February 2021

Local NO_2 Plans: baseline research findings

Annexes | 2020 Annual Report for the Evaluation of Local NO_2 Plans

Ipsos MORI & Institute for Transport Studies

UNIVERSITY OF LEEDS
Institute for Transport Studies

Ipsos MORI

Table of Contents

1 Additional information on the before-and-after analysis methods

This Annex provides additional information on selected aspects of the before-and-after analysis methods, namely:

- The selection of control sites to support the analysis of air quality data from the continuous analysers (CAs) from the Local Plan areas;
- The criteria for selecting the sites for installing the three additional CAs budgeted as part of the Central Evaluation;
- Further detail around the method for analysing the data from diffusion tubes (DTs);
- Further detail about the implementation of the Passenger car and Heavy-duty Emission Model (PHEM) to assess the impact of Basildon & Essex's speed limit reduction measure.

1.1 Continuous analyser control sites selection

As explained in the main report, the air quality trends observed from CA data available for the Local Plan areas will be compared against data from control sites to help estimate the extent to which observed changes in local air quality can be attributed to the Local Plan measures. The selection of these control sites involves devising criteria that help identify sites which are sufficiently similar to the Local Plan sites, but where no, or more limited air quality measures are being implemented.

All Local Plan monitoring sites will be categorised according to:

- Position: Inside / on boundary / outside Local Plan area / zone;
- Air Quality: Roadside, urban background, rural background, other.

Furthermore, Local Plan and potential control sites will be categorised according to:

- Traffic:
    - Lane configuration (one/two-way, 1,2,3,4 etc lanes)
    - Junction type (predominant in vicinity): Signal controlled, roundabout, priority, grade-separated, mixed
    - Speed limit: National speed limit, 60 mph, 50 mph, 40 mph, 30 mph, 20 mph
    - Traffic flow / demand: Annual average daily traffic (AADT) (threshold +/-10%?)

  - Traffic speeds peak period: i.e. 08-0900hrs from Department for Transport (DfT) Trafficmaster[1] data for Ordnance Survey MasterMap Highways Network[2] links (threshold +/-5%?)
  - %HGVs and %Bus

- Local environment:
  - Conurbation size: Population size
  - Setting (central, arterial, suburbs, rural)
  - Street configuration: Open / street canyon
  - Road alignment: Angle from north

The intention is to implement a coding protocol to cross-reference and match / rank sites as part control selection procedures. It is expected 'control sites' will reside in the same geographic region, as they are then considered to share comparable 'rural background' and climatic conditions (temperature, relative humidity, wind speed and direction).

1.2 Additional continuous analyser locations

The Central Evaluation is funding the installation of three additional CAs to enable the collection of granular air quality data in selected Local Plans areas which are not yet served by the Automatic Urban Rural Network (AURN) network[3] nor by local CAs. The selection decision process is summarised in Figure 1.1, and has resulted in the prioritisation of Derby, Liverpool and Basildon & Essex for additional CAs.

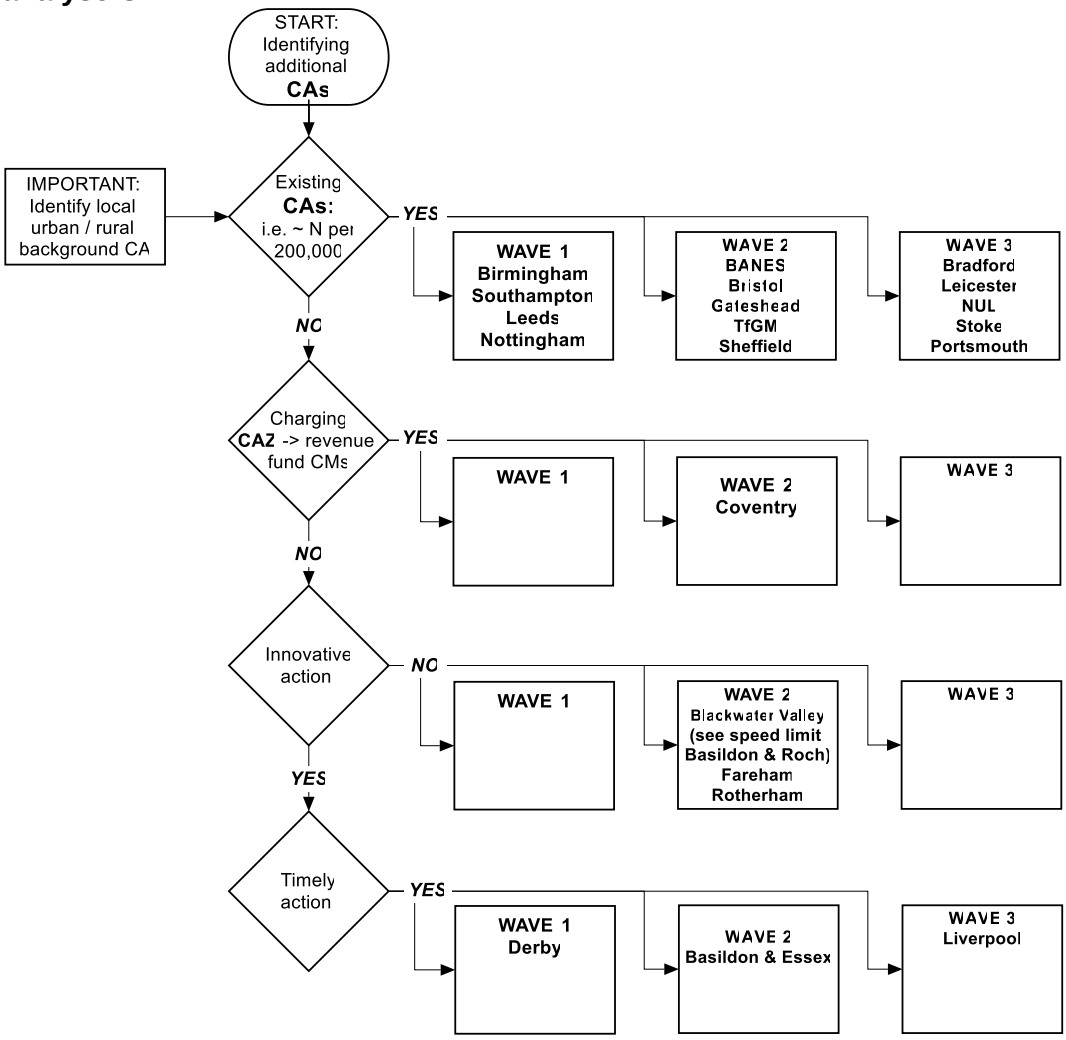
The site for the additional monitor in Derby is located at a mid-link location on Friary Street (A601, coordinates 52°55'21.42"N, 1°29'4.67"W). This is a broken street canyon inside the Local Plan area.

In Liverpool, which currently does not have any roadside CAs, the CA is proposed to be located on East-side of the major North-South Scotland Road (A59) arterial. The road is a 3-lane, two-way urban motorway link in an open setting. With the monitor located on the downwind side of the road in the prevailing westerly wind direction, it will detect a strong signal of changes in flow/emissions of the aggregate fleet inside the Local Plan area.

With Basildon & Essex being the first Local Plan area to implement a significant traffic management intervention, lowering the speed limit on sections of the major A127 dual carriageway from the national speed limit to 50 mph, this was deemed a priority for a CA. The measurements will also complement and support the vehicle tracking and PHEM investigation.

[1] https://www.basemap.co.uk/trafficmaster-data/ (Accessed on 1st February 2021)
[2] A road network dataset for Great Britain.
[3] An automatic monitoring network that allows compliance reporting against the ambient air quality directives.

Figure 1.1: Decision-making tree to determine locations of new continuous analysers



1.3 Diffusion tube priority sites selection

As explained in the main report, the Central Evaluation also foresees the implementation of DTs in Local Plan areas to support the monitoring of air quality trends. An approach to identifying priority sites for additional DT demands a multi-criteria approach. Firstly, metrics including the number of CAs and DTs per 250,000 people in each of the Local Plan areas have been calculated to provide a high-level indication of locations that warrant additional monitoring. Secondly, in part due the flexibility of DTs (ease of installation, low-cost), a range of priorities will be considered (see below). Any single, or combination of, criteria may trigger the prioritisation of sites for additional monitoring. The weighting of prioritisation criteria will be set in comparison with other Local Plan areas and actions. It is expected monitoring will be prioritised to locations that have a low nitrogen dioxide (NO_2) monitoring / exposed population ratio (CAs and DTs) and meet three or more prioritisation criteria documented below:

- Congested road links running through built up areas with poor ventilation characteristics (street canyons).
- Areas with unusual fleet compositions such as priority areas for public transport and taxi only zones.

- Locations also influenced by non road-transport sources e.g. emissions from railway lines running diesel locomotives, industrial areas or in the vicinity of an airport.
- Differences in concentrations between roadside environments and areas of significant population exposure (nearby residential, educational, business and retail areas).
- Sites that would be prohibitively expensive to establish electrical power connections needed for more accurate monitoring instruments.

It is also recommended that hybrid methods that combine the use of modified DTs, increased sample size and experimental design should be considered. Diffusion tubes should be installed at multiple locations in areas expected to be affected by the interventions, with a minimum of 6 DTs per site. This allows for an experimental design, comparing 'test-site before | control-site before | test-site after | control-site after', and also provides some indication of influence of intervention confounders. Ideally, at least one site should be an AURN site operating a continuous NO_2 analyser, so comparisons can be included in the analysis.

Defra's current guidance includes a recommendation that triplicate sampling be used in any given monitoring location (i.e. triplicate co-locational sampling and the discarding of any triplicates with ranges outside 20% of the triplicate mean). Given how easily a few 'bad' DTs could distort outcomes, such in-built quality assurance should be considered. Adopting this would, however, increase the number of DTs to 18 (3 x 6) or more per site.

The proposed experimental design does not guarantee very small changes can be detected with high statistical confidence, but will significantly improve sensitivity to small changes.

1.4 Diffusion tube analysis

Acknowledging the higher uncertainty of air quality measurements of DTs, the Central Evaluation team has explored diffusion tube (DT) measurement uncertainties to inform how many samples are required to detect the expected improvement in air quality due to Local Plans.[4,5] Table 1.1 below shows the estimated number of replicates needed to confidently detect changes of the order of 1-15% using Standard and Modified DTs. The analysis concluded that about six modified DTs or about 16 standard DTs would be needed to detect a 10% change in NO_2 concentrations. As it is unclear how viable deploying more than 50 DTs is, this suggests that the detection of changes less than 5% should be regarded as extremely challenging with DTs[6].

[4] Any additional DT monitoring will meet the Local Air Quality Management Technical Guidance 16 standards by using the accredited, well-established laboratories following the national accreditation body (UKAS) methods General Linear Model (GLM) 7 and GLM 9, whilst also fulfilling the specifications of the 'UK Urban NO_2 Diffusion Tube Network' being established. This will include having triplicate samples from all sites, anonymising sampling locations and IDs, and co-locating a site with a real-time station where available. All new monitoring sites will meet the local authority diffusion tube siting guidelines.

[5] As reported in the literature, this is as an expanded 95% Confidence Interval (95% CI, k=2) for total Uncertainty, where this is defined as: $U_{total} = (U1^2 + U2^2 + U3^2 + U4^2)^{1/2}$
Where U_{total} is the Total Uncertainty; *U1* is the NO_2 in air measurement (chemiluminescence analyser) uncertainty; *U2* is the sampler uncertainty; *U3* is the lab uncertainty; and, *U4* is the sampling time uncertainty.
Pfeffer et al[5] reported these to be about 20% for conventional DTs and 12.6% for DTs fitted with mesh caps (hereafter referred to as modified samplers) based on measurements made at about 40 ug/m^3.

[6] Analysis of archived data from existing DT studies indicates that real-world uncertainties might be larger (about 1.5 times) but this analysis was limited to conventional DTs and the data used was not collected for the purposes of uncertainty testing. So, results should be treated as tentative.

Table 1.1: Estimated number of standard and modified diffusion tubes needed to detect changes in air quality of different magnitudes

% change detected	Number of standard DT	Number of modified DT
15	7.1	2.8
10	16.0	6.4
5	64.0	25.4
4	100.0	39.7
3	177.8	70.6
2	400.0	158.8
1	1600.0	635.0

1.5 Implementing the PHEM methodology in Basildon & Essex

The reduction in the speed limit from 70 to 50 mph along the targeted stretch of the A127[7] is expected to help stabilise the traffic flow, moving from an unstable traffic flow state (particularly in peak periods), to a more consistent 'smoother' flow regime. The Passenger car and Heavy-duty Emission Model (PHEM) method aims to detect precisely this change in traffic flow dynamics and then estimate (using a detailed model) the associated reduction in fuel consumption and air quality emissions.

It will be complemented by the 'before-and-after' analysis, which will aim to corroborate the scale of NO_2 reduction observed with DTs deployed by the local authority (long-running and additional tubes deployed by the local authority for their own evaluation of the intervention) with the emission reduction due to the speed limit reduction (a traffic management intervention). As explained above, the Central Evaluation project will also be commissioning a CA to measure the concentrations of roadside NO_2 hour-by-hour on this stretch of the A127, but the set up timings for this CA mean that it will only be possible to collect CA data after the speed limit measure is implemented.

As part of the PHEM method, the 'before' driving conditions and driver behaviour has been measured over three days: 26th to 28th November 2019. Sample vehicle driving trajectories (second-by-second speed profiles) passing through the study area in peak, inter-peak and periods of free-flow were tracked. The data was collected by a standard passenger car, driven by an experienced driver, equipped with a high quality, fast up-date GPS tracking instrument with an interface to collect data from the vehicles own sensors i.e. road speed from wheel revolutions.[8]

Whilst ideally data would be pervasively collected from a large, un-biased sample of the vehicle fleet, this is not feasible at the appropriate time resolution (1Hz) and quality due for technical and data privacy restrictions. With a single instrumented car, differences in driving behaviour and vehicle type is explored by adopting different driving 'styles':

- 'FAST' – targeting driving at or just below the speed limit, as environmental (rain, fog, spray) conditions safely allow. The driving style to be followed will be to over-take slower vehicles using the fast lane of dual carriageway whenever appropriate and safe to do so. Acceleration phases will

[7] The site schematic from the OBC presents the stretch of road where the speed limit was lowered in the summer of 2020. Basildon and Essex councils. 2019. Air Quality Management Plan – A127. Outline Business Plan (OBC). 18th April 2019.

[8] Numerous automotive (e.g. www.millbrook.co.uk) and research organisations (e.g. Institute for Transport Studies) regularly use this type of GPS tracking equipment e.g. https://www.vboxautomotive.co.uk. This approach was also adopted by Transport for London (TfL) to develop the 'London Drive Cycle' (TfL. 2016. London Exhaust Emissions Study: Developing a test programme, and analysis of emissions)

either track lead vehicles (expected to be usually in the fast-lane) at a safe distance, or if unimpeded at a brisk but not overly aggressive rate.

- 'SLOW' – driving in the slow lane of dual carriageway, tracking the speed profile of vehicles in this lane. If a vehicle is driving at an un-characteristically low speed, such as a tractor or a towing vehicle, this will be over-taken and the next lead vehicle in this lane followed.

- 'HGV' – follow a HGV along the route at a safe and consistent headway, whilst observing the speed limit. The test car will be driven onto the test route and the first HGV that can be safely followed will be tracked i.e. sufficient headway to slot in behind. The vehicle registration, make, model, cargo and tractor / trailer configuration will be dictated using the Android hands free dictation facility.

The sampling strategy is documented in Table 1.2 below. The 'before' surveys were successful in collecting high quality checked speed trajectories on all dates and time periods, totalling over 800 km over more than 13 hours at an average speed of 58 $km.h^{-1}$.

The results from this analysis are provided in the section below.

Table 1.2: Sampling strategy

Time period	Circuit	Day 1	Day 2	Day 3
Free-flow i.e. 5.00 to 6.30AM	1	FAST	HGV	SLOW
	2	SLOW	FAST	FAST
Congested in the AM peak i.e. 7.30 to 9.00AM	1	FAST	SLOW	HGV
	N/a	N/a	N/a	N/a
Busy in the inter-peak i.e. 10.00 to 11.30AM	1	HGV	FAST	SLOW
	2	SLOW	SLOW	FAST

2 Detailed findings from the before-and-after analysis

This Annex provides information on the baseline air quality trends findings in each local authority as well as initial findings of the baseline PHEM analysis.

As outlined in the main report, one Local Plan area, Leeds City Council, was due to be implementing a Class B Clean Air Zone (CAZ) in 2021, but following air quality improvements and a joint review with the Government's Joint Air Quality Unit (JAQU) [9], Leeds will no longer be introducing a CAZ[10].

