Sheffield & Rotherham Clean Air Plan Full Business Case Transport Model Sensitivity Tests Note

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04/02/2022	Initial FBC Draft
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Contents

Section 1 Introduction

1.1.1 This document details the Transport Model Sensitivity Test work undertaken to support the Sheffield and Rotherham Clean Air Plan (CAP) proposals. This document has been put together to support the Full Business Case (FBC) submission and has been developed in accordance with JAQU guidance.

1.1.2 This document is part of a suite of documents that have been produced to describe the transport modelling deliverables for the study. Other documents in the series include:

- Local Plan Transport Model Validation Report (T2), which describes the level of calibration and validation in the SCRTM1 model;
- Local Plan Transport Modelling Methodology Report (T3), which describes the approach taken to forecast traffic in the Baseline situation; and
- Local Plan Transport Model Forecasting Report (T4), which presents the baseline transport and emissions modelling results for the study.

1.1.3 The purpose of this document is to describe the sensitivity tests which have been undertaken, the impact that the analysis could affect the conclusions of the FBC and specifically the delivery of compliance in the shortest possible time. In particular it will help to feed into the answers to the following questions:

- Is the Preferred Option the right scheme to take forward? And under more pessimistic scenarios how well does it perform?
- If things are better than expected in the Baseline do we still need a scheme?
- What are the key risks to achieving compliance in the shortest possible time?
- Where mitigation might be required to be undertaken under certain situations?

1.1.4 The sensitivity tests have been carried out for the year of 2022, i.e. the predicted year of compliance. The sensitivity tests have focussed on both the Baseline and the Preferred Option. The sensitivity tests have been chosen to demonstrate to JAQU and other key stakeholders that the scheme is both the right one to implement and proportionate to the challenges being faced.

Section 2 Transport Model Tests – Descriptions

2.1.1 The table below shows the sensitivity tests undertaken around the Baseline and Preferred Option for the CAP. Whilst most of these have been explored through the modelling suite, some of these sensitivity tests have been dealt with by inferring results from other tests (light yellow) or taking a qualitative approach (light blue) where most appropriate.

2.1.2 The list of sensitivity tests was developed using the suggested tests in the JAQU document, "Supplementary Note on Sensitivity Testing and internal" along with those specified by Sheffield and Rotherham councils in order to best understand and give confidence around the test results.

2.1.3 The table describes whether it was a test specified by JAQU or the local authorities, the rationale for undertaking the test, and the question it is seeking to answer.

Table 1. List of Sensitivity Tests

Table 2 ID	Test	Source	Comments / Purpose / Question Answering
M1	COVID Worse Case	JAQU / SCC / RMBC	Taking the 'worst' / most-polluting aspects from the agreed list of COVID impacts from previous sensitivity tests and apply to PO to asses impact on compliance
M2	COVID Best Case	JAQU / SCC / RMBC	Taking the 'best' / least-polluting aspects from the agreed list of COVID impacts from previous sensitivity tests and apply to the Baseline situation to asses impact on compliance
M3	No Behavioral Response to Charging (PO)	Priority Test from JAQU Guidance	In this case just the Preferred Option with the charge and incentives. For taxis this will include taxi licensing changes but not taxi behavioral response.
M4	Future Emissions Standards Sensitivity Test	Priority Test from JAQU Guidance	A JAQU required test to see what happens if Euro 6d diesel LGV and car comes online later than expected . This is modelled in ENEVAL only, with no transport model run required and is applied to both the Baseline and the Preferred Option.
M5	Gradient Sensitivity Test	Priority Test from JAQU Guidance	Tailpipe emissions based on EFT methodology of gradient will be calculated and included in the ENEVAL results. This will be run as a dispersion calculation in the air quality model. We will do firstly for Base Year to establish new calibration factors and then for forecast years. The impact on both the Baseline and the Preferred Option will be assessed

M6	M1 60mph smart motorway speed limit becomes permanent (with PO)	SCC / RMBC	If the smart motorway 60mph speed limit becomes permanent will there be any rerouting impacts at our hotspot sites in the Preferred Option case. Most pressing for Wortley Road in Rotherham as it is a diversionary route for M1 traffic.
M7	Future Fleet Age / Composition	Recommended Test from JAQU Guidance	Fleet updates more slowly than anticipated e.g., LGV owners holding on for grants. This is a JAQU required test undertaken in ENEVAL only and applied to both the Baseline and the Preferred Option.
A1	F-NO_2 Sensitivity Test	Priority Test from JAQU Guidance	F-NO_2 changes in future as per methodology set out in JAQU guidance. What impact does this have on the Baseline and Preferred Option.
A2	Retrofit Sensitivity	Recommended Test from JAQU Guidance	Sensitivity which examines the effect of retrofit technology failing to deliver the anticipated improvements. No model run was undertaken for this as we can interpolate what would happen based on other test results. This will be done only in the Preferred Option case.
A3	Incentive Scheme Sensitivity	Recommended Test from JAQU Guidance	Sensitivity testing the potential variation in uptake of incentive measures in the Preferred Option.
A4	Parkway Speed Limit Sensitivity Test	Recommended Test from JAQU Guidance	JAQU recommends that speed limit changes are subject to high / low sensitivity tests – The only place this happens and estimate emissions impact of the change of speed at this location can be calculated manually based on results from other tests
A5	Emissions at Low Speeds Sensitivity Test	Recommended Test from JAQU Guidance	Emissions factors at low speeds (<12kph) are very uncertain. We have identified how many of our links have an average speed <12Kph, checked how many of those are near key locations and decide if they are likely to lead to a non-compliance. This is only considered in the Preferred Option case.
A6	Responses for non-car vehicles	Recommended Test from JAQU Guidance	JAQU guidance states that this could be sources of uncertainty. LAs should consider plausible ranges around the assumptions used - we will do some qualitative discussion around this point in the write up.

A7	Daily Frequency of 1-Way Trips Within the Charging Area	Done at OBC stage	Off-model calculation and qualitative discussion
A8	Impact of Nearby City CAZ schemes	Done at OBC stage	Off-model calculation and qualitative discussion
A9	Impact of Exemptions	JAQU / SCC / RMBC	Off-model calculation and qualitative discussion

Section 3 Transport Model Tests – Results

3.1.1 In order to avoid the time consuming step of running the air quality dispersion model (AIRVIRO) in each of the tests, in some cases where it was possible we have interpolated the exiting air quality model results for the model Baseline and Preferred Option, based on re rule of thumb that the. impact on air quality will be roughly 50% of tailpipe emissions impact at a given location.

