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

Note 21: Sensitivity test: Full Electric Bus Fleet

Post-OBC approach

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COVID-19 Pandemic Statement

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

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

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

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

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

1 Introduction

1.1 2019. The methodology applied to modelling of conditions with and without action was set out in the supplementary Air Quality reports (AQ1/2/3) and Transport reports (T1/2/3/4), and the Economic Appraisal Methodology Report, set alongside a discussion of the limitations, uncertainties and risks of the evidence base in the Analytical Assurance Statement (AAS).

1.2 Following OBC submission, GM is now undertaking further data collection, analysis and modelling to improve the data and tools supporting the GM CAP and reduce the uncertainty of the conclusions reached.

1.3 As a result, a series of potential improvements have been identified to the assumptions about behavioural responses to a Clean Air Zone. Note 16 sets out the results of a sensitivity test carried out of those assumptions using GM's strategic modelling suite, based on a GM-wide CAZ C in 2023.

1.4 JAQU asked GM to investigate the potential impact of electric buses on the remaining exceedances. This test builds on the scenario used for Note 16, and switches the buses which were all set to be Euro VI in that test, to full electric, i.e. removing all NOx/NO2 emissions from buses.

2 Road Transport Emissions - EMIGMA

2.1 **Table 2-1** shows mass NOx emission totals for the sensitivity test from the EMIGMA model and percentage changes relative to the 2023 do-minimum. Totals are presented separately for the Regional Centre (inside the IRR - the boundary is illustrated in **Figure *3-3***) and the whole of Greater Manchester.

Table 2-1 Forecast Mass NOx Road Traffic Emissions with Percentage (2023)

Vehicle Type	Do Minimum	GM CAZ C test	% Change	GM CAZ C test plus All Electric Buses	% Change
Regional Centre	55	41	-26%	24	-35%
GM	6,385	5,432	-15%	5,305	-17%

2.2 The results for the test show a reduction in road traffic NOx emissions relative to the do-minimum forecast of approximately 17% for the whole of Greater Manchester. NOx emissions in the Regional Centre, which is more congested and has higher bus flows, are forecast to fall by approximately 35%, which is an additional 9% compared to the CAZ C alone.

3 Air Quality Summary and Impact on Compliance

3.1 The revised vehicle emissions for GM wide CAZ C in 2023 were then used in the dispersion modelling process to produce NO2 concentrations. The AQ modelling process is identical to that used in the OBC modelling, as set out in AQ2 and AQ3, as described in Note 16.

3.2 This sensitivity test focusses on providing an understanding of the impacts of removal of bus emissions in addition to the revised behavioural responses to a charging CAZ. Other measures included in the preferred option from the OBC, such as incentivisation funds for freight and investment in electric vehicles, are not included in this test. Therefore, direct comparison with any of the Options developed in the OBC is not relevant as all of these included the full suite of non-charging measures.

3.3 A summary of the results of this sensitivity test are presented in **Table 3-4**, alongside the Do Minimum results. The table provides the number of sites remaining in exceedance of legal limits by local authority.

Table 3-1 Number of sites remaining in exceedance of legal limits for NO2 concentrations, by local authority

Local Authority	Do Minimum 2023	GM CAZ C test 2023	GM CAZ C test plus All Electric Buses 2023
Bolton	3	0	0
Bury	12	4	3
Manchester	29	10	4
Oldham	3	0	0
Rochdale	2	0	0
Salford	10	2	2
Stockport	4	0	0
Tameside	4	0	0
Trafford	0	0	0
Wigan	0	0	0
GM Total	**67**	**16**	**9**

3.4 The results show that the updated GM CAZ C test substantially reduces the number of predicted exceedances in 2023 compared with the Do Minimum scenario. The addition of an all-electric bus fleet further reduces the number of exceedances, many of which are the most persistent in GM. However, a number of exceedances are predicted to remain. The majority of the removed exceedances are located in Manchester city centre, with five removed inside the IRR and the sixth on the A6 just south of the IRR.

Table 3-2 Number of modelled sites by scale of NO2 exceedance

Test Scenario	Compliant sites		Non-compliant sites			
	Very compliant (below 35 µg/m3)	Compliant but close (35 to 40 µg/m3)	Non-compliant (40 to 45 µg/m3)	Very non-compliant (45 to 50 µg/m3)	Extremely non-compliant (> 50 µg/m3)	Total non-compliant (> 40 µg/m3)
Do minimum 2023	16,856	210	58	10	0	68
GM CAZ C test 2023	17,020	97	16	0	0	16
GM CAZ C test plus All Electric Buses 2023	17,050	74	9	0	0	9

3.5 Greater Manchester aims to deliver compliance in the shortest possible time in a way that takes into account the need to minimise human exposure.