2.1 Baseline air quality trends: findings by LA

The baseline air quality trends were estimated using Theil-Sen methods coded in the 'openair' R package[11] up to the end of 2019, quarter 4, can be summarised as follows:

- In Bath & North East Somerset, the NO_2 concentrations measured by CAs have generally been on a downward trend since 2015, with levels at roadside sites falling by between -4% and -7% (A4 roadside AURN) per year.
- In Birmingham, NO_2 concentrations have also been on downward trend since 2015, with levels at the urban background site Birmingham Acocks Green falling by -4.7% per annum, and greater reductions at roadsides e.g. Birmingham A4540 Roadside -7.2% per year.
- At the single CA site in Derby, at the St Alkmund's Way (AURN) roadside site, NO_2 concentrations have been falling by -3% per annum since 2017.
- In Leeds, with a 2 AURN and 9 local authorities ran CAs, NO_2 concentrations are shown to also be on a downward trend, with urban background (Leeds Centre AURN) falling at -1.5% per year, and greater reductions at roadsides e.g. Kirkstall road -3.5% per year. There has been a slight +1% increase in traffic flow levels per annum on most arterials in Leeds.
- In Nottingham more significant improvements were observed, with levels at the urban background site Nottingham Centre (AURN) falling by -4.9% per annum, and greater reductions at roadsides e.g. Nottingham Western Boulevard (AURN) -6.9% per year.
- In Southampton levels at the urban background site (AURN) fell by -3.7% per annum, and greater reductions at roadsides e.g. A33 (AURN) -9.3% per year.

Figures 2.1, 2.2 and 2.3 provide a summary of NO_2 trends across the UK based the analysis of data from AURN monitoring stations. Yearly (pre-2020) trends were determined using TheilSen regressions and provide a measure of on-going changes that would be expected in the absence of the COVID-19 lockdown. Changes associated with the introduction of the main lockdown restrictions were typically large and rapid reductions in NO_2 and reported as 'locking down' changes observed between 10th March

[9] The Joint Air Quality Unit is a joint unit of the Department for Transport (DfT) and the Department for Environment, Food and Rural Affairs (Defra)

[10] https://news.leeds.gov.uk/news/leeds-clean-air-zone-has-achieved-its-aims-early-and-is-no-longer-required-joint-review-finds (accessed 4th February 2021)

[11] Carslaw, D. C. and Ropkins, K., 2012. openair - an R package for air quality data analysis. Environmental Modelling & Software, 27-28, p52-61.

to 10th April. Subsequent changes during lockdown, reported as 'locked down' changes, were most commonly much more gradual and less pronounced increases in NO_2 observed over the following weeks and months (11th April to 30 June). Results are grouped according to UK zone and colour-code by site type (Rural Background, Urban Background, or Urban Traffic) for comparison.

Changes are measured in micrograms/m^3. The Average Yearly Change (pre-2020) graphs show the average annual change as determined by Theil-Sen analysis for the period 01 January 2015 to 31 December 2019. The 'change locking down' and 'change while locked down' graphs below show the net sum of changes due for breakpoints/ segments detected during the periods 10 March to 10 April 2020 and 11 April to 30 June 2020, respectively.

Figure 2.1: NO2 Trends (change in concentrations) observed at individual AURN Stations (pt 1 of 3)

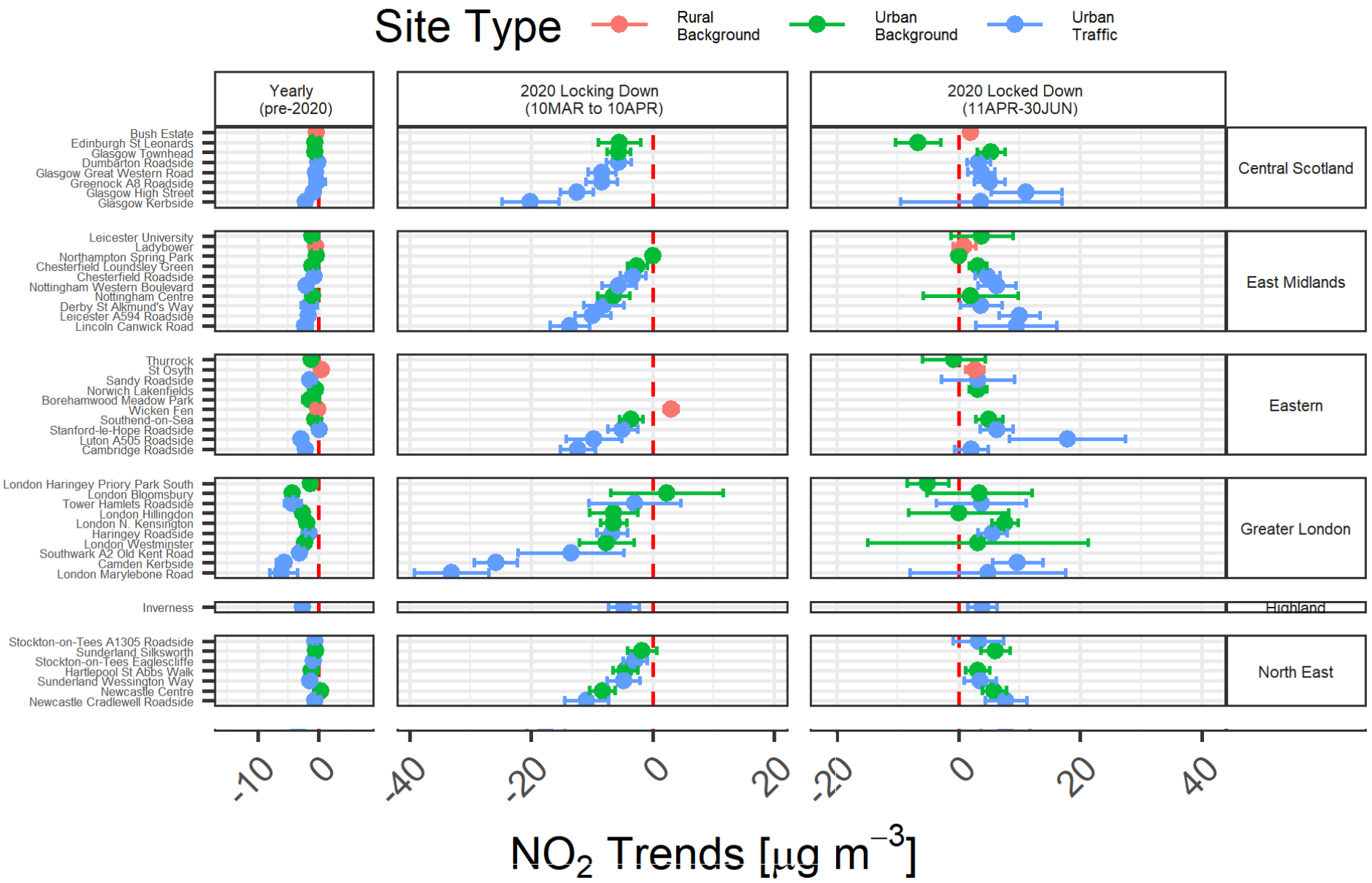


Figure 2.2: NO2 Trends (change in concentrations) observed at individual AURN Stations (pt 2 of 3)

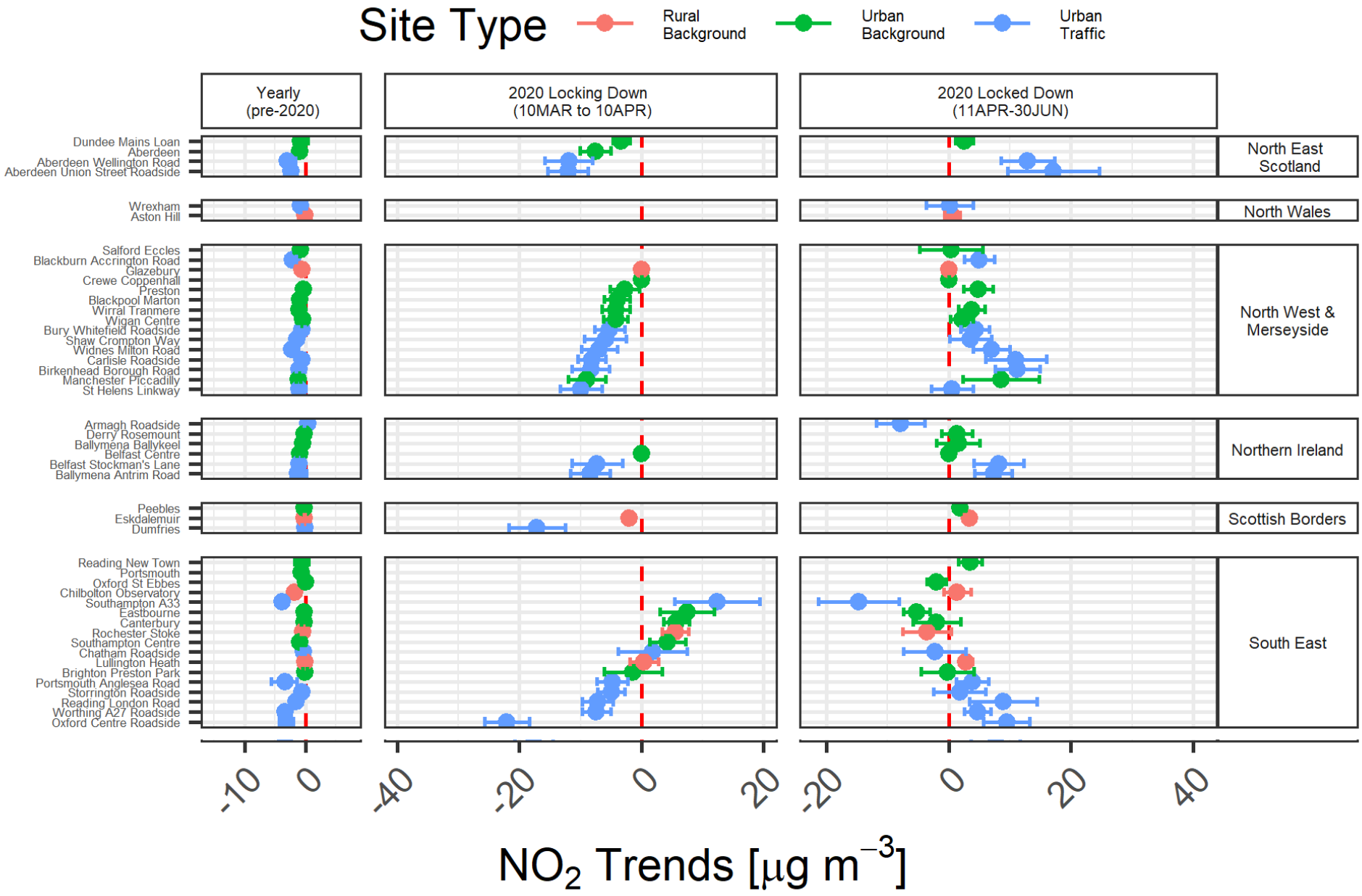
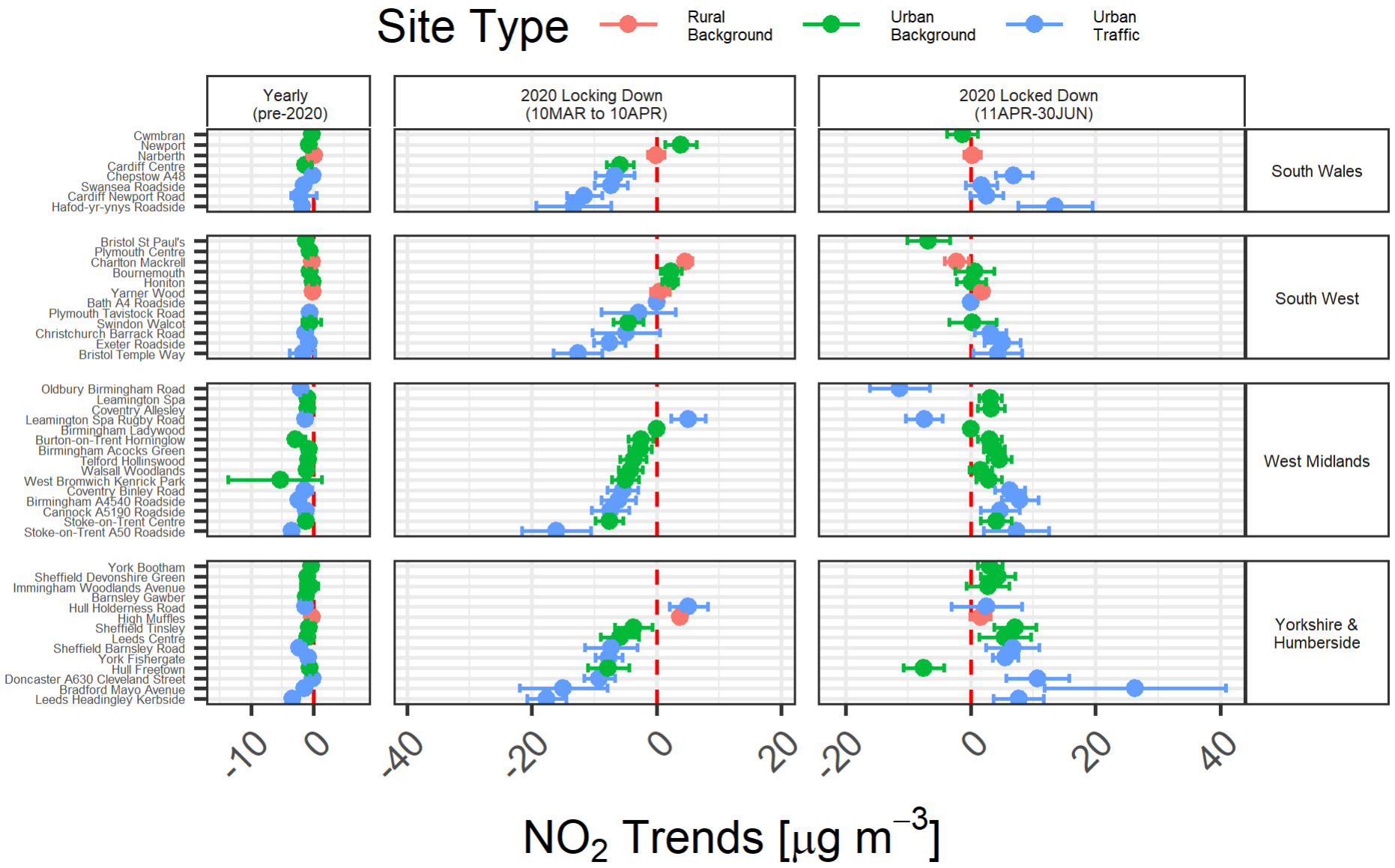


Figure 2.3: NO2 Trends (change in concentrations) observed at individual AURN Stations (pt 3 of 3)



2.2 Baseline PHEM analysis: initial findings

The surveyed second-by-second speed and position trajectories have been quality checked, split into 25 road segments selected between junctions, speed limit signs and changes in road slope/gradient (see schematic). The gradient for all road segments has been extracted from a digital terrain map and added to the trajectories. Results from simulations with road gradient included are being contrasted with those that assume the world is flat, as the majority of vehicle emission studies do not consider road gradient and the additional engine loads they impose (see Figure 2.4 below).

Figure 2.4: Segments defined by the evaluation team along the route where speed limits are being imposed (A127 from its junction with the M25 in the west to Southend-on-Sea in the east)[12]

The observed sample vehicle trajectories have been converted into a format compatible with the Instantaneous Emission Model PHEM. All trajectories have been simulated for each vehicle sub-category i.e. each vehicle and fuel type (passenger car [petrol/diesel/hybrid/electric vehicle (EV)], light-goods vehicle [size N1/N2/N3], HGV [rigid and articulated], bus and coach) in each Euro standard (1/I to 6/VI). This includes each of the different stages of Euro 6 i.e. Euro 6a/b, 6c, 6D-temp and 6D for passenger cars.

As shown in Figure 2.5 below, illustrative results are shown for the average emission factors and rates for diesel and petrol (gasoline) in each of the driver behaviour styles (slow, fast, HGV). As these results are the averages over the whole route, in all time periods, there is only a modest discernible difference with the rates for driving ‘fast’ greater than ‘slow’ and when following a ‘HGV’. More substantial differences are observed on individual segments.