3.1.2 This section summarises the results of the test undertaken based on the assumption from above. The table below shows the number of non-compliances in each of the sensitivity test situations, in each case anti-idling bus measures have been included in place on Arundel Gate (in order to achieve compliance).

3.1.3 It should be noted the table only shows those for which a model run (either transport model only or both transport model and air quality model) has been undertaken, those sensitivity tests which are purely qualitative in nature are discussed in the commentary below. A full set of results for all the sensitivity tests which have been run through the modelling can be found in **Appendix A**.

Table 3. Non-compliance after Sensitivity Tests

	Number of Non-Compliances
2017 Base	18
Baseline Tests	
2022 Baseline	5
M2	5
M4 - Low	2
M4 - High	5
M5	4
M7 – High	5
M7 – Low	3
A1	3
Preferred Option Tests	
CAZ C / PO	**0**
M1	**0**
M3	1
M4 – Low	**0**
M4 – High	1

M5	**0**
M6	**0**
M7 – High	3
M7 – Low	**0**
A1	**0**
A2	1

3.1.4 The following subsections discuss the results of each of the sensitivity tests in turn, including those not in the table. The key thing to note in advance is that there are 5 locations with non-compliance in the 2022 Baseline and all locations are compliant in the Preferred Option case with anti-idling bus measures in place on Arundel Gate.

3.1.5 The following descriptions of the results suggest where mitigations may be required. These mitigations are not described or defined in this document but can be found in the Benefits Realisation Chapter of the Management Case Report (Section 7.0).

*Note: The original PCM sites on the Sheffield and Rotherham parkway are not reported as they are deemed out of scope. This is discussed in the support document to AQ2 (**Appendix 1 – AQ2–SD01**). There is one site on the Rotherham part of the Parkway between Handsworth and Catcliffe where a public footpath crosses at grade, but this is well within the legal concentration limits in both the Baseline and the Preferred Option scenarios and is therefore excluded from the analysis below*.

3.2 M1 – COVID Worse Case

3.2.1 Under this scenario the worst elements of COVID were tested in the Preferred Option case, to see if those impacts were likely to make the scheme not achieve compliance.

3.2.2 This worst-case scenario is represented by the cycle of fleet replacement slowing down and not therefore reaching the expected fleet mix by 2022.

3.2.3 In this case compliance is still achieved but with much reduced head room. In particular Wortley Road is very close to non-compliance at a concentration of 40.3.

CONCLUSION – If worst elements of COVID persist, in terms of travel behaviour and the vehicle fleet, the scheme will probably reach compliance in 2022, but with slightly lower likelihood.

3.3 M2 - COVID Best Case

3.3.1 In this case a Baseline scenario was investigated to see if the 'best' elements of COVID behavioural changes remained without the 'bad' elements whether compliance might be achieved without intervention.

3.3.2 The Covid impacts (numbering system based on SYSTRA COVID impacts nomenclature shared with JAQU) included in this test are:

- TD1 : Travel demand to/from existing premises – commute (reduced employment) - 7.7% decrease in population is applied to full time and part time employed people;
- TD2 : Travel demand to/from existing premises – commute (more home working) – 25.0% decrease in commute trips applied. Based on the NTEM data this corresponds to 10.0% reduction to total trips; thus, we apply a 10.0% reduction to all relevant population groups to get the required person trip ends;
- TD3a : Travel demand to/from existing premises – business travel (economic downturn) – 11% reduction in business travel is achieved by applied 11% reduction to the full time and part time employed people to achieve the required reduction to the persons trip ends; and
- TD3b : Travel demand to/from existing premises – business travel (more online meetings) - 25% decrease in commute trips applied. Based on the NTEM data this corresponds to 5% reduction to total trips; thus, we apply a 5% reduction to all relevant population groups to get the required person trip ends.

3.3.3 The result of this test was the situation was better than the Baseline, i.e., lower concentrations, but none of the 5 locations which are non-compliant in the Baseline become compliant.

3.3.4 The Baseline is still non-compliant when these effects are included.

CONCLUSION – A scheme is required even if the 'best' responses to COVID are maintained.

3.4 M3 - No Behavioural Response to Charging (PO)

3.4.1 In this test the vehicle upgrades as a response to the charging zone in central Sheffield do not occur but the charging zone is present. The upgrades in the bus and taxi fleet still occur as they are less about behaviour and more and considered an integra; part of the scheme.

3.4.2 In this version of the Preferred Option there is 1 non-compliances in Rotherham.

3.4.3 This demonstrates that the behavioural reposes are both required and regional in their scope. In particular that the responses are needed even to contribute to the achievement of compliance in Rotherham.

CONCLUSION – The behavioural responses are required for the success of the scheme, in both Sheffield and Rotherham. The behavioural responses are required to make the fleet in the wider area compliant.

3.5 M4 - Future Emissions Standards Sensitivity Test

3.5.1 The M4 sensitivity test is really a series of sensitivity tests which look at what happens if the Euro6d-temp category exceeds expected standards (Low Emissions version of M4) or if they do not achieve target reductions in NO_x (High Emissions version of M4)

3.5.2 Both the Baseline and Preferred Option have been tested with these two scenarios and the results show that in:

- The low emissions version there are only 2 non-compliances in the Baseline, and the Preferred Option is compliant (and better than the standard Preferred Option) everywhere; and

- The high emissions version, there are still 5 non-compliances in the Baseline, but with 1 non-compliance in the Preferred Option at Wortley Road. In addition, Arundel Gate is also more likely to remain non-compliant even with anti-idling measures in place.

CONCLUSION – if future emissions standards exceed expectations there will be no danger to possible compliance, but if they do not it is likely that compliance will not be achieved. If the emissions standards do not achieve the expected improvements then some mitigation may be required to address non-compliances, but this is likely to be an issue which will need to be addressed nationally as it will affect all mandated areas.

3.6 M5 - Gradient Sensitivity Test

3.6.1 A series of sensitivity tests were undertaken to test the impacts of gradient on the tailpipe emissions and subsequently on the air quality modelling. This was undertaken by applying the gradient impact methodology from the Emissions Factor Toolkit (EFT) to the ENEVAL tailpipe emissions. This was done for the:

- Base Year – in order to establish new calibration factors within the air quality modelling;
- Baseline – to establish if there was any difference in the number of locations which are non-compliant; and
- Preferred Option – to ensure that compliance is still achieved at all locations.