3.6 Test Scenario	Compliant sites		Non-compliant sites			
	Very compliant (below 35 µg/m3)	Compliant but close (35 to 40 µg/m3)	Non-compliant (40 to 45 µg/m3)	Very non-compliant (45 to 50 µg/m3)	Extremely non-compliant (> 50 µg/m3)	Total non-compliant (> 40 µg/m3)
Do minimum 2023	16,856	210	58	10	0	68
GM CAZ C test 2023	17,020	97	16	0	0	16
GM CAZ C test plus All Electric Buses 2023	17,050	74	9	0	0	9

3.7 **Table *3-2*** demonstrates the benefits being delivered in terms of reduced concentrations even at sites remaining in exceedance in that year. This also shows that the number of sites close to exceedance reduces considerably in the updated GM CAZ C scenario with the addition of fully electric bus fleet.

3.8

3.9 **Table *3-3*** shows the concentrations at the maximum concentration point by local authority. This shows that, in 2023, the highest exceedances are in Manchester in the Do Minimum and GM CAZ C test, but other exceedances are predicted to remain in Bury and Salford. The addition of the fully electric bus fleet has reduced concentrations most significantly in Manchester and Bury, which had the greatest maximum predicted concentrations in the GM CAZ C test. The scale of the reductions in Manchester and Bury, mean that Salford would be authority with the maximum concentration in GM under this scenario. This is because there are very few buses operating on the A57 Regent Road, in Salford.

3.10 The greatest reduction is predicted to be in Wigan on King St West, which has very high bus frequencies, but this location was already compliant in 2023.

Table 3-3 Maximum predicted NO2 concentration in each local authority (ug/m3)

Vehicle Type	Do Minimum 2023	GM CAZ C test 2023	GM CAZ C test plus All Electric Buses 2023	Reduction Due to All Electric Bus from the GM CAZ C test
Bolton	40.5	38.2	38.1	-0.1
Bury	49.0	43.1	41.8	-1.3
Manchester	46.6	44.2	41.8	-2.4
Oldham	46.4	37.1	37.0	-0.1
Rochdale	44.0	39.8	39.6	-0.2
Salford	46.9	42.9	42.7	-0.2
Stockport	42.6	39.7	39.7	0.0
Tameside	42.7	39.5	39.3	-0.2
Trafford	39.1	35.3	35.1	-0.2
Wigan	38.4	33.5	26.8	-6.7
All GM	**49.0**	**44.2**	**42.7**	**-1.5**

3.11 Figure **Figure 3-1** and **Figure 3-2** provide maps of the exceedances across GM and focussed on the city centre. Overall, the exceedances in this test are located in sites where the OBC Option 7 contained persistent hot spots, and Local Measures are already being reviewed and developed where feasible in these locations. However, there is now only one site left in exceedance inside the IRR, on Quay Street.

3.12 There are two new sites (circled in red), which will be reviewed in further detail. These will feed into further work in the Local Exceedances work if package modelling indicates that they are not solved by the preferred scheme package.

Figure 3-1 Map of exceedances identified in the with-GM CAZ C plus all electric bus test (2023)

