London Borough Merton:

Introduction of an Emissions Based Parking Levy – Diesel Vehicles

Proposal

Prepared in partnership with London Borough of Merton

By:

Author(s)	Lisa Hawtin, Kevin Turpin, Anna Savage & Jason Andrews
Quality Control	Venn Chesterton & Jason Andrews
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1 EXECUTIVE SUMMARY

Air pollution is increasingly recognised as a major cause of ill health and premature death. The most recent report by The Royal College of Physicians 'Every breath we take: the lifelong impact of air pollution' (February 2016)[1] says that:

- Each year in the UK, around 40,000 deaths are attributable to exposure to outdoor air pollution.
- Air pollution plays a role in many of the major health challenges of our day, and has been linked to cancer, asthma, stroke and heart disease, diabetes, obesity, and changes linked to dementia.
- Neither the concentration limits set by government, nor the World Health Organisation's air quality guidelines, define levels of exposure that are entirely safe for the whole population.

Research by King's College London has estimated that air pollution was responsible for up to 141,000 life years lost, or the equivalent of up to 9,400 deaths in London in 2010, as well as over 3,400 hospital admissions. The total economic cost associated with this was estimated at £3.7 billion.

It is therefore the responsibility for Government, both locally and nationally to take steps to tackle the issue of air quality as well as highlight the impact of pollution.

Along with other Boroughs such as Islington, Camden, Kensington & Chelsea. Merton are considering introducing a residential parking scheme that takes into account vehicle emissions and will place additional charges on those vehicles that contribute disproportionately to poor air quality.

As part the Council's commitment to Air Quality, this study has been commissioned to consider the impacts of introducing an emissions based parking levy for both residential and business parking permits. This scheme would aim to encourage residents and businesses to consider changing to low or zero emission vehicles with revenue derived from the scheme invested to support local sustainable transport initiatives and necessary infrastructure.

The approach for a low emission based parking scheme considered in this study takes into account on-road emissions, rather than simply the manufacturing specification. As this report will show, diesel cars may have low fuel consumption and low CO_2 emissions but produce disproportionately high emissions of local air quality pollutants, such as nitrogen oxides (NO_X) and particulates (PM's).

The study has proposed implementation of an annual parking permit surcharge for all diesel vehicles; no surcharge for petrol vehicles and a free parking arrangement for all 'plug-in' electric and petrol hybrid vehicles.

The objective of imposing a diesel surcharge for parking within the Borough is to make resident's aware of the impact of diesel vehicles on local air quality, and to incentivise those changing their vehicles to consider adopting lower or zero emission technologies. The exemption for petrol vehicles is a recognition that the emissions of Particulate Matter (PM_{10}/$PM_{2.5}$) and nitrogen dioxide (NO_2) are generally less significant when compared to diesel, and provide a readily available, low cost option for those resident's that are currently unable to make the transition straight to zero emissions technologies.

The rate of the surcharge for diesel vehicles will need to be considered very carefully; this must provide a sufficient incentive to promote long term change as well as come into line with other boroughs, whilst not be seen as punitive to diesel drivers that have been given conflicting advice over the years around diesel emissions.

[1] Royal College of Physicians – Working Party Report (February 2016) https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution

CONTENTS

2 BACKGROUND TO THE MERTON AIR QUALITY PARKING PROJECT

Air quality in the London Borough of Merton remains an important public health issue. In 2013, 6.4% of deaths within the borough are considered 'likely' to be attributable to air pollution under the Public Health Outcomes Framework 3.01[6]. The Air Quality Action Plan (AQAP)[7] developed by the Council as part of their Local Air Quality Management (LAQM) responsibilities has been in place since 2003, but despite half of the 32 action plan measures having been implemented, pollution concentrations in parts of the borough remain in exceedance of the UK air quality objectives for nitrogen dioxide (NO_2) The whole borough of Merton has been declared an Air Quality Management Borough (AQMA) for NO_2 and particulates (PM_{10}).

In London, and other urban areas, attempts to address air pollution have been counteracted by continued growth in traffic, the increase in the proportion of diesel in the passenger vehicle fleet and the poor performance of vehicle emission reduction measures under real world driving conditions. The combination of these factors has meant that reducing pollution levels within AQMAs remains a challenge for many local authorities.

The revised Defra UK Air Quality Plan (2015) details the Government's plan for achieving the European Union (EU) air quality limit values for NO_2 in the UK. It was produced largely in response to the EU infraction proceedings for non-compliance with limit values and sets out targeted local, regional and national measures for reducing NO_2 in towns and cities across the UK. Defra's Air Quality Plan reinforces the requirement for local authorities to focus strongly on local actions to address the problem not only to comply with the UKs legal obligations but fundamentally to protect the health of its residents.

The measures necessary to improve air quality are multifaceted requiring a combination of improvements in vehicle technology and testing regimes but also the means to encourage individuals and businesses to make long term changes to their transport choices. To generate further improvements in air quality the focus needs to be on reducing vehicle miles, improving individual vehicle emissions and incentivising modal shift to public transport and active travel options. To instigate these changes it is generally accepted that there needs to be a combination of incentives and penalties to encourage movement away from higher pollution transport options to more sustainable/ low emission options.

In Merton a range of measures to influence transport choices have been initiated through the AQAP. This study considers whether the introduction of an emissions based parking levy for residential and business permit holders would be an effective means of incentivising the uptake of low or zero emission vehicles and stimulating more residents to switch to public/shared transport and active travel, such as walking and cycling, as an alternative to private car ownership. To do this, charging level of the permits would be based on vehicle emissions with the most polluting vehicles being charged at a higher rate, following the 'polluter pays' principle. Vehicle owners with zero emission cars would benefit by being exempt.

The overall aim of the scheme is to influence residents and business users to consider changing to low or zero emission cars with any revenue derived from the scheme reinvested to support local sustainable transport initiatives and necessary infrastructure. Successful introduction of this type of scheme demonstrates the local authority's commitment to reducing emissions and improving air quality towards national objectives.

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[6] Public Health England – Public Health Outcomes Framework – Merton data http://www.nepho.org.uk/pdfs/public-health-outcomes-framework/E09000024.pdf

[7] London Borough of Merton AQ Action Plan Progress Report 2014 http://www.merton.gov.uk/merton_2014_progress_draft.pdf[3] Defra 'Improving air quality in the UK Tackling nitrogen dioxide in our towns and cities' UK overview document December 2015 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/486636/aq-plan-2015-overview-document.pdf

3 THE CASE FOR RESIDENTIAL EMISSIONS BASED PARKING LEVIES

3.1 Scope of the project

Exhaust emissions from vehicles are dependent on many factors including the age (and Euro emission standard), type of vehicle, size of engine and fuel type. Emissions will vary according to the speed that the vehicle is driven at and these can be represented by average speed emission factors to compare emissions from the vehicle fleet. In the UK, the recognised emission factors are from the European Environment Agency from their COPERT 4 model (v10).

Error! Reference source not found., Figure 2 and Figure 3 show annualised NOx, PM_{10} and CO_2 emissions respectively, from a fleet of vehicles made entirely of diesel cars versus one made entirely of petrol cars (the age of the fleet and Euro standards are from the NAEI - National Atmospheric Emissions Inventory for London in 2016). These graphs show that NO_x emissions from diesel cars are much higher than from petrol cars, particularly at very low or very high speeds. PM_{10} emissions are less speed dependent but are also higher from diesels, whereas CO_2 emissions show a similar relationship with speed for both fuel type although are slightly higher from petrol cars.