3.6.2 The results show that there are 4 non-compliant sites in the Baseline rather than 5 in the 'standard' Baseline (with Wortley Road becoming just compliant), and that as with the 'standard' Preferred Option all locations are compliant under this scenario. This includes the specific locations in Rotherham which have significant gradients and Baseline air quality issues (ie Rawmarsh Hill and Wortley Road)

3.6.3 In most cases the reduction in downhill emissions is offset by the increase in uphill emissions, but at Wortley road where the ban on HGV's is in the uphill direction we would expect a much greater impact from modelling gradient explicitly, and that is exactly what happens. The concentrations here reduce to 38.1µg/m3 which is significantly less than the 'core' Preferred Option suggesting that there will be additional headroom.

CONCLUSION – The inclusion of gradient effects does not change the conclusions that a scheme is required, and it doesn't indicate that any more stringent measures are required including at the sites with the higher gradients, and that at Wortley Rod there is actually likely to be greater headroom.

Note: Gradient has not been included in the core modelling, in this way (although it is applied through the air quality calibration factors), as there is some uncertainty about the validity of the factors . For example for some (key) vehicle types there is a decrease in emissions going uphill and for others an increase downhill. These are both counter intuitive results and in order to mitigate a smoothing process was developed to apply to the results. This has been raised (and acknowledged) in discussions between SYSTRA, Bureau Veritas and the European Environment Agency (EEA).

3.7 M6 - M1 60mph Trial Becomes permanent (with PO)

3.7.1 In this test the current 60mph speed limit on the M1 through Tinsley and Meadowhall becomes permanent. This leads to no non-compliances in Rotherham or Sheffield. The amount of traffic increases slightly on Wortley Road in Rotherham, but it is negligible and should not affect compliance. Due to reassignment within the highway model there is also the suggestion that in this case there will be very slightly more traffic on Arundel Gate in Sheffield and therefore the anti-idling part of the scheme would have to work harder.

CONCLUSION – the possibility of the 60mph speed limit on the M1 should not be a threat to achieving compliance but some elements of the scheme will have to work harder. In particular some additional mitigation around Wortley Road could be required.

3.8 M7 - Future Fleet Age / Composition

3.8.1 This sensitivity test explored what would happen if fleet churn was not in line with expectation or guidance, i.e., what would happen with a fleet that was older or younger than that predicted in 2022. We have used a 2023 fleet instead of 2022 as a low emissions version and a 2021 fleet as a high emissions version.

3.8.2 Both the Baseline and Preferred Option situations were run under these scenarios with the following outcomes:

- In the low emissions case there were 3 non-compliances in the Baseline and 0 in the Preferred Option; and
- In the high emissions scenario there are 5 non-compliances in Baseline of which 3 remain non-compliant the Preferred Option (in this case it is Arundel Gate and all the two of the key Rotherham sites –Rawmarsh Hill and Wortley Road).

CONCLUSION – If the fleet churn is faster than normal and we have a 2023 fleet in 2022 the Baseline will still be non-compliant, but the Preferred Option will still achieve compliance. If the fleet is older than anticipated the Preferred Option will still significantly improve air quality but is likely to not achieve compliance.

3.9 A1 f-NO_2 Sensitivity Test (No Model Run)

3.9.1 In line with the guidance on sensitivity testing we have undertaken a test in which a 40% reduction in the f-NO2 values used in applied. This has been carried out for both the Baseline and the Preferred Option. The result of that is that:

- The Baseline is still not compliant with Arundel Gate still not achieving compliance in Sheffield and 3 sites being non-compliant in Rotherham; and
- The Preferred Option is compliant at all locations with more head room. If these f-NO2 values are achieved there would be less need for anti-idling measures on Arundel Gate)

CONCLUSION – The reduced f-NO2 values do not affect compliance in the Preferred Option, but rather give more headroom. More importantly the reduced f-NO2 values do not make the Baseline situation compliant. A scheme would still required even in the unlikely event of f-NO2 values being 40% lower than they actually are.

3.10 A2 - Retrofit Sensitivity (Inferred from other tests)

3.10.1 In the sensitivity test where the success of the retrofit in achieving the levels of road NOx reductions is not achieved the impact is felt mostly on locations with high percentage bus

fleet. In this case Arundel Gate is predicted to be non-compliant, although a more strict set of anti-idling measures could still potentially achieve compliance.

3.10.2 In Rotherham, this scenario would lead to all sites being closer to non-compliance but based on the outputs are still all, just, below 40.5.

CONCLUSION – If the retrofit technology does not achieve the desired reductions in emissions then there will be danger to compliance, especially in areas of heavy bus flow around Arundel Gate, Rawmarsh Hill and Fitzwilliam Road. Some mitigation may be required to address non-compliances, but this is likely to be an issue which will need to be addressed nationally as it will affect all mandated areas.

3.11 A3 - Incentive Scheme Sensitivity (No Model Run)

3.11.1 This has no test as there is no impact. In the Sheffield and Rotherham case the incentives are to support behavioural research and do not in themselves contribute further changes.

CONCLUSION – No impact on compliance

3.12 A4 - Parkway Speed Limit Sensitivity Test (Inferred from other tests)

3.12.1 If the Rotherham end of the Parkway remained at 70mph, rather than dropping to 50mph , then inferring from other tests undertaken that the Parkway would be non-complaint with a concentration of around 43.0.

CONCLUSION – The parkway needs to be reduced to 50mph, as part of the scheme, in order to achieve compliance

A5 - Emissions at Low Speeds Sensitivity Test

The figures below show the areas in Sheffield and Rotherham for which link speeds are at 12kph or below for the majority of the day. Any locations with speeds below this would therefore be subject to a greater degree of uncertainty in the modelling of the emissions.

