Annex 1

Overview of feasibility studies supporting the development of the draft AQAP3 framework

York Low Emission Zone Feasibility Study (July 2013)

Halcrow and Institute of Transport Studies (University of Leeds)

What is a LEZ?

1. A LEZ is an area where only vehicles meeting a specified emission standard are allowed to enter. Vehicle emission standards are set by the EU: new vehicles have to meet increasingly more stringent emission standards for specific pollutants over time. Oxford and Norwich already operate LEZs for buses. London has a much larger LEZ which applies to large vans, minibuses, buses and HGVs. Brighton has also recently introduced a LEZ. A large number of other local authorities are currently undertaking LEZ feasibility studies. These include the West Yorkshire Integrated Transport Authority (Bradford, Calderdale, Kirklees, Leeds and Wakefield) and Sheffield City Council.

Why was a LEZ feasibility study undertaken for York?

2. Buses are known to be responsible for over 40% of the road transport derived NO_2 in some areas of York even though they typically only make up about 3% of the total vehicle fleet. They are also responsible for high levels of diesel particulate emissions for which there is no known safe level. As buses have a disproportionately high impact on NO_x emissions, reducing emissions from buses is a priority for AQAP3.

3. CYC commissioned a LEZ feasibility study in November 2011 to investigate the level of air quality improvement that might be achievable through the creation of a low emission bus and coach corridor in the city centre. This project was partially funded from a DEFRA air quality grant.

How was the study undertaken?

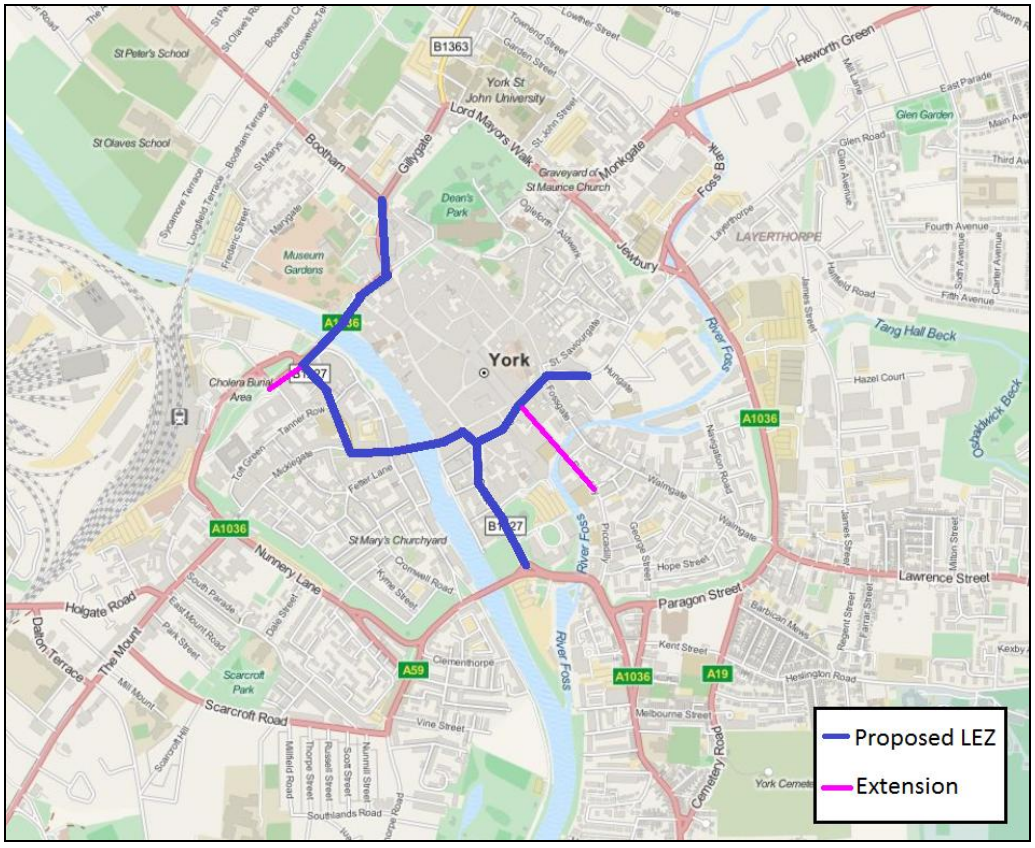
4. The project was undertaken in conjunction with Halcrow and the Institute of Transport Studies (ITS) at the University of Leeds. The study used a traffic micro-simulation model (PARAMICS) linked to a detailed emissions model (PHEM) to allow emissions from individual vehicles on the network to be modelled. The model could take account of factors such as the age of the vehicles, the number of stops made along the route and the level of congestion encountered along a typical journey. The emission factors used by the model were linked to real life measured bus emissions making this study one of the most detailed LEZ studies undertaken in the UK to date. For the majority of the modelled scenarios an air pollution dispersion model was also used to predict