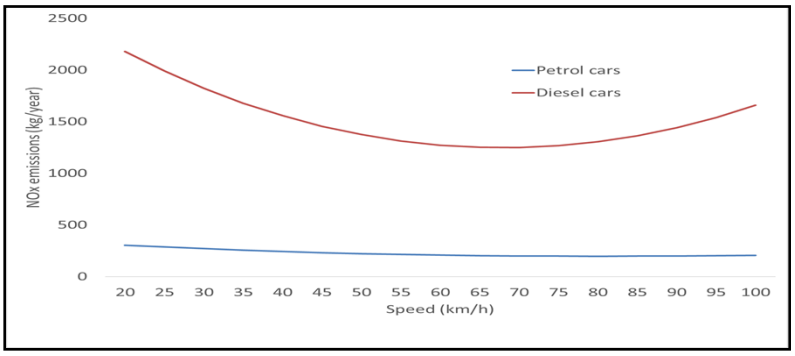

Figure 1: Speed related NOx emissions, petrol Vs diesel cars in London, 2016

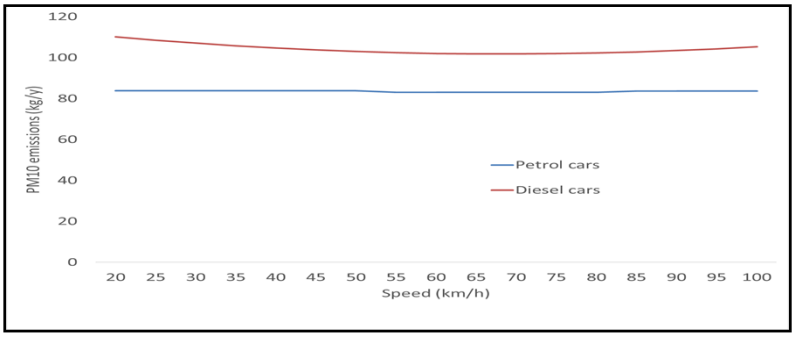

Figure 2: Speed related PM_{10} emissions, petrol Vs diesel cars in London, 2016

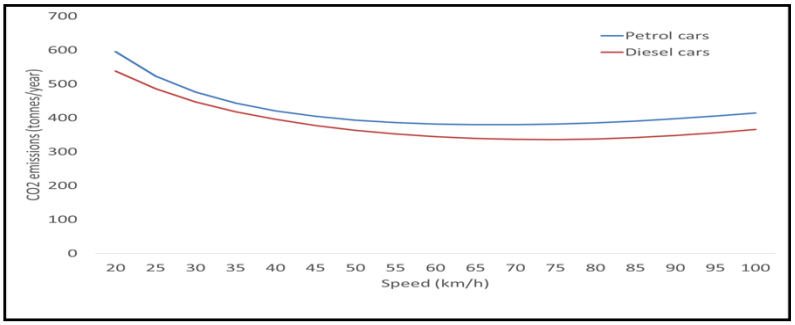

Figure 3: Speed related CO_2 emissions, petrol Vs diesel cars in London, 2016

By comparing more localised and refined data from the London Atmospheric Emissions Inventory (LAEI), the contribution by vehicle type to emissions is illustrated for Merton in Table 1.

Table 1: Annualised emissions for 2015 from the LAEI in Merton in tonnes per year

Vehicle type	Emissions (t/y)		
	CO2	**NOx**	**PM10 exhaust**
Motorcycle	1395.7	1.4	0.1
Taxi	1976.6	7.4	0.3
Petrol Car	48566.8	30.1	0.6
Diesel Car	42063.4	141.2	3.3
Petrol LGV	522.9	0.8	0.0
Diesel LGV	13971.1	49.0	1.6
London Bus	8745.4	49.6	0.3
Coach	3100.4	21.7	0.2
Rigid HGV	11484.7	63.6	0.4
Articulated HGV	3396.4	13.8	0.1

This data shows that the highest emissions are from cars which reflect their dominance in the vehicle fleet. For CO_2 emissions, there is a similar contribution from both petrol and diesel cars (around 30-35% each). The next highest contribution is from diesel light goods vans (LGVs) and diesel rigid Heavy Goods Vehicles (HGVs). **For NO_x and PM_{10} exhaust emissions, it is the diesel cars that dominate emissions.**

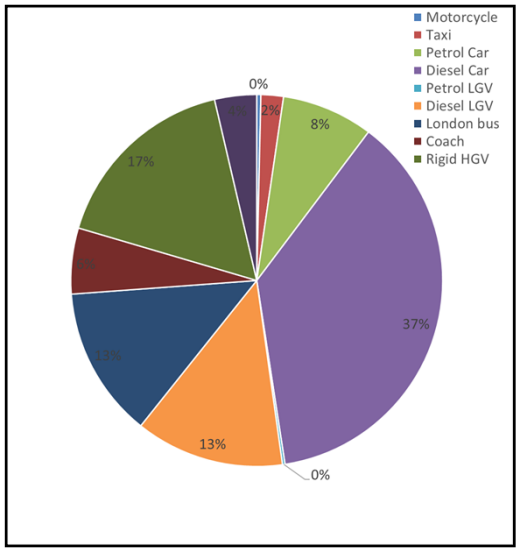

Figure 4: Annual NO_x emissions by vehicle type in Merton, 2015

Based on the findings from this data, the study focuses on a way to use parking controls as a mechanism to reduce the contribution of cars on local emissions. The scope of this study is therefore to primarily investigate introducing an emissions based parking levy for residential parking permits within Merton with an additional consideration of changing the levies for business parking permits.

The study models the effect of introducing a parking levy on residential permits for all diesel vehicles whilst offering free parking permits for all 'plug-in' or other zero emission technologies. The parking charge for petrol vehicles has been held level in the first phase to acknowledge that there is currently insufficient infrastructure to support a mass transition to electric vehicles and that petrol vehicles are generally less polluting in terms of NO_2, PM_{10} and $PM_{2.5}$ than diesel-fuelled vehicles.

There is scope to consider further differentiation of petrol vehicle emissions by applying different banding systems based on emissions and to consider their likely impacts on local air quality pollutants and CO_2 emissions. This method could be applied to future scenarios to encourage further transition to zero emission vehicles and as the local infrastructure expands to meet future demand. There is a

growing body of evidence suggesting that parking management in regulated car parks and on-street can be applied to create more balanced choices between alternative modes of transport[8]. The RAC has recognised the impact of inefficient parking on congestion and vehicle emissions and has called for better provision of information to ensure efficient vehicle parking, and a more consistent approach to pricing, both to cover the direct costs of parking and as a tool to manage congestion[9]. Parking management can also be used to encourage less-polluting vehicles, by means of establishing priority or dedicated parking, or reduced charges for zero or low emission vehicles. Examples of such policies already implemented in the UK include designated parking for electric vehicles, car-club vehicles and car-share vehicles, or lower parking charges for vehicles that meet a specific emission standard. This kind of scheme represents an alternative to a formal LEZ, and can potentially be enforced more easily through existing parking enforcement powers.

There a number of local authorities that have introduced emissions based charging structure for residential parking, based on CO_2 emissions. Some of these are used to encourage owners to purchase a low or zero emission vehicle by offering a discount to these only (e.g. Milton Keynes, Richmond, Westminster and York), whilst others have introduced a banding system where charges vary based on engine size and/or emissions. The aim of all these schemes are to encourage residents to consider the effect their vehicle has on emissions and effect a behavioural change, i.e. by moving to lower emission vehicles or those with smaller engine sizes.

In London, there are a large number of boroughs that have already introduced differential charges based on emissions, including;

Islington – In 2010, the Council introduced 13 bands based on engine size for older vehicles or CO_2 emissions (based on the Driver Vehicle Licensing Agency, DVLA's vehicle excise duty, VED bands) for newer vehicles. From 2015, a £96 surcharge was added to diesel vehicles with various exemptions applied. The maximum annual residential parking charge is currently £540 (see summary of annual charges in Table 2).

Band	Pre-2011 vehicle (engine size)	Post 2011 (CO2 g/km)	Petrol or alternative fuelled cars	Diesel cars
A	Electric	0-100	Free	N/A
B	1-900	101-110	£15.90	£111.90
C	901-110	111-120	£28.70	£124.70
D	1101-1200	121-130	£75.80	£171.80
E	1201-1300	131-140	£92.15	£188.15
F	1301-1399	141-150	£99.30	£195.30
G	1400-1500	151-165	£123.90	£219.90
H	1501-1650	166-175	£142.50	£238.50
I	1651-1850	176-185	£167.00	£263.00
J	1851-2100	186-200	£211.00	£307.00
K	2101-2500	501-225	£246.00	£342.00
L	2501-2750	226-255	£344.00	£440.00
M	>2751	<256	£444.00	£540.00

- **Camden** – Camden was one of the first boroughs

aea_air_quality_report_hitchcock_et_al_jun e_2014.pdf

[8] Bates, L. & Leibling, D. (2012). Spaced Out: Perspectives on parking policy. London: RAC Foundation. ates_leibling-jul12.pdf

to introduce this type of scheme in 2007. There are 4 charging bands for older vehicles (before 2001) based on engine size and 4 bands for newer vehicles (after 2001) based on CO_2 emissions with a maximum annual charge of around £270. There is also a diesel surcharge of £10 per vehicle and an additional charge for second or third car.

- **Kensington and Chelsea** – From 2014, there have been 9 charging bands with a £19 annual surcharge for diesel vehicles. The maximum annual charge for a single owned vehicle is £231. Higher charges are applied for multiple vehicles.