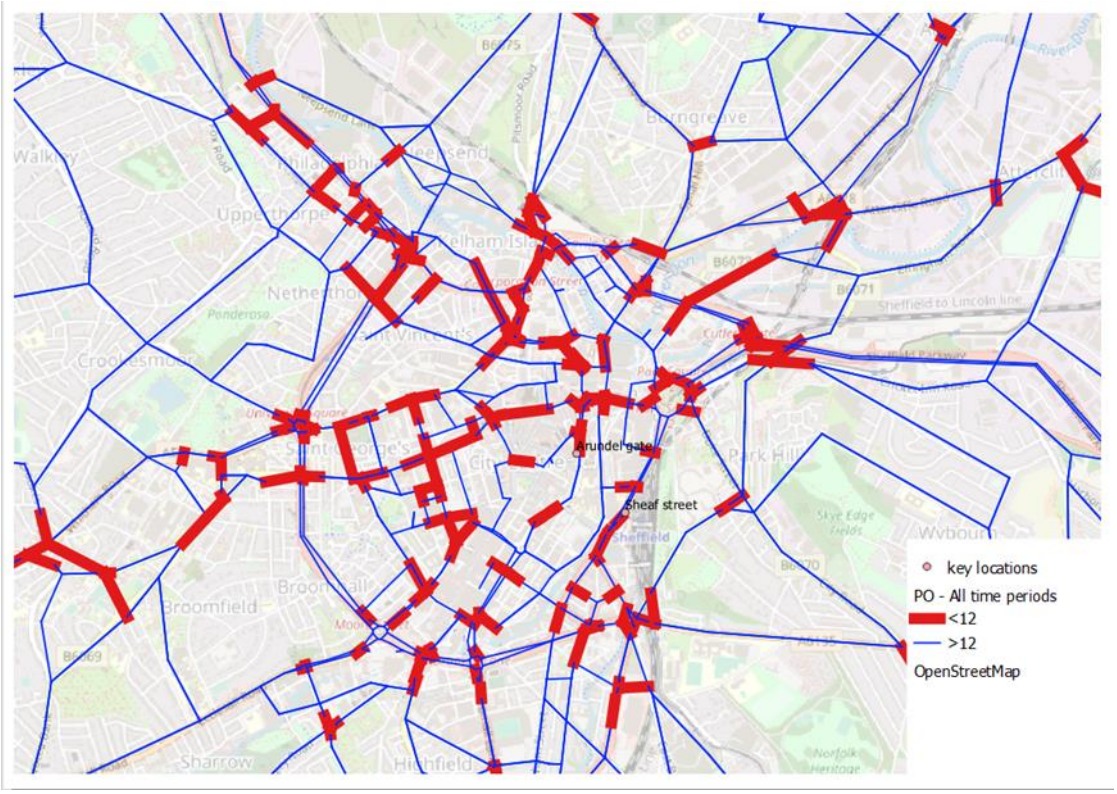

Figure 2. Locations in Sheffield with 12hr speeds less than 12kph

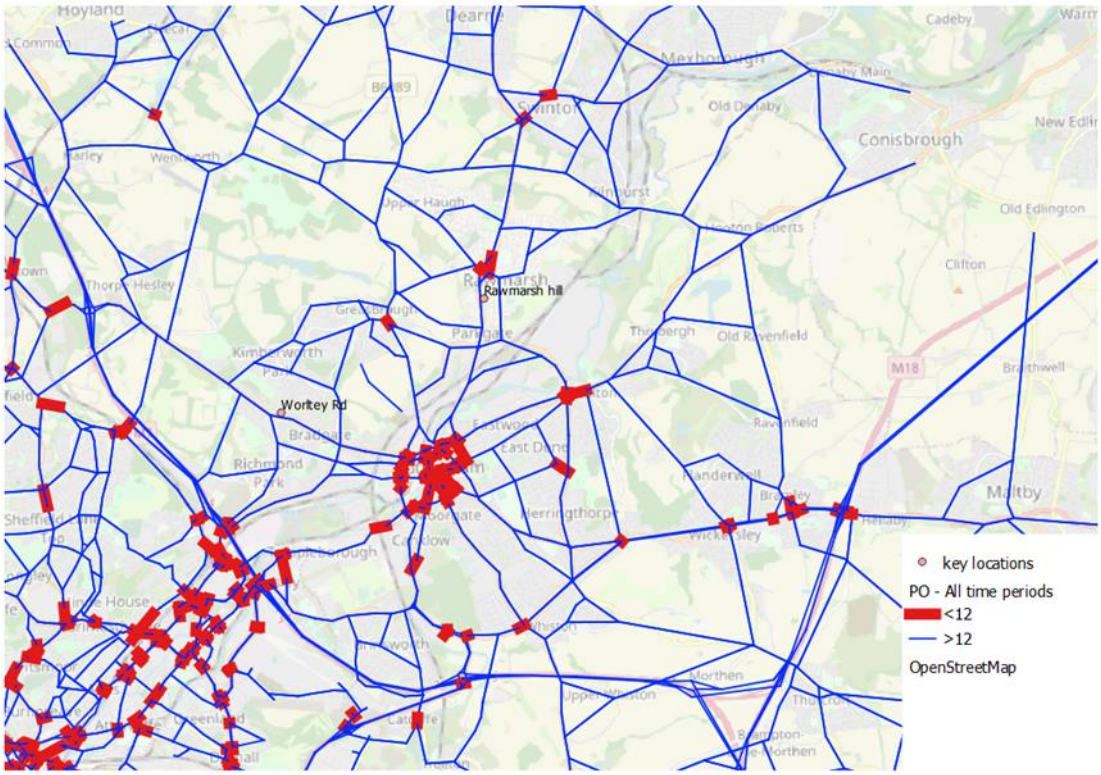

Figure 3. Locations in Rotherham with 12hr speeds less than 12kph

3.12.2 The key thing to note from these figures is that some locations which are identified as key locations are subject to these very low speeds including parts of the Sheffield Inner Ring Road, parts of Arundel Gate, particularly around the bus interchange, and Fitzwilliam Road in Rotherham (although it largely affects the junctions at either end of the road

rather than the main part of the road itself). This means that there is additional uncertainty in terms of whether these locations will achieve compliance. However, all of these sites have sufficient headroom under the preferred option that it is unlikely this will impact on compliance.

3.12.3 It is worth noting that Wortley Road in Rotherham, which is likely to be the closest location to non-compliance in the 2022 Preferred Option is not subject to regular speeds below 12kph and therefore at that location the likelihood of compliance is not lessened by this issue.

CONCLUSION – areas of low speeds around the key hotspots are a cause for greater modelling uncertainty and therefore there is an increased risk of non-compliance. It is therefore important that as much headroom as possible be achieved at these locations and hence we would hope to achieve concentrations of well under 40.0 to give the best chance of achieving compliance. At all the sites where there are Baselines issue in 2022, the headroom was sufficient to indicate that compliance would be achieved at all relevant locations.