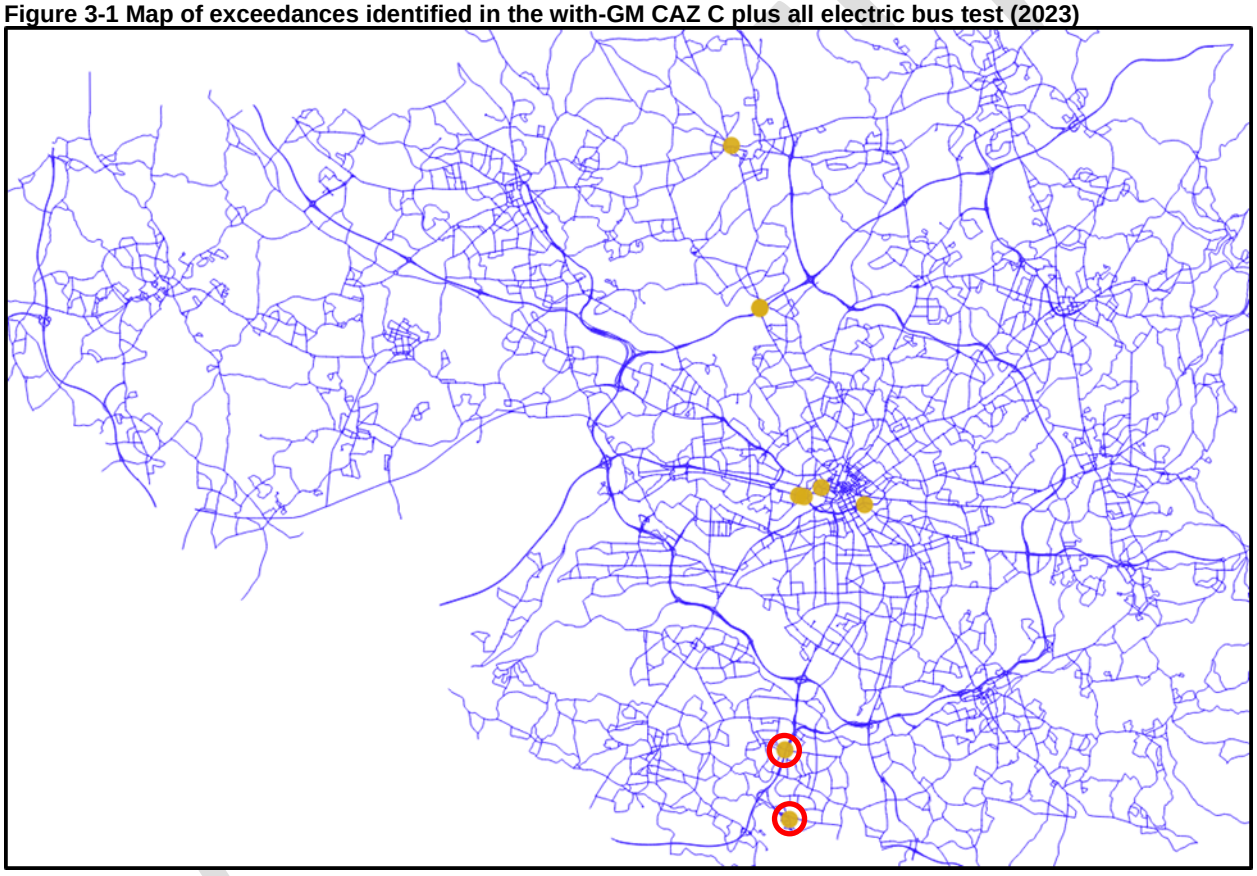


Figure 3-2 Map of exceedances identified in the with-GM CAZ C plus all electric bus test, city centre (2023)

3.13 The air quality and source apportionment data at key sites of exceedance are provided in **Table 3-4**.

3.14 The key points reported herein are those that would eventually come to define compliance within GM and each district in the OBC. These sites have been selected based on the maximum predicted concentrations and last points of compliance in each district in the best performing options, plus where there are several points with high concentrations, and those which display notably different source apportionment by vehicle type were added. The locations of these points are shown in Figure 3.