Band	Pre-2011 vehicle (engine size)	Post 2011 (CO2 g/km)	Petrol or alternative fuelled cars	Diesel cars
A	Electric	0-100	Free	N/A
B	1-900	101-110	£15.90	£111.90
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D	1101-1200	121-130	£75.80	£171.80
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Table 2: Example of an emissions banding residential permit system in Islington (annual charges)

Information from Islington has showed that there has been an increase in the number of lower emission vehicles (Bands A and B) from 6.3% to 13.5% and a decline in the highest banded vehicles (Bands L and M) from 9.2% to 6.7% in the last 7 years (see Figure 5).

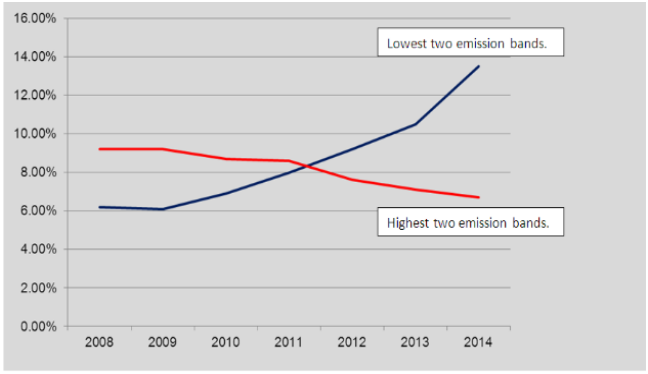

Figure 5: Change in proportion of lowest and highest banded vehicles with residential parking permits in Islington[10]

3.2 Current Permit Charges

Vehicle type	Diesel	Electric diesel	Electricity	Gas fuel Duel	Hybrid electric	Petrol	Grand Total
Motorcycle						5	5
Car	4,731	12	5	14	237	9,274	14,273
Car Van	132					6	138
Van	264			2		20	286
HDV	1						1
Grand Total	5,128	12	5	16	237	9,305	14,703

In Merton, currently an annual residential parking permit costs £65 for the first car, £110 for the second car and £140 for a third car to renew (or half the cost for 6 months). Households can also purchase a single permit for more than one car as long as only one is on the road at one time. Parking permits are provided for specific zones, with some permits applicable to more than one parking zone. There is currently a one off £25 administration fee to purchase a new permit.
The Council provided a list of the vehicle registration plates of these vehicles with information on whether the vehicle is the first, second or third or more car.

There are 15,074 unique residential parking permits in Merton. The vehicle registration numbers of these vehicles were sent to the Department for Transport (DfT) to obtain details from the DVLA database on vehicle make and model, fuel type, engine size or gross weight and date of first registration. 371 vehicles could not be matched to the DVLA database. It is likely that these were foreign or diplomatic vehicles, or perhaps that the registration had been recorded incorrectly or an error had been made.

A summary of the matched vehicles by vehicle type is given in Table 3. It can be seen that as expected, the vast majority of residential permits are allocated to cars (97%). Additional information on these vehicles in terms of fuel type is given in Table 4. This data showed that of these vehicles, 63% are petrol and 35% diesel fuelled as illustrated in Figure .

Table 3: Residents parking permits: Vehicles identified from number plate details in Merton, 2015

Vehicle type	Number
Motorcycle	5
Car	14,273
Car Van	138
Van	286
Heavy duty vehicle	1
Grand Total	14,703

Table 4: Residents parking permits: Vehicle split by fuel type

[10] http://democracy.islington.gov.uk/documents/s3051/Diesel%20Surcharge%20on%20Permits%20Executive%20January%202015.pdf

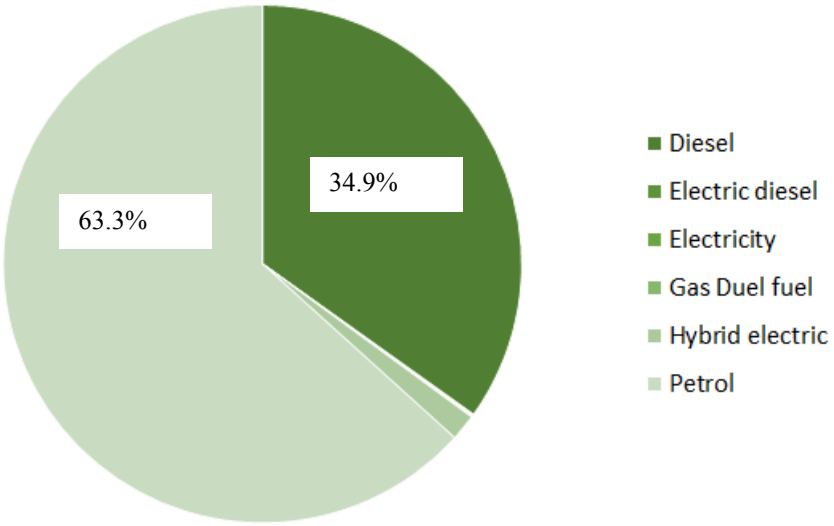

Figure 6: Residents parking permits: The percentage split of fuel use

The study further analysed this data to derive the vehicle's Euro emission standard. This was determined based on a number of parameters including vehicle type, engine size and date of first registration. This information is presented in Figure 7 for petrol vehicles and Figure 8 for diesel vehicles. The data shows that the majority of petrol vehicles are made up of cars, and these are mainly of Euro 4 standard (i.e approximately 10 years old), with also a high number of Euro 3 (>15 years old) and Euro 5 vehicles (around 5 years old). There are fewer older petrol vehicles (ie. Pre-Euro 2 more than 20 years old) and few of the newest Euro 6 vehicles (vehicles registered after 2014). The diesel fleet was generally newer, with the highest number of Euro 5 vehicles (from 2011) which reflects the recent shift to purchase diesels. The reasons for this may be due to the fact that diesel vehicles have lower CO_2 emissions and have been incentivised by the government through schemes such as discounted car tax to reflect this.

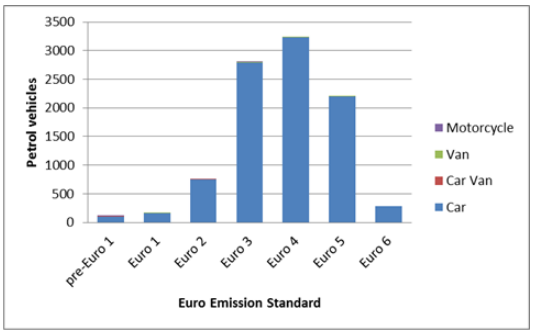

Figure 7: Residents parking permits: Number of petrol vehicles by Euro Standard

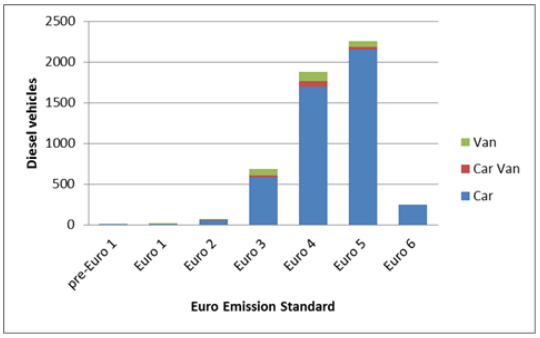

Figure 8: Residents parking permits: Number of diesel vehicles by Euro Standard

3.3 Parking levy options

Based on this data, this study has considered the impact of vehicle emissions in Merton that accounts for both direct and indirect air pollution impacts resulting from vehicle use, i.e. the direct local exposure to NO_2 and particulates and the indirect climatic effects caused by CO_2. This is in contrast to the majority of existing low emission parking schemes which are primarily based on CO_2 emissions or fuel consumption alone.

Recent evidence has shown that some diesel vehicles have very low fuel consumption and hence low CO_2 emissions for a given journey but they produce disproportional emissions such as NO_X and particulates. More so recent evidence is emerging that regulated emissions from certain vehicles on the road are possibly higher than vehicle manufactured specifications suggest. For example, findings from the International Council on Clean Transportation (ICCT) showed that modern diesel cars have low on-road emissions of carbon monoxide and hydrocarbons but unsatisfactory emissions of real world NO_x and PM emissions. Their report showed that the average on-road emissions of NO_x were 7 times the certified emission limit for Euro 6 diesel vehicles and that there was a significant range between the vehicles tested (ICCT, 2014). The reasons for this are partly due to the configuration of engine management systems and also the general performance of devices fitted to vehicles to regulate emissions which degrade over time. Clearly, vehicle emissions are annually tested as part of the MOT but there is currently no test for NO_x.