3.13 A6 - Responses for non-car vehicles (No Model Run)

3.13.1 If the responses that have been modelled were not achieved there would be a number of challenges to compliance:

- The lack of upgrade to buses would risk compliance on Arundel Gate in Sheffield, on Fitzwilliam Road and on Rawmarsh Hill in Rotherham (although it should be noted that 188 buses in Sheffield have already been retrofitted in recent years using CBTF. And therefore the fleet is well on its way to being compliant).;
- No upgrades to taxis (particularly black cabs) would risk compliance at a number of locations, but particularly at Sheaf Street in Sheffield; and
- It is likely that the lack of upgrades to HGV and LGV would significantly impact on the compliance at all key locations

Note: the Sheffield bus fleet has been retrofitted through CBTF but this has not happened in Rotherham and therefore making the retrofit funding available in Rotherham is a priority for achieving compliance.

CONCLUSION – The upgrade to various vehicle fleets is key to achieving compliance in Rotherham and Sheffield in the shortest possible time. If those upgrades of the key vehicle types are not achieved, then additional mitigation measures may be required.

3.14 A7 - Daily Frequency of 1-Way Trips Within the Charging Area

3.14.1 As part of the fleet modelling undertaken to support this SCC/RMBC CAZ Study, SYSTRA was given access to 12 months of ANPR data collected by a permanent network of ANPR cameras across the Sheffield and Rotherham area in 2017.

3.14.2 This data allowed us to estimate how many times in that year each vehicle passed each camera and therefore allowed us to classify vehicles by their annual frequency passing each camera location, ranging from 'Once per year' up to the highest frequency commuter patterns passing a given camera multiple times per week.

3.14.3 This (unique?) dataset has informed the various needs to switch between 'daily traffic' and the 'local fleet', including providing estimates of the number of unique vehicles which need to be upgraded to achieve a given level of improvement in the emissions profile of the daily traffic and the proportion of daily traffic which might be classified as 'regular' and therefore more likely to consider upgrading than paying the charge &/or be eligible for a grant or other incentive scheme.

3.14.4 The relevant distribution of non-compliant (NC) vehicles into the relevant annual trip frequency bands is summarised in Table 4 below. The top version of the table is the frequency distribution of the 'annual fleet' (i.e., the set of vehicles observed by one or more of the SCC/RMBC ANPR cameras during the year), while the 2nd table is the frequency distribution of 'daily traffic' (i.e., of all vehicles seen on a typical day, how many make regular trips past that location throughout the year and how many are 'low frequency' (e.g., pass that location less than once per month).

3.14.5 Regular trip-making vehicles contribute much more to the daily traffic than the low frequency vehicles, so that the distribution in the 2nd table is much-more-heavily weighted towards 'regular' vehicles than that in the first table.

Table 4. Trip Frequency Profiles by Vehicle Type

Distribution of Annual NC Fleet (by vehicle type and trip frequency) – City Centre Average

Trip Frequency	BUSES & COACHES	CARS Ordinary	CARS Special	GOODS - HEAVY (ARTIC)	GOODS - HEAVY (RIGID)	GOODS - LIGHT
Low (<1 per month)	56.6%	71.0%	14.6%	89.0%	74.8%	71.8%
LM (<1 per fortnight)	17.9%	16.0%	16.5%	8.3%	15.4%	16.6%
Medium (1 < = x < 2 per fo	7.1%	5.2%	9.0%	1.7%	4.5%	5.2%
MH (1 < = x < 2 per week)	7.3%	5.0%	20.4%	0.8%	3.6%	4.5%
High (>2 per week)	11.0%	2.9%	39.4%	0.2%	1.6%	1.9%

Distribution of Daily NC Fleet (by vehicle type and trip frequency) – City Centre Average

Trip Frequency	BUSES & COACHES	CARS Ordinary	CARS Special	GOODS - HEAVY (ARTIC)	GOODS - HEAVY (RIGID)	GOODS - LIGHT
Low (<1 per month)	5%	13%	1%	43%	18%	15%
LM (<1 per fortnight)	10%	19%	3%	28%	23%	23%
Medium (1 < = x < 2 per fo	8%	13%	4%	12%	15%	15%
MH (1 < = x < 2 per week)	16%	24%	16%	11%	22%	24%
High (>2 per week)	61%	30%	76%	6%	22%	22%

3.14.6 This trip frequency by vehicle type data has informed the relevant assumptions about the various links between 'daily traffic' and the number of individual vehicles which need to be/are likely to be upgraded etc.

3.14.7 In particular, it is unlikely that the large number of heavy goods vehicles which pass a given location less than once per month will upgrade in response to the introduction of a

CAZ scheme at that location (though they may well be influenced by other CAZ schemes elsewhere in the UK).

3.15 A8 - Impact of Nearby City CAZ schemes (No Model Run)

3.15.1 Prior to the introduction of SCC's CAZ scheme, it is possible that the various CAZ schemes being introduced in other UK cities will push some of the older non-compliant vehicles away from the new CAZ areas to areas which no CAZ restrictions apply. This effect would be created by a combination of 2nd-hand vehicle sales and the operators of larger fleets (including the national bus operators) re-allocating vehicles from CAZs to unrestricted areas of the UK.

3.15.2 This potential deterioration in local fleet quality will be offset by the benefits of the cleaner fleets generated by the introduction of the various neighbouring CAZ schemes, particularly for 'long-distance' vehicles which operate across the UK, particularly coaches and articulated HGVs. Those neighbouring schemes are likely to involve Bradford and Manchester (although at the time of writing the go-live date for that scheme is under review).

3.15.3 It is not easy to predict the net impact of these two competing pressures on the fleets operating in Sheffield and Rotherham prior to the introduction of our Preferred Option.

3.15.4 However, the announcement & subsequent introduction of Sheffield's own CAZ scheme will remove the migration of older more-polluting vehicles into the South Yorkshire area, leaving only the benefits of the cleaner UK-wide (or northern England) long-distance fleets generated by the CAZ schemes being introduced in other (nearby) cities.

3.15.5 In summary, this suggests that the CAZ schemes in other (nearby) cities increase the uncertainty of the future air quality in Sheffield and Rotherham in the Baseline 'Do Nothing' scenario, but will increase the likelihood of 'success' in the Preferred Option, as the long distance fleets are likely to be cleaner than expected under 'Business as Usual' assumptions.