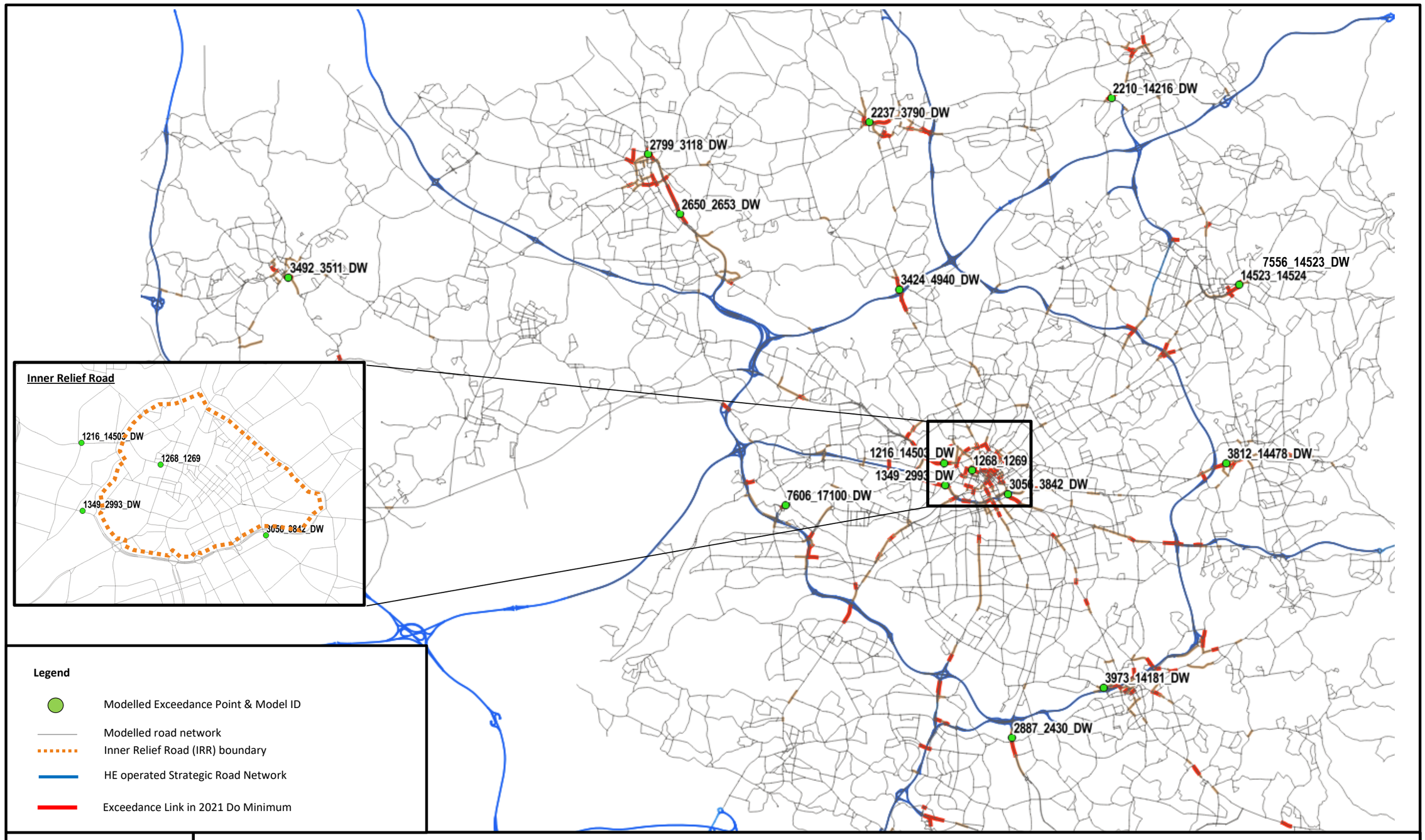
3.15 The analysis in the OBC showed that there are very diverse factors affecting vehicle emissions across Greater Manchester, with emissions from each vehicle type often differing between roads in close proximity to each other. The GM wide CAZ C sensitivity test imposes a penalty charge on all vehicle types except private cars, and therefore reduces the emissions contribution from these vehicles compared to the Do Minimum scenario, with all buses assumed to upgrade to Euro VI. However, whilst Euro VI buses are proven to provide significant reductions in NOx emissions over earlier standards, they do still emit NOx from their exhaust. Thus, an all-electric bus fleet test reduces the NOx emissions from the exhaust to zero, going beyond the Government's requirements in the Clean Air Zone Framework.

3.16 The results show that the modelled impacts of an all-electric bus fleet in addition to GM wide CAZ C leads to reductions in NO2 concentrations at typical worst-case locations of between 0 to -9 ug/m3. This essentially reflects the frequency of bus services at a given location, and their relative contribution to total NOx emissions from all vehicle traffic.

Table 3-4 Maximum Predicted annual mean NO2 concentrations and source apportionment at key compliance points on the Greater Manchester road network – GM wide CAZ C plus all electric bus sensitivity test 2023