The low emission vehicle parking levy system ideally should therefore be associated with on road performance rather than manufactured specifications. On this basis this study is recommending an approach which links all vehicles to an acceptable emissions factor database published by the NAEI. The problem is that emissions factors are generally based on a prescribed driving cycle which incorporates changes in speed. Emission factors such as COPERT 4 are then published for a given average speed as described in Section 4.1. In order to derive emissions it was assumed that all vehicles in the Merton parking scheme would be driven at some stage and that 25 km/h is the average speed in most cases. By combining the NO_X and CO_2 emission rates (g/km) at 25 km/h it is possible to derive total vehicle emissions.

3.3.1 Impact of Diesel Surcharge - and exemption for all electric vehicles

The principle of adopting a parking levy has been tested for the purposes of the study by considering the impact of a surcharge on diesel cars and zero charge for electric vehicles. This test does not take into consideration any changes which would occur, sensitivities around this are outlined in tests 1, 2 and 3. Table 4 shows there are 4,731 diesel cars and 132 diesel car derived vans under 3.5 tonnes with residential permits in Merton. The surcharge charge would only apply to these vehicles. There are 264 light goods vehicle vans (over 3.5 tonnes) that have residential parking permits. Under this test, electric vehicles would have zero charge.

3.3.2 Impact of Diesel Parking Levy on emissions

The following three sensitivity tests were considered to look at the change in annualised emissions compared to the base case fleet. For this part of the study vehicles holding an existing parking permit were divided into the following 5 bandings, based on emissions:

- Band 1 (Zero emission vehicles) Electric
- Band 2 (<10 g/km combined NOx/CO2)
- Band 3 (<90 g/km combined NOx/CO2)
- Band 4 (<170 g/km combined NOx/CO2)
- Band 5 (>170 g/km combined NOx/CO2)

The vehicle bandings were applied to the existing vehicle base case fleet.

Table 5: Division of current Merton residential permit vehicles into emission bandings.

Vehicle		Low emissions			High emissions	
	Engine Size or Gross Vehicle Weight (GVW)	Band 1	Band 2	Band 3	Band 4	Band 5
Petrol car	<1400 cc	0	1,316	2,449	55	26
Petrol car	1400-2000 cc	0	1,005	3,417	76	48
Petrol car	>2000 cc	0	0	940	127	69
Diesel car	<1400 cc	0	0	1	108	0
Diesel car	1400-2000 cc	0	0	168	2,811	0
Diesel car	>2000 cc	0	0	81	664	959
Petrol car derived van	1400-2000 cc	0	0	1	0	2
Diesel car derived van	<2000 cc	0	0	0	83	0
Petrol Van	<3.5t	0	4	9	0	9
Diesel van	<3.5t	0	0	0	0	264
Electric	Electric	5	0	0	0	0
Grand total						14,697*

Three tests have been applied to the base case to evaluate the impact on emissions of applying a parking levy to diesel vehicles.

- **Test 1.** All diesel cars are removed from the fleet
- **Test 2**. 10% of diesel cars in base year are switched to a minimum Euro 5 petrol variant. It is assumed that this effect is random. To do this, the first 10% vehicles in the database are modified which amounted to 474 vehicles.
- **Test 3.** 30% of diesel cars in base year are switched to a minimum Euro 5 petrol variant. It is assumed that this effect is random. The first 30% vehicles in the database are modified.

It was considered more appropriate to evaluate the impact of these options with respect to the change in annualised NO_X emissions from the base case rather than in terms of the impact on NO_2 concentrations at the roadside (which was originally proposed).

Base case

Annualised NO_x emissions were determined by each emission band for the base case. These results are given in Figure 9.

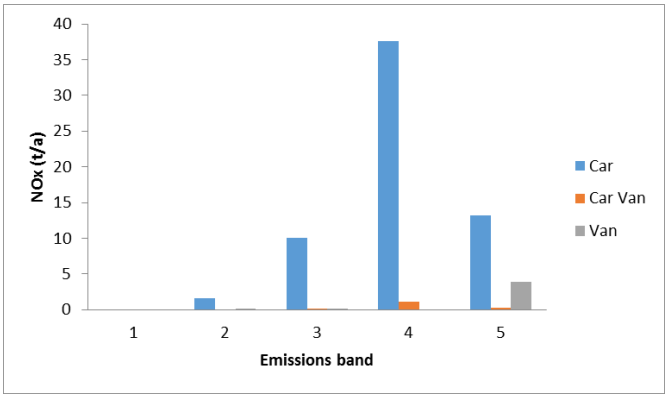

Figure 9 1: Base case annualised NOx emissions from vehicles with parking permits by emission band (1=cleaner vehicles)

Test 1: Removal of diesel cars

Test 1 involves analysing the effect on emissions if all diesel cars were replaced by petrol variants. The results are shown for NO_x emissions in Figure 9. The reduction in NO_x emissions is quite dramatic, particularly in band 4. Overall, this would result in a reduction of annualised NOx emissions by approximately 63%.

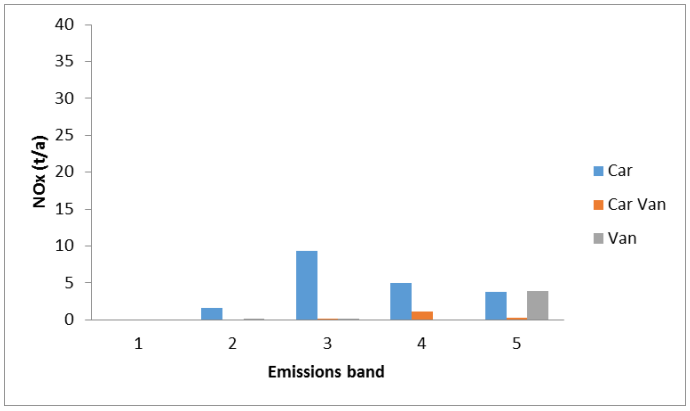

Figure 10: Test 1 - Annualised NO_x emissions with zero diesel cars in the parking permit fleet

Test 2 – 10% diesel cars switched to Euro 5 petrol equivalent

Test 2 analyses the effect on NOx emissions if 10% of residential permit holders could be persuaded to switch their diesel car to a Euro 5 petrol equivalent. The impact on NO_x emissions are shown in Figure 11.

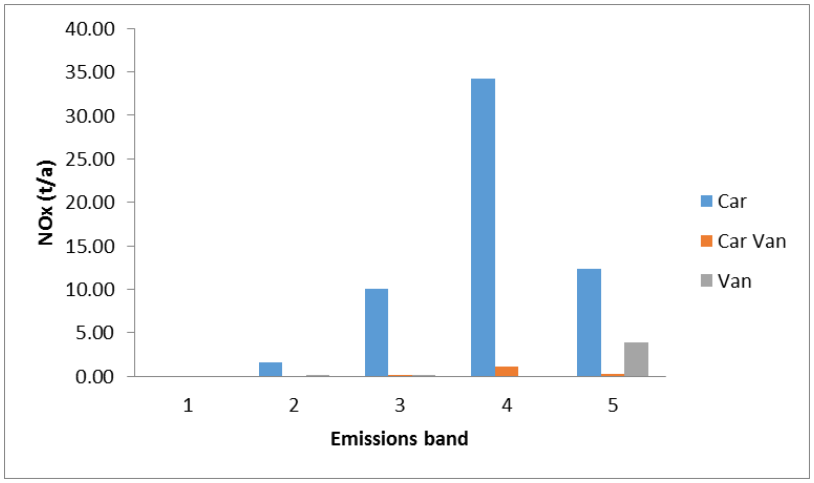

Figure 21: **Test 2 - Annualised NO_x emissions with 10% diesel cars switching to petrol equivalent**

Test 3 – 30% diesel cars switched to Euro 5 petrol equivalent

Test 3 is similar in principle to Test 2. This analyses the effect on NO_x emissions if 30% of residential permit holders could be persuaded to switch their diesel car to a Euro 5 petrol equivalent. The impact on NO_x emissions are shown in Figure 12.

