South Oxfordshire Low Emission Strategy Study

Feasibility assessment report

Report for South Oxfordshire District Council

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1 Introduction

South Oxfordshire District Council has commissioned Ricardo-AEA to develop and assess a package of measures to reduce emissions from transport. The focus is on NOx reduction in pursuit of NO_2 limit value compliance, but the assessment also considered PM and CO_2 emissions in an integrated approach. The package of measures seeks to reduce emissions from transport across the district, as well as within the three Air Quality Management Areas (AQMAs) in Wallingford, Henley and Watlington.

The package of measures will form a Low Emission Strategy that will complement the Council's statutory Air Quality Action Plan (AQAP) by providing an overarching approach to transport emissions reduction in the District and an evidence base on the emissions impact of this approach.

The report provides the main feasibility assessment of the measures to be included within the LES and covers:

- Initial *definition of measures* to be included in the LES, along with some background detail on how these measures could be implemented in South Oxfordshire;
- An *emissions assessment* of the initial list of measures to identify those that are likely to have the greatest emissions impact;
- A *cost benefit analysis* of the most effective measures.

Finally the report makes recommendations on the core measures to take forward within a Low Emission Strategy.

2 Defining the LES Measures

The initial set of measures for inclusion in the Low Emission Strategy feasibility work where developed in conjunction with officers from South Oxfordshire District Council. A steering group was established to guide the generation of ideas, providing input in terms of existing policy and actions and ideas for additional measures.

In setting out the LES measures a number of key principles were established by the steering group:

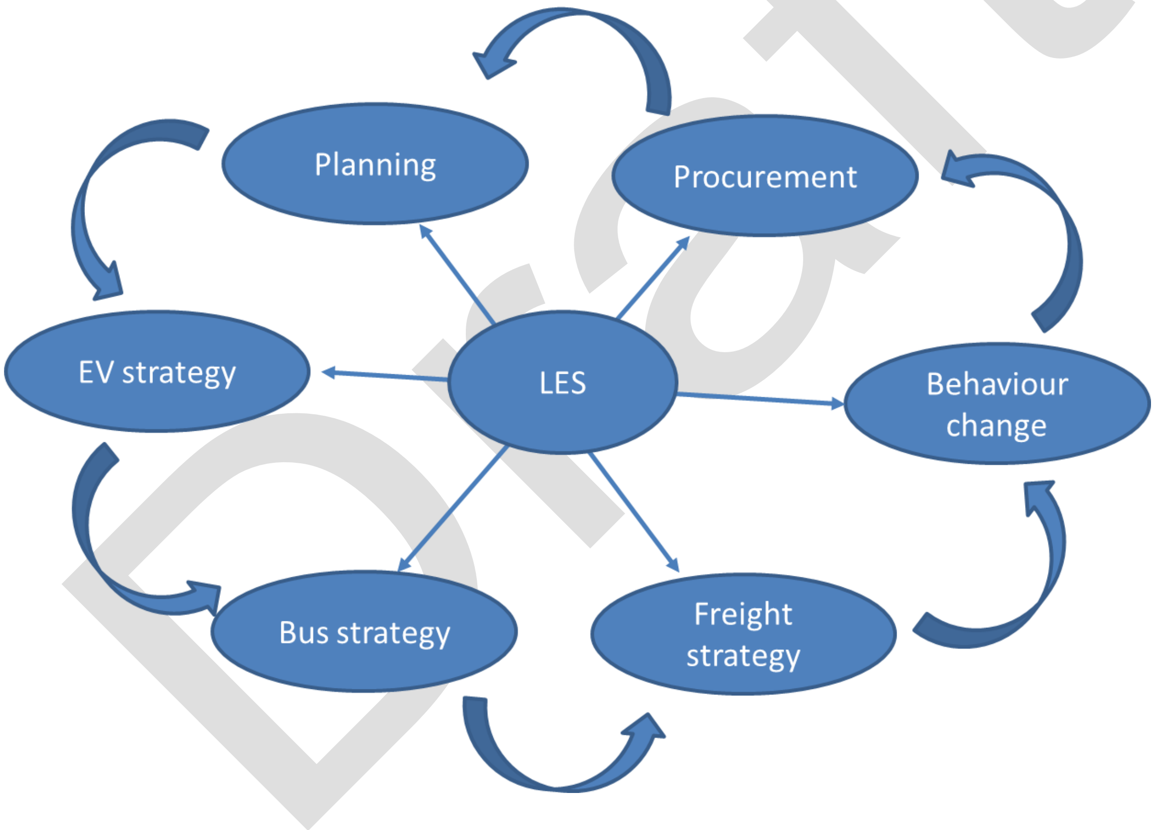
- The LES should be seeking to reduce both air pollution and climate related emissions from transport in an integrated way.
- It will need to consider the wider context of South Oxfordshire and potentially actions with a wider set of partners. In particular it needs to recognise:
    - Policies and programmes that are developed jointly with the Vale of White Horse District Council who are its partner authority;
    - Activities that are best carried out at a county level working through the Oxfordshire air quality group.
- The LES should support the economic development aspirations of the Council, in particular
    - Helping understand how improved environmental quality supports economic growth;
    - Exploring links with the Local Enterprise Partnership and wider business benefits from low emission activities.

Working with the LES steering group 6 core themes were identified for the LES and are developed in more detail below. The core themes are:

- Low emission planning
- Low emission procurement and licencing
- Electric vehicle strategy
- Bus emission strategy
- Freight emission strategy
- Low emission behaviour campaigns

Each of these themes are not separate but overlap and will need to work together as a coherent whole in order to provide an effective LES. For example the EV strategy will use planning and procurement powers to promote the uptake of vehicles, and the low emission behaviour theme includes eco-driving and anti-idling that will also be reflected in the bus and freight emission strategy. This integrated approach is illustrated below.

Figure 1 The six core LES themes



In addition to the core themes the measures have been considered in terms of those that will affect the district as a whole and those that are primarily focused on the three AQMA's (Wallingford, Henley and Watlington). As such the measures have been defined in terms area wide measures and a package for each of the three AQMA. This geographical packaging of the measures is summarized in section 2.7.

2.1 Low emission planning

The use of development planning policy is a key lever that the council can use in terms of driving a long term vision of reducing emissions from transport. The National Planning Policy Framework (NPPF) sets out the national policy on air quality impact from development planning. The NPPF places a presumption in favour of sustainable development, stressing the importance of local development plans and states:

> *"Planning policies should sustain compliance with and contribute towards EU limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and the cumulative impacts on air quality from individual sites in local areas. Planning decisions should ensure that any new development in Air Quality Management Areas is consistent with local air quality action plans (and strategies)".*

Therefore air quality needs to be considered from two perspectives in planning policy:

- *A top level strategic consideration* – clearly setting out an understanding of local air quality issues and the relationship to planning in the core strategy and its daughter documents.
- *Site level developer guidance* – setting out how air quality considerations should be tackled within individual planning applications and how this relates to the top level policy objectives.

The current core strategy was adopted in 2012 and needs to provide the overall context for air quality consideration at the strategic level and provide the 'hooks' to support action that will reduce emissions. Within the existing core strategy there are a number of areas which could be strengthen to support action on air quality:

- *Section 2 Issues and trends* – the environmental issues cover climate change and natural environment (in terms of ANOB's, SSSI, etc) but does not cover air quality. Air quality should be included, the AQMA's clearly identified and key principals to improve air quality set out.
- *Section 5 Moving around* – sets out transport objectives for the district. This should provide the hooks to support transport measures to improve air quality. General sustainable transport such as walking, cycling and public transport is set out clearly, but consideration could also be given to promoting low emission vehicles.
- *Sections 10 and 12 Area strategies* – these cover Henley and Wallingford and should note the existence of the AQMA's and provide support for emission reduction actions. In particular this should relate to transport activities.
- *Section 14 Environment* – again air quality should be mentioned here. The AQMA's should be defined and it should point to the AQAP and other strategies such as the LES as required by the NPPF.
- *Section 15 Quality development* – this could provide support for measures that promote sustainable travel such as walking and cycling, and low emission vehicles such as electric vehicles.
- *Section 17 Infrastructure provision* – this could potentially support electric vehicle charging infrastructure.

In terms of local area strategies Neighbourhood plans are now being developed. Those that cover the AQMA's can provide significant support to specific air quality measures within these areas. The draft Joint Henley and Harpsden Neighbourhood Plan (JHHNP) does make extensive reference to air quality as a key issue and provide support and 'hooks' for most of the specific measures set out below in relation to the LES.

Site level guidance on air quality has been tackled directly through the development of 'Developers Guidance' that has been included as annex to the AQAP and is provided for reference in Appendix 1 of this document.

2.2 Low emission procurement

Public authorities are responsible for an annual spend of over £230bn in the UK. The UK Government and Local Government Bodies have identified the significant role that public sector procurement can have in securing environmental improvements, particularly in relation to vehicle emissions, and assisting the accelerated transition to a low carbon economy. Appropriate procurement strategies can help stimulate economic development, encourage innovation and improve air quality. The Public Services (Social Value) Act 2012 places a requirement on commissioners to consider the economic, environmental and social benefits of their approaches to procurement before the process starts.

More specifically procurement can and should also be used to promote the use of Low Emission Vehicles. The Cleaner Road Transport Regulations (2011) implements the European Clean Vehicles Directive and applies to contracts for the purchase of road transport vehicles and services (including cars and light commercial vehicles, buses, and commercial vehicles such as trucks or refuse trucks). All public contracting authorities are required to take into account energy and environmental impacts by:

- Setting technical specifications for energy and environmental performance in the documentation for the procurement of road transport vehicles and services;
- Including energy and environmental impacts in the purchasing decision by using energy and environmental impacts as award criteria as part of a procurement procedure;
- Including energy and environmental impacts in the purchasing decision by monetising them in accordance with set methodology provided within the Directive (this is based on whole life costs and a tool is available.

More broadly the social values act supports the consideration of transport emissions impact of wider service procurement and low emission businesses such as low emission taxis or low emission delivery services.

A guide to low emissions procurement is set out in appendix 2.

2.3 Electric vehicle strategy

Emissions from cars, especially diesel cars, are a key aspect of the air quality problems in all of the AQMAs and the dominant issue in Henley. Electric vehicles have zero tailpipe emissions and therefore offer significant potential to help tackle local air quality issues (although account must be taken of air pollution caused by electricity generation when considering their overall air quality impact). Therefore the promotion of electric vehicles, as an alternative to diesel and petrol cars has been identified as a theme to take forward in the South Oxfordshire LES.

The key elements of an electric vehicle strategy should cover:

- A realistic adoption target
- Supporting planning and procurement policies
- Low emission parking incentives
- Developing a recharging infrastructure
- Engaging with business and residents

2.3.1 Adoption target

In the UK overall, in 2012, cars eligible for the Government’s Plug-in Car Grant accounted for just 0.1% of new car sales. Even hybrid cars, which are now well established in the market only captured 1.2% of sales. Norway is the country where electric cars have achieved the highest market share at 5%.

Estimates of future market shares for plug-in hybrid and battery electric cars vary widely. However most experts predict their market share will be somewhere between 2-10% by 2020 and 20-50% by 2030.[1] These wide ranges are due to the many uncertainties around factors which will strongly influence plug-in vehicle sales. These fall into two main areas:

1. **Technology breakthroughs –** Primarily reducing the cost and improving the performance of batteries and other energy storage devices.
2. **Government policy** – Policies to promote the uptake of electric vehicles can have a significant effect on sales. There are a range of options available, but perhaps the most effective are measures to reduce the additional upfront purchase price.

In October 2013, the Nissan Leaf battery electric vehicle (BEV) was the best-selling car in Norway. This has been achieved through a combination of policies designed to make plug-in vehicles an attractive option. BEVs are exempt from import taxes and VAT meaning that a Nissan Leaf in Norway costs about the same as a 1.4 litre petrol-engined Volkswagen Golf.[2] In the UK the Nissan Leaf retails for about £10,000 more than the Golf, so even after the £5,000 Plug-In car grant, it is £5,000 more expensive. Norway also provides BEV owners a range of benefits including exemption from all road tolls, free recharging facilities and parking and permission to use bus lanes to avoid traffic congestion.

Even if measures were put in place which meant battery electric vehicles achieved a 5% share of new vehicle sales in the UK by 2015, rising to 10% in 2020, then BEVs would still account for less than 5% of the total fleet by 2020. As a result their near-term potential to achieve improvements in air quality is likely to limited. *In terms of a target for EV penetration in South Oxfordshire, and to be used for the purposes of modelling, we propose a basic target of 2% by 2020 and a stretch target of 5%.*

2.3.2 Supporting planning and procurement policies

This is a clear area where separate themes in the LES overlap. In this case Low Emission planning and procurement policies can be used to promote the use of EV's and has been discussed to some extent above. In summary these powers should be used as follows:

- Planning – to support the introduction of EV charging infrastructure in new developments, and potentially the use of EV's by residents and business in the new developments.
- Procurement – the clean vehicles directive will directly support the use of EV's in council fleets and transport services. It can also be a consideration in wider procurement decisions.

2.3.3 Parking incentives

There are several dimensions to the parking strategy that can be considered:

- *Linking the parking to the re-charging infrastructure* – in this case the incentive can be either free/low cost parking, free charging or a combination of both.
- *Priority parking for electric and low emission vehicles* – in this case with no recharging, but free or low cost parking fees.

[1] RAC Foundation (2013), *Powering Ahead.* Available here: http://www.racfoundation.org/media-centre/powering-ahead-future-low-carbon-cars-fuels
[2] http://www.reuters.com/article/2013/03/13/us-cars-norway-idUSBRE92C0K020130313

- *On-street and off-street parking* – these spaces can be allocated in council off-street car parks or as special bays for on-street parking. The latter would involve working with the county Council.

Further discussion will be needed with SODC parking officers to look both at off and on street parking options and links with existing parking enforcement powers.

2.3.4 Re-charging infrastructure

Local authorities can install recharging facilities for EVs in off-street public and private car parks without the need to apply for planning permission. On street charging points can be installed as permitted developed.

The Department for Transport's *Driving the Future* strategy for ultra-low emission vehicles confirms that up to £37 million will be made available through to May 2015 to support the installation of charge points in homes, residential streets, railway stations and public sector car parks as well as rapid charge points to facilitate longer journeys. A second round of bidding for this money closed in October 2013, but further rounds are expected in 2014. The funding package includes a specific grant scheme for local authorities that will support:

- on-street charge points in residential streets where off-street parking is not available; and
- rapid charge points in locations where they will support uptake of plug-in vehicles.

Publically accessible rapid charge points which can charge any electric vehicle in under 30 minutes are seen as critical to uptake of EVs. There are currently fewer than 100 publically accessible rapid charge points across the UK, but Nissan is heading a consortium to provide 74 new ones in the UK through an EU-backed project.[3] Overall the Department for Transport's strategy document expects the number of rapid charge points to expand to up to 500, however there is no indication in the document that any of these will be in South Oxfordshire.

The Department also published *Lessons Learnt from the Plugged-in-Places Project* in July 2013.[4] This document highlights that there can be huge variations in costs of installing charge points. To help reduce these costs it encourages local authorities to:

- Work with the electricity distribution network operator (DNO) and energy providers to identify the most cost-effective locations, particularly for rapid chargers or locations where multiple chargers are planned to be installed.
- Consider the cost/ benefits of having a joint back office; utilising chargepoint manufacturers back offices; creating a bespoke back office or having no back office.
- Consider ways to initially lower scheme operations and maintenance costs by gaining sponsorship for electricity or back office arrangements.
- Procuring chargeposts from a variety of suppliers can help to minimise the risk of legacy network issues but may lead to back office compatibility challenges and reduce opportunity for cost savings.

Typical, however, you might expect the cost of on-street fast charge units to be £3,000-£4,000 installed and rapid charge units some £25,000 to £30,000 installed. One of the biggest variables will be any civil works required for the installation, including power connection.

The most common suppliers of public charging points in the UK are:

[3] http://www.rapidchargenetwork.com/
[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/236750/plugged-in-places-lessons-learnt.pdf

- Elektromotive – who supply the Elektrobay range from private home chargers through to public rapid charging facilities
- Pod point – who provide solo and twin charge posts
- Chargemaster – who provide both the supply of equipment and a back office system in the form of their Polar network. It should be noted that most of the points operated in Oxford are managed as part of this network.

Currently there are very few points available in South Oxfordshire., as illustrated in the Figure 2 below. While Didcot has two chargepoints (one slow, one fast), Henley-on-Thames, Thame, Wallingford and Watlington have none. The nearest points are at Reading to the south, and junction 8A of the M40 to the north. Therefore initially the development of any network of charging points should focus on these main areas. However, in the longer term any strategy should respond to user need to ensure that charge points support actual users. In addition there are a number of scheme offer free home charging points, such as the scheme by Chargemaster, that could be promoted to residents.

Figure 2: Chargepoints in South Oxfordshire region (source: www.zap-map.com)

In summary we propose that the key elements of a recharging strategy should be:

- Promote home recharges to residents, as most recharging happens at home;
- Look to develop a network of fast charge points in key locations in Didcot, Henley and Wallingford, where vehicles will be parked for 3 or more hours. This includes the

Councils own premises in Wallingford and key businesses. The charge points should aim to be dual chargers, with two allocated parking spaces each.
- Complement the fast charge points with a limited number of rapid charge points. Further consultation with businesses and potential users will be needed to identify the location for these chargers. Again these charge points should be dual or triple charges, with dedicated parking.
- Use existing back office payment systems such as that offered by Chargemaster or some of the Plugged in places schemes such as Source East. In addition consideration should be given to free charging in some locations such as Council sites and public car parks, such that no back office is required.

Funding for the recharging infrastructure can be sought through the next round of OLEV funding, developer contributions through the planning system and partnership working with businesses including energy suppliers.