[12] Map image from www.openstreetmap.org

Figure 2.5: average emissions factors and rates for different driver behaviour styles (slow, fast, following HGV)

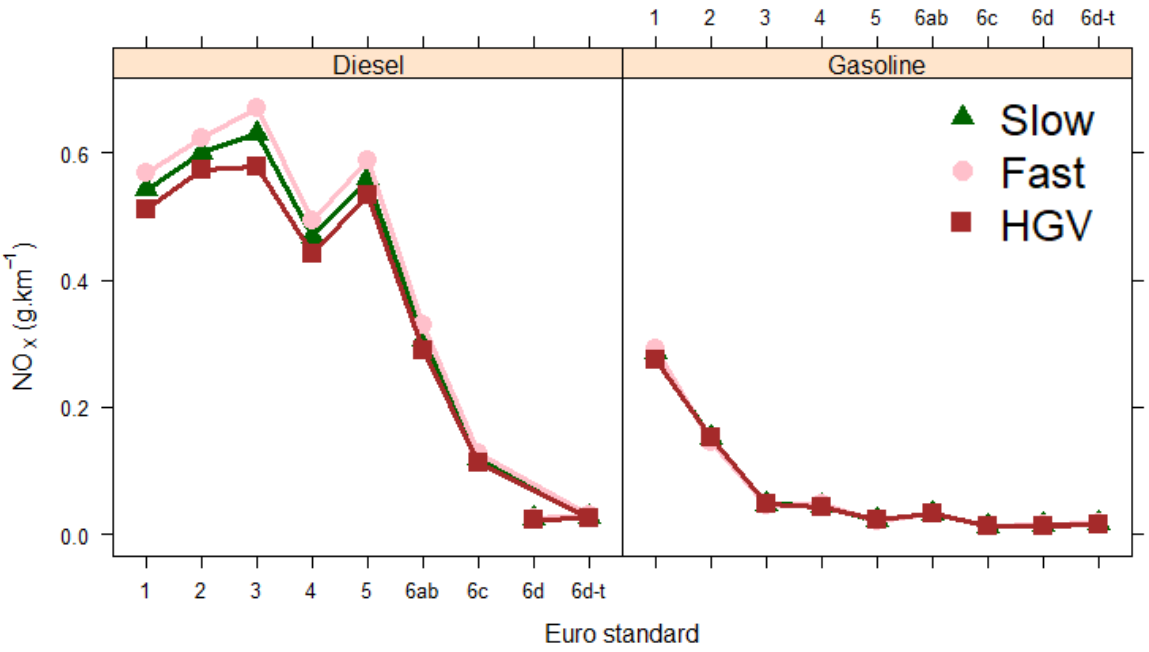
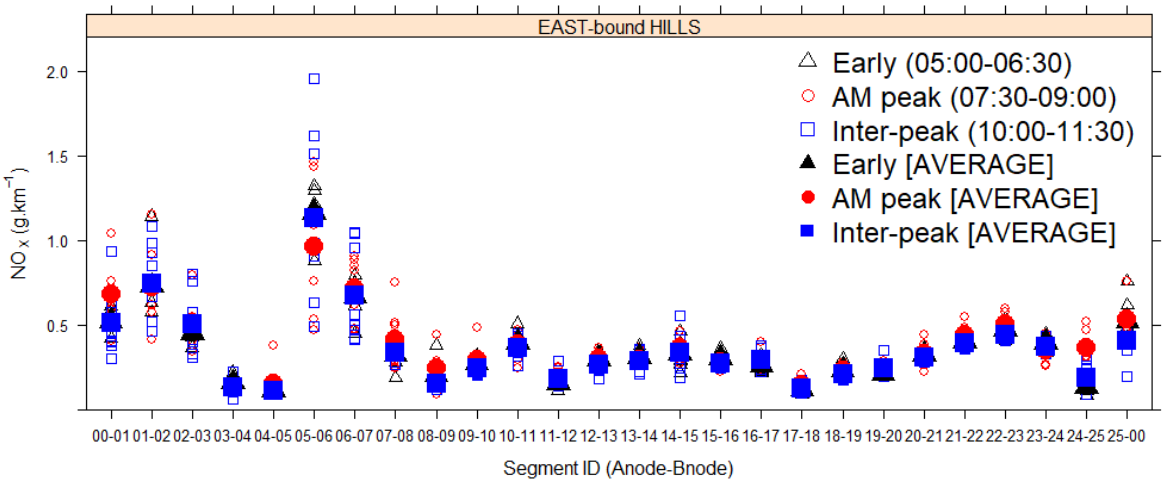


Figure 2.6 below shows the variability in NO_X emission rates for an illustrative Euro 6a/b diesel passenger car are visualised for each eastbound road segment, with the influence of road gradient considered. For each speed trajectory (run) in the three time periods are illustrated as different coloured symbols, with solid symbols presenting the average result. There is a significant variation in NO_X emission rates (grams.km^{-1}) along the route. Segments '00-01', '01-02' and '02-03' are at the national speed limit. The higher speeds and drag forces imposed result in elevated emission rates. The test vehicle is predominantly decelerating in segment '03-04' as it approaches a 40 mph speed limit in the approach to the 'Fortune of War Roundabout', so emissions are low. Similarly segment '04-05' is the approach to negotiate the roundabout, so the vehicle is predominantly decelerating and fuel consumption and associated NO_X emissions are low. Conversely the segment exiting the roundabout vehicles are accelerating to attain their desired cruising speed. Emission rates are therefore significantly higher. The average emission rate in the morning peak is lower, as the higher flow rate limits the road space available and opportunity to accelerate freely.

Figure 2.6: Emissions rates for a Euro 6a/b diesel passenger car for east-bound road segments, by time of day



3 Progress on deep-dive case study strand

As explained in the main report, the Central Evaluation will complete eight deep-dive case studies. Five areas have been shortlisted for a deep-dive case study, four of which are already underway. This Annex provides an update on the status of this strand summarising the rationale for selecting these areas.

As outlined in the main report, one Local Plan area, Leeds City Council, was due to be implementing a Class B CAZ in 2021, but following air quality improvements and a joint review with the Government's JAQU, Leeds will no longer be introducing a CAZ.

3.1 Local Plan measures in each of the deep-dive areas, and rationale for selection

Table 3.1 below outlines the key characteristics of the confirmed deep-dive case studies and the information that each can contribute to the wider evaluation.

Table 3.1: Summary of Local Plans measures as part of deep-dive case studies

Local Plan Area	Description of the measure	Key potential learning from case study
Birmingham	Birmingham is implementing a **Class D CAZ** on the central A4540 Middleway Ring Road. This will affect all non-compliant vehicles that drive and operate within the Middleway Ring Road excluding those for whom exemptions have been made. The charging CAZ will begin operating from June 2021 on a 24/7 basis with non-compliant vehicles (excluding those for which exemptions will be made) charged for driving in the CAZ. The measure of compliance will be Euro 6 for diesel vehicles and Euro 4 for petrol vehicles. In addition to implementing the CAZ, a further set of measures have been proposed as supplementary to the CAZ to improve air quality within the zone to the required level. These include parking restrictions and restricting traffic flows at selected junctions, making two roads into through routes.	Monitoring how the Class D CAZ and supplementary measures affect behaviours, and whether this differs across population segments. Exploring whether the CAZ is economically sustainable (including the potential impact on businesses) and whether there are distributional impacts of its effects. Understanding the impact of the CAZ on key groups for which mitigation measures are in place e.g. those who work within or regularly travel to the CAZ, taxi drivers, bus, HGV and coach fleets. We will also explore the effect of external, contextual factors on the outcomes of interest; and what has been learned about implementing this type of measure.
Leeds	Leeds was selected as it was due to implement a **Class B+ CAZ** in the central and northern part of the city, up to the Outer Ring Road boundary. This would have affected HGVs, buses, coaches, taxis and private hire vehicles (PHVs) that are not compliant with emissions standards. There were additional requirements (the "+") for taxi and PHVs that would require them to go beyond Euro 6 standard and upgrade to either a petrol hybrid or ultra-low emissions vehicle (ULEV).	*Following the decision to not proceed with the Class B+ CAZ, this case study is on hold and being redesigned.*
Basildon & Essex	Basildon & Essex are implementing a **speed limit reduction** on the A127. The speed limit has been reduced from 70 miles per hour to 50 in both directions on a five mile stretch of the road, from	To explore the impact of the speed limit reduction, as the evidence base for this type of measure is currently limited. The deep dive case study will explore how the speed limit reduction affects journey

Local Plan Area	Description of the measure	Key potential learning from case study
	Fortune of War roundabout in the west, to Pound Lane in the east. The speed limit will be enforced by average speed camera technology. This reduction is expected to reduce NO_2 concentrations, as the reduced speed limit is expected to lead to a steadier driving cycle, which evidence shows is linked to lower emissions. Furthermore, it is hoped that the speed limit reduction will raise awareness of air quality issues among the local population, and as such, will lead to other positive outcomes motivated by a desire for cleaner air.	times, travelling behaviours, and its impacts on local businesses. Basildon & Essex are working closely with a contractor around implementation and the case study will also seek to identify lessons learned from this type of partnership.
Bath & North East Somerset	Bath & North East Somerset is implementing a **Class C CAZ** in the centre of Bath in March 2021. This will affect HGVs, buses, coaches, vans, taxis and private hire vehicles (PHVs) that are not compliant with emissions standards, excluding those for whom exceptions have been made.	Monitoring of how the Class C CAZ affects behaviours, and whether the distributional impact of these effects differs across population segments. We will also explore the effect of external, contextual factors on the outcomes of interest. Another area of focus for the case study will be the approach taken for the implementation of the Plan, what has gone well and less well and what has been learned about implementing this type of measure. It is hoped learnings from this case study will provide useful insight for other local authorities with similar geographies, i.e. urban towns with wide rural fringes (e.g. Oxford, Cambridge).
Sheffield and Rotherham	Sheffield & Rotherham is implementing a **Class C+ CAZ** in Sheffield affecting large population including people travelling through the area. High polluting taxis, PHVs, vans, HGVs, buses and coaches would pay a charge to drive in the zone within the city's inner ring road but private cars will not. There will be additional requirements (the "+") for taxi and PHVs that will require them to go beyond Euro 6 standard and upgrade to either a petrol hybrid or ULEV. Rotherham will be implementing non-charging measures, including traffic management measures and bus lane changed priorities.	Similar to Bath & North East Somerset in monitoring a CAZ C and in this case an area where the CAZ will affect a large population journeying through the city. The case study is an opportunity to understand how local authorities in close proximity can work together, and to explore how joint measures such as the active travel communications campaign work in different contexts (with and without a CAZ).

4 Baseline findings from deep-dive case studies

This annex presents a detailed picture of the baseline findings obtained from a survey of residents in three Local Plan areas: Basildon & Essex, Birmingham and Leeds.

As outlined in the main report, one Local Plan area, Leeds City Council, was due to be implementing a Class B CAZ in 2021, but following air quality improvements and a joint review with the Government's JAQU, Leeds will no longer be introducing a CAZ.

Fieldwork took place between February and April 2020. In Basildon & Essex, 300 residents were interviewed, whilst in Birmingham and Leeds 500 residents were interviewed per city. Quotas were set related to area of residence to ensure a sufficient number responses from people living close to or within the proposed CAZ areas or the speed limit zone, with the remaining responses from people living within the local authority boundary but further away from the CAZ/speed limit zone. Quotas were set for various demographic metrics, based on local population data, and results data has been weighted to ensure it reflects the population on key demographic variables. The over-sampling of residents living close to Local Plan implementation areas, and the fact that the quotas for this part of the sample were set to reflect the demographics of these areas, means that the demographics of the overall sample may not reflect the demographics of the overall area covered by the survey. As such, when describing survey findings we do not attempt to generalise them to the relevant population.

Survey respondents were given information about the survey and asked for their consent to take part at the start of the telephone interviews. Respondents were told that they could change their minds about taking part at any time, and reminded of this at the end of the survey. When asking for sensitive personal data (special category data) about health, participants were reminded that the survey was confidential and that they could decline to answer these and any other questions, with a form of words suggested for this ("Prefer not to say"). The survey did not collect information about the identity of participants (beyond demographic information and district postcode) unless they gave permission to be re-contacted for another wave of the survey, in which case they were asked to supply a telephone number and contact name. Respondents were provided with a privacy notice explaining how their data would be used and given contact details for the researchers in case of any questions.

4.1 Baseline position: residents' awareness and attitudes

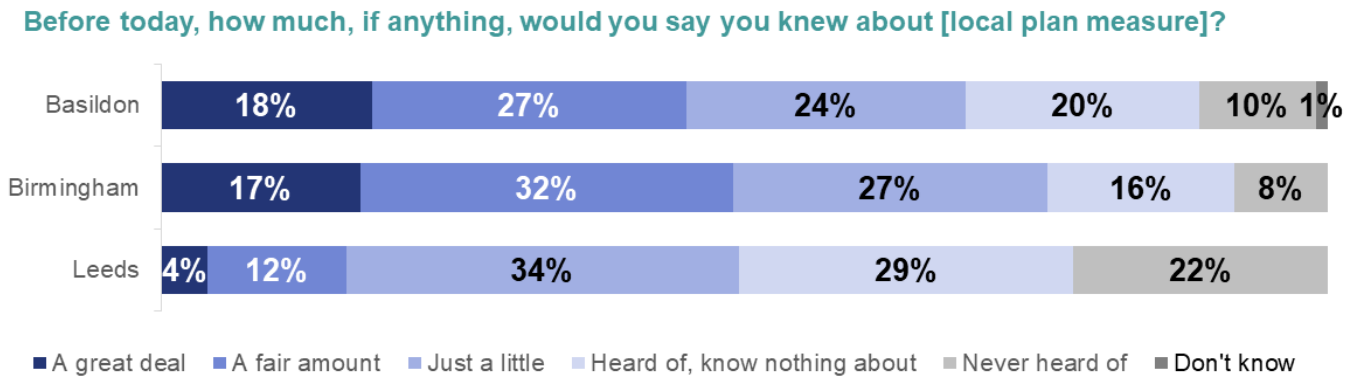
Awareness of Local Plan measures

Awareness of the Local Plan measures was widespread in all three areas: at least four in five residents in each area had heard of the measures (see Figure 4.1 below). However, levels of awareness were varied, with Basildon & Essex and Birmingham seeing higher proportions of residents who knew anything about the proposed measures beyond having heard of them. About half of those interviewed in Birmingham (49%) said they knew at least a fair amount about the CAZ there, and 45% of Basildon & Essex residents interviewed reported knowing at least a fair amount about the speed limit reduction.

This is likely to reflect the potential impact of the measures on residents. Birmingham's CAZ affects private cars as well as business vehicles, while the speed limit reduction in Basildon & Essex applies to a heavily-used road (80% of those interviewed used this road at least once per week, and awareness was highest among these users). In contrast, a lower proportion of Leeds residents were likely to be

directly affected by Local Plan measures there, since the Class B CAZ would have affected only business vehicles. Only 16% of respondents in Leeds reported knowing at least a fair amount about the proposed CAZ.

Figure 4.1: Local Plan awareness across areas



Base: All respondents (300 in Basildon & Essex, 500 in Birmingham, 500 in Leeds).

In Birmingham, awareness was higher among vehicle owners, men, younger people, and people who were currently employed.[13] In Leeds, awareness of the planned CAZ was also higher among men, as well as higher earners.[14] In Basildon & Essex, awareness of the speed limit reduction was higher among those that travel on the relevant stretch of the A127 at least once a week.[15]

In both Leeds and Birmingham, respondents had most often heard about the proposed CAZ from someone they knew (22% and 32% respectively), followed by television (21% and 25%). Respondents in both cities were much more likely to have heard CAZs in local rather than national media; for example, in Birmingham 24% of respondents said they had heard about the CAZ through the local news on television, compared to 1% who had heard about it on the national news. Likewise, local newspapers were mentioned by 13% of respondents whereas only 2% mentioned national newspapers. Seven percent of respondents in Birmingham and 4% in Leeds had heard about the CAZ directly from their respective city council, for example on the council website or through leaflets posted through their door.

The main sources of information for the speed limit reduction in Basildon & Essex were very different: by far the most common was road signs (42%) followed by social media (25%). Just 1% had heard about the scheme on television.

Knowledge of Local Plan measures: Clean Air Zones

Different classes of CAZ affect different types of vehicles. Capturing respondents' understanding of this helps assess the need for further communications to be targeted to affected groups. Perceptions of which vehicles would have been affected by CAZs appeared to be similar in Leeds and Birmingham (see Figure 4.2), although this implies some misunderstanding among respondents in Leeds, where fewer

[13] 99% of those with a non-compliant vehicle, and 94% of those with compliant vehicles, had heard of the CAZ compared to 75% of people who did not own a vehicle. 61% of men reported knowing "a great deal" or "a fair amount" compared to 38% of women. 51% of 18-34 year olds reported knowing "a great deal" or "a fair amount" compared to 35% of those over 65. 55% of working people reported knowing "a great deal" or "a fair amount" compared to 35% of people who were retired, students or not working for another reason.