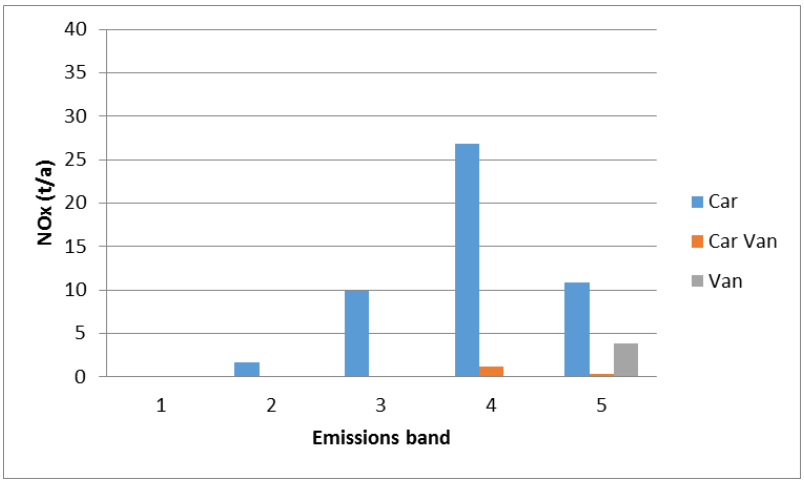

Figure 12: Test 3 - Annualised NO_x emissions with 30% diesel cars switching to Euro 5 petrol equivalent

Figure 11 shows that this test could reduce NO_x emissions from diesel vehicles in bands 4 and 5 as expected. The switch appears to have a negligible effect on bands 2 and 3 where the majority of petrol vehicles are due to the fact that the test assumes a shift to Euro 5 petrol. Overall the test estimates a 20% reduction in NO_x emissions.

3.3.3 Transition to Low/Zero Emission Vehicles

It is difficult to evaluate the impact of implementing a diesel parking levy on the uptake of zero/low emission vehicles. People that decide to purchase an electric vehicle are probably less influenced by preferential parking charges and more so by the way their vehicle is used on a daily basis and are likely to have an element of altruism in terms of their buying behaviour. There is also the need to consider the capacity of existing infrastructure, which may limit the opportunity for resident's to adopt low emission vehicle technology in the short term.

Introducing a low emission parking permit scheme for residential parking provides an incentive to discourage the most polluting vehicles. This can be an effective means of promoting behaviour change but can also be accompanied by complementary measures and incentives to encourage residents to choose other sustainable transport options. These may include purchasing Ultra Low Emission vehicles (ULEV) and reducing car use by switching to other modes of transport.

The rate of adoption of ULEVs is determined by a number of factors but primarily comes down to cost and convenience for the motorist. Government subsidies for the purchase of ULEVs has increased uptake of electric vehicles across the UK with registrations rising from 500 per month at the start of 2014 to an average of around 2,400 per month during 2015. As a percentage of new car registrations, electric cars now represent just over 1% of the total new car market in the UK (Society of Motor Manufacturers and Traders 2016). However, it is acknowledged that the cost of purchasing a new vehicle is still prohibitively expensive for a large section of society.

In terms of convenience, the accessibility of charging facilities also has a bearing on the attractiveness of adopting ULEVs. TfL has produced a fact sheet detailing charging facilities by London Borough and there are currently 1,400 charging points across London. There is currently a

lack of charging infrastructure in south London, for example Merton currently only has 6 public charging points, Richmond has 10, Sutton has 19 and Wandsworth has 24. This lack of local charging points could be seen as barrier to increasing the uptake of electric and hybrid vehicles in the short term and therefore improvements to the necessary infrastructure should be provided.

Other sustainable transport options have been promoted through the Merton AQAP including two public car clubs, the London Cycle Network, Walk-it scheme and development of green travel plans for businesses and schools. Merton is also committed to improving access to public transport and has used planning agreements to generate new car free developments as part of their overall plan to improve air quality.

The proposed low emissions parking levy, if adopted, would provide the Council with an opportunity to raise resident's awareness of the impact of emissions from their vehicles on local air quality and could provide an effective prompt to those considering changing their vehicle.

The scheme would benefit from additional public engagement prior to implementation to ensure that permit holders understand the justification for changes in the permit costs and are fully aware of the available opportunities for reducing emissions and minimising the personal impact of the levy.

3.4 Summary

This analysis was conducted to understand what effect the implementation of a resident's parking permit levy on diesel cars would have on reducing direct and indirect emissions. Emissions were calculated as a function of NO_x s over a limited number of vehicle types driven at a constant average speed and over a distance each year.

The idea behind this approach was to provide a parking levy system that reflects road emissions rather than the manufacturing specification.

To test the impact of implementing a diesel parking levy on revenue, a surcharge was applied to the existing residential parking permit fleet. Three further tests were undertaken to investigate the sensitivity on emissions for certain shifts in vehicle ownership due to the proposed parking levy.

The change in annual emissions was not estimated for the surcharge option as there is no real understanding as to people's preference to pay versus the preference to change vehicle types.
This could only realistically be achieved via public consultation to understand these preferences. For example, if the surcharge of £100 for diesel parking permits was found to be sufficient for everyone to switch to petrol variants (i.e. eliminating diesel cars and car vans), then an estimated reduction in annualised NO_x emissions of 60% (Test 3) would be possible.

4 BUSINESS EMISSION BASED PARKING LEVIES

4.1 Introduction

Business parking permits are only issued in Merton for vehicles that are essential for business and there is a limit of two permits per business. The business parking permits are issued for six months at a cost of £331 for all zones except for Wimbledon town centre where permits cost £376. There is a £25 administration fee for new permits, as for the residential permit system. The London Borough of Merton provided a list of the number plates and tariffs paid for all vehicles registered in the scheme, of which there were 324 unique vehicles. These number plates were sent to the DfT for analysis against the 2015 DVLA database whereby 311 vehicles were able to be matched and 13 unmatched. Nine of the 13 unmatched vehicles were registered in 2016 so vehicle details of these had to be determined manually the remaining four were discounted as having misread plate details. Of these matched vehicles, 90% of the vehicles were cars. A summary of the vehicle statistics are given in Table 6.

Table 6: Business parking permits – summary of vehicle types

Vehicle type	Number
Motorcycle	1
Car	288
Car derived van	14
Van	17
Heavy duty vehicle	0
Grand Total	320

The split of petrol and diesel vehicles was relatively even with 51% petrol and 49% diesels. This was in contrast to the residential permits where 64% of vehicles were petrol. This higher number of diesel vehicles for business use is likely to be due to company tax incentives and the higher mileage driven by businesses. The breakdown of these vehicles by Euro emission standard is shown for petrol and diesel vehicles in **Error! Reference source not found.**3. The analysis shows that petrol vehicles are dominated by cars of which there are mainly Euro 4 and Euro 5 vehicles. As for the residential permits, there are a higher number of newer diesel vehicles in the fleet with primarily Euro 5 vehicles but a lower number of the newest Euro 6 vehicles which may be reflecting a recent switch away from diesels.

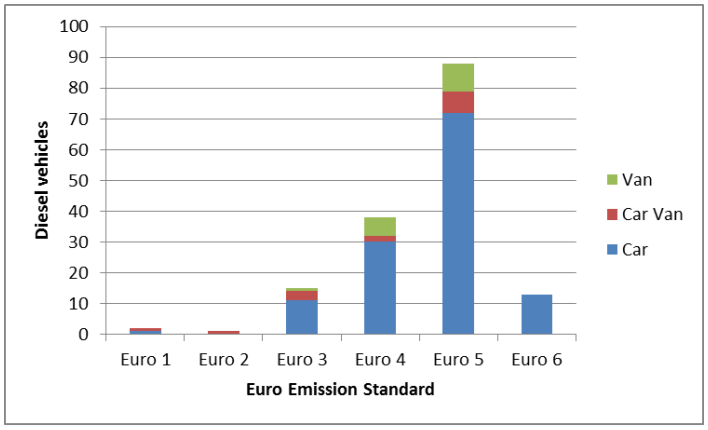

Figure 13: Business parking permits: Number of diesel vehicles by Euro Standard

*Excluding the motorbike from analysis

Impact –of surcharge for diesel cars and exemption for all electric vehicles

The impact of an annual surcharge on diesel cars was modelled. It is noted that car derived vans and LGVs are excluded because there currently no practical alternative variants for owners to procure. In the case of business permits, as these are paid every six months it is assumed that this surcharge equates to each six months. It is noted that at present there are no electric vehicles with business permits.

4.2 Impacts of options on emissions

In the same manner as for the residential parking permits, the following five sensitivity tests were considered to examine the change in annualised emissions compared to the base case fleet.

- **Test 1.** All diesel cars are removed from the fleet
- **Test 2**. 10% of diesel cars in base year are switched to a minimum Euro 5 petrol variant. It is assumed that this effect is random. To do this, the first 10% vehicles in the database are modified which amounted to 474 vehicles.
- **Test 3.** 30% of diesel cars in base year are switched to a minimum Euro 5 petrol variant. It is assumed that this effect is random. The first 30% vehicles in the database are modified.

To determine annualised emissions it was assumed that each vehicle travelled an average distance each year of (~32,000 kilometres) for business usage at an average speed (25 km/h) to be able to compare the impacts of each option.

Base case

Annualised NO_x emissions were determined by each emission band for the base case. These results are given in Figure 14.