3.15.6 This combination of impacts therefore supports the argument for a Charging CAZ scheme in Sheffield.

3.15.7 There is an additional '2nd-order' effect associated with the supply of compliant vehicles, where CAZ schemes elsewhere in the UK reduce the supply (and/or increase the cost) of compliant vehicles, reducing the proportion of Sheffield & Rotherham vehicle owners who are able to upgrade their vehicles to avoid the Sheffield CAZ charge. This impact would lead to lower-than-expected levels of vehicle upgrades (See Sensitivity Test A6 above). The mitigation for this would therefore be the regular monitoring of the emissions profiles of the various local vehicle fleets, to ensure that the predicted/required level of fleet upgrades have taken place each Quarter.

CONCLUSION – The (unmodelled) impacts of CAZ schemes in other cities is likely to increase uncertainty in the Baseline, but should reduce emissions in the Preferred Option in Sheffield and Rotherham. Careful/regular monitoring of the various fleets will help mitigate any addition risks from the impact of other regional CAZ schemes.

3.16 A9 - Impact of Exemptions (No Model Run)

3.16.1 Most exemptions, including the national exemptions, effect only a small number of vehicles and as such the expected impact on compliance is negligible.

3.16.2 There are concerns over the situation where significant numbers of vehicles operators are awaiting new vehicles on order or running to the end of existing finance periods (ie sunset periods). It is unclear what numbers of vehicles this will effect, but, if significant it could be a danger to compliance.

3.16.3 There is likely to be less danger to compliance through exemptions in Rotherham, although some of the exempt vehicles will operate on the key Rotherham roads.

3.16.4 This is discussed in greater detail in the Exemptions report.

CONCLUSION – Exemptions on their own are unlikely to have any impact on compliance. Sunset periods for significant numbers of vehicles are more likely to have a bigger impact. The scale and impact of any exemptions will be measured through the monitoring and evaluation plan and if effecting compliance additional mitigation can be considered as required.

Section 4 Air Quality Sensitivity Tests

4.1.1 The modelling undertaken to support the CAP (both transport and air quality) has a Base Year of 2017. That is the year at which target determination was undertaken and therefore the modelling pivots from that point. However, since the submission of the OBC additional monitoring data has become available, of particular use is the 2019 data (the 2020 data is available but including significant COVID impacts).

4.1.2 When the 2019 data is used in place of the 2017 monitored data we get results in Sheffield as shown in the table below, which illustrate the variability of the air quality results and the need to ensure there is adequate 'wiggle-room' built into the forecasts. In particular using these numbers it is clear that Sheaf Street only just achieves compliance under the Preferred Option.

Table 5. Comparison of 2022 Forecast NO_2 concentrations at key locations in Sheffield when using 2017 and 2019 based air quality Data

Road	Census_ID	Location	2022 Baseline (2017 Data)	2022 Preferred Option (2017 Data)	2022 Baseline (2019 Data)	2022 Preferred Option (2019 Data)
Arundel Gate	n/a	C710 Arundel Gate[1]	**48.6**	37.1	**47.5**	36.4
Arundel Gate	n/a	Stoddart Building	**42.7**	32.6	**47.0**	35.7
A61	48805	Shoreham Street	37.2	33.7	38.5	34.9
Sheaf Str station side	60030	Sheaf Street	36.8	32.8	**45.6**	40.3
A61	81236	Derek Dooley Way	36.7	32.7	34.0	30.4

4.1.3 At most of the air quality monitoring sites across Sheffield there has been a fairly steady reduction in annual average NO2 concentrations over the past 5 years, including a large (Covid-related) improvement in 2020. However, there were a number of Sheffield's 'AQ 'hot-spot' sites where the annual average air quality was significantly worse in 2019 than observed air quality trends at some other hot-spot locations. This variability is illustrated in Figure 4 below.

[1] With anti-idling measures in place

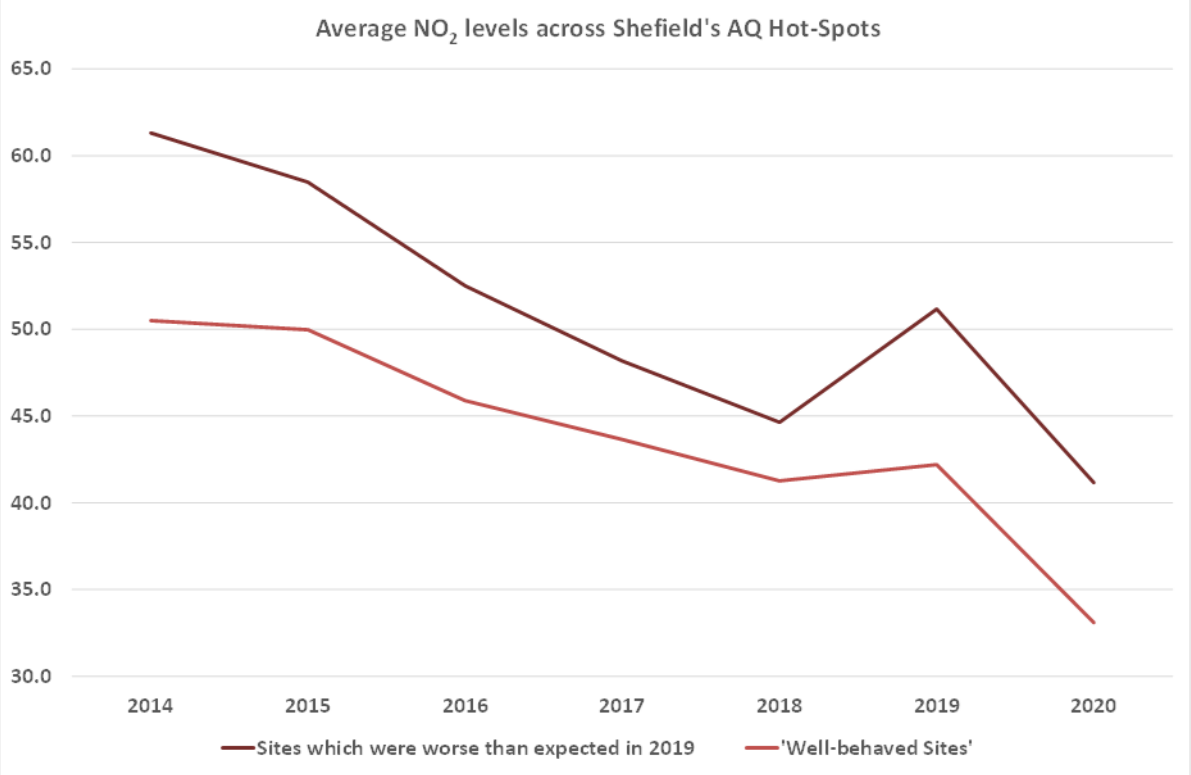

Figure 4. Air Quality Trends at Sheffield AQ Hot-Spots including those where 2019 was worse than expected

Note: the chart is based on the raw air quality values at monitored locations (regardless of whether these AQ monitors are at 'valid' locations and prior to any distance-from-roadside or height corrections).