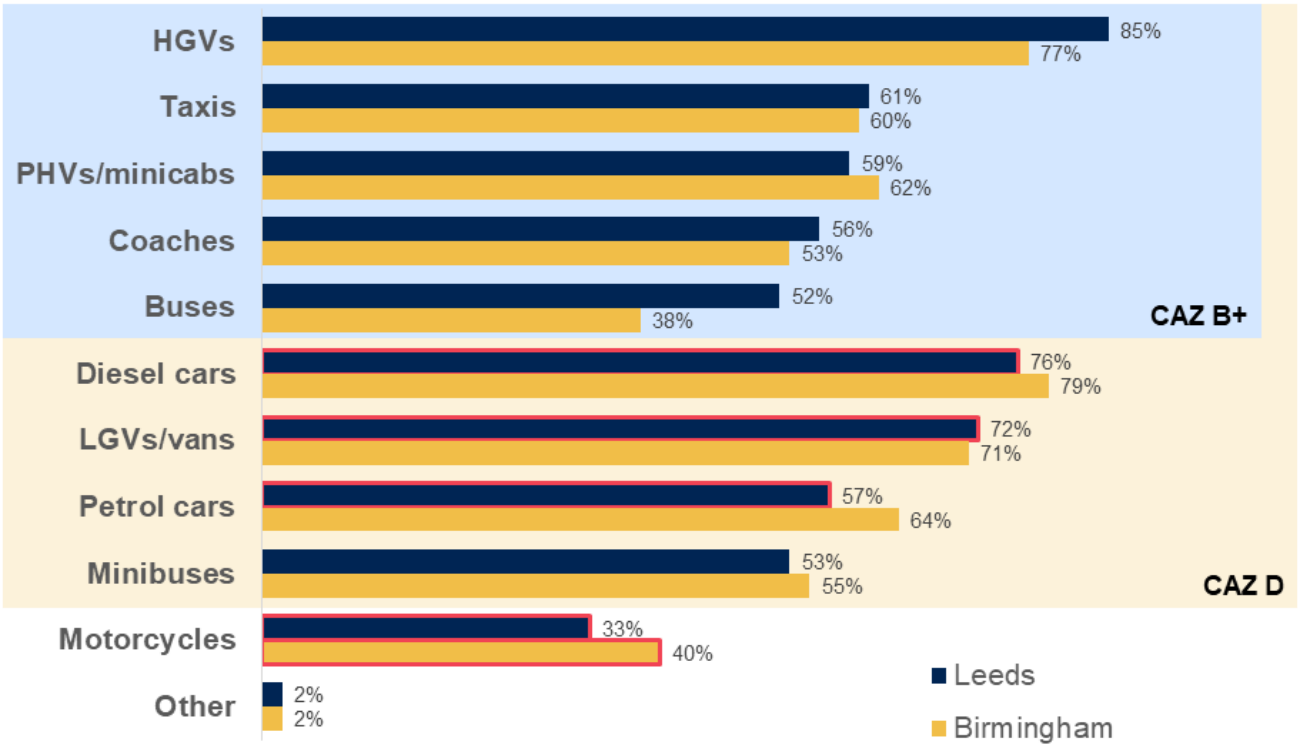
[14] 22% of men reported they knew "a great deal" or "a fair amount" compared with 10% of women, as did 22% of those with a household income of £50,000 or more, compared with 16% overall.

[15] Half of those that travel on the A127 at least once a week said they knew a great deal or fair amount about the speed limit reduction, compared with a quarter (26%) of those that travel there less often.

vehicle types would have been affected. In particular, in Leeds there was a widespread misunderstanding that private cars and vans would have been affected.

In Birmingham, nearly all (97%) of the respondents with any knowledge of the CAZ could correctly identify at least one group of vehicles that would be affected, although two in five respondents incorrectly thought that motorcycles would be affected by the CAZ. In Leeds, 91% of this group of respondents gave at least one correct answer to this question, with the most common being HGVs (identified by 85% of those interviewed). However, 76% of respondents (77% of car owners) incorrectly believed that diesel cars would have been affected, 72% incorrectly thought LGVs would have been affected, and 57% (58% of car owners) thought that petrol cars would have been affected. People living further from the proposed CAZ or who stated they had limited knowledge of the CAZ were more likely to think that diesel cars would be affected.

Figure 4.2: Which, if any, of the following vehicles do you think will be affected by the Clean Air Zone in [area]?



Base: All respondents reporting some knowledge of the CAZ (259 in Leeds, 370 in Birmingham,). Red border indicates incorrect answers.

In Birmingham, most (79%) respondents with some awareness of the CAZ were able to correctly identify (without being prompted with a list) some of the vehicles and individuals that would initially be exempt from CAZ charges. The most common responses given were electric vehicles, disabled people or vehicles with a disabled tax class,[16] specialist vehicles and residents of the CAZ. Some respondents (8%) gave incorrect answers to this question, for example believing that public-sector employees, older people, or taxi drivers will be exempt. One in ten respondents (10%) did not know and a small number (2%) believed that there would be no exemptions.

Although most Birmingham respondents were aware that there will be some exemptions to the CAZ, residents had relatively low awareness of the measures available to support affected businesses and

[16] Vehicles with a disabled tax class will be exempt from the CAZ for one year, but Blue Badge (disabled parking permit) holders have not been made exempt. Unfortunately, the survey was unable to determine whether this distinction was understood by respondents.

individuals. Of those respondents who reported having some knowledge of the CAZ, one in four (25%) were aware of measures being implemented by Birmingham City Council to help those affected by the CAZ. A small number of respondents (6% of the overall sample) were aware of the details of one or more of these measures, most often about the mitigation measures for low earners working within the CAZ.

Awareness of when the CAZs would launch was lower. In Leeds, two-thirds (64%) of those who reported knowing something about the CAZ did not know when it would have been implemented. In Birmingham only one-third reported not knowing when the CAZ would launch, but a wide range of answers were given, most commonly July 2020 (25% of responses). Whilst a delay to the CAZ was announced during the fieldwork period, there are no significant differences between responses to this question given earlier and later in the fieldwork.

Knowledge of Local Plan measures: speed limit reduction

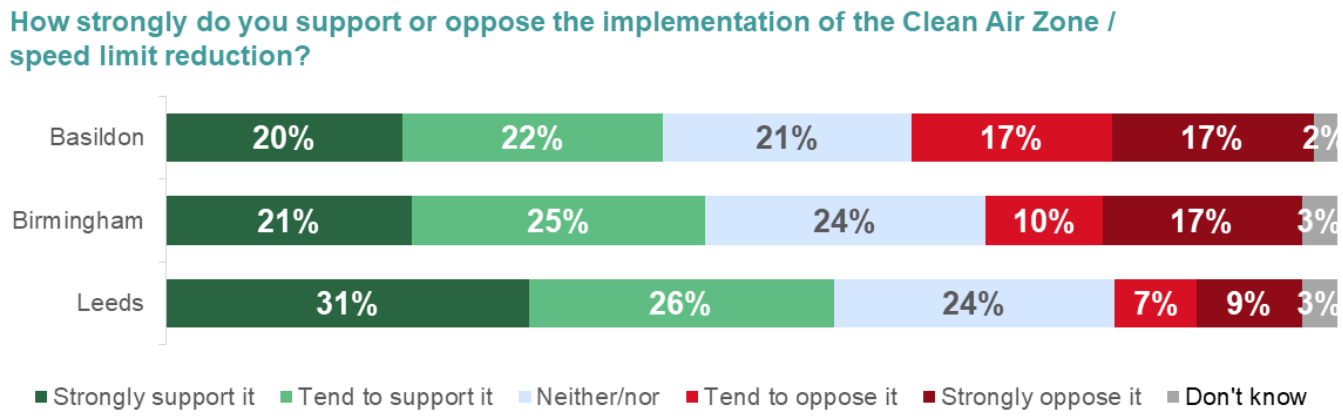
Awareness of the nature of the speed limit reduction in Basildon was relatively high: six in ten (62%) of all participants correctly stated that the speed limit will be reduced from 70 miles per hour (mph) to 50mph. Among those who knew at least a little about the measure, 90% correctly stated what the speed limit was changing from and to.

Attitudes towards Local Plan measures

As shown in Figure 4.3 below, attitudes towards the measures were more positive than negative in all three areas, but levels of support varied across areas, again perhaps reflecting the proportion of respondents likely to be negatively affected by the introduction of the measures.

In Basildon & Essex, where a high proportion of respondents used the road in question, 42% supported the speed limit reduction but 34% opposed it. Support for CAZs was higher; 46% of Birmingham respondents and 57% of Leeds residents supported the proposed CAZ in their area.

Figure 4.3: Attitudes to implementation of Local Plan measures



Base: All respondents (300 in Basildon & Essex, 500 in Birmingham, 500 in Leeds).

In both Leeds and Birmingham, support for the proposed CAZ was higher among women, people who were not working, and those who thought air quality in their area was poor. Opposition was higher among people who frequently drove within the proposed CAZ area. These differences were not apparent in Basildon & Essex, but support for the speed limit reduction there was highest among residents aged 65 and over.

Data on public attitudes to the CAZs is also available from public consultations, although these are self-selecting and likely to over-represent people who will be negatively affected by the CAZ. In Birmingham, responses to the public consultation held in summer 2018 appear to be more negative about the CAZ than the levels of support shown here: around half (52%) felt the CAZ would have an overall negative impact on Birmingham, with one-third (32%) believing the impact would be positive. In contrast, responses to the Leeds CAZ consultation appear fairly positive, although respondents were not asked directly whether they supported or opposed the CAZ: 61% of residents said that a CAZ in Leeds would have a significant impact on reducing air pollution in Leeds and 76% agreed that improving air quality in Leeds should be a priority for the council.[17]

Consultation respondents were particularly concerned about the potential for the CAZ to have a negative impact on businesses, with 72% of respondents in Birmingham and 47% of respondents in Leeds thinking this would be the case. As previously highlighted, the deep-dive case-study for Birmingham will include an assessment of the baseline position of businesses. This research commenced in September 2020.

In Basildon & Essex, the survey asked residents for their reasons for supporting or opposing the scheme. Those who supported the scheme were much more likely to spontaneously mention reduced accidents (77%) than reduced air pollution (19%), whereas those opposing most commonly cited more traffic (54%) and longer journeys (44%). Road safety was also thought by many respondents to be the reason behind the speed limit reduction: when asked to suggest (in their own words) why Basildon and Essex councils are implementing the speed limit reduction, many more survey participants spontaneously cited[18] reducing accidents (54%) than improving air quality and/or public health (33%), suggesting the reasons for the policy may not be well understood.

In Birmingham and Leeds, at least three in every five respondents could correctly cite at least one of the main reasons for implementing the CAZ (respondents could give more than one reason). Seven in ten respondents in Leeds (70%) and nearly as many in Birmingham (63%) correctly thought the CAZ would be implemented to improve air quality, reduce air pollution and/or improve public health[19]. Birmingham residents were more likely to mention air quality or air pollution specifically (56%) compared with Leeds residents (49%), and in Birmingham this answer was more common among those who believed air quality in the city was poor. Unsurprisingly, in both cities people who supported the CAZ were more likely to give one of these answers.

In Birmingham, one in five respondents (20%) believed the purpose of the CAZ was related to climate change or reducing carbon emissions; 18% believed its purpose was to raise funds for the council; and 9% did not know. Other reasons supplied included reducing traffic and noise pollution. A smaller proportion of residents in Leeds (9%) saw the CAZ as a money-making initiative, a view shared by a quarter of those who opposed the CAZ. Residents who travel into the proposed CAZ as commuters are also more likely to feel that it is a means of raising money (13% vs. 5% for leisure travellers).

4.2 Baseline position: travelling and related behaviours

In those areas implementing a CAZ, this measure is expected to cause a change in traffic flows, in part due to people choosing not to take some journeys, or choosing different routes or modes than they would have otherwise. The evaluation has therefore gathered evidence on people's travel behaviour

[17] CAZ informal consultation (Phase 1) Jan-Mar 2018, 8,744 responses to an online survey (m.e.l Research)
[18] Survey participants could suggest more than one reason for the council introducing the speed limit reduction if they wished
[19] 7% of Birmingham respondents referred to public health without specifically mentioning air quality.

before the introduction of the CAZ. In the mid- and end-line reports, the evaluation will track how the frequency of travel to and around the CAZ area changes (if at all) to assess the extent to which the CAZ implementation will have led to the effect of trips to the CAZ area being cancelled, re-routed or use a different mode of transport.

Frequency, routes and purpose of travel

In Leeds and Birmingham, at least three in five (69% and 61%, respectively) of those surveyed reported travelling in or around[20] the proposed CAZ at least once a week, with 35% of those in Birmingham saying they did so five days a week or more. Among those living within the CAZ or less than 800m outside it, more than two in every three reported travelling within the CAZ at least once a week (70% in Birmingham; 77% in Leeds). Overall, only 5% of respondents said they never travelled within the CAZ.

In Basildon & Essex, the section of the A127 between Fortune of War and Pound Lane is used extensively: eight in ten respondents (80%) travel on this stretch of road at least once per week, with high usage rates applying to both those living close to the road (83%) and those living elsewhere in Basildon & Essex (77%). Four in ten (40%) travel on it at least four times per week, whereas just 1% never use it. Those in work were more likely to report travelling in this zone at least four times per week, with the same number being attributed to those who oppose the scheme.

In Leeds, when asked their main reason for travelling into the proposed CAZ, respondents were equally split between commuting (47%) and personal reasons such as leisure trips or shopping (47%). Respondents in Birmingham were more often travelling into the CAZ for personal reasons (55% of respondents gave this as their main reason); around one-third of respondents (37%) travelled into the CAZ as part of their commute, and a further 8% were travelling for other work-related reasons such as making deliveries.

Frequency of travel in non-compliant vehicles

It is anticipated that as a result of the CAZ in Birmingham, fewer journeys will be made by residents in non-compliant vehicles and that overall such vehicles will be driven less. Currently, the majority of those who owned a non-compliant vehicle (56%) drove it in or around the CAZ at least once a week, and around a third (32%) did so five or more days a week. A quarter of respondents overall (26%) had a non-compliant vehicle which they drove into the CAZ at least once per month.

Mode of travel, public transport use and active travel

As highlighted above, a way in which the measures in all three Local Plans are anticipated to affect people's behaviour is by prompting them to use a different mode of transport, such as public transport, walking or cycling. This is particularly the case in Birmingham where the use of some cars will begin to incur a charge. In Basildon & Essex, the speed limit reduction is not expected to directly lead to significant modal shifts. Nevertheless, it is of interest to observe whether it will do so indirectly by raising awareness of air quality issues. We have therefore sought to capture people's choice of modes before measures are introduced so we can observe how this changes over time.

Census data[21] suggests that current active travel use is low in Basildon & Essex: among those in work, 9% travel to work on foot, and 2% by bicycle. Public transport use is more prevalent: 21% travel to work by public transport, with train travel (17%) accounting for most of these journeys. However, commuting

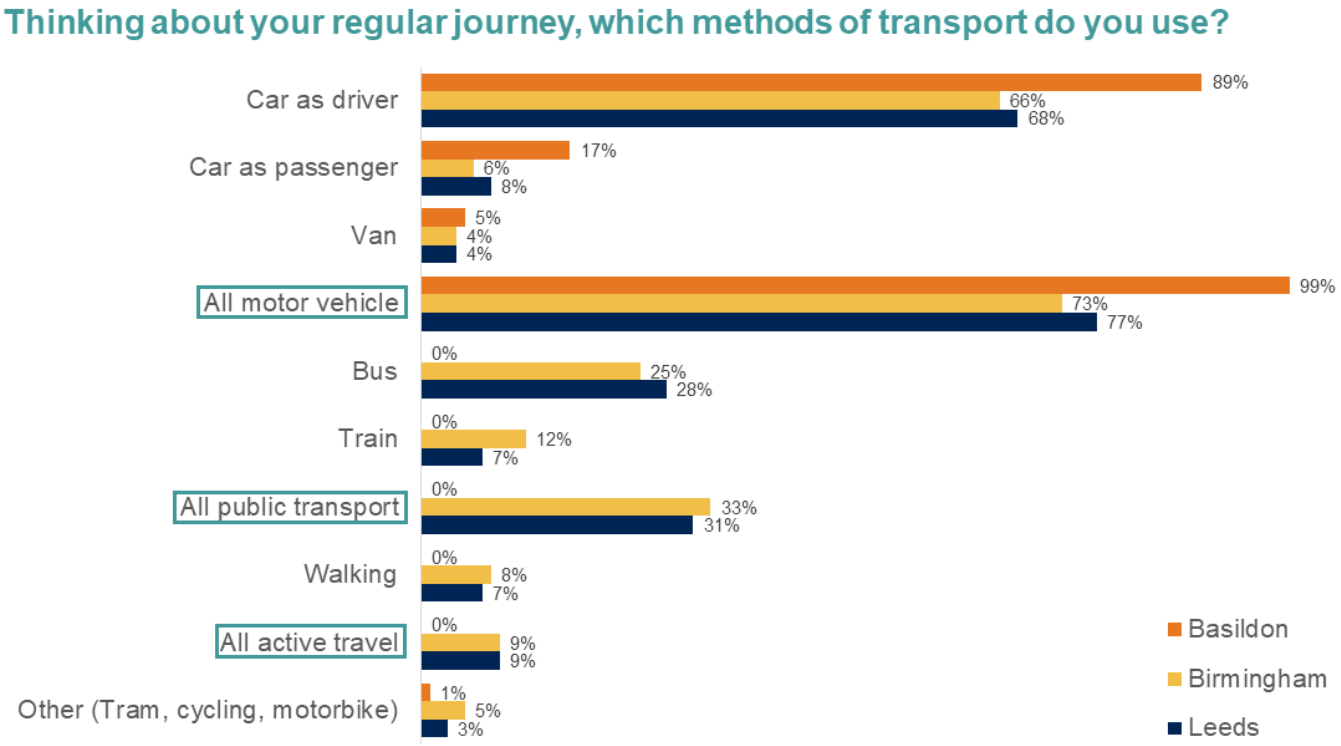
[20] The wording "in and around" was used to be inclusive of journeys that were wholly within the CAZ, rather than only journeys involving travel into the CAZ from outside.