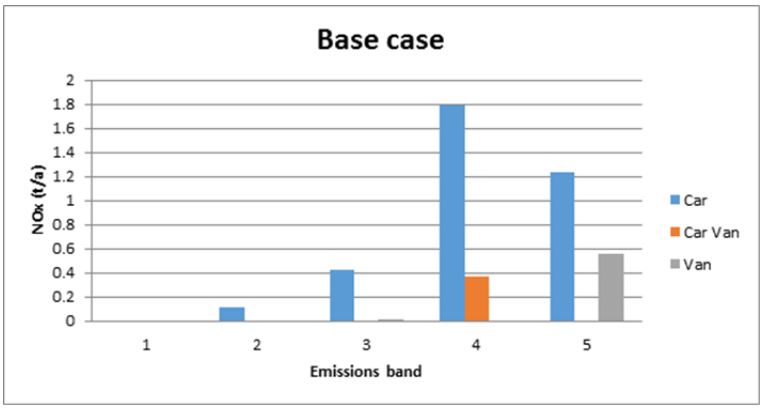

Figure 14: Base case annualised NOx emissions from vehicles with parking permits by emission band (1=cleaner vehicles)

Test 1: Removal of diesel cars

Test 1 involves analysing the effect on emissions if all diesel cars were converted to petrol variants. The results are shown for NO_x Figure 15. Overall, this policy would result in a reduction of annualised NOx emissions by approximately 63%.

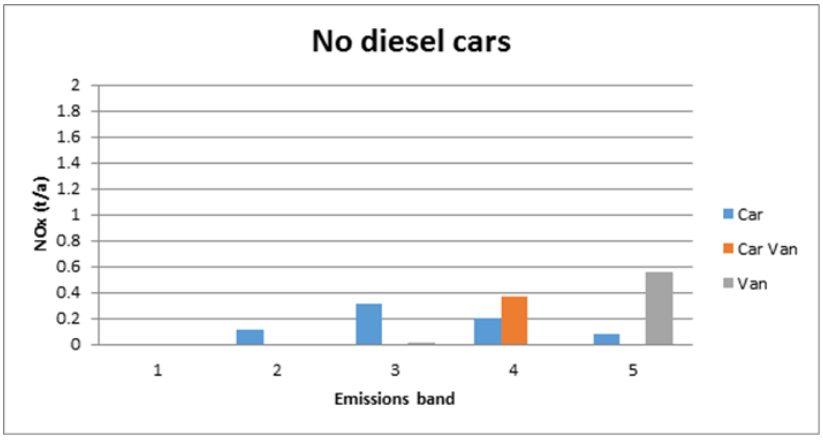

Figure 15: Test 1 - Annualised NO_x emissions with zero diesel cars in the parking permit fleet

Test 2 – 10% diesel cars switched to Euro 5 petrol equivalent

Test 2 analyses the effect on NOx if 10% of business permit holders could be persuaded to switch their diesel car to a Euro 5 petrol equivalent. The impact on NO_x emissions are shown in Figure 16.

The change in the profile of emissions from the base case is not immediately obvious from the figures compared to the baseline. However, there would be an overall reduction in NO_x emissions by 6% compared to the base case.

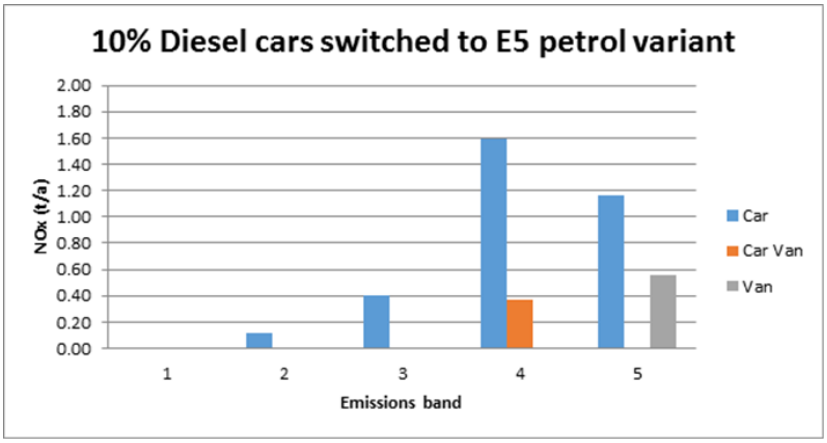

Figure 16: Test 2 - Annualised NO_x emissions with 10% diesel cars switching to petrol equivalent

Test 3 – 30% diesel cars switched to Euro 5 petrol equivalent

Test 3 is similar in principle to Test 2. This analyses the effect on NO_x emissions if 30% of business permit holders could be persuaded to switch their diesel car to a Euro 5 petrol equivalent. The impact on NO_x emissions are shown in Figure 17.

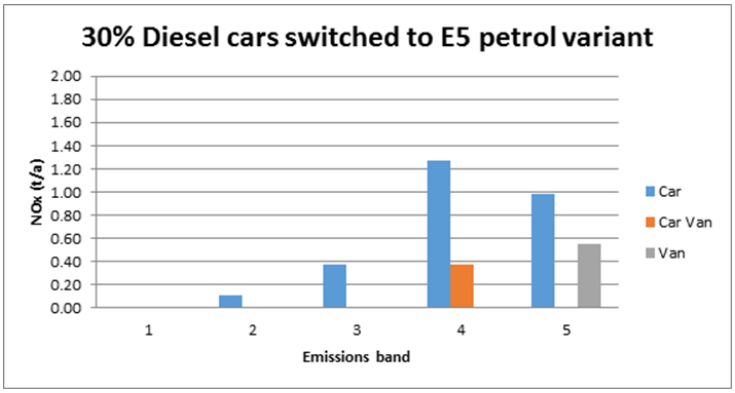

Figure 173: Test 3 - Annualised NO_x emissions with 30% diesel cars switching to Euro 5 petrol equivalent

.

This shows that this test could reduce NO_x emissions from diesel vehicles in bands 4 and 5 as expected. The switch appears to have a negligible effect on bands 2 and 3 compared to Test 4 where the majority of petrol vehicles are due to the fact that the test assumes a shift to Euro 5 petrol. Overall the test estimates that there would be an 18% reduction in NO_x emissions compared to the base.

5 CONCLUSION - MAXIMISING OPPORTUNITIES AND RECOMMENDATIONS

The whole of the London Borough of Merton is declared an Air Quality Management Area for nitrogen dioxide (NO_2) and PM_{10} which demonstrates that local air quality is therefore a key public health issue. The local authority has an Air Quality Action Plan that sets out a number of measures to reduce emissions and pollutant concentrations in the borough and to work with the local community and neighbouring or wider authorities to achieve this.

This study has demonstrated an approach for a low emission based residential and business parking permit system in Merton that considers on-road emissions rather than the manufacturing specification. Recent evidence has shown that although modern diesel vehicles (primarily cars) have very low fuel consumption and hence low CO_2 emissions they produce high emissions of local air quality pollutants such as NO_X. The approach taken in this study therefore takes into account the impacts of these pollutants and is considered to be more thorough and rational to many of the low emission parking schemes which are being used by local authorities as these are primarily based on CO_2 emissions or fuel consumption.

The study has considered the impact of implementing a surcharge on all diesel vehicles in the residential and business parking permit fleet. This together with a zero fee for all plug-in electric or hybrid vehicles is designed to encourage local residents to make a transition from diesel to zero/low emission vehicles. A surcharge is not proposed in the early stages of the scheme for petrol vehicles as it is acknowledged that a mass transition to electric/hybrid vehicles is unlikely to be achieved in the short term and petrol provides a viable alternative to diesel given generally lower emissions of air quality pollutants such as NO_x and particulates.

The approach adopted for calculating the impact of applying the diesel surcharge is based on dividing the fleet into 5 emission bands based on a combined emission rates for local air quality pollutants and carbon dioxide. The proposed surcharge scheme means that Merton can continue to charge differing amounts for second and third cars and different amounts for resident and business permits if they wish. It is also clear that the approach also needs to provide a fair system that benefits the environment but that isn't too detrimental to vehicle users. Although there may be an increase in revenue in the first year of a surcharge being applied, it is anticipated that over time this revenue will decline as the diesel fleet decreases, but this has not been tested.

The study has provided a number of recommendations which are summarised below.

1. Further analysis to consider the impact on revenue over a five year period as the fleet improves over time.
2. Consider impact of introducing different parking levies for petrol vehicles based on emission banding to encourage transition of higher emission petrol vehicles to zero/low emission alternatives in the medium to long term.
3. Consider the impact of different surcharge rates on revenue to take into account increased administrative burden to introduce this system and to provide additional investment in infrastructure to meet the needs of residents adopting zero/low emission vehicle technologies.
4. Consider preference surveys or behavioural analysis of residents and businesses to understand the preference of owners to either pay a higher permit change versus the preference to change their vehicle to pay a lower charge. This could help identify what percentage change to charges may be needed to result in the desired change and improvement in emissions.