2.3.5 Engaging businesses and residents

A potentially effective strategy to promote electric vehicle uptake is to identify businesses in the area which are most likely to see financial savings from switching to electric vehicles. The Energy Saving Trust offers independent, impartial advice to businesses including whole-life cost analysis for switching to electric cars and vans. This scheme, called the Plugged-in-fleets initiative can be promoted to local businesses. Any such initiative should be linked to the development of the recharging infrastructure to ensure that its support companies who are looking to invest in electric vehicles.

A more indirect approach is around raising awareness of the availability and benefits of EV's. This should include marketing and promotion of any infrastructures developments, inclusion of information on EV's and other low emission vehicles in any behavioural change programmes and working suppliers to provide information and demonstration days. Examples of this approach includes travel planning work in Bristol that include information on low emission vehicles and demonstration and displays days for EV's run in York.

Also the Council should lead by example and be looking to include electric vehicles in its own fleet and encourage use by employees. The Councils own fleet is limited but can be high profile. From initial information on the fleet consideration should be given to purchase or lease of 2-3 small electric vans such as the Renault Kangoo to replace existing small vans, and 1-2 electric pool cars to support staff movements between the two Council main offices. The introduction of these vehicles will need to be linked to provision of recharging infrastructure.

In terms of staff owned vehicles consideration could be given to adjustments to business mileage rates to advantage electric vehicles and pay-as-you-earn schemes to help with the purchase of EV's. Pay as your earn schemes are now well established for public transport session tickets and bicycles, but increase number of organisation are also looking at using them for low emission vehicles.

2.4 Bus emissions strategy

Although buses are not a major source of transport emissions across the district as a whole they can be important in some of the AQMA's. They are also a very visible element o fthe public transport system and one that we are seeking to promote to reduce car use. Therefore developing a low emission bus fleet is an important element of the LES.

The key elements of a bus strategy that have been identified for assessment with the LES are:

1. A voluntary Euro IV emission standard for all buses operating in the district (with a sensitivity case of Euro VI);
2. A bus eco driving and anti-idling programme across the district working with the bus companies;
3. Bus (and HGV) Low Emission Zones in each of the AQMA's with both a Euro IV and Euro VI standard;
4. A bus only river crossing in Wallingford.

The voluntary bus emission standard and the Bus LEZ measures overlap, therefore only one or the other would need to be included in the final LES. However, they have been identified separately for assessment purposes, and as they have different geographical focuses.

The bus only crossing measure in Wallingford would close the town river crossing to all traffic except buses. It would also require a minimum Euro IV standard for buses using the crossing. This is a specific measure to Wallingford and include in the Wallingford package.

2.5 Freight emissions strategy

Freight emissions, covering both vans and HGVs, are an important element of the transport emissions across the district and within in all of the AQMAs. Therefore a strategy to reduce emissions from freight is a key part of the LES. The measures identified for assessment in terms of a low emission freight strategy cover:

- *An HGV eco-driving and anti-idling campaign* – to help improve efficiency and reduce fuel costs and emissions potentially through Ecostars type programme linked to driver training.
- *HGV LEZs for Wallingford, Henley and Watlington* to explore the potential benefits of such an approach, even if at present the resources to implement such schemes would be limited.
- *A freight clearway in Watlington* – which would remove parked vehicles that are causing blockages and congestion.
- *Enforcement of the 7.5t limit in Watlington* – the perception is that this is not being adhered to in key areas and better enforcement, perhaps through ANPR, would help.

In addition, although not to be explored in this work, the strategy could support:

- Freight consolidation – which is being explored by Oxford City Council, who will look to link with local district councils;
- Interactive freight maps/app – to be pursued through the County Council.

2.6 Promoting low emission behaviours

Emissions from cars, especially diesel cars, are a key aspect of the air quality problems in all of the AQMAs and the dominant issue in Henley. Therefore it will be important for the LES to promote a range of measures to reduce emissions from cars. In this context we have explored three potential measures in the LES feasibility:

- Anti-idling campaigns and their effectiveness on reducing emissions;
- Transport, air quality and health behaviour change campaigns, in particular considering links with health bodies and community groups.
- Promoting low emission vehicles and driving styles, potentially linked to the campaigns above.

A review of experience by other UK authorities with anti-idling campaigns is included in Appendix 3. In light of this experience we would suggest that a formal route for enforcing anti-idling is not adopted due to the potential costs, but a more flexible approach is taken including:

- Working directly with bus companies, potential Oxfordshire wide, building on Oxford City Councils work and linking to wider eco-driving advice.
- Working directly with freight companies, again Oxfordshire wide, potentially as part of a wide scheme such as EcoStars.
- Including anti-idling information with other vehicle information in behavioural change programmes.
- 'Switch-off' signage at key traffic or waiting locations.

In terms of wider behavioural change promotion campaigns these are essentially a whole package of soft and hard measures designed to encourage mode shift away from car to other modes. The behaviour change element is the key aspect of this in terms of travel plans, personalised travel marketing and so on. There has been a considerable amount of work done on this with the key pieces being the DfT 'Smarter choices' project and the Sustainable Travel Towns demonstration programme. The headline results from the sustainable travel towns programme was a 7-8% reduction in road traffic in target areas, with an estimated cost of 4p per car km removed.

In terms of assessment behavioural change has been modelled as a single measure based on the smarter choices concept.

2.7 Geographic summary of measures assessed

In terms of assessment of the measures in each of the themes above they have been considered on a geographic basis. This covers district-wide measures and a package for each of the AQMA's. The measures assessed at the district and AQMA level are listed below and summarised in table 1:

District wide emissions assessment

- EV target
- Bus euro 4 target, plus Euro 6 sensitivity test
- Bus eco-driving and anti-idling campaign
- Freight eco-driving and anti-idling campaign
- Mode shift target from low emission behaviours

Wallingford specific measures

- Bus and HGV Euro 4 LEZ, and Euro 6 sensitivity test
- Bus only river crossing

Henley specific measures

- Bus and HGV Euro 4 LEZ
- Anti-idling assessment

Watlington specific measures

- Bus and HGV Euro 4 LEZ
- Freight Clear way
- Enforce 7.5 t limit

Table 1 Summary of measures assessed

ID	Measure	Description	Fleet composition	Traffic levels	Vehicle speeds
		District-wide modelling			
EV2% EV5%	EV strategy	The EV strategy is designed to promote the uptake of EV across the district. Various measures are covered including recharging infrastructure and promotion. A basic 2% and stretch 5% targets have been suggested.	2% car and van fleets as EVs Plus 5% stretch	-	-
Bus 1	Bus euro 4 target	Aim for all buses to be Euro 4 that run in any AQMA.	Bus E4 (2015)	-	-
Bus 1#	*Bus euro 6 target as a sensitivity scenario*	*Aim for all buses to be Euro 6 that run in any AQMA.*	*Bus E6 (2015)*	-	-
Bus 2	Bus eco driving and anti-idling	Bus eco-driving typically 4-8% fuel savings, emissions not clear. Anti-idling 2-3% fuel savings, emission savings less clear. Suggest combined gives 5% CO_2 saving, and 2% NOx and PM saving.	Bus CO_2 ↓ 5% Bus NOx and PM ↓ 2%	-	-
HGV	HGV Eco-driving and anti-idling	Same assumptions as for buses	HGV CO_2 ↓ 5% HGV NOx and PM ↓ 2%		
Smart	Behaviour change programme	The headline results from the sustainable travel towns behaviour change programme was a 7-8% reduction in road traffic in target areas, with an estimated cost of 4p per car km removed. Suggest less ambition is possible and a potential target of 3% reduction with a 5% stretch. Consideration could also be given to reducing emissions from better driving, but not included at present.	Could consider lower emission factors through better driving	3% reduction in car traffic (potential stretch test of 5%)	-

Wallingford package					
LEZ	Bus and HGV LEZ	Bus and HGV Euro 4 LEZ. Potential 2 scenarios of Euro 4 in 2015 and Euro 6 in 2020.	Bus and HGV min Euro 4	-	-
LEZ#	Bus and HGV LEZ	Bus and HGV Euro 6 LEZ as sensitivity test	Bus and HGV min Euro 6	-	-
BusX	Bus Only Crossing	County has studied this as it is not feasible, so perhaps don't need to model. Could do just as test to see impact and then push county again. Essential remove cars from bridge and approach roads after last junction. Could also consider anti-idling for buses at traffic lights, could we model this? – use idling factor	Bus Euro 4	Adjust car traffic round bridge	-
EV	EV strategy	As main EV strategy	2% car and van fleets as EVs Plus 5% stretch	-	-
Smart	Behaviour change programme	As main behaviour programme	Could consider lower emission factors through better driving	3% reduction in car traffic (potential stretch test of 5%)	-
Henley Package					
LEZ	Bus and HGV LEZ	Bus and HGV Euro 4 LEZ.	Bus and HGV min Euro 4	-	-
Idle	Specific Idling scheme	Focus measure on Duke street junction. Assume 2% reduction in emission from traffic on this link, in relation to suggested fuel reduction. Could also consider other	2% reduction in emission on Duke street	-	-

		routes to modelling	junction link.		
EV	EV strategy	As main EV strategy	2% car and van fleets as EVs Plus 5% stretch	-	-
Smart	Behaviour change programme	As main behaviour programme	Could consider lower emission factors through better driving	3% reduction in car traffic (potential stretch test of 5%)	-
Watlington package					
LEZ	Bus and HGV LEZ	Bus and HGV Euro 4 LEZ.	Bus and HGV min Euro 4	-	-
HGV1	Freight clear way	Scheme will be to remove parking vehicles in main route through Shirburn and Couching Street. Assume average speed increase and approaches limit.	-	-	Increase speed to limit
HGV2	Enforce 7.5 t limit	Enforcement of 7.5t limit rigorously. Use enforcement data to adjust HGV traffic/fleet to reflect full enforcement.	Enforcement data	Enforcement data	

3 Emissions impact assessment

3.1 Method

The emissions modelling work was carried out at the district level and for each of the AQMA in South Oxfordshire (Wallingford, Henley and Watlington). In addition to the emissions modelling dispersion and pollutant concentration modelling was carried out in the AQMAs to support compliance assessment.

The assessment was carried out for the base year of 2011 and a forecast year of 2015. In addition a sensitivity test was done in the AQMA areas for 2020. In all cases the assessment of the LES measures was done in relation to the 2015 baseline forecast.

The results are described in the sections below with detailed calibration and tabulated results in appendices 5 and 6.

3.1.1 District wide modelling

A district wide model was built using DfT's regional traffic data for Oxfordshire[5]. These data provide network of some 200 road links, with a total annual traffic flow of 1.5 billion vkm. This is expected to be the bulk of the traffic in the district and is about ¼ of the total estimated in Oxfordshire.

Along with the traffic data the DfT provides speed data for these links. Together these data were used with DEFRA's Emission Factor Toolkit (EFT) to model the vehicle emissions in the district. The model was used to provide emission results for the base year of 2015 and for each of the district wide LES measures.

3.1.2 AQMA modelling

Existing models had already been built for each of the AQMA areas in order to carry out the initial source apportionment work and to set up and calibrate the ADMS dispersion model. The source data for the models comprised:

- Oxfordshire County traffic data where it was available, or DfT data if not
- Traffic master speed data again where it was available, or national DfT data if not
- Local fleet data if available from the traffic counts, complemented by national fleet data.

These data were used in the EFT to provide the underlying emissions input for the ADMS model. The ADMS model was then calibrated to the measured data in 2011, before using for the forecast years. The calibration results for the each AQMA are provided in Appendix 1.

The EFT model was used to provide emission results for each of the measures in 2015. All of the district wide measures were modelled for each AQMA and the specific measures for that particular AQMA. The emissions assessment has been done for each individually and for a package of measures.

The dispersion modelling has been done for 2015, the proposed package of measures in 2015 and the sensitivity test in 2020.

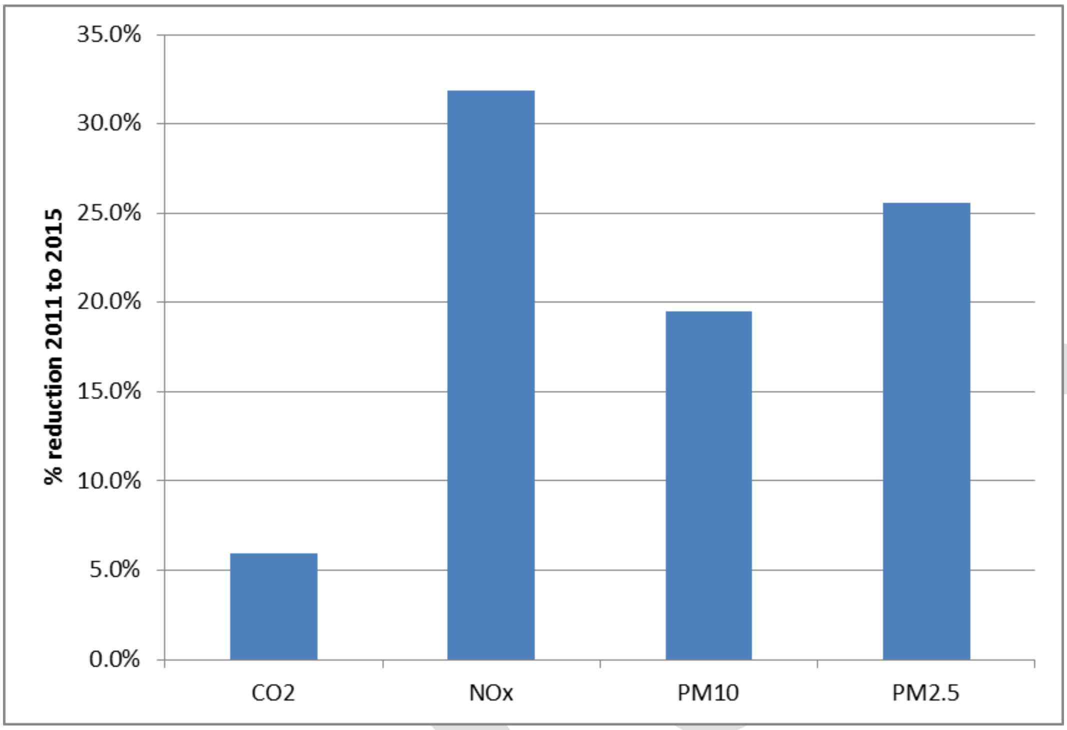
[5] http://www.dft.gov.uk/traffic-counts/area.php?region=South+East&la=Oxfordshire

3.2 District wide assessment

3.2.1 Baseline results

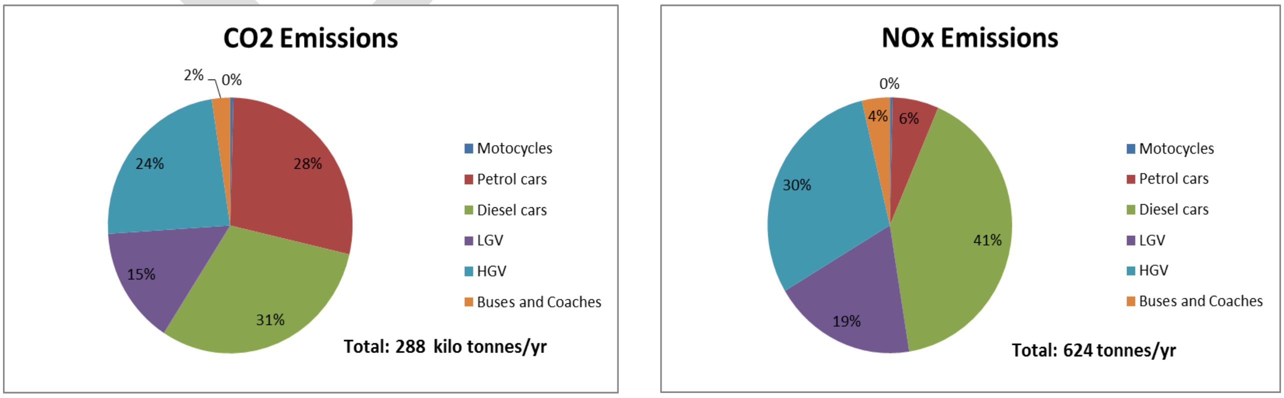
The baseline emissions were calculated for 2011 and 2015. The improvement in the fleet shows a significant reduction in emission from 2011 to 2015 of between 20% to 30% for NOx and PM, but a much lower reduction in CO_2 as shown in Figure 3.

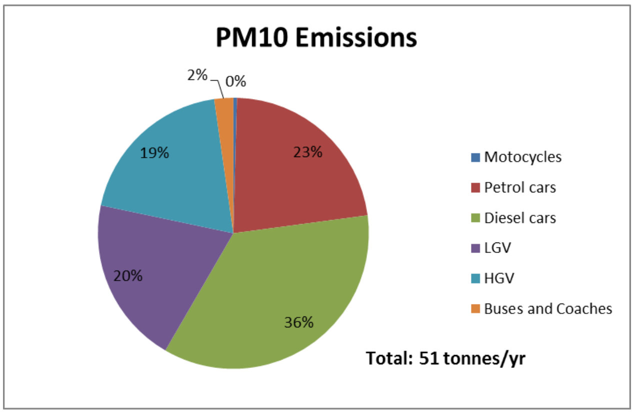
Figure 3 Reduction in baseline emissions from 2011 to 2015

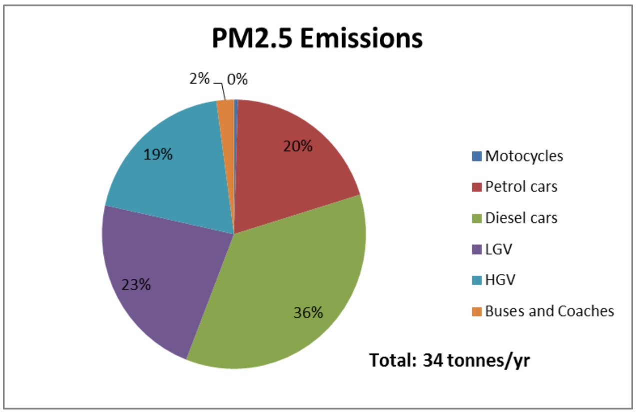


The split of emissions between the different vehicle types for the forecast year of 2015 is shown in Figure 4. These results show that cars are responsible for 59% of CO_2 emissions, split equally between petrol and diesel cars. Freight vehicles are responsible for 36% of CO_2 emissions with the remainder being buses and coaches. Freight vehicles are the largest contributor to NOx emissions at 49%, closely followed by diesel cars at 41%. These diesel vehicles comprise the majority of the NOx emissions will a small amount from petrol cars and buses /coaches.