[21] https://www.nomisweb.co.uk/census/2011/QS701EW/view/1946157210?rows=cell&cols=rural_urban (accessed 4th February 2021)

by motor vehicle is dominant: 63% travel to work as a driver or passenger in a car or van. In terms of the speed limit reduction zone, travel is done overwhelmingly by car. Among those who reported that they travel on the road in question, 97% do so by car, compared with just 4% in a van and 1% on a motorbike or scooter. No survey participants reported cycling or walking on the road in question. This supports DfT traffic count data, which showed an average daily flow of just 34 pedal cycles and 419 two-wheeled motor vehicles in 2017, compared with 47,680 cars.[22]

While the use of public transport is more common in Leeds and Birmingham, which have more substantial public transport services than Basildon & Essex, car use still prevails over public transport use in these cities. As shown in Figure 4.4 below, in the past 12 months, around seven in ten (70% in Birmingham, 73% in Leeds) respondents had regularly travelled into or around the proposed CAZ by car, either as a driver (66% and 68%) or as a passenger (6% and 5%). Around one-third (33% and 31%) used public transport, most often buses, and 9% of respondents in both cities walked or cycled.

Figure 4.4: Mode for regular journey in and around CAZ or Speed Limit Reduction area



Base: All respondents who have travelled in relevant area in last 12 months: 297 in Basildon & Essex, 465 in Birmingham, 476 in Leeds.

In both Leeds and Birmingham, those over 65 and retired people reported using public transport more frequently, and used a car less frequently, than under-65s and people of working age respectively. People who were travelling for leisure were more likely to use public transport than those travelling for work. This chimes with modelling carried out for Birmingham City Council, which predicted that mode shifts were more likely among lower-income groups (who may be less able to upgrade their vehicles) and for those making leisure trips[23]. Unsurprisingly, those who lived close to or within the CAZ were more likely to walk or cycle.

[22] https://roadtraffic.dft.gov.uk/manualcountpoints/16646 (accessed 4th February 2021)

[23] Birmingham CAZ behavioural research, October 2018. Available at: https://www.brumbreathes.co.uk/download/downloads/id/4/appendix-d---benchmarking-and-sensitivity-testing-updated.pdf (PDF download, accessed on 8th February 2021).

There is some indication from secondary data that those who travel by car may be over-represented in the survey and this will need to be taken into consideration in the mid- and end-line analyses, although this comparison makes use of 2011 census data and therefore conclusions should be interpreted with caution. Results for car usage for commuting in this baseline report are consistently higher than those from the 2011 census: that census found that 61% of residents would commute by car,[24] while this figure was 75% within the deep-dive survey. Similarly, census for Leeds found that 63% of residents in work commuted by car as a driver or passenger, while this figures in this baseline report show 80% of commuters into the proposed CAZ travelled by car.

Vehicle ownership

Vehicle ownership was high among respondents to all three surveys (see Table 4.1 below), but secondary data suggests that vehicle owners may be over-represented in our sample (see above). As above, census data is from 2011 and therefore should be interpreted with caution. However, figures from the National Travel Survey[25] suggest that at a national level, levels of car ownership did not decrease between 2011 and 2019.

Table 4.1: Comparison of data on vehicle ownership from a range of sources

Local Plan area	Own at least one vehicle: 2020 survey data	Own at least one vehicle: 2011 census data	Own two vehicles or more: 2020 survey data	Own two vehicles or more: 2011 census data
Basildon & Essex	**98%**	78%	**64%**	28%
Birmingham	**87%**	64%	**51%**	24%
Leeds	**90%**	68%	**43%**	26%
Nationally	-	74% (2018 National Travel Survey: 76%)	-	27% (2018 National Travel Survey: 35%)

In Birmingham, respondents were also asked about the fuel type and age of their vehicle/s to determine whether or not they were likely to be eligible for a charge. One-third (36%) of vehicle owners owned only compliant vehicles, and 44% of vehicle owners owned at least one non-compliant vehicle. For the remaining vehicle owners (20%) it was not possible to determine whether their vehicle/s were compliant because they were unable to provide information about the fuel type and approximate date of registration. People in work were more likely to have a non-compliant vehicle than people who were retired or otherwise not working.

Vehicle owners also appear to be over-represented in Birmingham's public consultation, in which 90% of respondents owned a car or van. Half of respondents (51%) stated they would be charged to drive their main vehicle into the CAZ, with 28% saying they would not be charged and 13% stating they did not know whether they would be charged or not.

Modelling for Birmingham's Local Plan assumed that 23% of cars would be non-compliant by 2020. This was based on local fleet proportions observed in ANPR surveys and a predicted year-on-year change in the age distribution of vehicles, causing an increase in the proportion of compliant vehicles over time[26].

[24] As reported in Birmingham City Council's responses to the CAZ consultation.

[25] https://www.gov.uk/government/statistical-data-sets/tsgb09-vehicles#car-ownership-and-driver-licensing (accessed 8th February 2021)

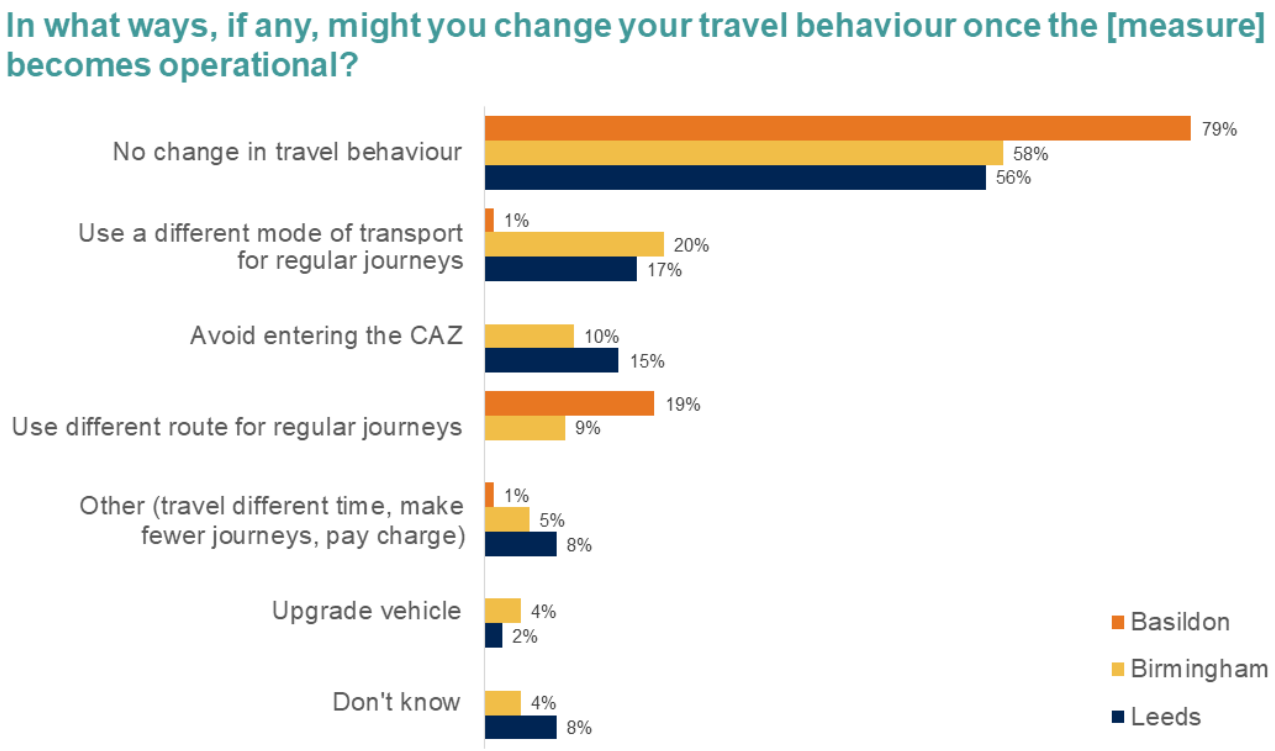
[26] Birmingham Clean Air Zone Feasibility Study: Full Business Case Air Quality Modelling Report (December 2018) https://www.birmingham.gov.uk/download/downloads/id/11353/aq3_-_birmingham_caz_fbc_report-_air_quality_v3_4-12-18.pdf (PDF download, accessed 8th February 2021).

Anticipated changes to travel behaviour

All three surveys asked respondents how they might change their travel behaviour as a result of the Local Plan measures (once these measures had been briefly explained). Respondents were asked to comment in their own words, rather than being provided with a list of options to agree or disagree with.

In each area, most believed they would not change their behaviour as a result of the Local Plan measures. This is perhaps understandable considering that in Leeds, very few respondents would have been directly affected by the measures, and in Birmingham, only around half are likely to be affected (based on the figures on vehicle ownership described above[27]). In Basildon & Essex, while the speed limit reduction is likely to affect the majority of respondents, many may judge that the change in speed limit does not warrant a noteworthy change in their travel patterns, and indeed this is not required for the measure to be effective (since reduced emissions are achieved through steadier driving).

Figure 4.5: Anticipated changes in travel behaviour



Base: Basildon: all respondents who travel on the A127 (297); Birmingham and Leeds: all respondents (500 in each city).

As shown in Figure 4.5 above, in Basildon & Essex, four in five (79%) of those who travel on the A127 believed they would not change their travel behaviour in response to the speed limit reduction, compared with 21% who would make adjustments (rising to 26% among those who do not live close to the A127). The main change participants anticipated was using different routes for their regular journeys (19%).

Most Leeds residents surveyed said they did not anticipate changing their behaviours (56%). Among those who did intend to change how they travel following the CAZ implementation, most intended to use a different form of transport (17% of all surveyed), or to re-route their trips by avoiding the CAZ or choosing an alternative route (15% of all surveyed). In Birmingham, around one in five (18%) of

[27] 11% of respondents did not own a vehicle, and 31% of respondents (36% of vehicle owners) had only compliant vehicles. This means that up to 58% of respondents may have owned a non-compliant vehicle, but it was only possible to determine that this was the case for 38% of respondents (44% of vehicle owners).

respondents anticipated that they would avoid the CAZ area and/or take a different route for their journey.

Focusing on those who typically *drive* into the proposed CAZ area, a larger proportion of people anticipated that they may change their behaviours following a CAZ implementation: 52% in Birmingham and 40% in Leeds. In Birmingham, respondents who owned a non-compliant vehicle were more likely to say they would change their behaviour (49% said they may change their behaviour, compared to 35% of owners of compliant vehicles and 17% of non-vehicle owners). In particular, they were more likely to say that they would use a different mode of transport for their journeys (27%) or upgrade their vehicle (8%). In Leeds, respondents were also more likely to say that they would change their behaviour if they knew a great deal or a fair amount about the CAZ, or view the levels of traffic to be a problem, but these differences were not apparent in Birmingham.

Birmingham City Council asked a similar question of the 10,392 individuals who responded to its public consultation about the CAZ in summer 2018. Two-thirds of these individuals (68%) said they would change their behaviour in some way as a result of the CAZ. This is a noticeably higher figure than in our survey, which is likely to be because a self-selecting consultation is more likely to attract responses from people who will be affected. Compared to consultation respondents, respondents to our survey were more likely to say that they would use a different mode of transport, and less likely to say that they would make fewer journeys, pay the charge[28], or upgrade their vehicles.

Vehicle purchasing decisions

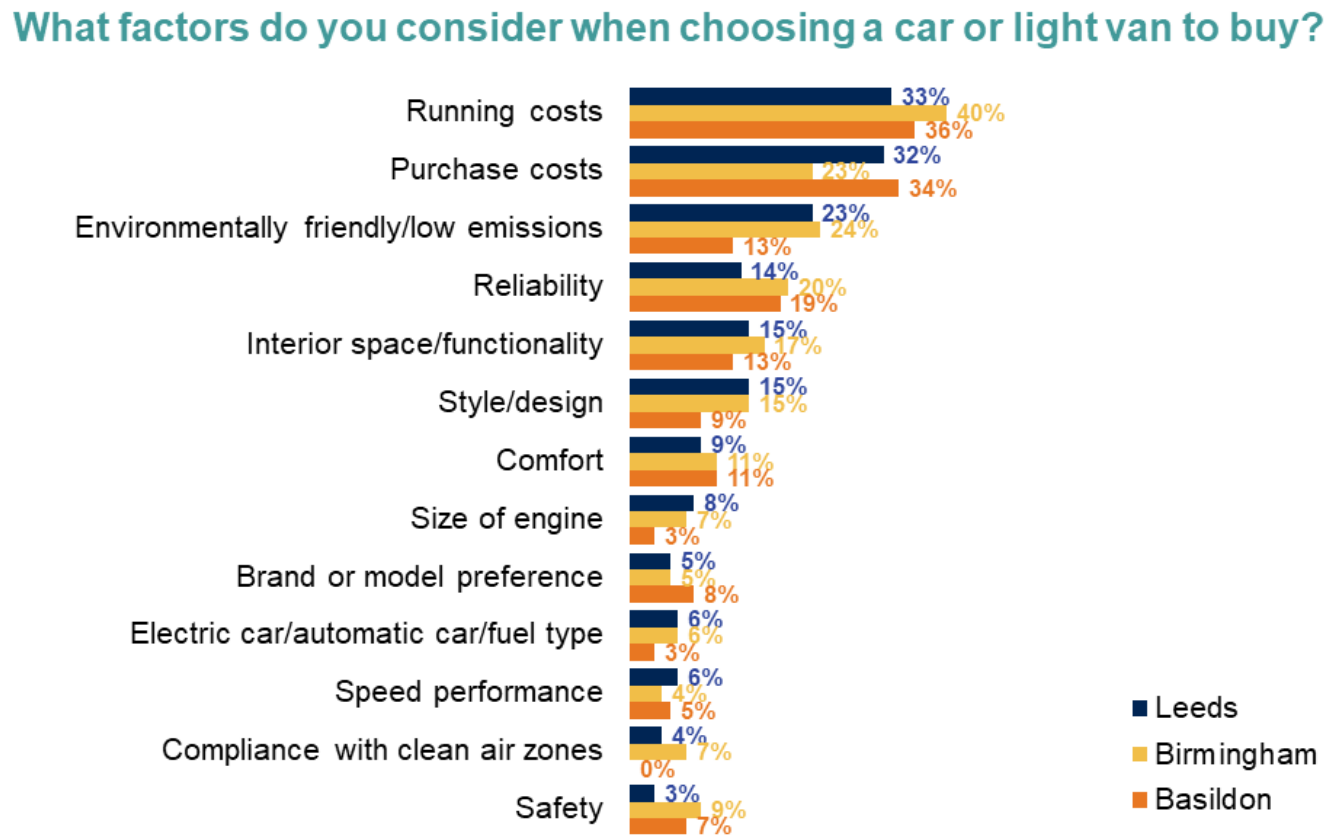
The CAZ is intended to encourage households to upgrade to compliant vehicles, or switch to using compliant vehicles that they already own.

In Birmingham, only 8% of those who had a non-compliant vehicle commented that they may upgrade their vehicle as a result of the CAZ, but 20% of all respondents and 27% of non-compliant vehicle owners reported that they may use a different form of transport, which may include cleaner vehicles. Very few respondents (less than 1%) mentioned that they may get rid of their current vehicle. These numbers were lower in Leeds, where private vehicle owners would not have been charged; only 2% of survey respondents commented that they may upgrade their vehicle as a result of the proposed CAZ and very few respondents (less than 1%) mentioned that they may get rid of their current vehicle.