4.1.4 In particular, annual average air quality at several locations in the Lower Don Valley (e.g., close to Meadowhall) was notably worse than expected in 2019, although they still show a reduction albeit smaller and are still on the improvement trajectory when compared to earlier years' (2014, 2015, 2016) concentrations.

4.1.5 Conversely, the annual average air quality at Arundel Gate was much better in 2019 than would have been predicted by applying the average trend to the 2017 air quality starting point, so much so that a modelling projection based on the 2019 data would achieve 'success' without the need for the additional anti-idling measures at this location.

4.1.6 This variability in average air quality is discussed in greater detail in Section XX the Strategic Case, and the associated need for careful monitoring is discussed in the Monitoring and Evaluation Plan, within the Management Case section of the FBC.

Section 5 Conclusions

5.1.1 These tests have tested the Baseline and Preferred Option under a range of scenarios that show:

- From the tests undertaken these have highlighted that there is minimal risk of the preferred CAZ C proposals not achieving compliance;
- Even under the optimistic scenarios the Baseline would not achieve compliance in 2022 (either in Sheffield or Rotherham) and therefore the scheme is required to achieve compliance in the shortest possible time;
- Under some of the more pessimistic scenarios the Preferred Option does not reach compliance so it is clearly the case that a lower class than CAZ C would not achieve compliance but there is no justification from the tests undertaken for a more onerous CAZ;
- In those scenarios which do not achieve compliance suggestions are made for additional mitigation. E.g., stricter anti-idling measures on Arundel Gate, additional bus rerouting on Rawmarsh Hill etc;
- The biggest risks to not achieving compliance are fleet related, either not achieving the behavioural changes hoped for or a slower fleet churn;
- Air quality Modelling Sensitivity Tests indicate that there is a small risk of the preferred CAZ C proposals not achieving compliance. That natural variability related to meteorology, reflected in the average NO2 trend analysis, is a risk to not achieving compliance in 2022;
- Future Emissions Standards Sensitivity Test is not considered a risk to compliance if emissions standards achieve the expected improvements. If they do not it is likely that compliance will not be achieved requiring some mitigation and will need to be addressed nationally as it will affect all mandated areas;
- The Projecting f-NO2 test is the same test as the A1 f-NO2 Sensitivity Test, which was found not to be a risk to the Preferred Option; and
- Gradient effects was not considered for Sheffield as there are no reporting locations with gradients greater than 2.5%. Therefore, in accordance with LAQM-TG16, the effect of gradients on all vehicles in Sheffield can be justifiably neglected.

Note: A 2023 test has been undertaken too which includes changes to the Baseline expected to come online between 2022 and 2023. This was undertaken to show that the Preferred Option still achieves compliance under this scenario. An earlier version of that test was included in this document, but as the timescales for delivery have changed and the go-live date has moved into 2023 this test has been moved into its' own technical addendum to the FBC as this will now be the year of compliance. It should be noted that the 2023 test does indeed show that the scheme achieves compliance everywhere across Sheffield and Rotherham.

Sheffield & Rotherham Clean Air Plan FBC
April 2022

Appendix 1

Sheffield & Rotherham Clean Air Modelling Results

Table 6. Detailed Sensitivity Results (M1 to M5)

Location	2017 Baseline	2022 Baseline	CAZ C with Bus Gate	COVID Worse Case	COVID Best Case	No Behavioural Response to Charging (PO)	Future Emissions Standards	Future Emissions Standards	Future Emissions Standards	Future Emissions Standards	Gradient - Baseline	Gradient - PO
				M1 - PO	M2 - Baseline	M3	M4 - Low - PO	M4 - High- PO	M4 - Low - BAU	M4 - High- BAU	M5 - BASELINE	M5 - PO
Wortley Road	46.7	41.9	40.1	40.3	41.5	40.4	38.6	40.9	40.4	42.6	40.3	38.1
Fitzwilliam Road	51.6	41.2	39.4	39.3	41.2	40.5	37.9	40.0	39.7	41.8	42.3	40.4
Rawmarsh Hill	50.2	41.3	39.2	39.0	41.1	40.0	37.9	39.9	39.9	41.9	42.4	37.8
C710 Arundel Gate	61.1	47.8	38.3	34.8	43.1	37.8	37.7	38.1	42.8	43.5	44.7	37.4
Sheffield Road (M1 34S)	46.3	36.0	36.1	36.3	35.7	36.7	37.8	39.8	34.7	36.6	34.8	37.8
Brightside Lane	45.6	35.1	34.2	33.5	34.6	34.1	36.3	37.6	34.2	35.5	32.1	33.8
Attercliffe Road	44.6	34.5	33.8	33.5	34.0	34.5	33.6	35.3	33.6	34.9	34.1	33.7
Shoreham Street	48.0	36.8	33.4	33.1	36.7	35.3	33.7	35.2	35.8	37.5	38.4	35.1
Sheaf Street	49.0	36.4	32.4	31.9	36.0	33.9	35.2	36.6	35.5	36.5	34.9	34.8
Derek Dooley Way	43.0	36.3	32.4	32.2	36.0	33.4	30.5	31.9	35.1	36.9	36.7	31.4
Arundel Gate, Stoddart Bldg	48.0	42.0	32.2	32.0	41.8	36.1	33.9	34.8	41.5	42.3	45.0	36.4
Meadowhall Road	40.3	31.7	31.4	31.1	31.5	31.4	33.8	35.3	30.8	32.2	28.4	31.1
Savile Street	42.0	34.8	31.3	31.0	34.5	32.2	27.9	29.2	33.7	35.4	35.9	29.0
Attercliffe Common	39.1	30.0	30.2	29.3	30.0	29.7	30.6	31.7	29.4	30.5	28.7	29.7
Shoreham Street	43.7	33.4	30.0	29.6	33.0	31.8	30.5	32.0	32.3	34.0	35.2	32.2
Fornham Street	39.0	32.8	29.8	29.5	32.6	31.2	28.8	30.2	31.9	33.5	36.1	31.9
Attercliffe Road	40.4	30.9	29.9	30.0	30.4	30.8	32.0	33.5	30.0	31.4	28.8	30.3
Penistone Road	41.3	30.6	29.9	30.0	30.4	30.8	30.3	31.9	29.6	31.2	30.3	30.8
Suffolk Road	43.3	32.8	29.2	29.1	32.6	30.7	29.9	31.2	32.0	33.3	33.1	30.7
Burngreave Road	38.7	29.1	28.9	28.6	28.8	29.8	29.0	30.6	28.3	29.5	28.6	28.7
Chesterfield Road	39.1	30.4	28.5	28.0	30.4	29.3	29.0	30.4	29.6	30.9	28.8	27.9
Arundel Gate, Gallery	45.0	35.0	28.2	28.1	34.9	31.2	28.3	28.6	34.7	35.2	38.1	30.5
Greenland Road	37.0	28.3	28.2	28.0	27.9	28.4	25.6	27.0	27.3	28.8	30.4	28.5
Bawtry Road	37.9	28.3	28.1	27.9	27.6	28.2	28.4	29.9	27.3	28.7	27.8	28.9
Hawke Street	37.0	28.0	28.1	27.8	27.9	28.2	29.1	30.6	27.1	28.5	26.5	28.3
Queens Road	38.4	30.0	28.2	28.1	29.5	29.4	27.2	28.5	29.0	30.5	30.5	28.4
Leppings Lane	35.0	28.6	27.9	27.7	28.2	28.9	27.2	28.3	28.0	29.0	26.1	25.3
Barkers Pool Taxi Rank	33.6	30.7	27.2	26.4	30.7	28.4	25.8	27.2	29.8	31.3	36.8	31.0
Wicker	41.1	31.7	27.7	27.6	31.8	29.9	26.3	27.1	31.1	32.0	31.5	26.8