Figure 4 Split of emissions by vehicle type in 2015





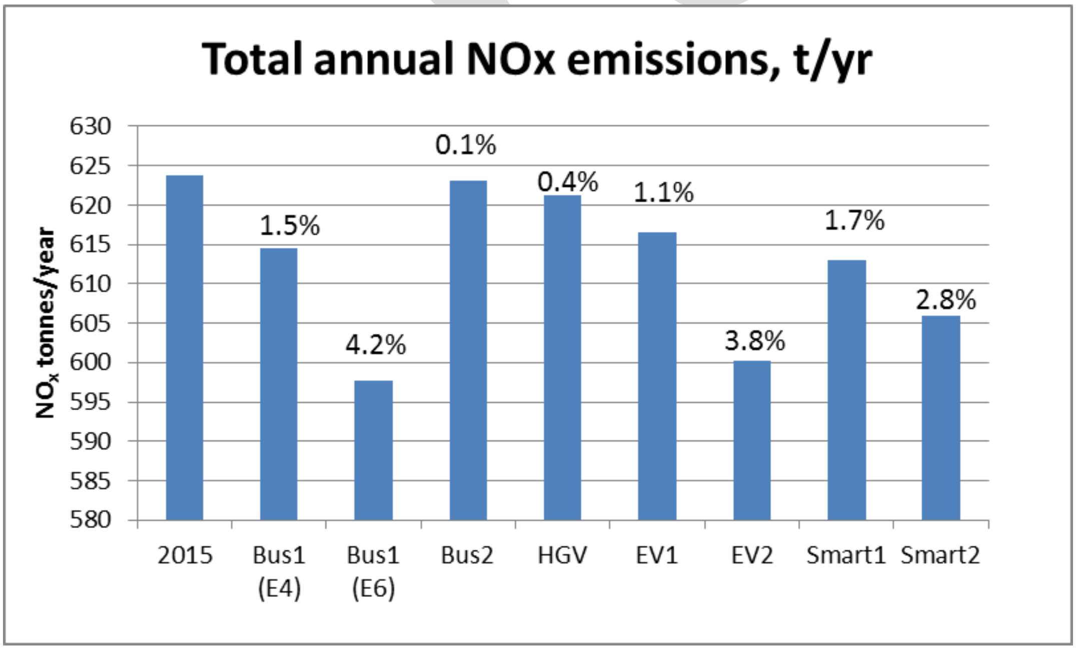


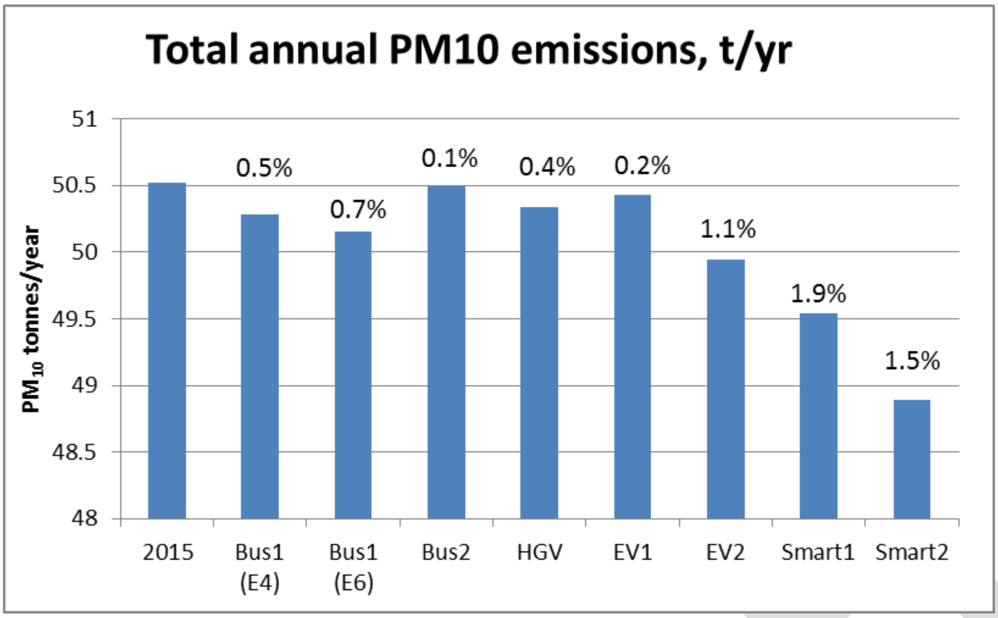
The results for PM emission show that cars are the dominant source at some 56% of the total, with diesel cars alone being 36%. Freight vehicles account for another 40%, with to remainder being buses and coaches. With PM_{10} emissions it needs to be recognised that these comprise both exhaust emissions and also those from brake and tyre wear and road dust. Therefore just improving engine technology will only reduce a proportion of these emissions. On average non-exhaust emissions can comprise 50-70% of the total.

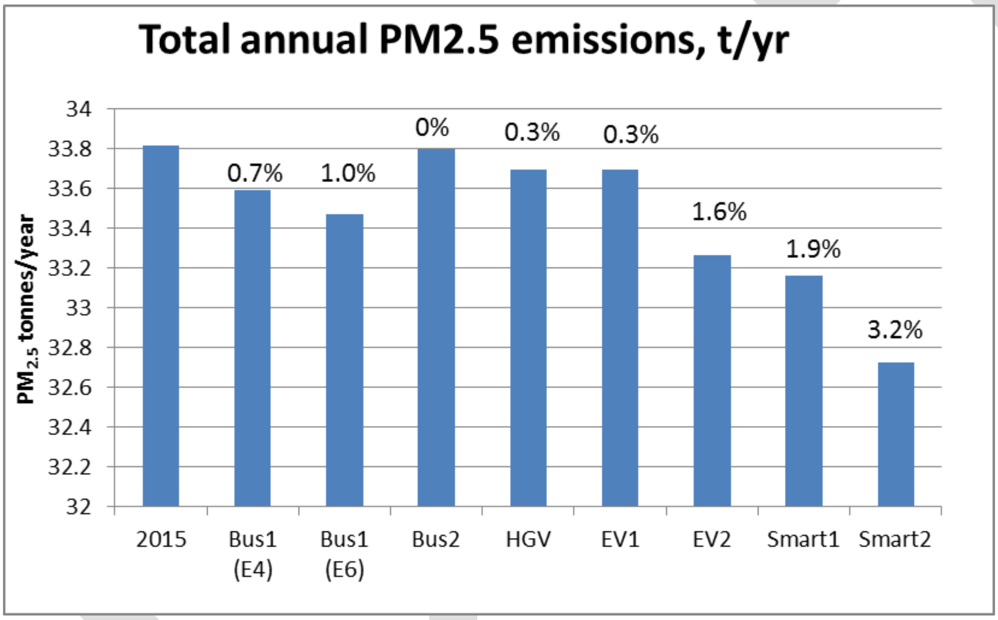
3.2.2 Measure results

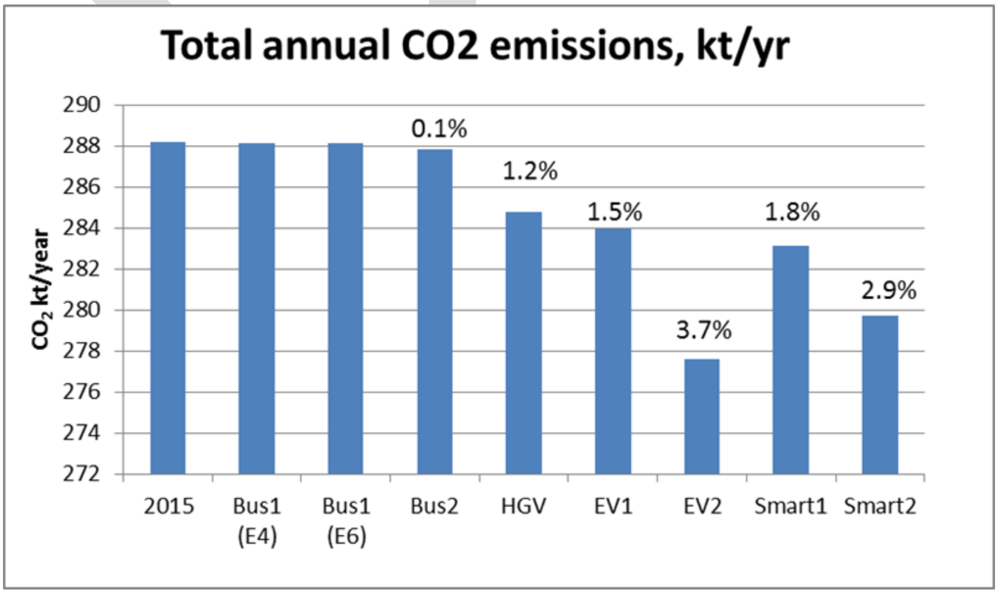
The emission results by measure and pollutant are shown in figure 5 below. The graphs show the actual emissions for each scenario plus the percent reduction above each bar. Overall the emission reductions for any one measure are relative small from <1% to about 4%. The EV and smart scenarios produce the greatest savings as they relate to cars which account for the dominant portion of the emissions. The exception is the bus Euro 6 scenario that has the highest impact on NOx emissions.

Figure 5 Emission results of the district wide LES measures




Total annual PM10 emissions, t/yr
PM10 tonnes/year
51
50.5
50
49.5
49
48.5
48
0.5%
0.7%
0.1%
0.4%
0.2%
1.1%
1.9%
1.5%
2015
Bus1 (E4)
Bus1 (E6)
Bus2
HGV
EV1
EV2
Smart1
Smart2


Total annual PM2.5 emissions, t/yr
PM2.5 tonnes/year
34
33.8
33.6
33.4
33.2
33
32.8
32.6
32.4
32.2
32
0.7%
1.0%
0%
0.3%
0.3%
1.6%
1.9%
3.2%
2015
Bus1 (E4)
Bus1 (E6)
Bus2
HGV
EV1
EV2
Smart1
Smart2


Total annual CO2 emissions, kt/yr
CO2 kt/year
290
288
286
284
282
280
278
276
274
272
0.1%
1.2%
1.5%
3.7%
1.8%
2.9%
2015
Bus1 (E4)
Bus1 (E6)
Bus2
HGV
EV1
EV2
Smart1
Smart2

This analysis suggests that at the district level targeting private cars will have the greatest effect. The measures should look to reduce traffic levels through behaviour change programmes, linked to health benefits, and promote electric and low emission vehicles. This could be complemented by working with the bus company to agree minimum emission performance for buses operating in the area.

In terms of freight this is a significant proportion of the emission but only a single measure has been assessed in terms of freight eco-driving. This measure in itself shows little impact. Other measures in terms of reducing freight traffic and promoting low emission vehicles need to be considered.

3.3 AQMA level assessment

The assessment of the measures for each AQMA area is described in the sections below. For the AQMA assessment as well as the 2015 forecast year we have done a sensitivity test for 2020. Two 2020 tests were carried one using the normal fleet evolution which includes a significant uptake of Euro 6 vehicles (2020a) and one assuming that Euro 6 will perform no better than Euro 5 (2020b).

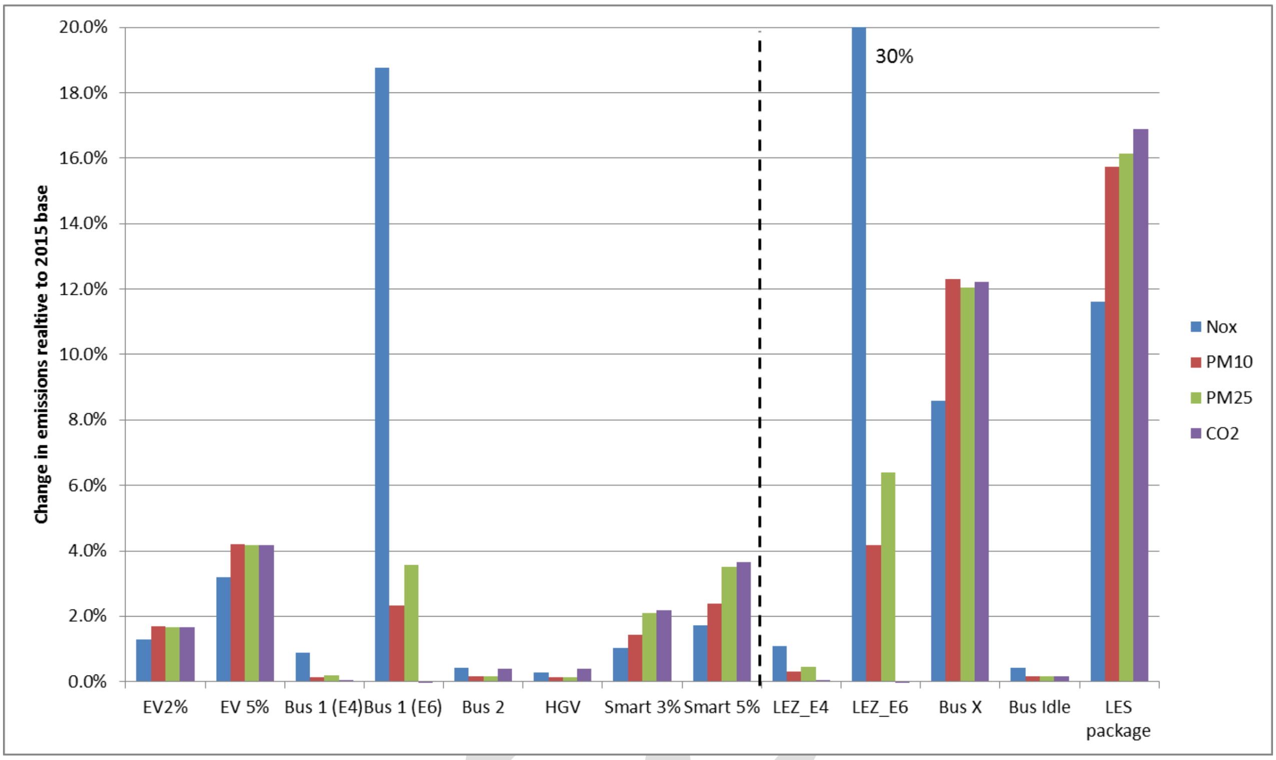
3.3.1 Wallingford

The impact of the forecast years, including the two 2020 scenarios, for the Wallingford AQMA ia shown in figure 6. The 2015 forecasts shows around a 10% reduction in emissions of NOx and PM, and a slight increase in CO_2. The 2020a scenarios shows a significant decrease in NOx emissions of some 40% and further reductions in PM emissions, all of which is largely a results of the penetration of Euro 6 vehicles into the fleet. The 2020b scenario which assumes Euro 6 is ineffective shows an increase in NOx and similar decreases in PM as the 2015 forecast. Both 2020 scenarios show increase in CO_2.

Figure 6 Baseline results for the Wallingford AQMA

The impact of the measures has been assessed in relation to the 2015 baseline forecast. These results are shown in Figure 7. In terms of the district wide measures the results are the same as the district wide assessment with the EV, Smart and E6 buses scenarios being the most effective. In terms of the Wallingford specific measures the LEZ (Euro 4) has little effect as most of the bus fleet and HGV fleeting operating in the town already meet this standard. Therefore to get significant impact a much more stringent LEZ standard, such as Euro 6, would be required. The most effective measure in Wallingford is the bus only crossing which removes car traffic from the narrow congested street round the bridge.

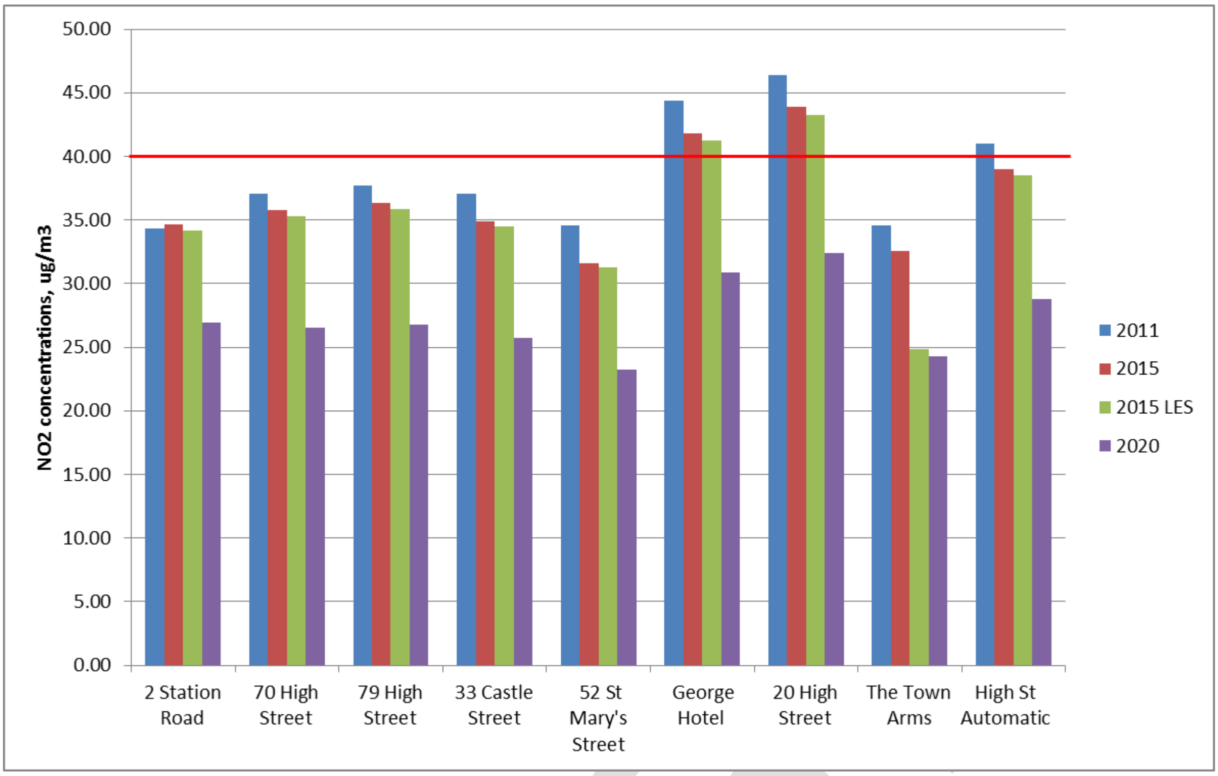
Figure 7 Impact of the LES measures in the Wallingford AQMA



Considering these results the most effective approach for Wallingford would be to implement the bus only crossing along with a package of measures to promote EV's and reduce wider car traffic through smarter choices measures. A package of these measures has been assessed based on the less ambition 2% EV target and 3% smarter choices target. This package would give around a 12% reduction in NOx emissions and 15% reduction in PM and CO_2 emissions in the AQMA.