In terms of upgrading vehicles, it is anticipated that following the launch of the CAZ, emissions standards may become a more important consideration for households when purchasing a new vehicle and that they will become more likely to purchase a vehicle which is compliant with the CAZ. We therefore asked car and van owners for their current priorities when purchasing a vehicle (respondents could comment in their own words and give more than one answer). Across Leeds and Birmingham, environmental aspects ranked third, just after costs. In both cities cost was the main priority for about 50%, and environmental was a priority for around a quarter of the surveyed residents. A small number of Leeds (4%) and Birmingham (7%) respondents explicitly mentioned compliance with CAZs as a consideration. In Birmingham, these considerations were more frequently mentioned by people with higher levels of awareness of the CAZ, as well as people who regularly travelled into the CAZ.

[28] Note that at the time of the consultation, the charge levels had not been published. By the time the survey took place the charges had been published on the Birmingham City Council website, although the levels of charges were not mentioned in the survey script.

Figure 4.6: Factors influencing vehicle purchasing decisions



Base: all respondents with cars or light vans in the household: Leeds 454, Birmingham 429, Basildon & Essex 280.

As shown in Figure 4.6 above, environmental factors are less of a concern when Basildon & Essex residents purchase a new vehicle: many more would consider running costs (36%) and purchase costs (34%) than the vehicle's emissions / environmental friendliness (13%). Those who support the speed limit reduction were more likely to cite environmental factors (19%) although these were still less important than cost factors. The consultation carried out by Essex County Council in 2018 also suggested cost is a key barrier to upgrading to ULEVs: 65% of consultees agreed that they would use an electric car if they were cheaper to buy, compared with 41% who agreed they would do so if more electric plug in points were available on their route.

4.3 Baseline position: traffic, vehicle mix and noise

Vehicle mix on the roads within and outside the CAZ area

The main objective of the CAZ is to change the vehicle type profile within the zone, so that there will be lower numbers of older, more polluting vehicles. However, there is some concern that while this may be achieved within the CAZ, numbers of non-compliant vehicles using the roads outside the CAZ area may increase as they take a different route to avoid the area.

The evaluation team is working on techniques to analyse sample ANPR vehicle registration data, when it becomes available, in order to assess whether the vehicle mix on the road changes over time both within and around the CAZ area. Modelling carried out for the Local Plan[29] suggests that, in the absence of

[29] *Birmingham Clean Air Zone Feasibility Study - Future Year Traffic Modelling* (June 2018) https://www.birminghambeheard.org.uk/economy/caz_individual/supporting_documents/Transport%20Modelling%20Forecasting%20Report%202020%20OBC%20with%20Addtional%20Measures.pdf (accessed 8th February 2021)

intervention, car and taxi traffic in Birmingham city centre would be expected to grow by around 4%, HGV traffic by 3% and LGV traffic by more than 10% between 2016 and 2020.

The data presented above on vehicle ownership suggests that between two in five and three in five[30] vehicle owners in Birmingham have a non-compliant vehicle. This did not vary significantly between those who lived in or near the CAZ area and those living further away.

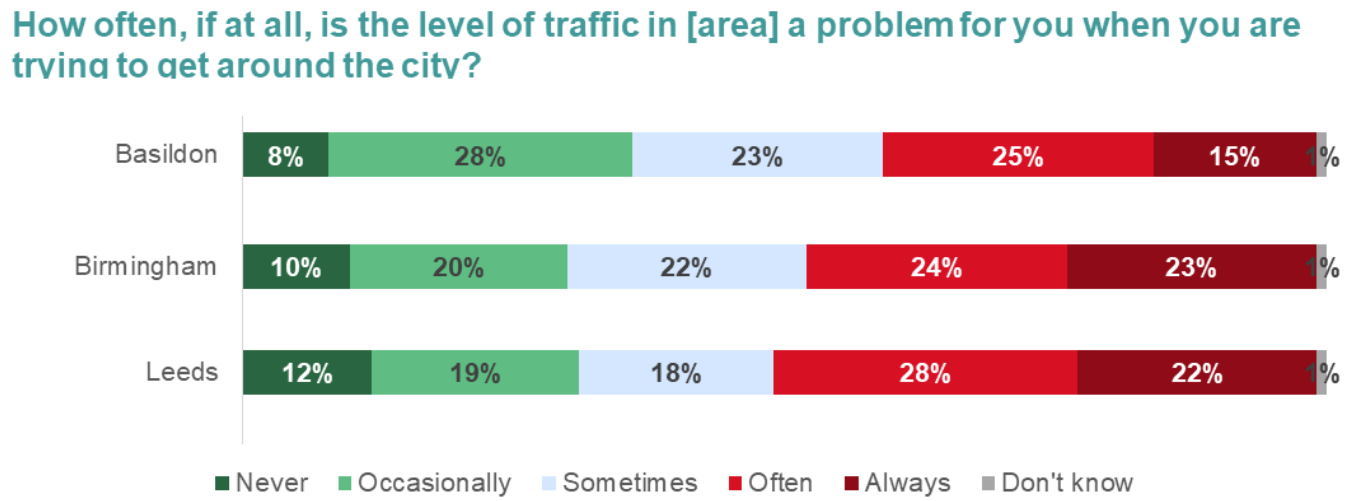
As mentioned above, 18% of respondents in Birmingham and 15% in Leeds anticipated that they would avoid the proposed CAZ area and/or take a different route for their journey, and around 4% and 2% respectively reported that they may upgrade their vehicles. A similar proportion of Basildon & Essex residents reported that they may use different routes for their journey (19%). The mid-line and end-line evaluation reports will explore the extent to which these behaviour changes have happened, as well as measuring traffic levels and air quality in different locations within the relevant areas.

Traffic levels

Local Plan measures may affect traffic levels by changing people's travel behaviour. It is anticipated that traffic will reduce as people switch to other modes of transport and potentially also make fewer journeys (although the latter is not a desired outcome). However, some concerns have been raised that Local Plan measures may worsen traffic in some areas as motorists take different routes or, in Basildon & Essex, due to the speed limit reduction itself. It is therefore of interest to measure baseline perceptions of traffic levels.

As Figure 4.7 below shows, traffic appears to be a problem for a significant proportion of residents in all three areas. In Basildon & Essex, four in ten (39%) report traffic is always or often a problem for them when getting around the area; in Birmingham, this figure was 47% and in Leeds it was 50%.

Figure 4.7: Perceptions of traffic levels



Base: All respondents (300 in Basildon & Essex, 500 in Leeds, 500 in Birmingham).

A review of Leeds historical traffic data has indicated that traffic flows on most arterials within Leeds[31] have been steadily increasing by about 1% yearly since 2015, while outside of the proposed CAZ area

[31] Covers major Leeds arterials (A660, A58, A64, A61, A643, A647), the central A58M. The Sheepscar ATC site is a core arterial connecting the north of Leeds with the City centre but also the Leeds urban motorway (A58M) and routes to the south including the M1 and M621/M62. It is a 2-3 lane bi-directional link. The York Road (A64) is the main arterial, a dual-carriageway in the west of Leeds.

there has been little discernible change in traffic flow levels. We will also track traffic flow in Birmingham once we receive baseline data from Birmingham City Council Automatic Traffic Count (ATC) sites. The mid- and end-line reports will compare actual trends in traffic flows with these historical trends, as well as with those trends at control sites (to be selected) and with the trends modelled in Final Business Cases.

Basildon & Essex residents were asked for their views on the likely impact of the speed limit reduction on traffic. Many more residents think that the speed limit reduction will increase traffic (44%) than decrease it (9%). Around one in six (18%) think it will increase traffic a lot. As described above, more traffic was the most commonly cited reason for opposing the scheme. Further evidence of the importance of concern about increased traffic is that two thirds (67%) of those that oppose the speed limit reduction believe it will increase traffic, many (44%) believing it will increase traffic a lot.

Journey times

Related to traffic levels, it will be of interest to observe whether Local Plan measures have an effect on journey times. In Birmingham and Leeds, the majority of typical journeys taken into the proposed CAZ (58% and 57% respectively) took less than 30 minutes, and nearly all (92% and 93%) took less than one hour.

In Basildon & Essex, residents were more pessimistic with respect to the impact of the speed limit reduction on journey times than traffic levels. More than half (57%) think it will increase journey times, including one in six (18%) that expect journey times to increase a lot. As with traffic levels, this expectation may be related to opposition to the scheme: eight in ten (83%) of those that oppose the speed limit reduction expect journey times to increase, with four in ten (40%) thinking that they will increase a lot. This increase in journey times is an expected downside of the scheme by local policymakers: Basildon & Essex have modelled £4.8m of time disbenefits in 2020, most of which (£2.7m) are anticipated at inter-peak periods.

Perceived noise levels

Research suggests that on higher speed roads, reducing the speed limit by 20 kilometres per hour can reduce noise levels by 1-2 decibels. It is therefore anticipated that the speed limit reduction in Basildon & Essex (by approximately 32 kilometres per hour) will reduce noise levels significantly along the A127 at interpeak periods, therefore improving the wellbeing of local residents. As well as traffic, we therefore also asked Basildon & Essex residents for their views on the noise levels in their area.

Among all Basildon & Essex survey participants, three in ten (29%) said that noise from road traffic bothers, disturbs or annoys them. Traffic noise disturbs more of those living close to the A127 (36%) than elsewhere (22%). This indicates noise reductions could benefit a significant proportion of local residents. The baseline survey also suggests that those who support the speed limit reduction (36%) are twice as likely as those opposed to it (19%) to be bothered by traffic noise.

However, most residents do not expect the speed limit reduction to reduce noise. Eight in ten of all surveyed (82%) expect it will make no difference, and only around one in ten (8%) expect road traffic will disturb them less than it does currently. However, there is more optimism among those that are currently bothered by road noise: One in five (22%) of these participants believe road noise will reduce.

4.4 Baseline position: air quality

The ultimate aim of the Local Plan measures is to improve air quality and reduce levels of NO_2 concentrations. In each Local Plan area in 2016, annual average NO_2 concentrations exceeded the legal

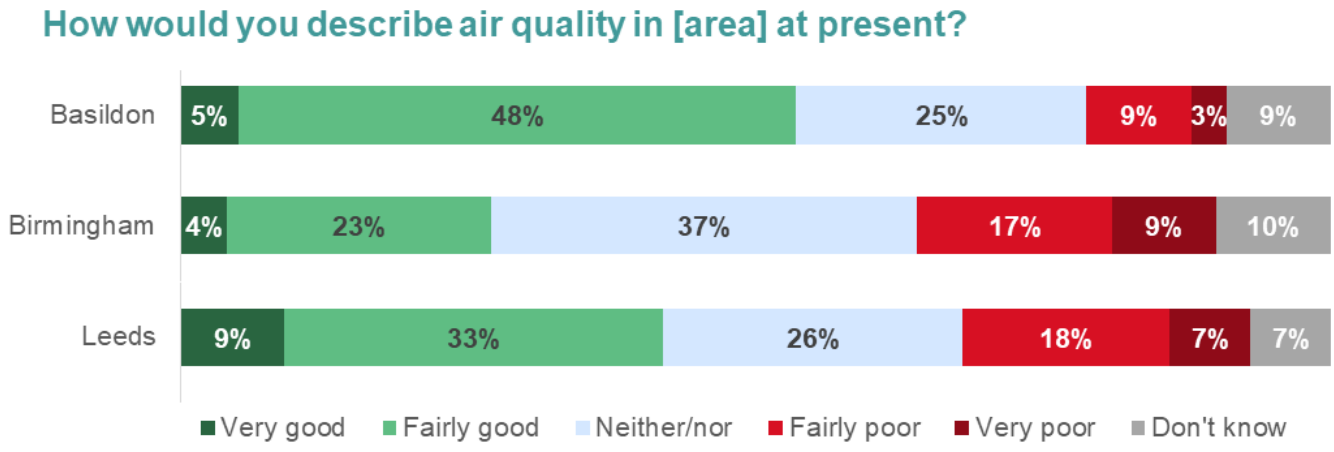
limit in certain parts of the local areas targeted by this evaluation. Predictions for 2020 suggested that although there would be an overall improvement in air quality due to reductions in background concentrations, ongoing upgrades of vehicles and other interventions, this would not be enough to achieve compliance on NO_2 concentrations[32].

There is an appetite amongst the public for improvements to be made to air quality and actions to be taken to reduce air pollution. Research conducted by Ipsos MORI in June 2020[33] suggests that 10% of British adults identified pollution and the environment as one of the top issues facing the country. Another global study by Ipsos MORI found that three in four people in 16 major countries, including the UK, expect their government to make protection of the environment a priority when planning a recovery from the coronavirus pandemic.[34]

Phase 1 of the Leeds CAZ consultation in 2018[35] found that 76% of participants agreed that improving air quality within the shortest amount of time possible should be a priority for Leeds. Likewise, 87% of participants in Birmingham City Council's air quality survey thought air quality is a 'serious issue' to be tackled now[36]. However, it is important to note that these were self-selecting surveys and therefore likely to overstate average views on the importance of air quality.

We asked respondents in each of the three areas to describe current air quality in their local area. Results are presented in Figure 4.8 below, and discussed in more detail for each area, alongside an analysis of air quality trends where this is available.

Figure 4.8: Perceptions of air quality



Base: All respondents (300 in Basildon & Essex, 500 in Birmingham, 500 in Leeds).

[32] Birmingham Clean Air Zone Feasibility Study: Full Business Case Air Quality Modelling Report (December 2018) https://www.birmingham.gov.uk/download/downloads/id/11353/aq3_-_birmingham_caz_fbc_report-_air_quality_v3_4-12-18.pdf (PDF download, accessed 8th February 2021).

[33] Ipsos MORI Issues Index June 2020 https://www.ipsos.com/ipsos-mori/en-uk/ipsos-mori-issues-index-june-2020 (accessed 4th February 2021)

[34] https://www.ipsos.com/ipsos-mori/en-uk/majority-people-expect-government-make-environment-priority-post-covid-19-recovery (accessed 4th February 2021)

[35] CAZ informal consultation (Phase 1) Jan-Mar 2018, 8,744 responses to an online survey (m.e.l Research): https://melresearch.co.uk/casestudy/clean-air-zone-consultation (accessed 8th February 2021)

[36] https://www.birminghambeheard.org.uk/economy/birmingham-air-quality/ (accessed 8th February 2021)

Basildon & Essex

In Basildon & Essex, clean air quality is a key issue to those surveyed, half of whom (52%) perceive local air quality to be good (although this includes just 5% that would describe it as very good). This is compared with 12% that believe air quality is poor. More than half (57%) reported clean air to be very important while another third (36%) felt it was important. Those who support the speed limit reduction were more likely to place a high level of importance on air quality than those in opposition, as were those with a long-term illness or disability.

Given the lack of a robust air quality monitoring network in the Basildon & Essex area, these perceptions cannot be compared with reliable data for the same period of the survey. A continuous analyser is being commissioned as part of this Central Evaluation and will enable the research team to track changes in concentrations and perceptions once it is installed.

Birmingham

As outlined in Annex 2, the Central Evaluation team has undertaken an analysis of air quality trends in Birmingham from 2015 to the end of 2019. This provides the baseline against which the plan effectiveness will be monitored; future quarterly reports from ITS will include early assessments of the effectiveness of the plans on air quality and traffic levels.

NO_2 concentrations in Birmingham have generally been on a downward trend since 2015, with levels at the urban background site at Acocks Green falling by 4.7% per annum, and greater reductions at roadsides e.g. Birmingham A4540 Roadside falling 7.2% per year. This is a faster reduction trend than the average trend for the West-Midlands roadside (-3.6% per year).

Survey respondents were evenly split in their views of air quality in Birmingham, with equal proportions describing it as good and poor (27%), and a larger proportion of respondents describing it as neither (37%). Among those with strong views, however, more respondents described Birmingham's air quality as "very poor" than "very good". The proportion of respondents describing air quality as poor increased with age, with 49% of over-65s reporting this compared to 19% of 18-34 year-olds.

Leeds

Based on analysis of air quality trend data between 2015 and 2019, NO_2 concentrations in Leeds have generally been on a downward trend since before 2015, with urban background (Leeds Centre AURN) falling at 1.5% per year, and greater reductions at roadsides e.g. Kirkstall road falling by 3.5% per year. This is comparable with the trends in the Yorkshire and the Humber region roadside (-3.6%).