GLOSSARY

AQAP	Air Quality Action Plan
AQMA	Air Quality Management Area
CAZ	Clean Air Zone
CO_2	Carbon dioxide
COPERT	Computer Programme to Calculate Emissions from Road Transport
Defra	Department of Environment, Food and Rural Affairs
DfT	Department for Transport
DVLA	Driver Vehicle Licensing Agency
EU	European Union
GLA	Greater London Authority
GVW	Gross Vehicle Weight
HGV	Heavy Goods Vehicle
LAEI	London Atmospheric Emissions Inventory
LAQM	Local Air Quality Management
LEZ	Low Emission Zone
LGV	Light Goods Vehicle
LIP	Local Implementation Plan
NAEI	National Atmospheric Emissions Inventory
NHS	National Health Service
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
PM_{10}	Fine particles with a diameter of less than 10 µm
$PM_{2.5}$	Fine particles with a diameter of less than 2.5 µm
TfL	Transport for London
ULEV	Ultra Low Emission Vehicle
ULEZ	Ultra Low Emission Zone

APPENDIX A - AIR QUALITY OVERVIEW

National Air Pollution and Public Health Evidence

Air pollution is increasingly recognised as a major cause of ill health and premature death. The most recent report by The Royal College of Physicians 'Every breath we take: the lifelong impact of air pollution' (February 2016)[11] says that:

- Each year in the UK, around 40,000 deaths are attributable to exposure to outdoor air pollution, with more linked to exposure to indoor pollutants
- Air pollution plays a role in many of the major health challenges of our day, and has been linked to cancer, asthma, stroke and heart disease, diabetes, obesity, and changes linked to dementia.
- Neither the concentration limits set by government, nor the World Health Organisation's air quality guidelines, define levels of exposure that are entirely safe for the whole population.

Ongoing research provides evidence that the impact of poor air quality on an individual's health can start in in the womb and continue through childhood affecting the development of the lungs and other major organs. These effects can have a lasting effect into adulthood, compromising a person's health further as the individual ages and becomes increasingly vulnerable to the effects of air pollution.

The financial cost of air pollution to the United Kingdom has been valued at more than £20 billion per year. This cost is related to the annual mortality burden in the UK from exposure to outdoor air pollution (equivalent to around 40,000 deaths per year) together with the additional impacts of exposure to indoor air pollution such as radon and passive smoking. Poor health caused by air pollution has wide impacts on society, business, and the health service and on individuals who suffer from illness and premature death.

There is no doubt that air pollution has improved significantly in the UK since the smogs of the 1940s & 50s, mainly as a result of the Clean Air Act 1956. However, whilst there has been a reduction in smoke and sulphur dioxide emissions in line with the decrease in coal burning, the change in our lifestyles and the increase in road transport means that many people are now more exposed to NO_2 and particulate matter arising primarily from the transport sector.

In 2012, road traffic in the UK was ten times higher than in 1949 and the total average distance walked each year decreased by 30% between 1995 and 2013. (RCP 2016)[4]

Previous fuel regulations have been effective in reducing sulphur and lead in diesel and petrol but NO_2 and particulates from diesel engines have been poorly controlled and these remain a problem. In the UK today nearly all buses, vans, lorries and approximately 50% of passenger cars run on diesel.

The Environment Act 1995 and associated regulations established the LAQM system, under which all local authorities in England, Wales and Scotland are required to regularly review and assess air quality in their areas against objectives for several pollutants of particular concern for human health.

Where a local authority has identified areas with pollution concentrations in excess of the objectives it is required to designate an AQMA and produce an Air Quality Action Plan (AQAP) detailing the remedial measures to be adopted to tackle the problem within the AQMA. Currently there are more than **700 AQMAs** in UK mostly related to exceedances of NO_2 as illustrated in **Error! Reference source not found.**.

In addition to the LAQM process, the European Union, through the 2008 ambient Air Quality Directive, sets legally binding limits for concentrations in outdoor air of major air pollutants that impact public health such as particulate matter (PM_{10} and $PM_{2.5}$) and NO_2. The EU Air Quality Directive divides the UK into 43 zones and agglomerations with the UK failing to meet the annual mean limit

[11] Royal College of Physicians – Working Party Report (February 2016) https://www.rcplondon.ac.uk/projects/outputs/every-breath-we-take-lifelong-impact-air-pollution

value for NO_2 in 38 of the 43 zones. In addition some parts of London also breached the European hourly NO_2 limit with the maximum limit for more than 18 hours per year being breached within the first few weeks of 2016.

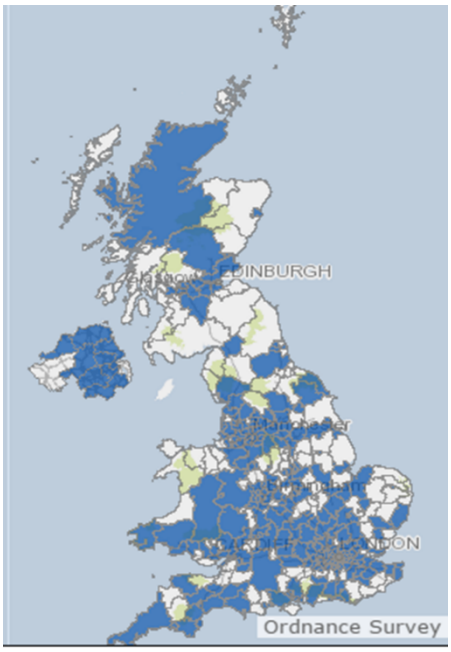

Figure 4: Map of UK Local Authorities with AQMAs (Source: Defra)

As a consequence of the failure to comply with the limit values the UK is currently subject to EU infraction proceedings which may result in the imposition of substantial fines. The UK government have indicated that any fines imposed by the EU may be passed down to local authorities through the discretionary powers under Part 2 of the Localism Act.

In April 2015, the UK Supreme Court ordered the Government to redraft the national action plan to ensure compliance with legal NO_2 limits as soon as possible. Defra's Air Quality Plan aims to try and achieve compliance with the limit values in the shortest time possible. The plan includes the introduction of a national framework for the introduction of Clean Air Zones (CAZs), together with a range of other measures to deliver effective vehicle emission standards and to accelerate the uptake of ultra-low emission vehicles.

APPENDIX B – LONDON AIR QUALITY

Research by King's College London has estimated that air pollution was responsible for up to 141,000 life years lost or the equivalent of up to 9,400 deaths in London in 2010, as well as over 3,400 hospital admissions. The total economic cost associated with this was estimated at £3.7 billion[12] In addition, analysis by Policy Exchange[13] has established that 328,000 children attend schools in London where annual mean NO_2 concentrations exceed the health based objective. This number represents nearly 25% of all pupils in London.

Much has already been done across London to address the air quality problem both at a strategic level and within local boroughs but the magnitude of the problem means that significant improvements still need to be made. The Mayor's first Air Quality Strategy in 2001 instigated the London Congestion Charge Zone, provided investment in public transport and introduced measures to reduce emissions from buses, taxis and HGVs. It also paved the way for introduction of the Low Emission Zone (LEZ) in 2008.

The Mayor's Air Quality Strategy was updated in 2010 introducing additional measures including imposing an age limit for black cabs and private hire vehicles; investment in cleaner hybrid and hydrogen buses; retrofitting/replacing older buses, and investment in public transport. The Mayor's Clean Air Fund also provided £5m to promote innovative pollution reduction measures, such as dust suppressants, green walls and other green infrastructure, and a no engine idling campaign across Central London.

In 2013 the Mayor further extended the Strategy to introduce the London Ultra Low Emission Zone (ULEZ). The ULEZ comes into force in 2020 and will increase restrictions on vehicles travelling in the congestion charge zone. The ULEZ charge will be dependent on vehicle emission standards with only diesel vehicles meeting Euro 6 standards, and petrol vehicles meeting Euro 4 standard being exempt from the additional charge.

In July 2016 the new Mayor of London started consultation on a number of air quality initiatives including the potential extension of and earlier start to the implementation of the ULEZ.