Concentration modelling for has been carried out for 2011, 2015, the 2015 LES package and the 2020a scenario. These results are shown in figure 8 below. The results show an improvement in air quality for all scenarios against the 2011 base year. However, the LES package is showing only a small improvement of the 2015 base forecast of about 1.5% with the main locations which have exceedances still showing exceedances. The biggest impact of the LES package is at the High Street Town Arms location which shows a significant improvement 24%. This is the site which will be the main beneficiary of the car traffic reduction from the bus only river crossing. By 2020, if Euro 6 performs as expected, then all exceedances are modelled to be removed.

Figure 8 NO_2 concentration results for Wallingford



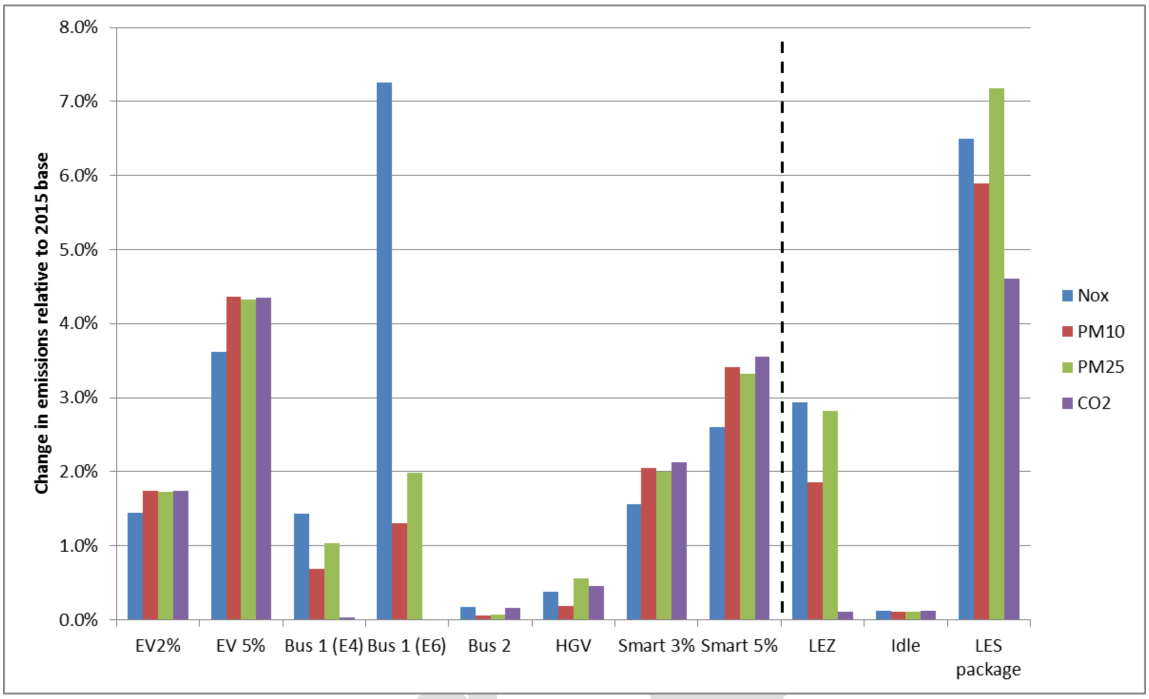
3.3.2 Henley

The base line emission results for Henley are shown in figure 9 below. These results show a similar trend as those of Wallingford, with a somewhat greater impact of from the 2020 scenario. This is likely to be related to the greater proportion of diesel car traffic in Henley and the impact of Euro 6 on these vehicles.

Figure 9 Baseline emission results for Henley

The impact of the LES measures in Henley in 2015 is shown in figure 10. Again the EV and smarter choices scenarios show useful reductions in emissions, especially for the higher targets. The impact of bus measures is less than in Wallingford as there are fewer buses. However, the LEZ has a greater impact than in Wallingford, although still relatively small. The impact of the LEZ is likely to be related to a greater proportion of HGV's in Henley. The assessment of an anti-idling campaign showed little impact, although our assumptions used in modelling this scenario as based on limited evidence.

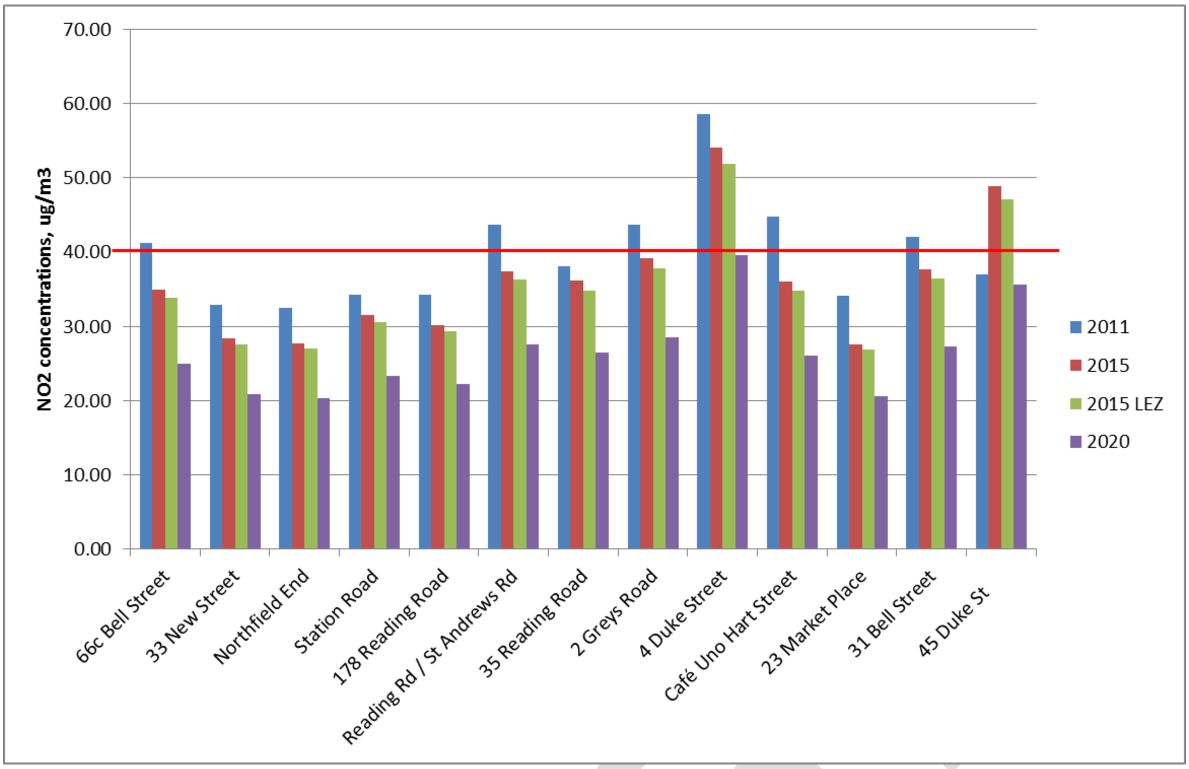
Figure 10 Emissions impact of LES measures in Henley



Overall the greatest benefits would seem to be to tackle car emissions through promoting electric and low emission vehicles and reducing trips through smarter choices work. The adoption of a LEZ may also be worthwhile. A package for Henley based on the less ambitious EV and smarter choices targets, combined with an LEZ will give emission reduction of just under 10%. This is somewhat less than the package proposed for Wallingford.

The NO_2 concentration modelling results for Henley are shown in figure 11 below. The results suggest that by 2015 all locations except Duke street will comply with the limit value. The LES package shows a useful further improvement of some 3-4%. However, in Duke Street concentrations will still be significantly above the 40µg/m^3 limit. Even in 2020 with a significant uptake of Euro 6 vehicles Duke Street is struggling to comply with the limit value. This suggests that more radical solutions are needed for this particular location that would require significant reduction in traffic movements.

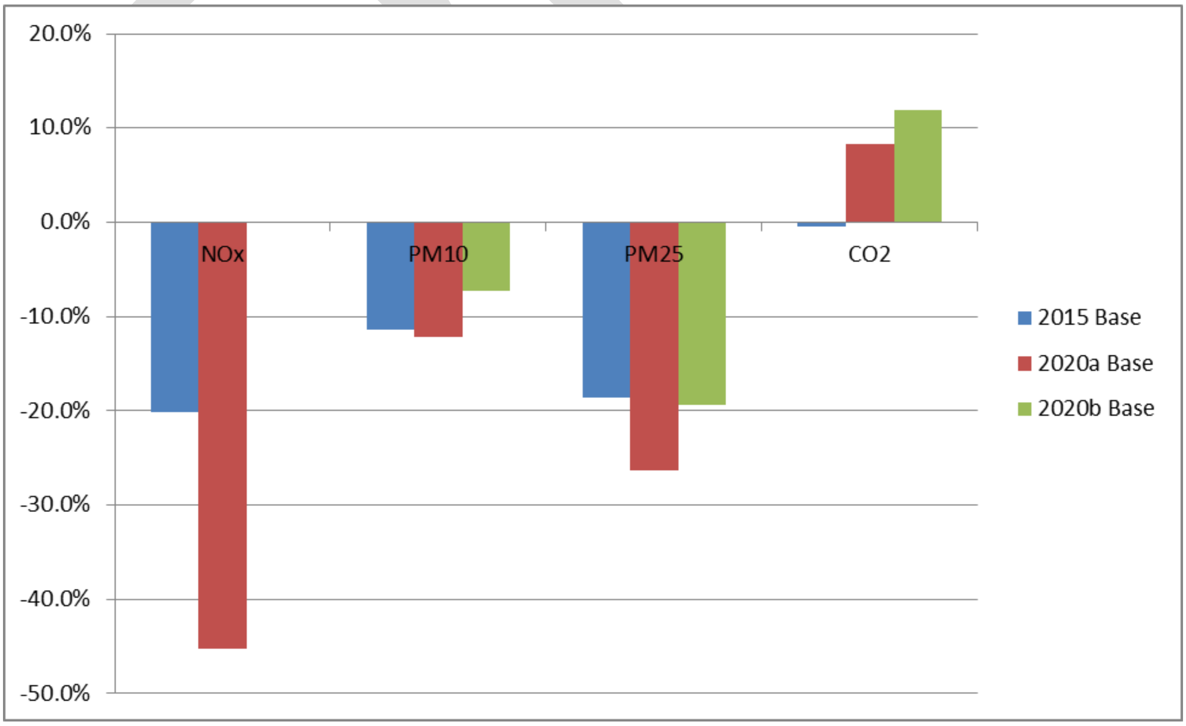
Figure 11 NO_2 concentration results for Henley



3.3.3 Watlington

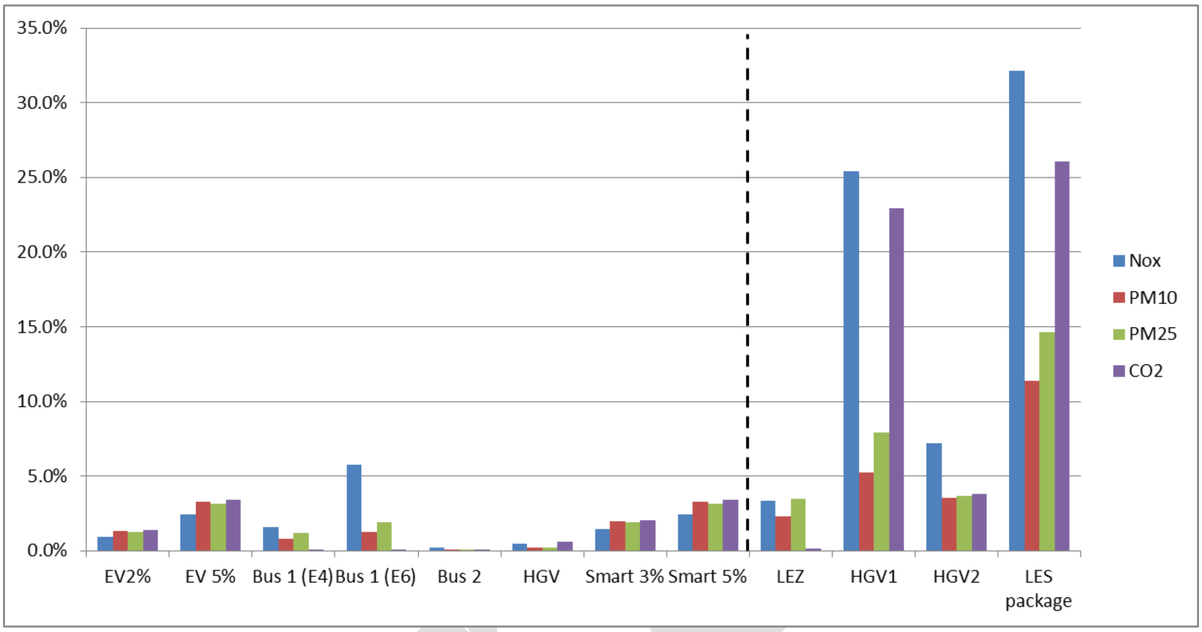
The baseline results for Watlington are shown in figure 12. Again the basic pattern is similar to that of Henley and Wallingford. The reduction in NOx emissions going forward is somewhat greater and again linked to HGV emissions which are a significant issues in Watlington.

Figure 12 Baseline emission results for Watlington



The impact of the LES measures in Watlington relative to the 2015 base is shown in figure 13 below. Again the EV and smart scenarios give useful emission reduction, but bus measures are not particularly relevant for this location. The measure that stands out is HGV1 which is the 'freeway' concept where all obstructions from parked vehicles are removed from the main routes through the village to allow the traffic to flow freely. We have perhaps a somewhat optimistic assumption that speed will move up to the speed limit. However, it still suggests this would be a good measure. It also needs to be recognised that this will increase the speed of all vehicles so will improve emissions from cars as well as HGVs.

Figure 13 Emissions impact of LES measures in Watlington

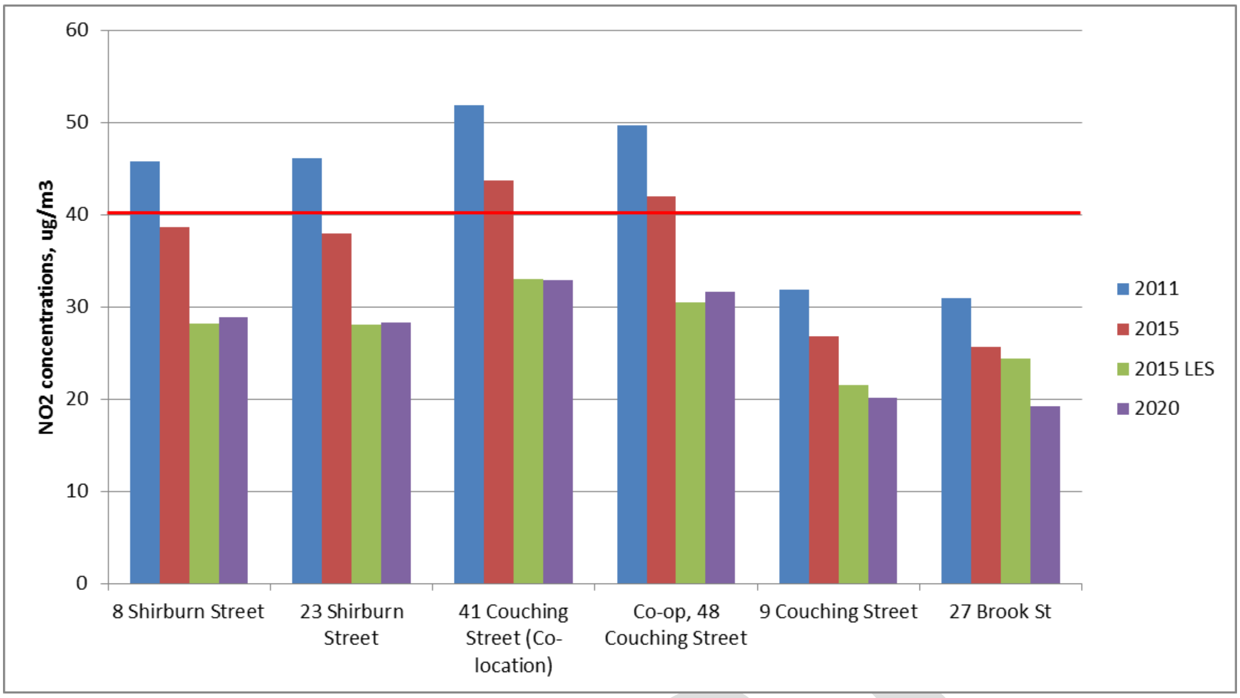


The HGV 2 option which gives full enforcement of the weight limit is also giving useful emissions benefits. In addition the LEZ option seems to have the greatest impact in Watlington compared to the other AQMA's. This suggests a package of measures aimed at HGVs with the enforcement of the weight limit, removal of parking obstructions and the LEZ. This package of measures suggest significant reductions in NOx and CO_2 emissions of more than 25%, with PM reductions around 12-15%.

