.13.5 The Bradford survey does have some useful qualities, most notably the separate treatment of both business and personal LGV usage, which is not considered in either the Sheffield survey or those studies based on the London ULEZ survey. However, Bradford may not be able to provide a totally apt comparison due, in part, to the relatively small size of the city-centre focused scheme in comparison to the regional GM CAP. In addition, the allowed responses in the stated intention questions do not align perfectly with the responses modelled for the GM CAP. In particular, there are no specific options for LGV drivers to switch to cars, or for any business users to stop trading entirely. Furthermore, in the first set of scenarios (based on the respondent's last trip) business users may choose to use a different vehicle in their fleet that does meet compliance standards, but the 2022 scenarios do not specifically allow for this mixed fleet composition option. Considering these drawbacks, results from this survey are likely only suitable for benchmarking the scale of impacts of the scheme, instead of being used to directly inform the GM response models.

3.13.6 Of the European Clean Air Zones, the Area C scheme in Milan offers the most appropriate comparison, in that it offers drivers the alternative of paying a charge or upgrading their vehicle, although requiring an electric vehicle is a significantly higher standard than is required in the GM CAP. As such, data from this scheme (if available) could be used as a benchmark for responses a high upgrade cost.

3.13.7 Some comparison may also be made to the restricted access style CAZ scheme, such as the Berlin CAZ, by considering the GM CAP charges to be 'fines' for noncompliant vehicles entering the zone. In this respect, the compliance rates observed in these European CAZ schemes could provide an indicator of driver's willingness to accept a 'charge'.

3.13.8 The Stockholm system offers a different perspective, providing an incentive for drivers to upgrade their vehicles, as well as encouraging reduced traffic within the city centre, but these two schemes operate independently. The lack of emission-based charges makes comparisons to the GM CAZ inexact, as there is no reduction in trip cost to offset the expense of upgrading. Similar reasoning applies to the Berlin CAZ, where there are no charges in place at all.

3.13.9 In addition to the usage of any supporting data, the GM-specific assumptions that have been made to tailor the weighting of the data must be robust. The two most notable considerations are:

- The diversity of income within the GM area must be taken from a sufficiently large sample in order to capture distinct minorities, such as very wealthy drivers who, all else equal, will be less sensitive to charging.
- The analysis of trip frequency must be based on a sufficiently long period of data gathering in order to give a fair understanding of low-frequency trips. The Sheffield survey demonstrated distinctly different responses for trips with a frequency of less than once per month (see Tables A3 and A4), which, by definition, would require at least a month of data.

A.1 Sheffield and Rotherham CAZ Behavioural Research Modelling Note Tables

A.1.1 Behavioural Response by Trip Type – Taxis

		Use same		Change to a		Change to an		
		vehicle as now &		petrol-based	Change to a Euro 6	electric vehicle	Work/drive to	
		pay the charge	Convert vehicle	vehicle and	diesel vehicle and	and avoid the	different	Leave
	Scenario	every day	to run on LPG	avoid the charge	avoid the charge	charge	town/city	trade/retire
PHV	£5	16%	0%	16%	14%	35%	14%	5%
PHV	£10	5%	0%	12%	12%	45%	19%	7%
PHV	£10+Sub	0%	0%	11%	13%	45%	21%	11%
PHV	£20	3%	0%	13%	8%	39%	21%	16%
Black Cab	£5	27%	11%	0%	29%	18%	7%	9%
Black Cab	£10	16%	12%	0%	30%	19%	7%	16%
Black Cab	£10+Sub	18%	9%	0%	27%	20%	7%	18%
Black Cab	£20	15%	15%	0%	23%	17%	9%	21%