Four in ten (42%) of the surveyed residents in Leeds rate the air quality as either very or fairly good, with a quarter describing it as poor. Respondents that knew a great deal or fair amount about the CAZ were more likely than average to say the air quality in Leeds is poor (36% vs. 25% of total sample) and the same pattern can be seen among those who support the implementation of the CAZ (33% of supporters vs. 14% who oppose the CAZ think air quality is poor).

Following the lockdown period and the drop in in-flow of vehicles, NO_2 concentrations dropped to about half of their previous level, but then increased slightly as lockdown measures were eased, and by early June 2020 were at about two-thirds of the level of concentrations before lockdown measures were implemented. In Leeds City Centre, the drop was less pronounced (they dropped by about a fifth as compared to pre-lockdown levels), reflecting emissions from construction and residential/commercial

heating, which will be more significant, and possibly due to higher traffic than in other parts of the city, given that it hosts the Leeds General Infirmary (a hospital).

Despite this improvement in NO_2 concentrations, there were no significant changes in perceptions of air quality among respondents surveyed after lockdown compared with those interviewed earlier. This is perhaps because changes in air quality would only have been apparent for a short time when the survey was completed, and it may be that people are slow to change their perceptions in relation to variations in air quality levels.

4.5 Baseline position: health

Improving air quality is important because air pollution is a major public health risk. According to the UK Clean Air Strategy,[37] "*[poor] air quality shortens lives and contributes to chronic illness*" both through short-term, high-pollution episodes and through long-term exposure to lower levels of pollution. Exposure to air pollution is a contributory factor to deaths and poor health and unlikely to be the sole cause of death or illness. The Royal College of Physicians has estimated that air pollution is responsible for more than 20,000 hospital admissions a year due to respiratory or cardiovascular diseases[38] and six million sick days a year in the UK.[39]

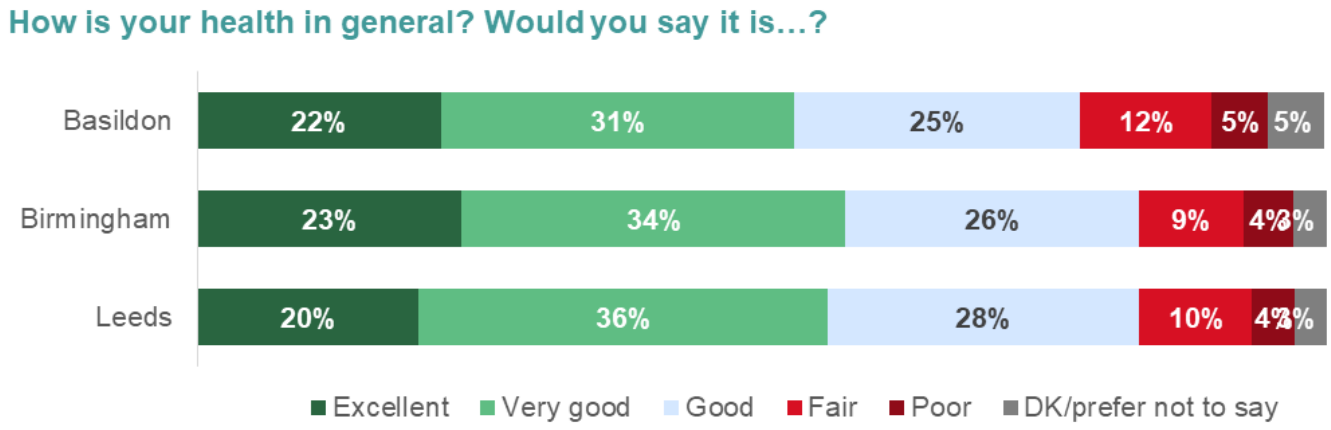
The evaluation will measure trends in health outcomes over time where it is possible to do so. In terms of self-reported data, survey respondents were asked to report the overall state of their health before Local Plan implementation. These primary research findings will be supplemented and contextualised with secondary data on health outcomes such as hospital admissions.[40] Initial research into this secondary data has been summarised below for Basildon & Essex and Birmingham.

Self-reported health data

Overall, around four in five respondents reported that their health was good or excellent.[41] A noticeably higher proportion of Basildon & Essex respondents reported that their heath was poor compared to Birmingham or Leeds respondents (see Figure 4.9 below).

[37] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/770715/clean-air-strategy-2019.pdf (accessed 8th February 2021)
[38] Royal College of Physicians, 2018, Reducing air pollution in the UK: progress report, London: RCP https://www.rcplondon.ac.uk/news/reducing-air-pollution-uk-progress-report-2018 (accessed 8th February 2021)
[39] Royal College of Physicians 2016, Every breath we take: the lifelong impact of air pollution. Report of a working party, London. RCP https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution (accessed 8th February 2021)
[40] Such data will be sourced in collaboration with local authorities and will not include personal data about individuals.
[41] Although a slightly different response scale was used in the Local Plans surveys, the findings are in line with data from the 2018 Health Survey for England, where 75% of respondents reported their health as good or very good. http://healthsurvey.hscic.gov.uk/data-visualisation/data-visualisation/explore-the-trends/general-health.aspx http://healthsurvey.hscic.gov.uk/data-visualisation/data-visualisation/explore-the-trends/general-health.aspx

Figure 4.9: Self-reported health



Base: All respondents (300 in Basildon & Essex, 500 in Birmingham, 500 in Leeds).

Around a quarter of respondents across all three areas reported that they have a long term physical or mental health condition or disability (23%, 24% and 26% in Basildon & Essex, Birmingham and Leeds respectively).

The survey also asked respondents whether they have respiratory problems or a heart condition and, if so, the frequency of episodes of their condition requiring treatment. Only small numbers of respondents had these conditions: across all three surveys, 9% had a respiratory condition and 3% had a heart condition. This means that we are unlikely to be able to use frequency of episodes as a baseline since the numbers of respondents we interview will be too small to give confidence in the findings.

Basildon & Essex

Data from Public Health England shows an asthma prevalence of 6% among the population of Basildon and Brentwood NHS Trust, and 96.7 hospital admissions per 100,000 adults each year for asthma. There were 1,405 emergency hospital admissions in 2018/19 for respiratory disease, and 15% of all deaths have respiratory disease as an underlying cause[42]. Furthermore, coronary heart disease has a prevalence of 3%, and the coronary heart disease mortality rate of those under 75 is 35.3 per 100,000[43]. Therefore by improving respiratory and cardiac health from lower NO_2 and particulate matter $(PM)_{2.5}$ levels, the speed limit reduction is expected to yield significant benefits.

Birmingham

The health impact assessment for the West Midlands Low Emission Zones[44] calculated the likely effect on health of long-term exposure to air pollution in the West Midlands.[45] The report estimated that in 2018, the equivalent of 175 deaths and 648 hospital admissions in Birmingham would be attributable to nitrogen dioxide pollution, and 441 deaths would be attributable to particulate air pollution. By 2026, these figures would have reduced even if no action was taken (due to predicted emissions reduction from motor vehicles), but there would still be 59 deaths attributable to nitrogen dioxide pollution and 426 deaths attributable to particulate matter. Moreover, since these calculations were made it has come to

[42] Accessed at https://fingertips.phe.org.uk/ in August 2020.
[43] Ibid.
[44] https://go.walsall.gov.uk/Portals/0/Uploads/PollutionControl/west_midlands_letcp_low_emission_zones_-_technical_feasibility_study_wp2_economic_and_health_impacts-2.pdf
[45] This calculation was based on research conducted by the World Health Organisation for Europe about the effect of exposure to pollution, and on estimated emissions in different areas of the West Midlands based on traffic data.

light that the real emissions of many diesel vehicles are higher than predicted, meaning that these figures are an underestimate[46].

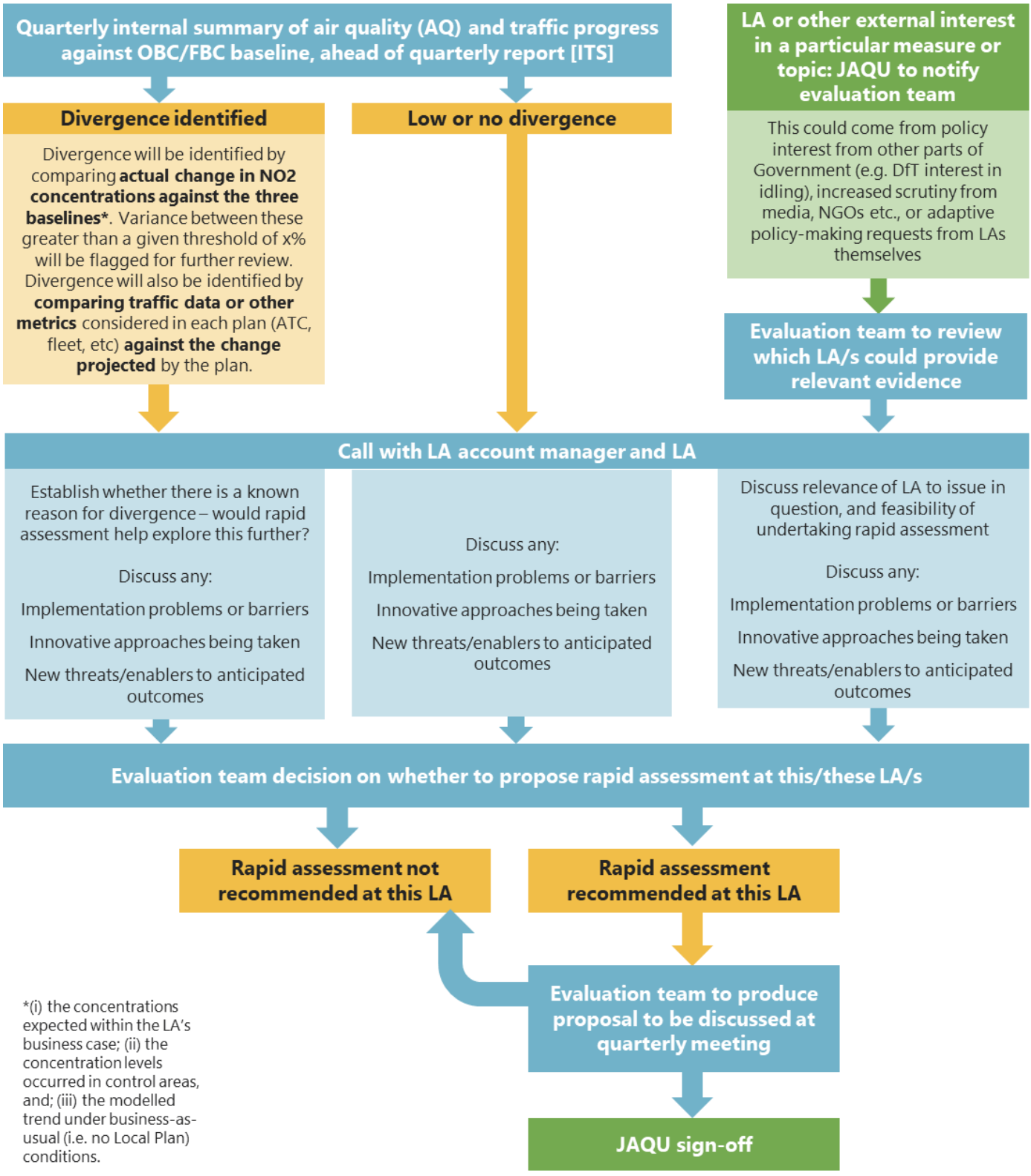
Birmingham's Health Profile for 2019[47], published by Birmingham City Council, found higher death rates in Birmingham for respiratory conditions and cardiovascular disease compared to England as a whole, but notes that rates of asthma in Birmingham are similar to national averages (around 6% of the population, rising to 6.2% in the east and south of the city, and lower in the west of the city).

[46] Franco, V., Sánchez, F.P., German, J. and Mock, P., 2014. Real-world exhaust emissions from modern diesel cars. communications, 49(30), pp.847129-102. https://theicct.org/publications/real-world-exhaust-emissions-modern-diesel-cars (accessed 8th February 2021)
[47] https://www.birmingham.gov.uk/downloads/file/11845/birmingham_health_profile_2019 (accessed 8th February 2021)

5 Process for selecting rapid assessments

Figure 5.1 outlines the process that was developed in order to select the rapid assessments that will be conducted as part of this evaluation.

Figure 5.1: Rapid assessment selection decision tree



6 Evaluation framework

This Annex covers the evaluation framework including the intended impacts and expected outcomes of the Local Plans, the overall theory of change for the NO2 Local Plans, and the theory of change for charging CAZs.

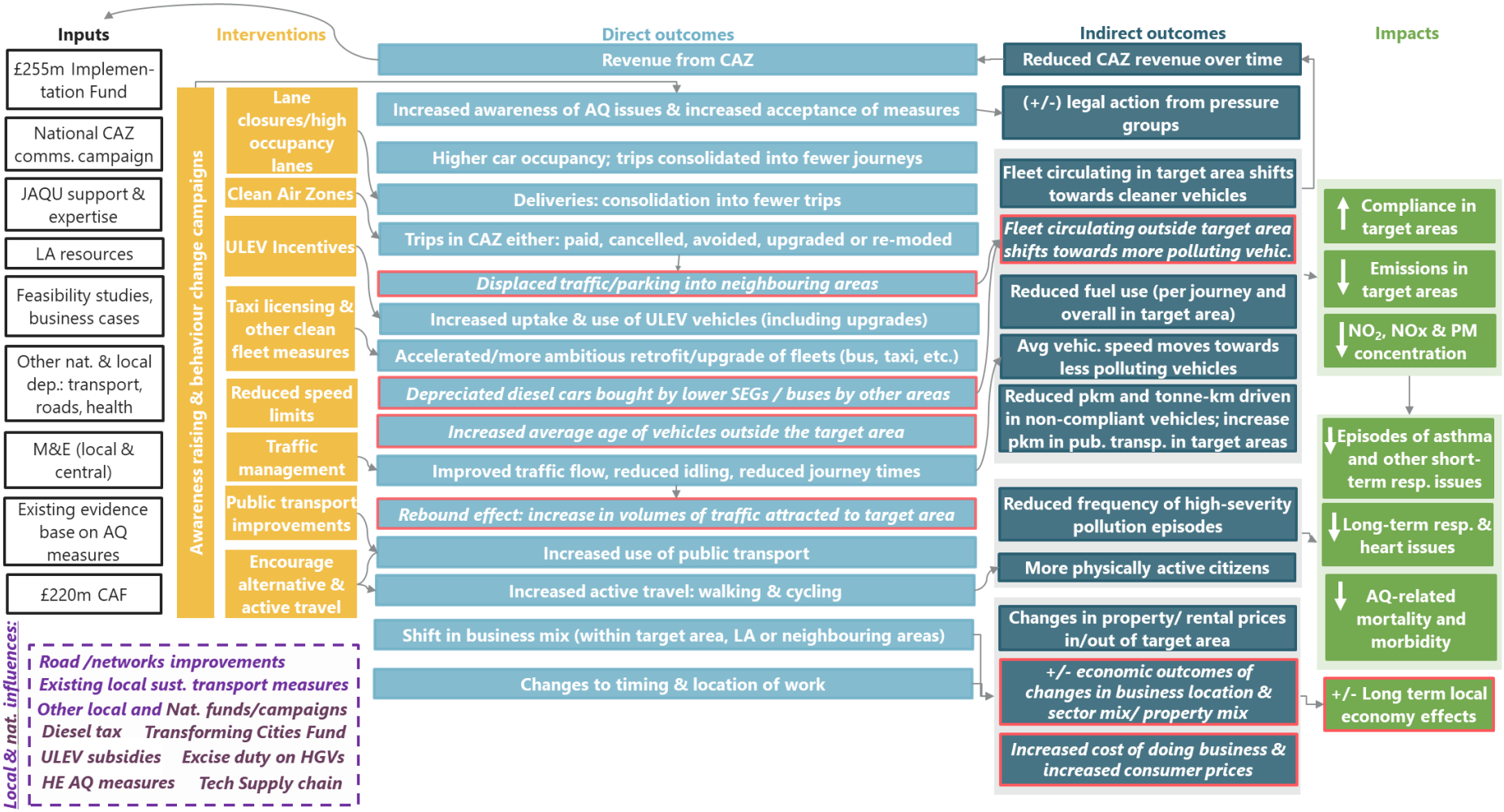
The NO_2 Local Plans outline the measures proposed by local authorities to bring NO_2 concentrations to statutory levels in the shortest time possible. The three high-level intended impacts of the Plans are:

- Reduced emissions of NO_2 from road transport, which is then expected to lead to;
- Improved air quality, in particular ambient NO_2 concentrations against three baselines, namely: (i) the concentrations expected within the LA's business case; (ii) the concentration levels occurred in control areas, and; (iii) the modelled trend under business-as-usual conditions (i.e. no Local Plan).
- Improvements to health, particularly in terms of respiratory health, with associated effects on wellbeing.