The modelled NO_2 concentration results for Watlington are shown in figure 14. This suggests that by 2015 of the four measured exceedance locations 2 will have dropped just below the limit and 2 will remain just above. The modelled impact of the LES package would have a significant impact bringing all locations to around 30µg/m^3 or less. Allthough we have been optimistic with the HGV 'freeway' scenario this still suggests a package of measures based on HGV's could solve the problem in Watlington.

The 2020 scenario shows a similar impact to the 2015 LES package will all locations comfortably below the NO_2 limit.

Figure 14 NO_2 concentration results for Watlington



3.4 Conclusions

Perhaps the first point to make is that improvements in the vehicle parc will make potentially significant improvements in air quality. The latest Euro standard vehicles (5 and 6) are expected to make significant reductions in both PM and NOx emissions. Although Euro 5 vehicles have provided less effective in slower urban areas, they work well on freer flowing roads in suburban and rural areas. In addition with the improvements introduced with Euro 6 we expecting these to perform better in urban areas. This is reflected in our analysis which suggests that by 2015 there could be a 30% reduction in NOx emission across the district as a whole but only about a 10-15% reduction in the three AQMAs. The sensitivity test for 2020 assessed for the AQMAs shows that by then Euro 6 vehicles will be having a much greater impact with potentially over a 30% reduction in NOx emission.

The picture for CO_2 emission is quite different with little improvement or even a worsening in emission as we move forward to 2015 and 2020. This is related to some expected growth in traffic levels and only small improvements in vehicle efficiency.

At the district level the biggest contributor to emissions are passenger cars, closely followed by freight vehicles (HGV's and LGVs). Buses make up only a small proportion of the emission, around 2-4%. Therefore cars should be a key target of the wider Low Emission Strategy for the district. Of the measures assessed the EV and smarter choices scenarios have the greatest impact reflecting the importance of tackle emissions from cars. Only one HGV measure was assess, the HGV eco-driving measure, and this had only a small impact. This suggests that further freight measures should ideally be considered to tackle this significant proportion of the emissions. In terms of the buses, although a small contribution at the district level, a back stop Euro 4 standard through a bus agreement could provide useful benefit.

At the AQMA level the impact of reducing emissions in relation to the future baseline will help improve air quality and achieve compliance. The modelling suggests some of the exceedances will be removed by 2015, with pretty much all of them removed by 2020. However, this does rely on the performance of Euro 5 and Euro 6 vehicles being as expected.

In terms of making significant improvements in the AQMAs beyond the baseline forecast year in 2015 quite major measures are likely to be needed. Considering each of the AQMA's in turn:

- Wallingford – the bus only river crossing was the only measure that made a significant impact.
- Henley – although some benefits were gained from general traffic reduction measures, to solve the Duke Street problem most of the traffic would need to be removed.
- Watlington – the 'clearway' concept which removes all parking and loading areas on Couching street will make a significant impact but is unpopular with residents and businesses.

It should also be noted that the LEZ options, based on a Euro 4 standard, only had a small impact. To be effective a much more stringent standard would be needed.

4 Cost benefit analysis

Based on the recommendations from the emissions assessment above a short list of measures was identified and agreed with South Oxfordshire Council to taken forward into the Cost Benefit Analysis (CBA). These shorted listed measures comprise:

Area wide measures

- An electric vehicle scenario (EV2%) which targets a 2% uptake of electric car and van fleets. Various measures such as promotion and recharging infrastructure are included.
- A voluntary bus emission stanrad (Bus 1) where all buses which run in any AQMA are brought up to Euro 4 standard.
- A bus eco-driving and anti-idling scheme (Bus 2) which results in 4-8% fuel savings for eco-driving and 2-3% fuels savings from anti-idling.
- A HGV eco-driving and anti-idling scheme (HGV) which results in the same fuel saving assumptions as Bus 2.
- A behaviour change programme (Smart) aiming for a 3% reduction in traffic.

Wallingford AQMA

- Making the main river crossing a bus only bridge crossing (Bus X)
- The area wide electric vehicle strategy (EV) impacting in the AQMA, using the same assumptions as EV2% at the area wide level.
- The behaviour change programme (Smart) impacting in the AQMA, with the same assumptions as Smart at the area wide level.

Henley AQMA

- A low emission zone (LEZ) which requires buses and HGV's entering the AQMA to be Euro 4 or above.
- The area wide electric vehicle strategy (EV) impacting in the AQMA, using the same assumptions as EV2% at the area wide level.
- The behaviour change programme (Smart) impacting in the AQMA, with the same assumptions as Smart at the area wide level.

Watlington AQMA

- A freight clear way (HGV1) where parking vehicles will be removed from the main route through Shirburn and Crouching Street. We assume here that the average speed will increase to the speed limit.
- Rigorous enforcement of the 7.5t limit (HGV2).

The Cost Benefit analysis carried out for these measures and set out in this section covers:

- The estimated costs associated with the implementation of each measure;
- Damage cost benefits associated with the emissions savings generated by each measure and assessed in the screening assessment;
- Abatement cost savings related to NO_2 compliance;
- Aggregated benefit-cost results in terms of total net present value (NPV) and benefit cost ratio (BCR).

4.1 Costs

4.1.1 Methodology

We have estimated both the initial capital costs (CAPEX) and annual operating costs (OPEX) of each option using evidence from other published studies such as the Leeds and Bradford LEZ study and the London TfL Low Emission Vehicle Road Map. The costs have been adjusted to match the scenarios proposed and where possible reflect South Oxfordshire specific conditions.

For appraisal purposes the costs has been aggregated over a 10 year period to give a total net present value (NPV) cost.

4.1.2 Area wide measures

4.1.2.1 EV 2%

The electric vehicle strategy is based on the provision of charging points to promote the uptake of electric vehicles. The strategy assumes a 2% uptake of electric vehicles in the car and van fleet. For the costing we estimated the number of drivers who would switch from conventional fuel to electric vehicles and scaled them up with the capital cost of the electric vehicle minus the operational fuel savings. We assumed that maintenance costs were equal for conventional fuel and electric vehicles and therefore did not include any additional maintenance costs within the sums.

Vehicle numbers by registered postcode are available from Vehicle Licensing Statistics[6] and we counted the number of cars in postcodes OX3, OX4, OX9, OX10, OX14, OX33, OX39, OX44, and OX49 which approximates to South Oxfordshire. This amounted to 117,731 cars. Our confidence in these numbers are medium in scale; some of these postcodes part cover South Oxfordshire and part cover another district and therefore this may be a slight overestimation of the number of cars registered in South Oxfordshire.

In order to estimate the magnitude of the shift in vehicles from cars to a 2% uptake in electric vehicles, we require an understanding of the existing EV uptake. The ‘pathways to high penetration of electric vehicles’ report by the CCC (2013) states that about 110,000 electric cars and vans were sold in 2012 globally which represents approximately 0.14% of car and van sales, although we are unsure what proportion of these sales might be located in South Oxfordshire and how this then relates to the total vehicle stock. We have decided to assume that current EV uptake in South Oxfordshire is near the 0% mark. This assumption may

[6] https://www.gov.uk/government/collections/vehicles-statistics

slightly overestimate the number of cars required to shift to EV to meet the 2% target, although we do not feel this assumption will be a significant factor to the appraisal results.

We therefore estimate the number of vehicles to shift from cars to electric vehicles in South Oxfordshire to be 2% or 2,355. The estimated capital cost to the users of this shift is based on an additional marginal cost of £10k per vehicle giving an estimated capital cost of around £23,550,000.

Complementing this the users will see an operational cost saving associated with the shift to EVs. Our modelling identifies that there could be approximately 6,851,213km driven by battery electric vehicles if the 2% overall target was reached. Assuming that an average car drives at 40mpg and fuel cost is £1.40 per litre, we have estimated that fuel costs before their switch to EV would be in the order of £6.7m annually. Assuming electric car fuel use is 0.145 kwh/km and the cost of electricity is 12p/kwh, the total operating cost of the new electric vehicles would be around £119,211. The savings may therefore be in the order of £558k compared to the current fuel costs for these vehicles.

In addition there will be the capital cost associated with the recharging infrastructure which is assumed to fall to the public sector. The capital costs is assumed to be £1,800 per charging post[7]. We also assume that 1 post will be needed to support 10 vehicles. This gives a total requirement for 235 charging points across the district at a cost of £423k.

Over the 10 year appraisal period this equates to a net present value for capex of £21 million and an net present value opex saving of £4,7 million considering both the user and public sector costs. However, considered just the public sector costs for the investment on charging infrastructure as an alternative view of the costs of this measures. In this case the total net present capex amounts to £382k and there are no opex savings.

4.1.2.2 Bus 1

Bus 1 assumes that all buses which run in an AQMA comply with Euro 4 standard or are retrofitted with combined selective catalytic reduction and particle trap (SCRT) technology. So we have we estimated the number of buses that fall below the Euro 4 standard and used this to scale up the retrofitting costs per bus as an proxy for the costs of compliance.

Data from the Leicester City Council Project BREATHE (Bus REtrofit: ATtenuating Harmful Emissions) estimated the cost of purchasing and fitting SCRT technology as £18,235 per bus (14,235 for SCRT technology and £4,000 for the microhyprid eFan). We have assumed that the operating and maintenance costs per vehicle will be similar to the current operational and maintenance costs and therefore, have only included the purchasing and fitting costs within our assessment.

For the number of vehicles the retrofit would apply to we used the Thames Travel Fleet List as a proxy for the age distribution of buses in the district. This indicated that about 22% of buses would be older than Euro 4. In terms of vehicle numbers this was based on modelled bus km in the district of 9 million vkm per year and annual average bus kms of 65,000. This gave a total of 140 buses operating the district or which 30 would need updating. This gives an estimated capital investment of £550k.

The total present value cost of the this scenario is then estimated to be £495k.

4.1.2.3 Bus 2

Bus 2 is an eco-driving and anti-idling scheme which results in 4-8% fuel savings for eco-driving and 2-3% fuels savings from anti-idling. The Bus 2 costs were derived by estimating and scaling up the initial eco-driver training costs per bus, which is offset by cost savings from eco-driving.

[7] The Ricardo-AEA report for Transport for London (2013) 'Environments support to the development of a London Low Emission Vehicle Road Map' stated that the cost of standard (3-7kW) charging points at work places would be £1,800.

The cost of the Safe and Fuel Efficient Driving programme dedicated to influence eco-driving has been estimated by Ricardo-AEA staff as £300 per bus. Scaling this to the 140 buses (as derived for Bus 1), this amounts to around a total capital cost of £43k.

There will be cost savings associated with eco-driving. Bus eco-driving has typically 4-8% fuel savings while anti-idling causes an estimated 2-3% fuel savings. We suggest that combined, we would see 5% fuel savings which gives 5% CO2 saving, and 2% NOx and PM saving.

Current fuel costs are estimated based upon the fuel use of a small bus (0.19l/km) relecting that the majority of buses in the district are smaller single deck buses. Bus and coach distances, as modelled, are 30,355km per day and therefore we have estimated current fuel costs as around £4,672 per day. A 5% saving gives an estimated saving of around £235 per day or £85,000 per annum (rounded to the nearest thousand).

The total present value capital cost of the Bus2 scenario is estimated to be £37k offset by an present value operating saving of £717k. There overall the savings outweigh the cost.

4.1.2.4 HGV

Similarly to the Bus 2 option, HGV costs were derived by estimating and scaling up training costs for HGV vehicles and offsetting them with cost savings from eco-driving.

Vehicle Licensing Statistics[8] stated that the number of HGV's registered in Oxfordshire was 5,407. More detailed data on buses showed that 34% of bus vehicles registered in Oxfordshire were based in South Oxfordshire, so with low to medium confidence, we estimated that the number of HGV's registered in South Oxfordshire was 1846 using the same proportion.

The Safe and Fuel Efficient Driving programme, as in Bus 2, is estimated at £300 per vehicle. Scaling this up gives us a one off cost of £533,752.

We estimated the annual fuel saving from mileage driven and average fuel consumption. Our modelling suggested that around 119, 000km are driven by artic HGVs and 123,000km are driven rigid HGVs by in South Oxfordshire on a daily basis. We used an estimate of 0.19l/km for rigid HGVs and 0.33l/km for arctic HGV and £1.30/l fuel cost to estimate a total baseline fuel cost of £82,600 for 24hrs. A 5% saving as a result of the scheme could therefore see savings of around £4,130. Scaling this up to a calendar year, this represents savings of around £1.5million per annum.

The total present value cost of the HGV scenario, combining capital costs and operational savings, is estimated to be -£12.2million. In other words, the savings considerably outweigh the cost.

4.1.2.5 SMART

A general smarter choices package has also been considered which will provide information to encourage fewer car based journeys. Its actual impact will be hard to predict, but the scenario assumes that 3% fewer journeys are taken.

The cost of the smarter choices programme is stated as 4p/km saved in 2009 prices based on the results of the sustainable travel towns demonstration project. This price has been updated to 4.4p/km, the 2013 price, using CPI data (ONS, 2013).

The number of journeys saved would equate to around 37 million km pear year, which is 3% of the total car km from this project's modelling data. Thus, we have estimated the one off cost to equate to around £1.7 million.

Investment would need to continue annually in order to continue the impact of the scheme during the appraisal period. We have assumed the annual cost of maintaining a 3% car

[8] https://www.gov.uk/government/collections/vehicles-statistics

mileage reduction would be around 30% of the upfront cost. This is about £500k per annum for the 10 year appraisal period.

The total present value cost of the SMART scenario is estimated to be £5.7m.

4.1.3 Wallingford measures

4.1.3.1 Wallingford Bus X

The bus only cross scheme is designed to remove cars form the river crossing and the roads leading to this which are narrow and congested. Costs were used from a similar scheme which removed cars from Lendal Bridge in York[9]. Here, the capital cost was £70,000, the consultation was £10,000 and project management £50,000. The operating costs were £80,000 per annum for the network operating staff.

The total present value cost of the Wallingford Bus X scenario is estimated to be £792k.

4.1.4 Henley

4.1.4.1 Henley Low Emission Zone

The Henley Low Emission Zone (Henley LEZ) scenario would restrict bus and HGV traffic from operating on the main AQMA corridors unless they met the Euro 4 emission standard. The scheme would be enforced by fixed ANPR cameras operating at key points in the AQMA. The scheme would be established through the use of a traffic regulation order (TRO). The LEZ scenario would restrict buses and HGVs operating in the AQMA unless they meet the Euro 4 emission standard.

The scheme implementation costs are based on ANPR camera enforcement with a back office system. The camera costs were scaled up based upon £35k per fixed camera[10]. We have applied this to three fixed cameras located on Hart Street, Duke Street and Market Place which should be able to monitor all traffic passing through the AQMA. We have assumed 60% of on road ANPR costs as back office costs and 25% as set up costs. In addition an annual operational cost of 70% of the camera and back office costs is assumed, along with a further 10% for maintenance. This equated to an estimate one off capital cost of £194k and operational cost of £134k per annum.

In terms of vehicle compliance costs this has been estimated for HGVs as around £7.2m. This is based upon the cost of replacing a rigid truck being £60k and an arctic being £73k[11]. The number of vehicles that would be affected was hard to estimate without full ANPR data. Therefore we have assumed that the same vehicles access the area every week and vehicle trip represents a single vehicle. Based on this and using traffic data from our emissions model we estimate that some 1165 rigid HGVs and 165 artic HGVs would be affected by the scheme. National fleet data suggests that 10% of the rigids and 2% of the artics would be older than the Euro 4 standard and would need replacing, equating to 117 rigid trucks and 3 artics. This gives rise to a one off replacement cost to the users of £7.2m.

The cost of the bus compliance is based on retrofitting with SCRT. The costs of this are estimated as £18,325 capital (see bus 1-retrofit scenario cost details. Based on the routes running through Henley and the same fleet mix as the district an estimated 9 buses would need retrofitting. The capital cost of retrofitting these 9 buses gives a total capital cost £164k.

The total estimated present value of the scheme, covering both implementation and compliance costs, over the 10 year appraisal period is £7.9m. If we consider only the implementation costs incurred by the local authority it would amount to lesser figure of £1.3million.

[9] http://democracy.york.gov.uk/ieListDocuments.aspx?CId=733&MId=6884&Ver=4
[10] Cost data based on a review of LEZ studies carried out by AEA for Defra, 'Appraisal of UK LEZ feasibility studies', AEA, 2012
[11] Road Haulage Association data, cost tables, 2012

4.1.5 Watlington

4.1.5.1 Watlington HGV 1

The HGV1 scheme removes all parking bays and obstructions in the main AQMA roads to allow the vehicles to flow more smoothly. The simple assumption is that vehicles will then be closer to the speed limit than the current slow congested speeds.

A simple assumption has been made that a new or adjusted TRO will need to be made to remove the obstructions and make the route no parking. Cost for setting up a TRO has been estimated at £150,000 to cover legal costs, staff costs and consultation costs. This is assumed to be the only cost involved although ongoing enforcement may be need. On this basis the net present cost is £135k.

4.1.5.2 Watlington HGV 2

The HGV 2 scheme is to use ANPR to provide rigorous enforcement of the 7.5t limit. The same costs component have been assumed as for the LEZ scheme in Henley, but the HGV 2 scheme would be based on only 2 fixed ANPR cameras. Using these costs the estimated present value capex is £166k and the opex is £872k.