what impact reducing emissions from individual vehicles would have on ambient pollutant concentrations in the city.

Scope of the study

5. The area assessed covered 2km of roads in the city centre through which all current scheduled bus services pass through (figure 1). Because most scheduled bus services pass through this small area any LEZ policy applying emission controls to this area would effectively create a city wide LEZ for scheduled bus services. The study also included a cost-benefit analysis which considered the cost to operators and CYC of implementing the LEZ bus corridor and the likely air quality / health benefits that would be achieved.

Figure 1 – Area considered in the York LEZ study



6. The York LEZ feasibility study considered the following scenarios:

   - Euro 3 LEZ for buses and coaches (all bus services in the study area assumed to be upgraded to meet the criteria)
   - Euro 4 LEZ for buses and coaches (all bus services in the study area assumed to be upgraded to meet the criteria)

- Euro 5 LEZ for buses and coaches (all bus services in the study area assumed to be upgraded to meet the criteria)
- A hybrid P&R scenario which could reflect either the use of full electric buses or hybrid diesel-electric buses on all P&R routes (with battery operation within the AQMAs). This scenario was modelled separately from the other LEZ scenarios and could be implemented in conjunction with any of the other scenarios.
- Some further emission scenarios were also run looking at the emission impact of including HGVs in the emission controls (the impact of these on air quality concentrations were not modelled).

Results of the study

7. The study showed that implementation of LEZ style controls in the city for buses and coaches has the potential to significantly reduce average NO_x emissions in the city centre and beyond. LEZ policies restricting access to buses and coaches that did not comply with the Euro 3, 4 and 5 emission standards, were predicted to reduce the total NO_X emitted in the city centre AQMA by 4.0%, 11.8% and 14.3% respectively. If the LEZ policy was widened to also restrict access to all Euro 3, 4 and 5 heavy-duty vehicles (rigid- and articulated-HGVs), average reductions in total NO_X emissions of 5.1%, 13.9% and 18.1% were predicted.
8. However, the impact of LEZ style controls is not consistent across the entire road network. This is because emissions are strongly influenced by the numbers and types of each vehicle operating in a certain areas and the amount of congestion individual vehicles encounter as they move around the network. The predicted change in emissions varied between the different air quality technical breach areas depending on the number of bus and HGV movements in these areas. Rougier Street for example is dominated by bus movements; therefore the bus / coach LEZ scenarios are forecast to deliver much greater reductions in NO_x (e.g. Euro 4 Bus LEZ, ≈26%) and even greater cuts in tail-pipe emissions of PM (e.g. Euro 4 Bus LEZ, ≈43%) on these critical streets than the average figures suggest.
9. The main pollutant of concern in York is NO_2. This can be emitted directly from the back of vehicles (primary NO_2) or can be formed in the atmosphere from nitric oxide (NO). Whilst all the LEZ scenarios predicted a total reduction in NO_x (NO + NO_2), some of the scenarios indicated that they might give rise to an increase in the amount of primary NO_2 . This is because some vehicle emission technology reduces the quantity of NO_x emitted but at the same time increases the proportion emitted as NO_2. On this basis it was found that scenarios

requiring a Euro 3 emission standard would not deliver significant reductions in NO_2 and in some locations could potentially increase the current NO_2 concentrations. All other scenarios were predicted to give rise to slightly lower primary NO_2 emissions than under the current situation.