[12][12] 3.8 million people work in parts of London which are above legal limits for NO2 pollution, representing 44% of London's workday population (policy exchange)[6]

[13] Policy Exchange – Capital City Foundation 'UP IN THE AIR: How to Solve London's Air Quality Crisis: Part 1' Richard Howard (2015) http://www.policyexchange.org.uk/publications/category/item/up-in-the-air-how-to-solve-london-s-air-quality-crisis-part-1

APPENDIX C – MERTON AIR QUALITY

The London Borough of Merton is a south London borough covering an area of 15 square miles and a population of 203 200 (Office of National Statistics 2014). It is a predominantly residential area with the main commercial areas centred in Mitcham, Morden and Wimbledon. Merton declared a borough-wide AQMA in 2003, based on exceedance of the annual mean objectives for both NO_2 and PM_{10}. The Detailed Assessment report[14] produced by Merton identified the main source of pollution as being from road traffic particularly on busy and congested routes within the borough together with elevated background levels generated from the wider surrounding urban areas. The pollution contour map reproduced in **Error! Reference source not found.**1 provides the predicted annual mean NO_2 concentrations for 2015 from this report and clearly identifies elevated concentrations on the principal roads through the Borough including the A3 trunk road, the A24, the A217, A236, A237 and A296.

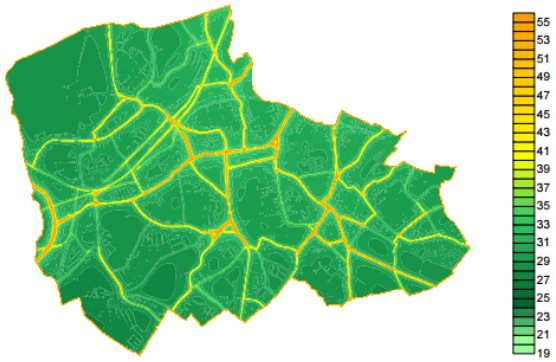

Figure 1: Modelled annual mean NO_2 concentrations (µg/m^3) in Merton, 2015

Figure 2 shows that the number of days exceeding the daily mean PM10 objective (of no more than 35 days) is only likely to be exceeded on a small section of the London Road (A236) on the south east boundary of the borough.

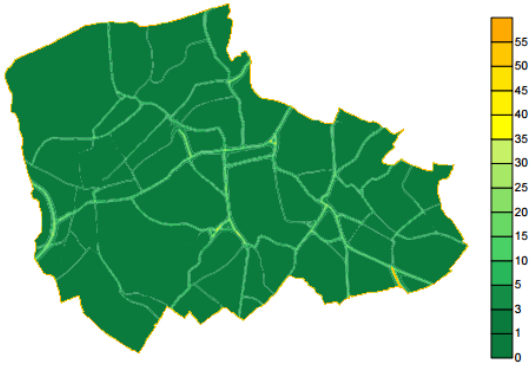

Figure 2: Modelled daily mean PM_{10} (number of days exceeding 50 µg/m^3) in Merton, 2015.

Merton produced their AQAP in 2003 setting out measures to improve air quality across the borough and ultimately to achieve compliance with the UK air quality objectives. Sixteen of the 32 original action plan measures have been completed, are ongoing as statutory functions undertaken by the Council, or have become redundant due to changes implemented by others. Completed actions include improving the Council's vehicle fleet; establishing two public car clubs; the introduction of a number of 20mph 'Home zones'; the adoption of supplementary planning guidance on air quality and the use of Section 106 planning agreements to bring forward 6 car free developments. Other

[14] London Borough of Merton Air Quality Detailed Assessment, 2003

measures have promoted active travel campaigns and supported the development of sustainable school and business travel plans.

Ongoing and current action plan measures include the introduction of controlled parking zones; improving access to sustainable travel modes and development of Freight Quality Partnerships through work with the local business community. Merton have tracked the progress of individual action plan measures since inception and continue to monitor air pollution across the borough through the monitoring network based on two long term automatic stations and a series of diffusion tube sites.

The latest available monitoring data is available from the 2015 Updating and Screening Assessment, which indicates that the annual mean NO_2 objective was exceeded at six monitoring sites during 2014, these were all roadside sites at various locations across the borough including Morden, Wimbledon, Merton High Street, Colliers Wood and Raynes Park. There were no measured exceedances of either the short or long term PM_{10} objectives in 2014.[15]

[15] London Borough of Merton Air Quality Updating and Screening Assessment in fulfilment of Part IV of the Environment Act 1995 LAQM (June 2015).

APPENDIX D – LOCAL POLICY DRIVERS

In addition to the AQAP there are additional local policy drivers linking transport and health. This includes the Merton Annual Public Health Report 2015 entitled, *'The Time for Prevention is Now - Keeping People Healthy Reduces Health Inequalities*'[16]. This is the second annual public health report for Merton which makes the case for prevention and recognises the work of the Public Health team and its partners since the transition of public health from the NHS to local government.

Within the report, Theme 5: 'A good natural and built environment' encourages the transition to more sustainable transport initiatives within the borough by, 'Promoting and enabling sustainable 'active' travel modes such as walking, cycling and using public transport, enables people to integrate increased physical activity levels into their everyday lives'.

By coordinating efforts to increase active travel and reduce dependence on car travel there are clear benefits to health, both in terms of increasing physical activity but also in reducing harmful emissions to air.

[16] Merton Annual Public Health Report 2015 entitled, 'The Time for Prevention is Now - Keeping People Healthy Reduces Health Inequalities'. http://www.merton.gov.uk/annualpublichealthreport2015-web.pdf

APPENDIX E - LEGAL FRAMEWORK FOR EMISSIONS BASED PARKING LEVIES

The key legal framework for allowing for parking operation and enforcement duties comes under the Road Traffic Regulation Act 1984 and Road Traffic Act 1991. Designation of parking is achieved through traffic regulation orders.

The Road Traffic Act 1991 provides local authorities with the power to enforce parking activities themselves rather than the police (i.e. decriminalising parking enforcement). Under these powers, local authorities can issue fines or parking tickets. Under Sections 45 and 46 of the Road Traffic Regulation Act 1984, Councils can designate parking places on the highway, to charge for parking in these places and to make a charge for parking permits for their use. Local authorities can also introduce differential permit charges between vehicles of different classes based on factors including their level and type of emissions. Exemptions to these charges may be granted, for example for disabled drivers, carers, tradespeople including taxis.

Under this act, the function of setting charges for permits and vouchers must, be exercised to "*secure the expeditious, convenient and safe movement of vehicular and other traffic (including pedestrians) and the provision of suitable and adequate parking on and off the highway...*" so far as practicable having regard to:

a) the desirability of securing and maintaining reasonable access to premises;
b) The effect on the amenities of any locality affected and the strategy prepared under section 80 of the Environment Act 1995 (national air quality strategy);
c) the importance of facilitating the passage of public service vehicles and of securing the safety and convenience of persons using or desiring to use such vehicles; and
d) any other matters appearing to the local authority to be relevant (section 122 of the 1984 Act)

In London, local authorities must also have regard to the Mayor of London's Transport Strategy (sections 142 and 144(1)(a) Greater London Authority Act 1999) which emphasises the importance of reducing emissions and improving air quality.

Other relevant guidance for consideration include the Secretary of State's non statutory Operational Guidance on Parking that recommends that authorities set charges which are consistent with the aims of their transport strategy including road safety and traffic management strategies. For example, Merton's Sustainable Transport Strategy and Local Implementation Plan (LIP) for 2011-2026 states that they will review, introduce or enhance existing parking controls subject to consultation. The LIP also has an important role in supporting Merton's Air Quality Action Plan in working to reduce emissions associated with transport[17].

It is unlawful for a Council to set or increases charges for parking permits for the purpose of generating additional income to fund its traffic management functions. In the event that the impact of the proposed new charges generates a surplus over and above the cost of the on street parking scheme and its administration and enforcement, the Road Traffic Regulation Act 1984 requires that surpluses are used for specific transport purposes as listed in section 55(4) of this act and amended by more recent regulations including the Greater London Authority Act 1999, the London Local Authorities and TfL Act 2003 and the Traffic Management Act 2004. These schemes include:

- Provision and maintenance of off-street parking facilities
- Provision and operation of (or facilities for) public transport services
- Highway improvements
- Other schemes that facilitate the implementation of the Mayor's Transport Strategy
- Roads maintenance
- Environmental improvements

Any shortfall or deficient as a result of the emission based parking scheme is required to be made good from the general rate fund (i.e. the Council tax).

[17] http://www.merton.gov.uk/merton-lip2-only-web.pdf

There is already precedent set for introducing emissions based parking permits or providing discounts for low emission vehicles under provisions given in the Road Traffic Regulation Act 1984. Currently at least ten London Boroughs have successfully introduced or are considering such schemes as part of measures to reduce road vehicle related emissions set out in their Air Quality Action Plans and LIPs.