4.1.6 Summary cost data

A summary of the cost data is shown in Table 2 below. The EV2% has two cost options (a) which only includes the public sector implementation costs and (b) which includes the user costs. Similar for the Henley LEZ we have included 2 costs options again for (a) public implementation costs and (b) including user compliance costs. We have also combined the costs to give an overall cost for the area measures as a package and an overall cost of the area measures plus the AQMA specific measures.

Table 2 Summary Cost Data

Scenario	Total PV CAPEX (£millions)	Total PV OPEX (£millions)	Total PV Cost (£millions)	Rank (cheapest)
Area measures				
EV 2% (a)	£ 0.38	£ -	£ 0.38	4
EV 2% (b)	£ 21.62	-£ 4.71	£ 16.91	12
Bus 1	£ 0.50	£ -	£ 0.50	5
Bus 2	£ 0.04	-£ 0.72	-£ 0.68	2
HGV	£ 0.50	-£ 12.72	-£ 12.22	1
Smart	£ 1.50	£ 4.22	£ 5.72	9
AQMA measures				
Wallingford BusX	£ 0.12	£ 0.67	£ 0.79	6
Henley LEZ (a)	£ 0.18	£ 1.13	£ 1.31	8
Henley LEZ (b)	£ 6.84	£ 1.13	£ 7.98	10
Watlington HGV1	£ 0.14	£ -	£ 0.14	3
Watlington HGV2	£ 0.12	£ 0.76	£ 0.87	7
Combined				
Area LES	£ 24.53	-£ 13.93	£ 10.60	11
Area LES Plus AQMA	£ 31.75	-£ 11.37	£ 20.38	13

4.2 Damage cost saving

Air pollution impacts on human health and the natural and built environment. In particular, there are chronic mortality effects (loss of life years due to air pollution), morbidity effects (increase in the number of hospital admissions for respiratory or cardiovascular illness), damage to buildings (from particulates) and impacts on materials. The Interdepartmental Group on Costs and Benefits (IGCB, 2008) provides guidance[12] on monetising these damage costs for use in appraisal.

The damage cost approach has been used to calculate the damage costs savings from proposed policy scenarios in order to understand the magnitude of the benefits of changes in emissions. Where the magnitude is estimated to be greater than £50m, a full impact pathway assessment would be required, but this is not the case for this project.

4.2.1 Damage cost calculations

The IGCB guidance has been implemented in the form of a Damage Cost Calculator (IGCB, 2008) which has been used for this study. The calculator requires information on appraisal timeframe and emissions to be inputted.

For this assessment, 2015 was inputted as the base year by which emissions were compared to reflect our modelling scenario baseline. Benefits were calculated over a 10 year period to reflect an interest in a medium to long term effects of policies.

Our emissions modelling provided information on the estimated change in NOx, $PM_{2.5}$, PM_{10} and CO_2 emissions compared to a 2015 forecasted baseline within the AQMA area which is the focus of the analysis. These data were entered into the Damage Cost Calculator.

[12] https://www.gov.uk/air-quality-economic-analysis#damage-costs-approach

The calculator then multiplied our emissions data by the adapted annual pulse damage costs, as set out within Table 2 of the Damage Cost Calculator Guidance (IGCB, 2008). The annual pulse damage costs were adapted by the calculator by inflating 2008 price data to 2015 prices assuming an inflation rate of 2.5% and uplifting the damage cost values by 2% per annum to reflect increases in willingness to pay. A damage cost schedule over 10 years was then discounted at a rate of 3.5% per year as set out in the Treasury's Green Book (2003) to estimate the 2015-2024 present value damage avoidance costs.

Table 3 presents the results of the analysis. It shows the damage costs saved by each policy scenario compared to the 2015 baseline. Separate damage cost savings are shown relating to the changes in emissions of oxides of nitrogen, particulate matter and carbon dioxide. The table illustrates the total damage cost saved for each scenario and the estimated range[13]. The low range reflects a potential 40 year time lag between a change in particulates and impact on health, while the high range reflects a 0 year time lag.[14]

Overall the area measures generate the greatest damage cost savings as might be expected as the cover a much wider area than the AQMAs. The Smart choices behavioural change measures generates the most benefit followed by the EV scenario and the HGV eco-driving scenario. The bus measures generate the least benefit. In terms of the AQMA measures the Watlington freight clear way (HGV1) has the most benefit followed by the Wallingford Bus only river crossing scheme.   When combined as a pack the area measures could provide a damage cost benefit of some £5.2 million, which increases to £5.4 million when the AQMA schemes are added.

Table 3: Present value damage costs avoided

Scenario	PV damage costs saved 2016-2025 (£millions)						
	NO_x	PM	CO_2	Total	Low range	High range	Rank (most beneficial)
Area measures							
EV 2%	0.074	0.066	1.218	**1.358**	1.226	1.631	4
Bus 1	0.096	0.179	0.019	**0.295**	0.233	0.336	6
Bus 2	0.006	0.020	0.100	**0.126**	0.112	0.150	7
HGV	0.026	0.140	0.971	**1.136**	1.019	1.361	5
Smart	0.111	0.753	1.456	**2.320**	2.010	2.740	3
AQMA measures							
Wallingford BusX	0.002	0.014	0.030	**0.046**	0.040	0.054	9
Henley LEZ	0.003	0.012	0.001	**0.016**	0.013	0.018	11
Watlington HGV1	0.007	0.008	0.073	**0.088**	0.079	0.106	8
Watlington HGV2	0.002	0.006	0.012	**0.020**	0.017	0.023	10
Combined							
Area LES	0.313	1.158	3.764	**5.235**	4.600	6.218	2
Area LES Plus AQMA	0.328	1.198	3.879	**5.405**	4.748	6.420	1

[13] The calculator also provides high and low sensitivity ranges, but since these are the same as the low and high ranges, we have not provided them here.
[14] The Damage Cost Calculator Guidance, (IGCB, 2008), states that "although the evidence is limited, the recent expert judgement from COMEAP tends towards a greater proportion of the effect occurring in the years soon after a pollution reduction rather than later. This suggests that more weight should be given to the high end (0-year lag) of the damage costs range."

4.2.2 Health impacts

The damage cost calculations were derived by monetising the effect of changes of health on healthcare services and employee productivity. We have presented these health effects separately in order to conceptualise the potential impact of the scenarios. This is not additional to the damage costs; the damage costs are inclusive of these factors. Therefore, this table is just for information.

Table 4: Estimate changes in hospital admissions and avoided loss of life

Scenario	Total				
	Avoided years of life lost over 100 years		Respiratory hospitals admissions avoided (per annum)	Cardiovascular hospitals admissions avoided (per annum)	Rank (most beneficial)
	No lag	40 year lag			
Area measures					
EV 2%	8.63	8.90	0.09	0.09	5
Bus 1	15.11	15.15	0.15	0.15	4
Bus 2	1.28	1.26	0.01	0.01	7
HGV	7.91	7.61	0.07	0.07	6
Smart	40.45	38.65	0.35	0.35	3
AQMA measures					
Wallingford BusX	0.75	0.71	0.01	0.01	10
Henley LEZ	0.74	0.72	0.01	0.01	9
Watlington HGV1	0.93	0.95	0.01	0.01	8
Watlington HGV2	0.40	0.40	0.00	0.00	11
Combined					
Area LES	73.39	71.57	0.68	0.68	2
Area LES Plus AQMA	76.21	74.36	0.70	0.70	1

4.2.3 Qualitative impacts

There are a number of impacts which have not been included within the damage cost estimates. These include[15]:

- ‘Effects on ecosystems (through acidification, eutrophication, etc);
- Impacts of trans-boundary pollution;
- Effects on cultural or historic buildings from air pollution;
- Potential additional morbidity from acute exposure to PM;
- Potential mortality effects in children from acute exposure to PM;
- Potential morbidity effects from chronic (long-term) exposure to PM or
- other pollutants;
- Effects of exposure to ozone, including both health impacts and effects on
- materials;
- Change in visibility (visual range);
- Macroeconomic effects of reduced crop yield and damage to building materials; and
- Non-ozone effects on agriculture’

[15] List sourced from IGCB, 2008

These impacts have not been monetised due to the difficulty in estimating the link with emissions and monetised impact. For the majority, if these effects were monetised we would see an increase in the magnitude of damage cost savings for each scenario proportionate to emissions.

4.3 Abatement cost saving

The ‘abatement cost guidance for valuing changes in air quality’ (Defra, 2013) states that where air quality is in breach of a regulation and a full impact pathway assessment is not necessary, the use of the abatement cost approach is required. So in the case of South Oxfordshire AQMA which breaches the NO_2 limits we also need to consider the abatement cost approach.

This approach reflects the cost of mitigation to comply with the regulation. In essence the approach aims to determine the abatement costs that would be necessary to comply with the limit which are avoided by the proposed measures in South Oxfordshire. This is in contrast to the damage cost approach which aims to quantify the damage costs avoided by the emissions savings. The abatement costs are to be applied only to the emissions which exceed legally binding obligations, so in this case only applies to NOx emissions that contribute to the NO_2 breaches. In addition it only applies to the emissions savings that would be needed to reach compliance and not emission savings that would go beyond compliance.

4.3.1 Compliance assessment

In terms of compliance this was assessed for each of the AQMA areas as part of the emissions screening assessment reported in Technical Note 3. This assessment showed that in both Wallingford and Henley the package of measures would not be sufficient to reduce NO_2 concentrations below the 40 µ/m3 limit in all areas in the AQMA. Therefore we can use the full abatement costs for all the emission savings generated in these two AQMAs.

However, in Watlington the measures will reduce concentrations below the 40 µ/m3 limit, therefore the abatement costs cannot be applied to the full emission savings. In this case DEFRA’s NOx to NO_2 conversion tool was used to estimate what proportion of the savings would be needed to meet the 40 µ/m3 limit. This analysis showed that a 14.6% reduction in road NOx emissions would be required be required for compliance. This equated to:

- 57% of the emission reduction achieved by the HGV 1 measures
- 3 times the emissions reduction achieved by the HGV 2 measures (so 100% of these savings could be assessed with abatement costs)
- 45% of the combined HGV1 and HGV 2 measures.

These compliance proportion are then used below to estimate the abatement cost savings.

4.3.2 Choice of unit abatement costs

Defra developed estimates of the unit costs for NOx emission abatement using a marginal abatement cost curve (MACC). The MACC reflects the abatement cost of a range of different abatement technologies. Wider impacts on society are incorporated, including: impacts on other pollutants; energy and fuel impacts, and health impacts (damage costs). The abatement represented by the national average compliance gap is compared against the MACC to estimate an indicative unit cost of abatement. It is only indicative because both the gap and the abatement potential from different technologies will vary between areas.

The unit cost is provided in terms of the marginal cost of emissions, usually measured in £/tonne. Defra’s guidance recommends that the appraiser should decide which value is most appropriate for a particular case. If there is no clear rationale to use a particular measure the recommended default value is £29,150 per tonne. For simplicity and clarity we have opted to use the default value for all scenarios, so that they are all assessed in the same way.

Table 5: Marginal abatement costs of national measures to reduce oxides of nitrogen emissions

Sub sector	Baseline Technology	Abatement Measure	Marginal Abatement Cost (£/Tonne of NOx) 2015
HGV	Euro II	SCR	5099
HGV	Euro III	SCR	5380
Buses	Euro II	SCR	6251
Buses	Euro I	Hybrid	6500
Buses	Euro I	SCR	6625
Buses	Euro III	SCR	7257
Buses	Euro II	Hybrid	7462
HGV	Euro IV	SCR	8053
Buses	Euro III	Hybrid	9423
Buses	Euro IV	SCR	11889
Buses	Euro I	Electric	14669
Buses	Euro II	Electric	14872
Buses	Euro III	Electric	17352
Articulated HGV	New Euro V	Euro VI	17743
Buses	Euro IV	Hybrid	18391
Buses	New Euro V	Euro VI	24852
Rigid HGV	New Euro V	Euro VI	28374
Buses*	**Euro IV**	**Electric**	**29150**
Buses	Euro V	Hydrogen	72932
Diesel LGV - class 1	New Euro 5 class I	Euro 6	79323
Diesel LGV	Euro 1	Electric	100665
Diesel LGV	Euro 2	Electric	111619
Petrol cars	Euro 1	Electric	112030
Diesel cars	Euro 1	Electric	135949
Diesel LGV - class 2	New Euro 5 class II	Euro 6	144124
Diesel LGV - class 3	New Euro 5 class III	Euro 6	144124
Diesel cars	Euro 2	Electric	156046
Diesel LGV	Euro 5	Electric	240484
Diesel LGV	Euro 3	Electric	262466
Petrol cars	Euro 2	Electric	280450
Diesel cars	Euro 3	Electric	304593

Note: * this is the value that should be used as the default.

4.3.3 Abatement costs avoided

Table 6 shows the abatement costs avoided for each of the emission reduction measures applied to the Wallingford, Henley and Watlington AQMAs. It shows the unit abatement cost applied in each case and the net present value (base year 2015) of the abatement cost avoided by the measure. A discount rate of 3.5% was applied to future year abatement costs avoided (up to 10 years).

Table 6: Abatement cost savings

Scenario	Abatement cost savings (£/t)	NOx saved per annum (tonnes)	Compliance proportion	Abatement cost saved per annum (£)	Total PV abatement benefits 2016-2025 (£)
Wallingford					
EV2%	£ 29,150	0.028	1.00	£ 802	£ 7,490
Smart	£ 29,150	0.022	1.00	£ 644	£ 6,015
Bus X	£ 29,150	0.185	1.00	£ 5,385	£ 50,289
Henley					
EV2%	£ 29,150	0.152	1.00	£ 4,416	£ 41,244
Smart	£ 29,150	0.164	1.00	£ 4,778	£ 44,621
LEZ	£ 29,150	0.307	1.00	£ 8,962	£ 83,688
Watlington					
HGV1	£ 29,150	0.712	0.57	£ 11,888	£ 111,015
HGV2	£ 29,150	0.201	1.00	£ 5,845	£ 54,584

The abatement cost savings are only applied to the proportion of NOx savings required for compliance.

4.3.4 Significance of the impact on compliance

The abatement cost guidance for valuing changes in air quality recommends that more detailed analysis is required if the net present value of the air quality impacts valued using unit costs is greater than £50m. The net present value of the abatement costs avoided in the South Oxfordshire AQMA area is substantially less than £50m.

4.4 Aggregating costs and benefits

We have aggregated the present value cost of each scenario with the benefits. For NOx we have used the abatement cost approach to valuing cost savings where compliance is required and for PM_{10} and CO_2 we have used the damage cost approach.

The present value results are outlined in the table below. We have presented the Net Present Value results (net present benefits minus net present costs) and the results for the benefit cost ratio test (net present benefits divided by net present costs). We understand that for air quality, the preferred option is made on the basis of benefit cost ratio. This is the measure which will reap more benefits per pound spent.

Table 1: Cost-benefit analysis results

Scenario	Total PV benefits 2016-2025 (£millions)	Total PV cost 2016-2025 (£millions)	NPV (£millions)	Rank (NPV)	Benefit Cost Ratio	Rank (BCR)
Area measures						
EV 2% (a)	1.41	0.38	**1.02**	2	**3.68**	3
EV 2% (b)*	6.11	21.62	**-15.50**	13	**0.28**	9
Bus 1	0.29	0.50	**-0.20**	5	**0.59**	7
Bus 2*	0.84	0.04	**0.81**	3	**22.24**	2
HGV*	13.86	0.50	**13.36**	1	**27.76**	1
Smart	2.37	5.72	**-3.35**	9	**0.41**	8
AQMA measures						
Wallingford BusX	0.09	0.79	**-0.70**	6	**0.12**	10
Henley LEZ (a)	0.10	1.31	**-1.21**	8	**0.07**	12
Henley LEZ (b)	0.10	7.98	**-7.88**	11	**0.01**	13
Watlington HGV1	0.20	0.14	**0.06**	4	**1.44**	4
Watlington HGV2	0.07	0.87	**-0.80**	7	**0.08**	11
Combined						
Area LES	23.48	28.37	**-4.89**	10	**0.83**	5
Area LES Plus AQMA	23.94	38.15	**-14.21**	12	**0.63**	6
Package - public costs	19.23	10.24	**8.99**		**1.88**	

* Opex savings added to benefits

Only 4 of the measures generate a positive NPV and BCR of greater than 1, indicating that the benefits will out weight the costs. The two area wide eco driving scenarios show the best results as the fuel costs savings easily out weight the costs of the training. Therefore they is a clear business case for the bus and freight industry investing in these measures with encouragement from the local authority. As well as the fuel cost savings these measures will also generate wider emission reductions that have health and economic benefits to the wider community.

The district wide EV strategy also has a positive NPV when we consider only the public sector implementation costs. In this case the damage cost savings will outweigh the initial investment by the authority in the charging infrastructure. The only AQMA measure that generated a positive CBA is the freight clear way in Watlington. In general the emissions benefit generated just in the AQMA are not sufficient to offset the costs of the measures.

Overall when the measures are combined into a package they do not provide a positive CBA. The poorer performing measures more than out weight those with a positive CBA. However, greatest costs are associated with the user investment costs for the EV scenario (EV 2%b) if we only consider the public cost scenarios (EV2%b and Henley LEZb) then the package of measures has a positive NPV of 9 and a BCR greater than 1.

As the Treasury Green Book outlines, we chose a preferred scenario on the basis of net present value, which is the (discounted) benefits net of cost. We have summarised the ranking of the scenarios in terms of most beneficial, lowest cost, highest benefits net of cost and highest payback per £1 spent to understand what is driving the most preferred option.

The ranking of the HGV and Bus 2 scenarios is driven largely by the potential opex savings. Meanwhile, the area wide EV2%(a) provides a balance of being one of the lowest cost scenarios and one of the most beneficial.