10. Unlike the NO_x standards, Euro emission standards for PM (Particle Matter), have led to consistent improvements in the on-road emission performance of light and heavy-duty vehicles. All the LEZ scenarios considered were therefore expected to deliver significant PM benefits (including the Euro 3 scenario). As with NO_x the predicted impact of the LEZ scenarios on PM emissions is not consistent across the network with the greatest impacts likely to be in areas that have a high density of bus movements. Rougier Street was predicted to experience a 43% reduction in PM emissions with a Euro 4 emission standard in place for buses and coaches.

11. The introduction of Euro 4 and Euro 5 scenarios for all buses and coaches were predicted to give rise to sizeable reductions in NO_2 at some receptors. However, even with these restrictions in place some exceedances of the UK health based annual AQS objectives and the EU Limit values for NO_2 were still predicted to exist. It is therefore unlikely that blanket Euro 4 or Euro 5 LEZ controls applied to all buses and coaches would deliver the national air quality objectives at all locations in York.

12. The scenario considering the introduction of electric / hybrid P&R buses was shown to have the potential to deliver a reduction in NO_2 of 1.0 µg m^{-3} across the study area compared with 0.1 µgm^{-3} in the Euro 3 (all buses) scenario to 2.6 µgm^{-3} in the Euro 5(all buses) scenario. This indicates that applying zero emission controls to a small number of frequent bus services could potentially be more effective at reducing NO_2 concentrations than applying a blanket Euro 3 or 4 emission standard across the whole fleet. Whilst a blanket Euro 5 emission standard would be likely to give rise to a greater overall reduction in NO_2 it would require the entire bus fleet to be rapidly upgraded to a Euro 5 standard. This would be difficult and costly to achieve, particularly for smaller operators who normally buy their vehicles second hand.

Electric bus feasibility study July 2013 (ARUP)

Purpose of the study

1. Early results from the York LEZ study indicated that using electric P&R buses within the AQMAs could potentially offer similar or greater reductions in NO_2 concentrations than blanket Euro emission standard controls across the whole bus fleet. The purpose of this study was to examine the feasibility of operating electric buses in York.

Scope of study

2. In January 2013 ARUP were commissioned to :

    - Provide a full review of low emission bus technology (considering both electric and gas powered solutions)

    - Develop a realistic roadmap for introducing low emission buses into York based on matching the real life duty cycles of current services with the most suitable and available low emission technology.

    - Provide an operations and economic analysis to support the proposed low emission bus road map.

Study outcomes

Low emission bus technology review

3. This review has provided a detailed evidence base for the use of electric buses within urban environments. It provides examples of electric buses in use in a variety of different locations and using a variety of different battery and charging solutions. The review includes a case study for the Travel de Courcey Park & Ride site in Coventry. This site is already using three plug-in rapid charge pure electric buses to provide a successful 15 minute Park & Ride service along a 6 mile city centre route (including a number of stops on-route). This is a similar to the service in York using conventional diesel engines.

Development of a low emission bus roadmap

4. The York study identified around 65 scheduled bus routes through the city serviced by approximately 200 buses of varying age and emission standards. It was found that 82% of all bus movements are carried out by only 49% of the buses and that these buses operate on only 20 routes (including all the Park & Rides). As demonstrated by the LEZ study these 'frequent' flyers are having a disproportionate impact on local air quality.

5. Due to their predominantly short, frequent duty cycles the majority of 'frequent flyer' buses operating on the 20 main routes have been found to be well suited to adoption of electric bus technology. Converting these services to electric would offer substantial benefits for air quality as well as 60% reduction in greenhouse gas impact. There would be additional benefits in that noise is greatly reduced and passenger experience enhanced.

6. Those buses which make less frequent journeys or pass through the city as part of a longer journey are not suited to the use of pure electric technology. In these cases hybrid, or even conventional diesel technology remain the most suitable options at the present time. There are also opportunities for the use of gas powered vehicles if suitable refuelling infrastructure is made available in the city.

7. Table 1 shows what is considered to be a challenging but achievable timetable for the introduction of electric buses into the York fleet based on the findings of the ARUP study. This timetable would ensure that by 2017 80% of all bus movements in the city will be made by electric vehicles. The economic analysis carried out in relation to the development of this proposed timetable has shown that there is a commercial case for upgrading buses based on fuel savings alone, however early engagement with bus operators is required if this timetable is to be pursued. The introduction of electric buses into York has already commenced and table 1 has informed the development of the Clean Air Zone (CAZ) proposals (see Annex 2).