The implementation of the Local Plans will involve a range of charging and non-charging measures to reduce NO_2 emissions and, hence, concentrations of NO_2 in the target areas. These measures and their intended outcomes are represented in Figure 6.1 and further detailed in Table 6.1. The outcomes include a shift towards cleaner vehicles circulating in the plan area, increased vehicle occupancy and consolidation of deliveries into fewer trips, increased active travel etc. Beyond the intended consequences of the NO_2 measures, these are also expected to drive unintended consequences, e.g. increase/decrease on property prices, changes to business mix within the plan area, uptake of more polluting, lower cost vehicles in areas outside the CAZ (with uptake of these lower cost vehicles potentially higher among lower social economic groups), effect on composition of traffic on roads just outside target area, increased parking just outside area etc. The possible detrimental effects from Local Plans should be mapped and local authorities can propose measures to mitigate some of these effects through funds from the Clean Air Fund (CAF). This evaluation will be monitoring both the intended and unintended effects from NO_2 mitigation measures.

The list of measures in Table 6.1 is not exhaustive but aims to reflect the main measures being proposed as part of the NO_2 Local Plans. Table 6.2 also maps the key outcomes against key stakeholders of interest according to the ITT underlying this evaluation. These are: transport users, private vehicle owners, businesses, public transport providers and public bodies.

Figure 6.1: Overall theory of change for the NO_2 Local Plans



Source: Ipsos MORI & ITS, based on inputs gathered during the Theory of Change Workshop, 25 March 2019.
Note: This Theory of Change does not depict all existing links between the its various elements, but only the links between the interventions and their key direct outcomes

Table 6.1: Key outcomes per plan measure

Measure	Anticipated behavioural responses and outcomes of measure (both direct & indirect)
Charging CAZ	Increased awareness of the charging CAZ and of Air Quality issues and the need to take action. 5 typical behavioural responses: Journeys will be **paid for** (through the charge), **cancelled**, **avoided**, **upgraded** (through use of a cleaner vehicle) or **re-moded** (e.g. through active travel or use of public transport). Key outcome: **Cleaner vehicles in CAZ area** Other outcomes: Reduced journey times (minus rebound effect that reduced journey times can attract further traffic), increased active travel & public transport use. Fleet circulating outside target area shifts to more polluting vehicles (unintended),
Reduced speed limits	Reduced speed limits lead to reduced average speed and to increased perception of non-motorised travel being safer. Key outcome: **Average speed of vehicles in target area move towards the 'bottom' of the speed-emissions curve** Other outcomes: Changes (+/-) in journey times, increased active travel
Lane restrictions: High-occupancy lanes, Bus lanes, etc.	Drivers adapt their travel: increasing their vehicle occupancy & frequency of trips/ deliveries, or switching to an alternative route, destination or mode of transport. Key outcome: **Reduced vehicle person-kilometre (pkm) in target area / Reduced frequency of high-severity pollution episodes associated with traffic congestion (through reduction of traffic and idling at peak times) / Increased pkm in public transport** Other outcomes: Change (+/-) in journey times, increased active travel & public transport use
Other traffic management	Improved operation of junctions & rearrangement of existing roads lead to smoother flow of traffic, reduced speed variation and reduced idling. Key outcome: Improved traffic flow, leading to decreased idle emissions. Other outcomes: Changes (+/-) in journey times
Taxi licensing, bus reforms, HGV restrictions	Accelerated/ more ambitious retrofit/upgrade of fleets (bus, taxi, HGVs, etc.) Key outcomes: **Cleaner vehicles in target area**

Measure	Anticipated behavioural responses and outcomes of measure (both direct & indirect)
Public transport route improvements and encouragement	Increased public transport use as an alternative to private vehicles as a result of improved journey times & punctuality of public transport & better information about timetables & travel options. Key outcome: **Reduced pkm driven and increased pkm ridden in public transport in target area, reduced frequency of high-severity pollution episodes associated with traffic congestion** (through reduction of traffic and idling at peak times) Other outcomes: Increased active travel; more physically active citizens moving between public transport
Encourage alternative & active travel	Increased use of non-motorised modes of transport, including walking, cycling (electric or not) through provision of better cycle infrastructure and as perception of cycle safety within urban area improves Key outcome: **Reduced pkm driven and increased pkm ridden in public transport or through other non-motorised modes of transport (e.g. Cycle counts) in target area** Other outcomes: More physically active citizens
ULEV incentives e.g. expanded charging point network, subsidies to businesses/ general public	Increased uptake of ULEV's as becomes more practical option. Key outcome: **Increase in clean journeys as % of all journeys, Reduced fuel consumption overall in target area**

Table 6.2: Expected outcomes for key stakeholders

Affected group	Key anticipated outcome to explore with this affected group
Transport users – those whose travel choices may be affected by Local Plan measures (includes individuals and businesses).	Route choice (and factors affecting route choice) Mode of transport Journey destination Vehicle occupancy Eco-driving awareness & practices
Private vehicle purchasers - those whose purchasing behaviour may change as the result of Local Plan measures.	Factors affecting recent/planned future purchasing decisions Fleet profile (status and trends): proportion of fleet that is Euro 4/ 6, ULEV Statutory Off-road Notifications
Businesses – whose travel/delivery related behaviours may change response to Local Plan measures; they may also be affected by the impacts of measures on their customers – for example if customer access is improved or deteriorates – and wider economic impacts, such as changes in rental prices.	Composition of vehicle fleets & factors affecting leasing choice Fleet management, including planning of trips Behavioural measures (e.g. encouraging sustainable forms of travel to work) Business performance Composition of local business population & relocations outside the exceedance zone Prices of goods and services Changes in commercial property markets
Public transport providers - whose vehicle purchasing/leasing choices or route/schedule planning may be affected by NO2 Local Plans; they may also be affected	Composition of vehicle fleets Fares and ticket prices Routes and frequency of services Performance (regularity, punctuality)

Affected group	Key anticipated outcome to explore with this affected group
by the impacts of measures on their customers – for example changes in customer uptake of public transport.	Customer uptake of services Changes in revenue (due to retrofitting/upgrading process)
Public bodies - branches of local government may change their behaviour as a result of Local Plan measures.	Composition of vehicle fleets & factors affecting leasing choice Fleet management, including planning of trips Behavioural measures (e.g. encouraging sustainable forms of travel to work) Relocation to areas outside the exceedance zone Prices of goods and services

Theory of Change (ToC) for Charging Clean Air Zones

A CAZ is an area within a Local Plan area where measures are introduced to improve local air quality. In a charging CAZ, minimum emission standards are established for vehicles circulating in that area. Charging CAZ vary in terms of the categories of vehicles that they cover: depending on the coverage, a charging CAZ can be Class A (buses, coaches, taxis, and private hire vehicles), B (Class A + HGVs), C (Class B + LGVs) or D (Class C + cars). Within a charging CAZ, the most polluting vehicles are charged a fee, with the aim of encouraging users to shift towards cleaner vehicles. Therefore, the key outcome targeted by a charging CAZ is a shift towards a cleaner fleet within the CAZ. Other direct and indirect outcomes can also be expected, such as mode shift or higher vehicle occupancy, and also development outcomes. The distributional effects of a charging CAZ are of interest to the evaluation, as are any displacement or spill over effects; for example, on the composition of vehicles in the adjacent area, whether journeys in more polluting cars are being diverted to other areas (rather than reduced overall), as well as potential implications for the property market both within and outside the zone.

Figure 6.2 below summarises the anticipated causal links between a CAZ and its direct and indirect outcomes and ultimate impacts. A summary narrative to accompany this ToC is provided below (for illustration, a CAZ D is considered).

Elements of the intervention. Four key elements to the establishment of a charging CAZ are:

(i) The conduct of feasibility studies to establish an appropriate design for the CAZ and the development and subsequent review and sign-off of business plans with the support of JAQU;

(ii) The communication around its introduction; the exact nature of the information provided is likely to vary but may, for example, inform stakeholders about where the CAZ is in operation, the charging level and which vehicles it affects, the penalty risks and what can be done to minimise the impacts that the CAZ may have on journeys (in some areas, this may follow an initial public consultation phase on the design of the CAZ);

(iii) The establishment of a vehicle monitoring infrastructure and institutional framework to take appropriate action according to the monitoring data; and,

(iv) The accurate and effective charging of vehicles that driver within the zone in line with the CAZ standards.

Beyond these four core elements, the Clean Air Fund (CAF) provides funds to help minimise the impacts of introducing a charging CAZ. The fund can be used to implement a range of measures to support affected individuals and businesses, such as support to upgrade their vehicles or purchase new cleaner vehicles.

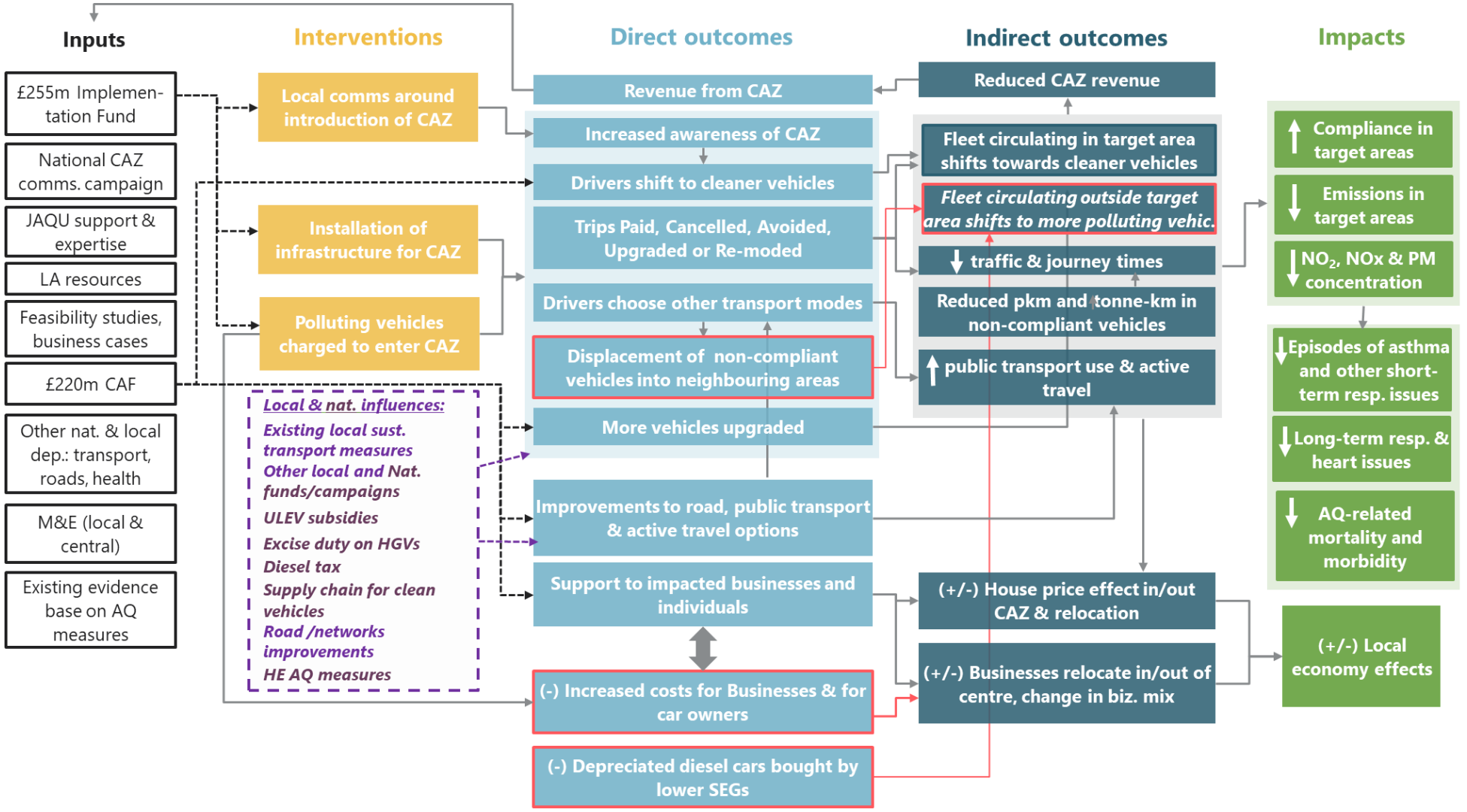
Direct outcomes. The information campaigns around the CAZ, combined with the accurate and effective charging of polluting vehicles (and potentially further helped by CAF measures), is anticipated to encourage increasingly positive perceptions of cleaner vehicles and lead to drivers shifting towards those vehicles. A shift towards clean vehicles can for instance, be facilitated through CAF subsidies to the purchase of compliant vehicles, aiming at reducing the price difference between both categories. Another effect might be a behaviour shift among private vehicle owners and businesses making journeys in the area. This could include: changing their mode of travel (e.g. towards public transport or non-motorised modes), changing their routes or destination (which can have the unintended effect of increasing the volume of polluting vehicles in neighbouring areas) or cancelling their trips as a whole. From the point of view of commercial vehicles and delivery vehicles, such behaviour change would be reflected in the consolidation of deliveries into a smaller number of trips. These effects can start to occur in the months leading up to the CAZ implementation, as a direct result of the communication that precedes it. CAF measures, such as subsidies for fleet/vehicle upgrade or support to active travel or public transport use, would help mitigating increased costs (to businesses) or reduced available income (for individuals).

Indirect outcomes. The accelerated retrofit or purchase of cleaner vehicles, leads to a reduction in the number of polluting vehicles going into the CAZ area as a percentage of all vehicles entering the zone. Changes made to the mode and route of trips also contributes to a reduction in passenger miles driven in the zone, which in turn lead to reduced travel times within the zone. This may be associated with a rebound effect; any road space that is released tends to be consumed by the high level of suppressed traffic demand, which is attracted by lowered journey times initially enabled by the CAZ. Other indirect outcomes of the CAZ may include a shift in the destination of polluting vehicles, an increase in the onward purchase of polluting vehicles outside of the zone (particularly by those in lower socio-economic grades and related to changes in the relative price of compliant compared to non-compliant vehicles), an increase in parking in the roads adjacent to the charging boundary and implications for the property market and price of goods and services both within and outside the zone (with property purchase prices potentially increasing within the zone due to improved air quality but goods and services becoming more expensive to help compensate increased business delivery costs). Furthermore, where present, the CAF measures are effective in containing impacts from the CAZ, and hence, the effects on the business mix within and outside the target area are positive. That is, local businesses are preserved and thrive, and new businesses are attracted to the target area and to neighbouring areas. Where there are no measures to mitigate the possible adverse effects of the CAZ, the key indirect outcome that can be expected are the displacement of local individual tenants and businesses to outside the CAZ and the displacement of polluting fleet towards areas without exceedance.

Impacts. The cleaner fleet mix in the CAZ area will contribute to a reduction in transport-related emissions of NO2, but also of particulate matter (PM) and may impact greenhouse gases emissions (GHG). All other variables constant, this should be reflected in a reduction in NO2 concentrations (and of PM) at the CAZ area, and support an area to bring NO2 concentrations within statutory levels. In the fairly immediate term, improved air quality is likely to contribute to reduced episodes of asthma and other respiratory diseases across the population. In the longer term, reduced exposure to NO2 and other pollutants has been linked to reduced pulmonary and other heart diseases, reduced prevalence of mental illness, reduced morbidity and mortality by those diseases. Following on from the range of economic outcomes the introduction of the CAZ may have on the local economy, through its effects on the property market, business mix and employment, there are likely to be a range of longer-term economic impacts, although how these may manifest is currently not clear.

External influences. There are also external influences that can contribute to the effectiveness of the charging CAZ. Existing local sustainable transport measures will contribute to the increased active travel and use of public transport; national incentives to ULEV will favour the shift towards cleaner vehicles, as will an existing supply chain for cleaner vehicles. Beyond these, the CAF also contributes to mitigating any unintended negative effects of the charging CAZ.

Figure 6.2: Theory of Change | Charging CAZ



Source: Ipsos MORI & ITS, based on inputs gathered during the Theory of Change Workshop, 25 March 2019.

Note: This Theory of Change does not depict all existing links between the its various elements, but only the links between the interventions and their key direct outcomes

About Ipsos MORI Public Affairs

Ipsos MORI Public Affairs works closely with national governments, local public services and the not-for-profit sector. Its c.200 research staff focus on public service and policy issues. Each has expertise in a particular part of the public sector, ensuring we have a detailed understanding of specific sectors and policy challenges. Combined with our methods and communications expertise, this helps ensure that our research makes a difference for decision makers and communities.

3 Thomas More Square
London
E1W 1YW

www.ipsos-mori.com
http://twitter.com/IpsosMORI