Table 8: Scenario ranking

	Ranking			
	Most beneficial	Lowest cost	Highest benefit net of cost (NPV)	Highest payback per £1 spent
Area measures				
EV 2% (a)	4	4	2	3
EV 2% (b)	4	12	13	9
Bus 1	6	5	5	7
Bus 2	11	2	3	2
HGV	10	1	1	1
Smart	3	9	9	8
AQMA measures				
Wallingford BusX	9	6	6	10
Henley LEZ (a)	7	8	8	12
Henley LEZ (b)	7	10	11	13
Watlington HGV1	5	3	4	4
Watlington HGV2	8	7	7	11
Combined				
Area LES	2	11	10	5
Area LES Plus AQMA	1	13	12	6

4.5 Conclusions

The concept of the South Oxfordshire project was to identify cost effective measures to reduce emissions in South Oxfordshire, working towards compliance of the air quality limits. The costs and benefits of a variety of scenarios were assessed, including area wide and AQMA only measures relating to electric vehicles, bus retrofit, and low emission driving programmes.

Four scenarios came out as cost beneficial. These were (in order of preference) the area wide HGV scheme, area wide EV2%(a), area wide Bus 2 and Watlington HGV1 scenario. The economic benefit of the HGV and Bus scenarios is driven by potential opex savings, especially the HGV scenario, and so should be pursued with operators from this point of view alone.

Meanwhile, the area wide EV2%(a) provides a balance of being one of the lowest cost scenario (for South Oxfordshire Council) and one of the most beneficial. This provides a case for promoting this measure.

Overall one could decide to only pursue those measures that have a positive NPV. However, if we consider only the public cost scenarios then the whole package of measures becomes cost beneficial, with those measures having positive NPV's out weighing those without. Although the benefits are dominated by the fuel costs savings of a single measure, the HGV eco-driving scheme.

5 Conclusions

This report has developed an outline set of measures that could be included in a low emissions strategy and then carried out an emissions assessment and cost benefit analysis. This final section draws on those results to propose a final group of measures to take forward in a Low Emission Strategy.

5.1 Emissions assessment

Across the district as a whole the majority of emissions are generated from car and freight traffic. In terms of NOx emissions 49% related to freight activity in terms of diesel trucks and vans, with a further 41% related to diesel cars. As regards CO_2 emissions cars, both petrol and diesel, are the biggest culprit's accounts for 59% of emissions, with a further 36% produced by freight vehicles. Therefore the LES should ideally focus its measures on reducing emissions from cars and freight traffic as a priority, complementary measures to continue to manage bus emissions.

At the district level the measures with the greatest impact were smarter choices measure to reduce car traffic and the EV strategy to further reduce emissions from cars. The voluntary bus Euro IV measure gave a useful emissions benefit, however, the HGV eco-driving scheme gave some useful CO_2 benefit but no real impact on NOx or PM emissions. Firstly this strengthens the case for focus on measures to reduce car emission, but also shows that further work is needed to find measures that will tackle freight emissions across the district.

Within the AQMA the smarter choices and EV measures give good benefits as the do at the district level. Within Wallingford the Bus only river cross scheme gave a major benefit for this local hotspot. Also in Watlington the freight freeway scheme along with enforcement of the weight limit gave a significant benefit and would potential reduce NOx emission below the objective limit. This gives support for again tackling car emissions, but also identify specific scheme in relation to buses and HGV's in Wallington and Watlington.

In summary the emissions assessment suggests key elements in the LES as follows:

- District wide
  - Focus on car emission reduction through behavioural change and promoting electric and low emission vehicles
  - A voluntary bus agreement based on a euro 4 standard by 2015 and an accompanying eco-driving/anti-idling policy
  - Work with the freight industry to identify further measures that could help reduce freight emissions
- Wallingford – a package of measures based on a bus only river crossing
- Henley – a package of measures to reduce traffic levels and promote low emission vehicles, and explore the potential of closure or significant traffic reduction on Duke street
- Watlington – an HGV programme based on the 'freeway' concept and enforcement of the weight limit.

5.2 Cost benefit analysis

Overall few of the measures proved to have a positive net present value (NPV) as the costs were high for the relatively modest emission savings that are generate at the scale of the district of AQMA. The main exceptions were:

- HGV and bus eco-driving where the fuel saving costs should outweigh the investment in training, making it a commercial attractive proposition to operators;
- The Watlington freeway scheme that produced significant benefit for minimal cost.

The biggest costs were the capital costs of vehicle purchases in the EV scheme and the HGV LEZ. However, if these costs are not included and we focus only the costs to the public sector for implementing the schemes then an overall positive NPV can be achieved for the package of measures as a whole. In this case the economic benefits of the eco-driving schemes outweigh the some of the more costly measures.

Therefore it would make sense the go forward with a package of measures that generates positive emission savings, where not all the individual measures will have a positive NPV but the package as a whole does.

5.3 Recommendations

Based on a package approach and trying to maximise emission benefits, yet maintaining a positive NPV we would suggest going forward with a package of LES measures based on the following:

- *Low Emission Behaviours* – working with the County and community groups on to develop and take forward behaviour change programmes linking travel behaviour change with air quality and health. Potentially this would also link with the public health board and partners at the Vale of the White Horse.
- *Electric Vehicle Strategy* – pursue an electric vehicle strategy focusing on car trips in the main towns. Some assessment will need to be made of the true demand and potential up take of electric and wider plug-in vehicles, but the core components would include:
    - Developing the recharging infrastructure potentially building on funds available from Office of Low Emission Vehicles;
    - Supporting parking measures that incentivise the use of electric and low emission vehicles;
    - Engagement with business and residents to support the uptake, ideally integrated with the low emission behaviours work above.

  In addition the strategy could be developed jointly with the Vale and seen as technology theme to support the wider Science Vale concept that is being developed by the two districts.
- *Freight Emissions Strategy* – comprising:
    - The development of eco-driving through a ECoStars campaign ideally done at the county level;
    - Pursuing the freeway scheme and weight limiting enforcement in Watlington working with the County;
    - Working with the freight industry and County to explore and develop other measures such as freight consolidation.
- *Bus Emission Strategy* – comprising:
    - Bus eco-driver training based on the bus and coach SAFED standard, along with anti-0adling promotion, ideally roled out across the county;
    - A minimum Euro 4 standard for buses operating in the district and again ideally across the county;
    - Pursue the bus only crossing concept in Wallingford with the County.
- Supporting planning and procurement policies - that would focus on:

- Promoting low emission travel behaviour for new developments;
- Supporting recharging infrastructure and EV use through the planning process;
- Leading on low emission vehicles through the Council procurement processes

These planning and procurement approaches, set out in draft in the appendices, should be adopted jointly for both South Oxfordshire and the Vale as partner authorities.

We would not recommend introducing a formal LEZ in any of the AQMA's as the emission benefits generated for these relatively small areas would not justify the significant costs imposed on both the public and private sectors.

Appendices

Appendix 1 – LES developer guidance

To be added

Appendix 2 LES procurement guidance

This note provides guidance on the procurement of low emission vehicles and transport services in order to meet the Council's duties with regards to improving local air quality and compliance with the EU Clean Vehicles Directive.

Local Air Quality Management and the Clean Vehicles Directive

Under the Environment Act 1995, and as set out in the Government's National Air Quality Strategies of 1997 and 2000, the Council has a duty to assess and manage local air quality. The Air Quality Strategy provides the policy framework for local air quality management (LAQM) and provides air quality standards and objectives for key air pollutants, which are designed to protect human health and the environment. The air quality standards and objectives are laid down in the Air Quality Regulations 2000.

Where an authority finds that pollution levels are in breach of the Regulations, they have a duty to examine the potential for human exposure to these pollutants. If there is a risk of the public being significantly exposed to a pollutant then the authority are required to designate an appropriate Air Quality Management Area or AQMA. Where local authorities have designated an AQMA they have a duty under section 84(2) of the Act to produce an Action Plan (AP). This plan must set out the measures the authority intends to introduce in pursuit of the air quality objectives.

The Council has declared three such areas and has put together a district wide action plan to reduce emissions and improve air quality. As part of this action plan the Council is seeking to use its procurement powers to reduce emissions from its own vehicles and those of contractors working on behalf of the Council.

In line with this approach the Council also has an obligation under the EU Clean Vehicles Directive (2009) to use its purchasing power to promote the uptake of clean and energy efficient vehicles. When the public sector either buys or leases a vehicle, they must take into account energy consumption, CO2 emissions and pollutant emissions over the whole lifetime of vehicles. The Clean Vehicle Directive is enacted in England, Wales and Northern Ireland by the Cleaner Road Transport Vehicles Regulations 2011. The Regulations state that any public sector contracting authority, entity or operator when purchasing or leasing road transport vehicles must take into account the operational lifetime energy and environmental impacts, in respect of vehicles purchased or leased, including:

- Energy consumption
- Carbon Dioxide emissions
- Emissions of Oxides of Nitrogen, Hydrocarbons and Particulate Matter
- Noise can also be taken into account

To satisfy the requirements of the Regulations, one of 3 options must be chosen:

1. The technical specification for energy and environmental performance is set out in the documentation for the purchase and leasing of road transport vehicles or services.
2. Energy and environmental performance is included as part of the contract award criteria.
3. A monetised whole life cost assessment, including the damage cost of lifetime emissions, is carried out as part of the tender evaluation.

Therefore to carry out any vehicle or transport service procurement one of these three options MUST be included in the procurement process. The following section provides basic guidance on how to include these options in your procurement process.

Low emission vehicle specifications and award criteria

Table 1 below provides criteria that should be used for if providing specifications or using award criteria, and are based on the Government Buying Standards for Transport[16]. These three sets of criteria should be used as follows:

- Minimum standards – these are the minimum standards that are expected to be used for procuring vehicles or services. They form the minimum specification standards or minimum award criteria.
- Best Practice – provide more stringent standards that can be used for specifications or enhanced award criteria.
- Other considerations – provide additional elements that could be used for specifications or within award criteria.

Table 1 Criteria to be used in specifications and award criteria.

Vehicle category	Minimum standard	Best Practice	Other considerations
Cars	CO_2 - 130g/km or less Emissions – Euro 5	CO_2 – 100g/km or less Emissions – Euro 6 or better (e.g zero emission)	Use of renewable fuels – e.g. bio fuels, renewable electricity Telematics to support fuel efficient driving.
Vans	CO_2 - 175g/km or less Emissions – Euro 5	CO_2 – 150g/km or less Emissions – Euro 6 or better (e.g zero emission)	Use of renewable fuels – e.g. bio fuels, renewable electricity Telematics to support fuel efficient driving.
Heavy duty vehicles	Emissions – Euro V	Emissions – Euro VI or better	Use of renewable fuels – e.g. bio fuels, renewable electricity Telematics to support fuel efficient driving.
Waste collections services	Emissions – Euro IV or equivalent retrofit	Emissions – Euro VI or better (e.g zero emission), or equivalent retrofit	Use of renewable fuels – e.g. bio fuels, renewable electricity Telematics to support fuel efficient driving. Monitoring and targets for CO_2, NO_x and PM emissions.
Bus services	Emissions – Euro IV or equivalent retrofit	Emissions – Euro VI or better (e.g zero emission), or equivalent retrofit	Use of renewable fuels – e.g. bio fuels, renewable electricity Telematics to support fuel efficient driving. Monitoring and targets for CO_2, NO_x and PM emissions.

[16] http://sd.defra.gov.uk/advice/public/buying/products/transport/standards/

Whole life costing

The alternative to using set specification and award criteria is to carry out a whole life cost assessment as part of the tender or contract evaluation process. This should form the cost element of the tender evaluation process, should be calculated for the full vehicle or contract life and should include:

Vehicles

- Capital cost
- Running costs including fuel consumption, maintenance, taxes
- Re-sale value
- Damage costs

Services

- Full contract costs
- Damage costs

In order to calculate vehicle running costs the supplier will need to provide vehicle fuel consumption data and expected annual maintenance costs. This can then be combined with mileage data and fuel cost data to provide total lifetime running costs.

To calculate damage costs you will first need to calculate total emissions generated by the vehicle or service over its lifetime. This not necessarily straight forward but can potentially be done in one of two ways:

1. Using emissions performance data provided by the supplier (in terms of g/km), combined with mileage data;
2. Using emission calculation tools such as:
    a. The DEFRA emission factor toolkit - http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html
    b. The Low Emission Toolkit fleet tool - http://www.lowemissionstrategies.org/les_toolkit.html

These emission results can then be monetised using factors in Table 2 below to give the whole life cost of the vehicle or service, accounting for the damage costs associated with its emissions.

Table 2 Damage cost data

CO_2	NOx	PM
£0.03/kg	£0.95/kg	£48.52/kg

Source: CO_2 cost based on the shadow price of carbon estimated for 2010, NO_x and PM costa are based on IGCB damage cost data for 2010.

Appendix 3 – A review of LA experience with anti-idling campaigns

Anti-idling campaigns are one approach to reduce vehicle emissions and fuel consumption, and improve air quality. They typically advise drivers to switch their engine off whenever it is likely to be idling for more than one minute.[17] Estimated fuel savings are 2-3%.[18] Currently there is little or no evidence available of measured air quality benefits from UK sources, but some evidence is available from the US. Burning less fuel might be expected to result in reduced emissions, however this cannot necessarily be assumed, as it is also dependent on performance of the emissions aftertreatment system.[19]

Anti-idling laws are common in the US where drivers can face fines of up to $25,000.[20] US research has demonstrated that anti-idling campaigns can be effective at reducing levels of air pollutants including PM2.5, elemental carbon and particle number concentrations in some instances.[21,22] However there does not appear to be similar evidence available for UK locations.

The UK Government introduced the 'stationary idling offence' in Section 6 of the Road Traffic (Vehicle Emissions)(Fixed Penalty) Regulations which came into force in 2002. This allows local authorities to enforce Regulation 98 of the Vehicle Construction and Use Regulations (1986) relating to the stopping of engines when stationary (other than owing to the necessities of traffic etc.) to prevent exhaust emissions.

A fixed penalty notice (FPN) of £20 can be issued if a driver fails to switch off the engine of a parked vehicle when requested to by an authorised officer of the Local Authority. The driver then has 28 days to pay or the fine rises to £40. However one source indicated that by May 2008 there were no reports of any FPNs having been issued in conjunction with stationary idling offences.[23] In 2010, publication of data on FPNs issued by local authorities did not include any for idling offences.[24] Communications received when researching this technical note indicate that at least two local authorities who have adopted these powers still have yet to issue an FPN.

A 2009 report for the Scrutiny and Petitions board of Renfrewshire County Council (Scotland) examined the issue of vehicles found to be idling unnecessarily.[25] It highlighted that the requirements for any council wishing to adopt powers to enforce anti-idling stipulate minimum levels of publicity which include the need for adverts to be placed in both national and local newspapers. The report also included evidence from seven other Scottish Councils who had implemented powers, only three of whom had issued any FPNs. The report concluded that adopting the powers would have ongoing cost implications which would not be covered by any income generated through FPNs. As a result it advised against adopting powers to issue FPNs, but instead to raise public awareness through other publicity campaigns (allowing a more flexible approach).

Again these findings were confirmed in correspondence with another local authority who stated that adverts would have to be placed borough-wide for a month, highlighting the

[17] For example TfL's FORS Anti-Idling factsheet, available here: http://www.fors-online.org.uk/resource.php?name=PF_AA_FACTSHEET
[18] http://dx.doi.org/10.1016/j.enpol.2013.11.074 (Paper cites DfT Freight Best Practice Fuel Ready Reckoner and FTA Carbon intervention modelling tool).
[19] See for example Ricardo's report examining the emissions performance of hybrid buses for further information: http://www.lowcvp.org.uk/news,new-lowcvp-study-looks-at-air-quality-impacts-of-low-carbon-buses_2894.htm
[20] http://www.turnyourengineoff.org/laws.html
[21] http://pubs.rsc.org/en/Content/ArticleLanding/2013/EM/C3EM00377A#!divAbstract
[22] http://www.sciencedirect.com/science/article/pii/S135223101201165X
[23] http://www.legco.gov.hk/yr07-08/english/panels/ea/papers/ea0116cb1-1601-1-e.pdf
[24] http://www.theguardian.com/news/datablog/2010/oct/07/fixed-penalty-notices-england
[25] http://www.renfrewshire.gov.uk/wps/wcm/connect/47c1faa5-3484-4a7e-a7ef-2f15d5a3efd9/cs-jb-scrutiny-vehicleidling.pdf?MOD=AJPERES&CACHEID=47c1faa5-3484-4a7e-a7ef-2f15d5a3efd9

adoption of anti-idling powers. The high cost of doing this, combined with the low likelihood of actually issuing FPNs led to them deciding to tackle anti-idling without adopting these powers.

UK local authorities introducing 'anti-idling campaigns'

London – The Mayor's Air Quality Strategy (2010)[26] announced it would "make London a 'no idling zone' for parked vehicles with a particular focus on buses, coaches, taxis, private hire vehicles, and delivery vehicles." In January 2012, Mayor Boris Johnson announced a campaign to tackle illegal idling, urging drivers to switch off engines when stationary for more than one minute.[27] However in June 2012 it was reported that TfL's scheme encouraging reporting of engine idling in the capital had only received 40 emails in one year.[28] While this was reported as indicating the scheme was a failure, much of the aim of most anti-idling campaigns is to raise driver's awareness of the need to switch their engine off. A low number of reports of offenders could therefore potentially be considered as an indication that the publicity had been effective.

Mayor Boris Johnson has since written to the Department for Transport highlighting that the £20 FPN for idling offences may not be a sufficient deterrent. However the Department responded that a punitive regulatory solution may not be the best approach, highlighting that serious idling offences can also be enforced by the police with a maximum fine on conviction of £1,000.[29]

Oxford City Council was one of the first councils to implement the powers to issue FPNs for stationary idling offences. Its *Air Quality Action Plan 2013-2020* highlights it is working with bus operators and freight companies to encourage compliance with anti-idling policies.[30]

Reading Borough Council has just been awarded £12,500 to introduce an anti-idling campaign (November 2013).[31]

City of York Council has commissioned research into anti-idling campaigns (October 2013).[32] The study is part of York's Low Emission Strategy.