Table 1: Timetable for introducing low emission buses into York (Electric Bus Feasibility Study 2013)

Year	Percentage of Bus Movements Electric
2014	6%
2015	8%
2016	45%
2017+	87%

Progress to date

8. Significant progress has already been made towards the widespread introduction of electric buses in York. A brand new P&R site was opened in June 2014 that utilises battery operated electric buses and further electric buses were introduced to the existing Monks Cross P&R site in May 2015. A battery operated electric bus is operational on the University bus route and six city centre tour bus are scheduled for retrofitting with electric drive trains following the successful completion of a demonstration project in 2014. All these projects have been made possible through Greener Bus Fund (GBF) and Cleaner Bus Technology Funds (CBTF). CYC is continuing to work closely with bus operators to bring further low emission buses to the city.

9. It is anticipated that the electric bus feasibility work and the resultant road map for low emission bus technology will help CYC and the relevant bus operators to continue to take maximum advantage of further rounds of GBF and CBF funding. The inclusion of a CAZ in the AQAP3 framework can only strengthen this position as it will allow York to formalise its commitment to cleaner bus technology and provide greater confidence and certainty in the market to bus operators. Whilst the cost of electric bus technology (in the absence of grant funding) currently remains a challenge to operators it is expected that the cost effectiveness of green bus technology will rapidly improve as the cost of battery technology continues to fall and the price of diesel rises. A full copy of the electric bus feasibility study and the roadmap for low emission buses can be obtained on request from public protection.

York idling study

Transport & Travel Research Ltd (January 2014)

Purpose of the study

1. York's LES identified adoption of an anti-idling policy as a potential measure to support emission reduction and air quality improvement. Anti-idling policies aim to prevent unnecessary emissions from stationary vehicles and can take a variety of forms ranging from provision of basic advice and signage through to adoption of anti-idling legislation. In February 2013 CYC commissioned an anti-idling feasibility study to determine the extent of idling emissions in York and to consider the cost-effectiveness of introducing anti-idling policies. The study was carried out by TTR Ltd and funded by a DEFRA air quality grant.

Scope of study

2. TTR-Ltd were commissioned to undertake the following:
    - A review of current scientific evidence in relation to the advantages and disadvantages of switching off an idling engine
    - A review of anti-idling polices in place within other LAs and the legislative powers available to LAs to deal with idling
    - Consultation with operators (bus and HGV) to determine current practice, principles and policy options
    - A survey of observed vehicle idling at a number of key locations in the city
    - A cost benefit analysis of a basic package of anti-idling measures for York

Study outcomes

Scientific evidence to support anti-idling measures

3. The anti-idling study concludes that where a vehicle is expected to be stationary (parked, waiting or loading) for more than 1 minute it is both economically and environmentally advantageous to switch off the engine. In these situations research indicates that it is unlikely that any damage would be caused to the battery above and beyond normal driving behaviour. The report also addressed a number of other 'myths' surrounding the use of anti-idling policies including impact on catalytic convertors, use of ancillary vehicle equipment and requirements to

maintain in-vehicle temperatures. In all cases it was found that solutions exist which can operate alongside anti-idling polices.

Uptake of anti-idling measures by other LAs

4. The study provides many examples of anti-idling measures already in place in other areas e.g. North Lincolnshire, Croydon and Aberdeen. In the majority of cases promotional activity, erection of signs and polite requests by LA officers to switch off engines have been enough to reduce idling.

Consultation with operators

5. During the study consultation took place with operators of Heavy Duty Vehicles (HGV, Bus and Coach).

   Feedback from discussions with freight operators were that:
   - All operators were aware of cost of idling so were conscious of the activity as a negative influence to business;
   - All managers/owners wanted to reduce vehicle idling;
   - Technology is often used to either control or monitor idling;
   - Driver behaviour was recognised as the primary reason for vehicle idling, and raising driver awareness was part of all company policy.