Table 7. detailed Sensitivity Results (M6 to A2)

Location	2017 Baseline	2022 Baseline	CAZ C with Bus Gate	M1 60mph Test Becomes permanent (with PO)	Future Fleet Age / Composition	Future Fleet Age / Composition	Future Fleet Age / Composition	Future Fleet Age / Composition	f-NO2 Reduction	f-NO2 Reduction	Retrofit Sensitivity
				M6	M7 - High - BAU	M7 - Low - BAU	M7 - High - PO	M7 - Low - PO	A1 - Baseline	A1 - PO	A2
Wortley Road	46.7	41.9	40.1	40.1	43.8	41.0	41.1	39.1	40.8	36.3	40.3
Fitzwilliam Road	51.6	41.2	39.4	39.2	41.3	38.9	40.6	38.2	40.7	36.5	39.6
Rawmarsh Hill	50.2	41.3	39.2	38.8	45.0	41.4	40.7	37.9	41.4	35.2	39.6
C710 Arundel Gate	61.1	47.8	38.3	34.7	54.6	47.7	39.6	36.8	38.5	32.0	41.4
Sheffield Road (M1 34S)	46.3	36.0	36.1	35.1	36.4	34.5	40.4	37.8	30.1	32.6	39.0
Brightside Lane	45.6	35.1	34.2	32.8	37.4	34.8	38.8	35.8	29.3	31.0	36.7
Attercliffe Road	44.6	34.5	33.8	33.1	35.3	32.3	35.7	33.2	31.0	30.7	35.5
Shoreham Street	48.0	36.8	33.4	32.7	36.6	34.3	35.7	33.7	32.7	30.5	33.3
Sheaf Street	49.0	36.4	32.4	31.7	38.4	36.1	37.4	35.4	29.4	29.7	36.5
Derek Dooley Way	43.0	36.3	32.4	31.9	38.1	35.4	32.7	30.8	34.0	29.6	30.9
Arundel Gate, Stoddart Bldg	48.0	42.0	32.2	31.9	37.0	32.8	35.8	33.4	36.0	30.2	36.2
Meadowhall Road	40.3	31.7	31.4	30.2	33.0	30.9	36.1	33.6	26.6	29.0	34.5
Savile Street	42.0	34.8	31.3	30.8	36.3	33.8	30.0	28.0	35.1	28.8	27.7
Attercliffe Common	39.1	30.0	30.2	28.9	30.1	28.3	32.4	30.1	27.0	28.0	31.2
Shoreham Street	43.7	33.4	30.0	29.4	32.0	30.1	32.6	30.8	29.4	27.6	30.3
Fornham Street	39.0	32.8	29.8	29.2	31.0	29.0	30.5	28.9	30.5	27.5	28.9
Attercliffe Road	40.4	30.9	29.9	29.7	32.6	30.3	34.2	31.9	26.2	27.7	32.7
Penistone Road	41.3	30.6	29.9	29.8	30.8	28.8	32.4	30.1	27.1	27.6	31.2
Suffolk Road	43.3	32.8	29.2	28.8	35.2	32.4	32.0	30.0	28.7	27.1	30.9
Burngreave Road	38.7	29.1	28.9	28.5	29.3	26.8	30.9	28.6	26.7	26.9	30.3
Chesterfield Road	39.1	30.4	28.5	27.8	33.1	30.3	31.1	28.9	26.9	26.4	30.2
Arundel Gate, Gallery	45.0	35.0	28.2	28.0	40.9	36.7	29.8	27.5	32.4	26.8	31.5
Greenland Road	37.0	28.3	28.2	27.6	28.5	27.0	27.3	25.7	27.9	26.1	26.5
Bawtry Road	37.9	28.3	28.1	26.8	29.5	27.7	30.5	28.5	25.0	26.0	29.6
Hawke Street	37.0	28.0	28.1	27.5	27.5	26.1	31.0	28.9	24.4	26.1	30.0
Queens Road	38.4	30.0	28.2	27.9	31.2	29.1	29.2	27.3	27.9	26.3	28.3
Leppings Lane	35.0	28.6	27.9	27.6	29.6	27.2	28.9	26.7	26.9	26.2	28.6
Barkers Pool Taxi Rank	33.6	30.7	27.2	26.3	29.5	28.1	27.3	26.0	28.9	25.2	17.4
Wicker	41.1	31.7	27.7	27.5	37.6	32.6	28.5	26.0	30.9	26.6	29.4