A.2 Behavioural Response by Trip Type – LGVs

	Trip Type	Scenario	Use same vehicle as now & pay the charge every day	Convert vehicle to run on LPG	Change to a petrol-based vehicle and avoid the charge	Change to a Euro 6 diesel vehicle and avoid the charge	Change to an electric vehicle and avoid the charge	Work/drive to different town/city
LGV	Internal - Internal	£5	51%	9%	1%	15%	5%	19%
LGV	External - External	£5	50%	10%	1%	14%	6%	19%
LGV	Internal<->External	£5	51%	9%	1%	14%	6%	19%
LGV	Link by link (all site average)	£5	51%	9%	1%	14%	5%	19%
LGV	Internal - Internal	£10	43%	4%	0%	18%	6%	29%
LGV	External - External	£10	43%	5%	0%	16%	6%	29%
LGV	Internal<->External	£10	43%	5%	0%	17%	6%	29%
LGV	Link by link (all site average)	£10	43%	5%	0%	17%	6%	29%
LGV	Internal - Internal	£10+Sub	38%	8%	0%	12%	18%	24%
LGV	External - External	£10+Sub	37%	9%	0%	12%	17%	25%
LGV	Internal<->External	£10+Sub	37%	8%	0%	12%	17%	25%
LGV	Link by link (all site average)	)£10+Sub	38%	8%	0%	12%	18%	25%
LGV	Internal - Internal	£20	31%	4%	0%	17%	3%	45%
LGV	External - External	£20	32%	5%	0%	15%	4%	44%
LGV	Internal<->External	£20	31%	4%	0%	16%	4%	45%
LGV	Link by link (all site average)	£20	31%	4%	0%	16%	3%	45%

A.3 Distribution of Annual Fleet (by vehicle type and trip frequency) – all ANPR Clusters Combined

A.3.1 This table shows the trip frequency distribution of the total fleet of vehicles observed throughout the year.

Trip Frequency	BUSES & COACHES	CARS Ordinary	CARS Special	GOODS - HEAVY (ARTIC)	GOODS - HEAVY (RIGID)	GOODS - LIGHT	All Vehicles
Low (<1 per month)	63%	74%	32%	87%	77%	76%	74%
LM (<1 per week)	22%	20%	25%	11%	18%	19%	19%
MH (1 < = x < 2 per week)	8%	4%	18%	1%	3%	4%	4%
High (>2 per week)	7%	3%	25%	1%	2%	2%	3%

A.4 Distribution of Daily Fleet (by vehicle type and trip frequency) – all ANPR Clusters Combined

A.4.1 This table considers the frequency profile of the traffic on a given day, generated by multiplying the annual trip frequency from Table A3 by the likelihood that the vehicle will be seen on a particular day. This gives a significantly higher weighting to high-frequency vehicles, highlighting the importance of a strong understanding of the trip frequencies of different vehicle types.

Trip Frequency	BUSES & COACHES	CARS Ordinary	CARS Special	GOODS - HEAVY (ARTIC)	GOODS - HEAVY (RIGID)	GOODS - LIGHT	All Vehicles
Low (<1 per month)	7%	15%	2%	35%	19%	18%	15%
LM (<1 per week)	20%	33%	10%	36%	36%	37%	33%
MH (1 < = x < 2 per week)	23%	22%	21%	15%	22%	22%	22%
High (>2 per week)	50%	30%	68%	14%	23%	22%	30%

A.5 Comparison between local research and JAQU published responses

A.5.1 In the following results table, 'Pessimistic' and 'Conservative' refer to two different ways of modelling the responses which imply a reduction in trip frequency.

A.5.2 Pessimistic: Drivers are prevented from making trip-reducing choices, and instead must pay the charge or upgrade their vehicle in accordance with the same proportions as other owners of the relevant vehicle type.

A.5.3 Conservative: Trips formerly made by noncompliant vehicles are removed and the business is taken by a driver of a compliant vehicle.

		Pay to Pollute			**Upgrade the Vehicle**			**Remove from traffic matrix**	
	Daily Charge	**Local**		**JAQU**	**Local**		**JAQU**	**Local (tbc by mode choice)**	**JAQU**
		Pessimistic	**Conservative**		**Pessimistic**	**Conservative**			
Car	£10	13%	8%	18%	68%	73%	64%	19%	18%
PHV	£10	6%	5%	N/A	94%	95%	N/A	0%	N/A
Black Cab	£10	21%	16%	N/A	79%	84%	N/A	0%	N/A
LGV	£10	61%	43%	28%	39%	57%	64%	0%	8%