Point ID	Census ID	Road name	Local Authority	Annual mean NO_2 conc ($\mu g/m^3$)	BG NOx conc ($\mu g/m^3$)	BG NO_2 conc ($\mu g/m^3$)	Road NOx contribution ($\mu g/m^3$)	Road NO_2 contribution ($\mu g/m^3$)	AADT	NOx contribution by vehicle type (%)					Change in Annual mean NO_2 conc ($\mu g/m^3$)
										Bus	Taxi	HGV	LGV	Car	
2799_3118_DW	58048	A673	Bolton	37.0	26.0	18.1	40.1	18.9	27,820	0%	5%	24%	25%	46%	-0.3
2650_2653_DW	7431	A666	Bolton	38.1	24.8	17.3	41.9	20.8	69,895	0%	5%	2%	43%	49%	-0.1
2237_3790_DW	38354	A58	Bury	41.8	21.4	15.2	57.4	26.6	79,499	0%	6%	16%	26%	52%	-1.3
3424_4940_DW	17924	A56	Bury	40.2	17.0	12.4	59.3	27.8	19,939	0%	6%	21%	24%	50%	-0.3
3056_3842_DW	26157	A6	Manchester	41.8	32.2	21.6	43.1	20.2	38,857	0%	6%	14%	29%	51%	-2.4
1268_1269	27974	A34	Manchester	33.5	35.6	23.4	21.8	10.1	9,320	0%	7%	7%	27%	59%	-8.8
7556_14523_DW	36632	A62	Oldham	37.0	24.5	17.1	40.6	19.9	24,933	0%	6%	9%	28%	57%	-0.1
2210_14216_DW	17322	A664	Rochdale	39.6	17.9	13.0	60.6	26.6	34,464	0%	4%	35%	25%	36%	-0.2
1349_2993_DW	73792	A57	Salford	42.7	24.7	17.2	54.1	25.5	57,604	0%	6%	9%	33%	52%	-0.2
1216_14503_DW	17926	A6	Salford	35.9	25.2	17.6	38.8	18.3	31,601	0%	6%	24%	24%	46%	-3.9
3973_14181_DW	58034	A5145	Stockport	38.6	20.9	14.9	49.5	23.7	26,336	0%	5%	18%	28%	48%	-1.1
2887_2430_DW	26352	A34	Stockport	39.7	19.0	13.8	53.2	25.9	40,340	0%	6%	6%	28%	61%	0.0
3812_14478_DW	99618	A635	Tameside	38.9	25.5	17.7	44.5	21.3	41,270	0%	6%	14%	35%	46%	-0.6
7606_17100_DW	N/A	B5214	Trafford	31.7	19.6	14.1	36.0	17.6	28,960	0%	6%	18%	21%	55%	-2.9
3492_3511_DW	8566	A577	Wigan	33.0	29.1	19.7	26.9	13.3	22,508	0%	6%	13%	29%	52%	-0.3

Figure 3-3 Map of key exceedances points across Greater Manchester



Transport for Greater Manchester	**Key Exceedance Points across GM**			
	Drawn by: NB	**Scale: NTS**	**Date: 1-8-19**	**Figure 3**

4 Summary and Conclusion

4.1 This note presents the results of sensitivity testing carried out to investigate the impact of an all-electric bus fleet applied in addition to the revised behavioural responses used in the GM wide CAZ C scenario in 2023.

4.2 Further information on these behavioural responses and the GM wide CAZ C sensitivity tests are available separately as part of the suite of reports provided to JAQU in July 2019.

4.3 The key comments and conclusions relating to this test are detailed below:

- This test is purely hypothetical. The behavioural assumptions used in the CAZ C modelling are not finalised, and a wider package of other supporting measures would also be included in any future package.
- The use of an all-electric bus fleet delivered an additional 9% reduction in mass NOx emissions, inside the Inner Ring Road (IRR) compared with the GM-wide CAZ C scenario.
- Seven districts are fully compliant in this test: Bolton, Oldham, Rochdale, Stockport, Tameside, Trafford and Wigan. However, these are not brought into compliance due to the impact of electric buses, but were already compliant in the GM wide CAZ C scenario.
- The number of non-compliant sites falls from 16 in the Do Minimum to nine, located in three districts (Bury, Manchester and Salford):
    - The majority of these are already identified as the last remaining exceedances under OBC Option 7 (a GM-wide CAZ B with supporting measures) and are included in the current Local Exceedances project, which seeks to identify local interventions that could be effective in bringing forward compliance at the last points of exceedance.
    - The measure is most effective in the regional centre. The majority of the removed exceedances are located in Manchester city centre, with five removed inside the IRR and the sixth on the A6 south of the IRR. Only one exceedance remains inside the IRR.
    - Two additional exceedance locations have been predicted in the updated modelling for the GM wide CAZ using the revised behavioural responses. These are on the approach to Manchester Airport, and on Hollyhedge Road crossing the M56. There are some concerns as to the validity of these exceedances and analysis indicates that these are likely to be overestimates and not representative of exceedance.
- Overall, maximum concentrations are lower in all districts than the GM wide CAZ C scenario, with the exception of Stockport.

- Further work is required to refine the behavioural response assumptions to be applied to the testing of a GM CAZ. Nevertheless, the results of this test suggest that a CAZ C with an all-electric bus fleet, as defined here and implemented without further supporting measures may not be sufficient to achieve compliance in the shortest possible time and that further interventions will be necessary to tackle exceedances in Bury, Manchester and Salford.
- The feasibility of delivery of an all-electric bus fleet in GM has not been considered. There would be significant practical constraints relating to procurement, supply and lead times. Additionally, fully electric buses may not have the range to operate all of the routes and the scale of provision of suitable charging infrastructure would also need to be understood.