   Feedback from discussions with local bus operators were that:
   - There was awareness of the direct cost of idling to the business;
   - Vehicles always remain idling whilst loading and unloading passengers;
   - Idling during laying over (non-operational periods) was targeted for reduction by some but not all operators;
   - All operators had some automatic shut-down varying between 2 and 7 minutes on their newer vehicles and larger operators had full telematics tracking and reporting on their vehicles, including idling;
   - Some older vehicles are never switched off during the working day due to likelihood of failed re-starting;
   - Vehicles in bus fleets tend to be older than road freight – due to purchase costs – so technology interventions are slower to be introduced.

Feedback from discussions and correspondence with coach operators was that:

- vehicles are reliant on engine power to operate heating and air conditioning. This results in vehicle engines being switched on up to 10-15 minutes prior to passenger loading. Operators stated this was a passenger expectation;
- Telematics were not as widespread as for freight
- Drivers were regularly briefed to minimise idling, but not at the expense of passenger comfort

Idling observations

6. In-depth observations were made of idling vehicles at 10 locations in York including the railway station, coach parks, Memorial Gardens, Coney Street and Rougier Street . Additional surveys were undertaken by observers located on buses travelling along various route throughout the city. These observations concluded that there are currently significant levels of bus and coach idling across the city centre, but less evidence of idling emissions arising from HGVs.

7. At one bus stop and one loading/unloading area outside the railway station in a typical morning period (3 hour, 20 minute observation) the total amount of time all vehicles spent idling waiting at bus, coach and loading bays was equivalent to 6 hours 30 minutes. This is equivalent to 20 g Particulate Matter (PM) and 861 g $NO_{x,}$ 26.86 kg CO_2 emitted and 10.14 litres of fuel used unnecessarily. When factored across the city and over a year it can be seen that an anti-idling campaign has the potential to result in significant emission and fuel savings.

Cost –benefit analysis

8. An estimate has been made of the costs and benefits arising from one option for an anti-idling campaign which would include 20 street signs, a basic promotion and marketing campaign and minimal enforcement (4 days per month for first 2 months and 2 days thereafter). The option would also include a telephone hotline for public reporting of idling. The anti-idling campaign would focus mainly on buses, would run for a period of 5 years. It would aim to prevent vehicles idling for more than two minutes over the whole network. The benefits of a scheme of this type have been identified in terms of :

    - fuel saving (and value);
    - emissions saving (and value);

An additional benefit is likely to be reduced noise levels but this was outside the scope of the York anti-idling feasibility study.

9. If successfully implemented it is estimated that an anti-idling scheme of this magnitude could yield benefits worth around £200,000 over a 5 year period set against an investment of around £54,000. The possibility of some of this investment coming via the Better Bus Area Fund 2 is being investigated. The majority of this benefit would be to bus operators in terms of fuel savings. If all idling for greater than 2 minutes was anticipated and prevented before the 2 minute period had elapsed benefits would be much greater (in the range of £560,000). In reality benefits are likely to fall somewhere between these two figures. The cost of implementation could be reduced significantly if the enforcement role was undertaken by existing bus monitoring officers and/ or local operators made a contribution towards setting up the scheme.

10. The cost benefit analysis undertaken to date assumes the bus fleet remains a diesel fleet, the reported savings will be less if a large proportion of the fleet are switched to electric services over the coming years as recommended by the electric bus feasibility study. Under this scenario the length and extent of an anti-idling campaign could be scaled down to target in later years only those services expected to be still operating with hybrid or diesel technology.

Progress to date

11. The anti-idling study provides compelling evidence of excess emissions currently arising from idling activities in the city which could be reduced significantly through the erection of anti-idling signage, further information and advice sessions with vehicle operators and some on-street spot checks combined with provision of anti-idling advice. It is recommended that all these actions should be progressed as part of the AQAP3 delivery programme. At this stage adoption of anti-idling legislation is not considered necessary to tackle the problem, but should be kept as an option within AQAP3 should other measures prove ineffective.

12. A number of locations around the city centre have been identified as potential anti-idling zones as shown in Figure 2 (these are in addition to the area to be included in the proposed CAZ). Further consultation with HGV, bus and coach operators to determine an appropriate level of anti-idling action within these zones will be undertaken over the coming

months and an anti-idling delivery programme drawn up. A full copy of the York idling study can be obtained from public protection.

Figure 2 – Potential anti-idling zones in York (subject to further consultation)