Oldham Metropolitan Borough Council has been awarded just under £88,000 for a CCTV car to be used to carry out enforcement of illegal idling and parking.[33]

Cheshire West and Chester Council is running a campaign to tackle bus idling problems in Chester. It has not adopted enforcement powers but has conducted surveys to establish the extent of the problem and is working with bus and coach operators to raise awareness and reduce unnecessary idling.

The following local authorities have adopted powers to enforce idling offences (although most have never issued penalty notices):

- Sefton (2009)[34]
- Portsmouth (2004)[35]
- North Lincolnshire Council
- Croydon Council
- Torfaen Council
- Wandsworth Council
- Manchester City Council

[26] https://www.london.gov.uk/sites/default/files/archives/Air_Quality_Strategy_v3.pdf
[27] http://www.businessgreen.com/bg/news/2136399/mayor-boris-launches-anti-idling-campaign-tackle-smog-threat
[28] http://www.standard.co.uk/news/mayor/mayors-antiidling-road-scheme-branded-an-absolute-failure-7854400.html
[29] http://www.londoncouncils.gov.uk/London%20Councils/ResponsefromPatrickMcLoughlintoMayorSept2013AirQua.pdf.
[30] http://www.oxford.gov.uk/Library/Documents/Environmental%20Development/Air%20Quality%20Action%20Plan%202013.pdf
[31] https://www.gov.uk/government/news/new-projects-receive-1-million-to-improve-local-air-quality
[32] http://www.ttr-ltd.com/Latest-News/York-Idling-Study-Moving-Ahead_31.htm
[33] https://www.whatdotheyknow.com/request/143809/response/364094/attach/10/Summary%20of%20bids%202012%2013.pdf
[34] http://modgov.sefton.gov.uk/moderngov/mgConvert2PDF.aspx?ID=7412
[35] http://www.portsmouth.gov.uk/media/epp20042503r5.pdf

- Aberdeen Council
- South Yorkshire Passenger Transport Executive
- Dudley Metropolitan Borough Council
- Merseytravel

Summary

Anti-idling campaigns have been used in a number of locations in the UK. Where successful they have been found to reduce average vehicle fuel use by 2-3%. A brief review has not found evidence of direct benefits for air quality in the UK, although with reduced fuel use some might be expected. Also studies in the US have found evidence of air quality benefits. A number of local authorities have adopted powers to enforce stationary idling offences but there are specific requirements for publicity which must be in place before FPNs can be issued. It appears that low numbers of FPNs have actually been issued in conjunction with idling.

We would suggest that a formal route for enforcing anti-idling is not adopted due to the potential costs, but a more flexible approach is taken including:

- Working directly with bus companies, potential Oxfordshire wide, building on Oxford City Councils work and linking to wider eco-driving advice.
- Working directly with freight companies, again Oxfordshire wide, potentially as part of a wide scheme such as EcoStars.
- Including anti-idling information with other vehicle information in behavioural change programmes.
- ‘Switch-off’ signage at key traffic or waiting locations.

In addition other options could be considered including:

Encouraging uptake of stop-start ‘micro-hybrid’ technology: Stop-start technology is becoming increasingly common on passenger cars and vans. The system automatically shuts off the engine when the vehicle comes to a rest and the driver selects neutral and brings the clutch pedal up. The engine automatically restarts as soon as the clutch or accelerator pedal is depressed. Specifying heavy-duty vehicles with stop/start systems can significantly reduce fuel consumption and CO2 emissions, depending on the vehicle’s typical usage patterns. For a city busy savings can be 10 to 30%.[36] Local companies and bus operators can be encouraged to ensure their vehicles have this technology fitted. Also more than half of all new passenger cars in Europe are already fitted with stop-start.[37] Market analysts are predicting this will rise to over 80% for vehicles sold in Western Europe by 2022.[38]

Promoting vehicle telematics systems: Telematics systems can enable operators of vehicle fleets to monitor how much time a vehicle spends stationary and idling. Drivers can be incentivised to minimise idling time, helping to save fuel costs for the operators and reduce air pollution. Fitting telematics systems to vehicle fleets can also be used to monitor many other aspects of driver behaviour, giving fleet operators the information they require to help make further fuel cost savings and safety improvements.

[36] Ricardo-AEA, Reduction and Testing of Greenhouse Gas Emissions from Heavy Duty Vehicles – Lot 1: Strategy
[37] http://wardsauto.com/suppliers/stop-start-bound-50-take-rate-bosch-says
[38] http://www.navigantresearch.com/wp-assets/uploads/2013/12/SSV-13-Executive-Summary.pdf

Appendix 4 – ADMS calibration plots

Figure A4.1 Wallingford ADMS model calibration results

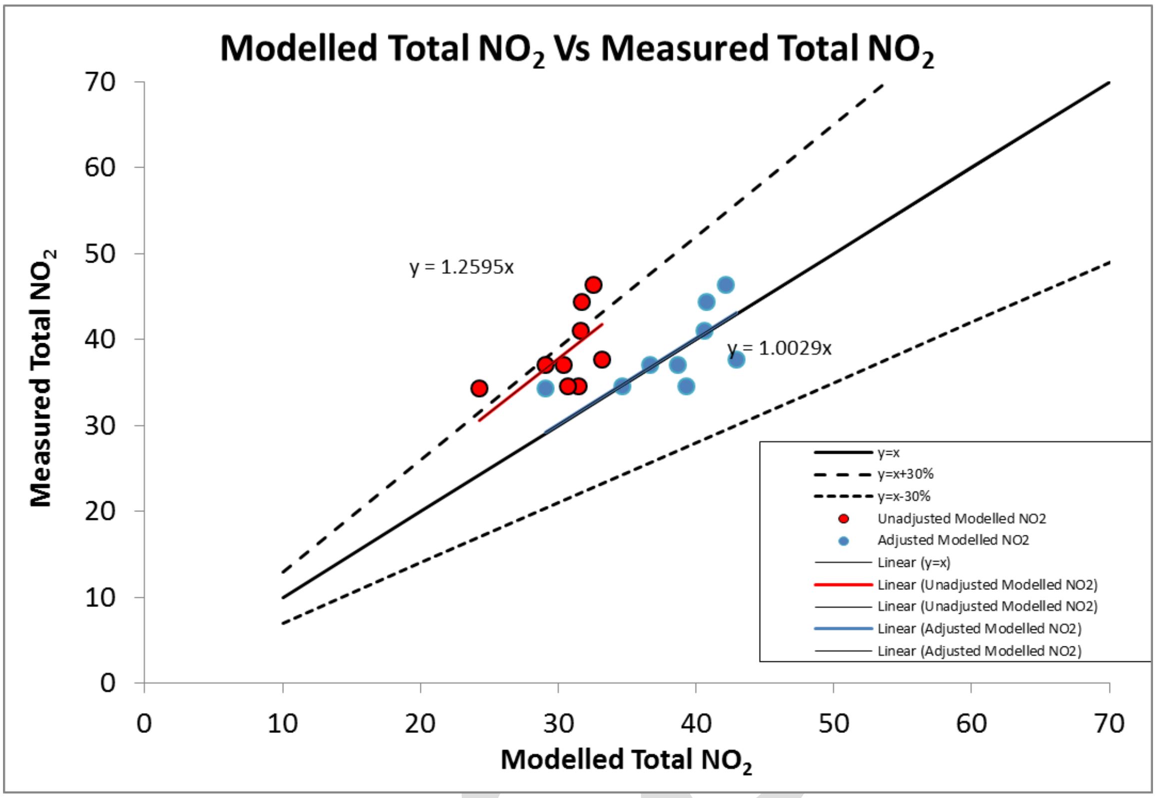


Figure A4.2 Henley ADMS model calibration results

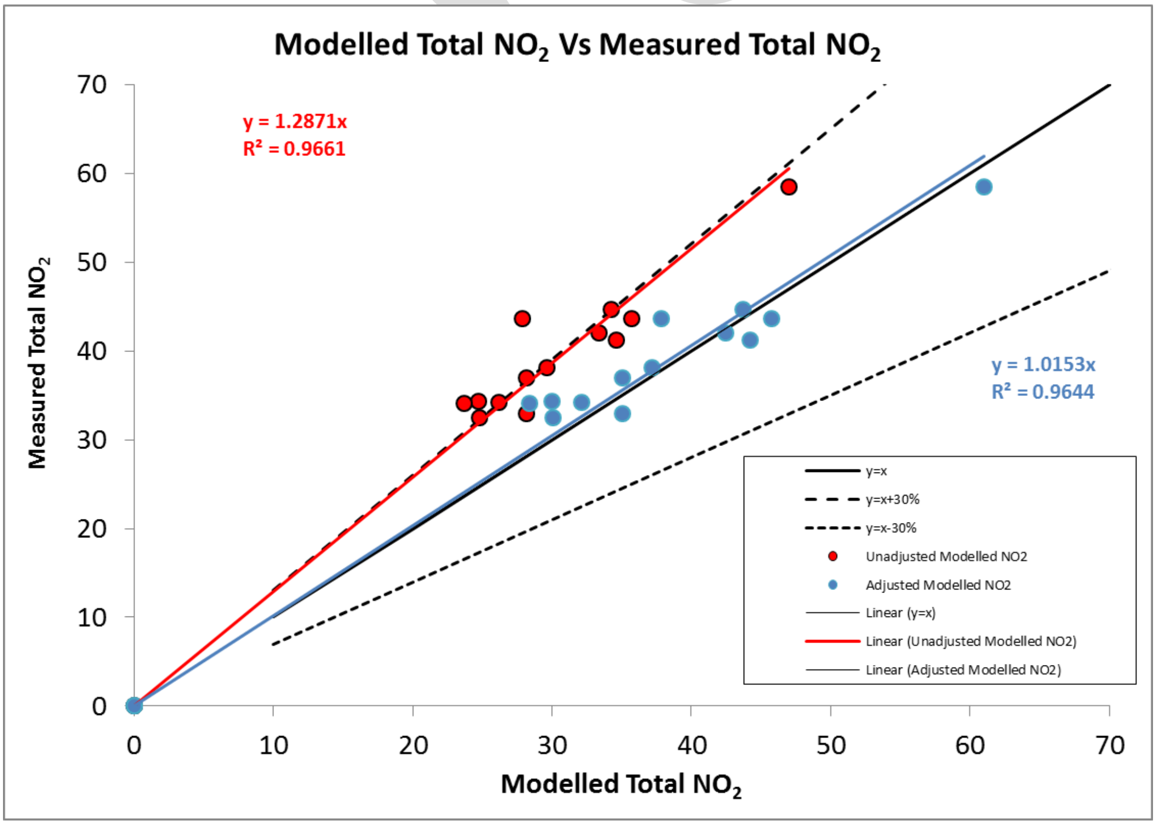
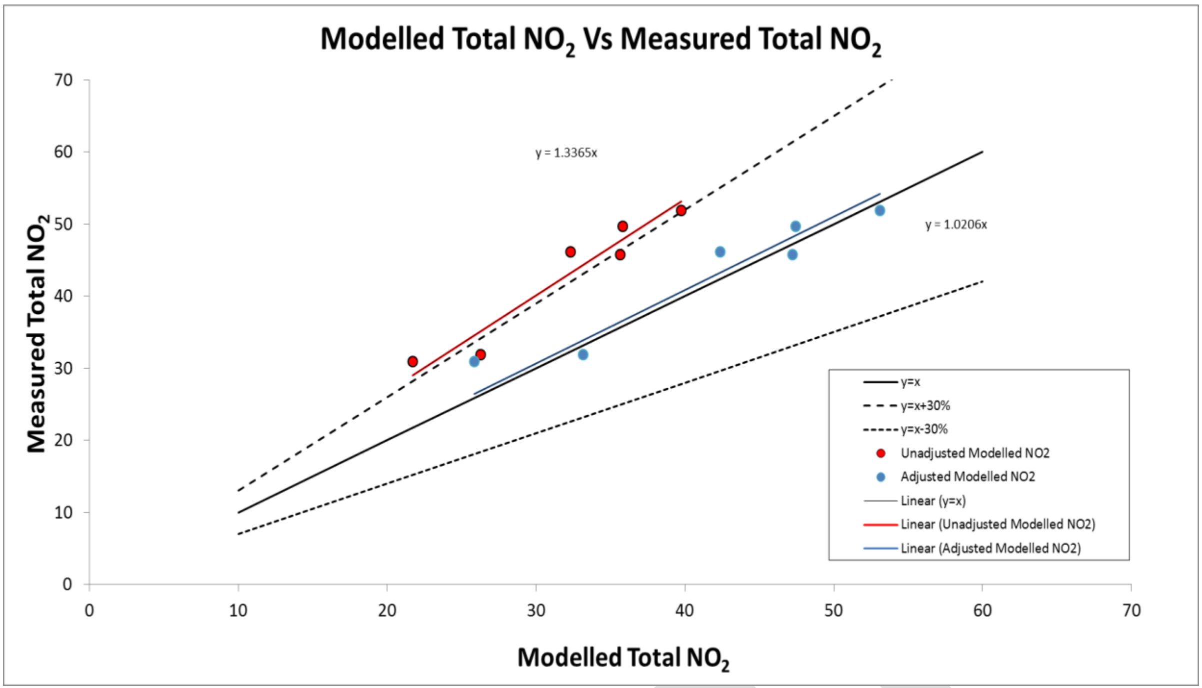


Figure A4.3 Watlington ADMS model calibration results



Appendix 5 – Emission results for the district wide assessment

Total annual NOx emissions, t/yr

Scenarios	Total	% reduction from 2015	Motocycles	Cars	LGV	HGV	Buses and Coaches
2011	915.27	-46.8%	3483.75	428696.22	144741.16	3483.75	42402.21
2015	623.69	0.0%	2864.13	354196.47	142657.89	224886.13	27686.03
Bus1 (E4)	614.47	1.5%	2864.13	354196.47	142657.89	224886.13	18464.60
Bus1 (E6)	597.71	4.2%	2864.13	354196.47	142657.89	224886.13	1702.81
Bus2	623.14	0.1%	2864.13	354196.47	142657.89	224886.13	27132.30
HGV	621.24	0.4%	2864.13	354196.47	142657.89	223569.24	27686.03
EV1	616.59	1.1%	2864.13	347112.54	142657.44	224886.13	27686.03
EV2	600.18	3.8%	2864.13	336486.65	142657.89	224886.13	27686.03
Smart1	613.07	1.7%	2864.13	343570.57	142657.89	224886.13	27686.03
Smart2	605.98	2.8%	2864.13	336486.65	142657.89	224886.13	27686.03

Total annual CO2 emissions, kt/yr

Scenarios	Total	% reduction from 2015	Motocycles	Cars	LGV	HGV	Buses and Coaches
2011	306.28	-6.3%	1243.82	186374.57	43228.10	1243.82	7056.01
2015	288.18	0.0%	1228.41	169208.95	42809.22	68049.01	7000.23
Bus1 (E4)	288.11	0.0%	1228.41	169208.95	42809.22	68049.01	6932.92
Bus1 (E6)	288.14	0.0%	1228.41	169208.95	42809.22	68049.01	6963.92
Bus2	287.83	0.1%	1228.41	169208.95	42809.22	68049.01	6650.22
HGV	284.80	1.2%	1228.41	169208.95	42809.22	66742.96	7000.23
EV1	283.94	1.5%	1228.41	165824.77	42788.74	68049.01	7000.23
EV2	277.57	3.7%	1228.41	160748.50	42809.22	68049.01	7000.23
Smart1	283.10	1.8%	1228.41	164132.68	42809.22	68049.01	7000.23
Smart2	279.72	2.9%	1228.41	160748.50	42809.22	68049.01	7000.23

Total annual PM2.5 emissions, t/yr

Scenarios	Total	% reduction from 2015	Motocycles	Cars	LGV	HGV	Buses and Coaches
2011	45.45	-34.4%	234.99	26238.71	8890.72	234.99	1123.83
2015	33.81	0.0%	184.01	21776.56	8854.38	7626.47	840.55
Bus1 (E4)	33.59	0.7%	184.01	21776.56	8854.38	7626.47	619.48
Bus1 (E6)	33.47	1.0%	184.01	21776.56	8854.38	7626.47	497.74
Bus2	33.80	0.0%	184.01	21776.56	8854.38	7626.47	823.74
HGV	33.70	0.3%	184.01	21776.56	8854.38	7570.48	840.55
EV1	33.70	0.3%	184.01	21341.03	8854.37	7626.47	840.55
EV2	33.26	1.6%	184.01	20687.73	8854.38	7626.47	840.55
Smart1	33.16	1.9%	184.01	21123.26	8854.38	7626.47	840.55
Smart2	32.73	3.2%	184.01	20687.73	8854.38	7626.47	840.55

Total annual PM10 emissions, t/yr

Scenarios	Total	% reduction from 2015	Motocycles	Cars	LGV	HGV	Buses and Coaches
2011	62.77	-24.2%	295.72	37294.76	11270.10	295.72	1576.51
2015	50.52	0.0%	242.06	32597.76	11211.87	10924.57	1278.32
Bus1 (E4)	50.29	0.5%	242.06	32597.76	11211.87	10924.57	1045.62
Bus1 (E6)	50.16	0.7%	242.06	32597.76	11211.87	10924.57	917.47
Bus2	50.49	0.1%	242.06	32597.76	11211.87	10924.57	1252.75
HGV	50.34	0.4%	242.06	32597.76	11211.87	10837.62	1278.32
EV1	50.43	0.2%	242.06	31945.81	11211.85	10924.57	1278.32
EV2	49.94	1.1%	242.06	30967.87	11211.87	10924.57	1278.32
Smart1	49.54	1.9%	242.06	31619.83	11211.87	10924.57	1278.32
Smart2	48.89	3.2%	242.06	30967.87	11211.87	10924.57	1278.32

Appendix 6 AQAMA assessment results

A6.1 Assessment results for Wallingford

Summary	Emissions in AQMA, kg/yr				% reduction against 2015 base			
	Nox	**PM10**	**PM25**	**CO2 (tonnes)**	**Nox**	**PM10**	**PM25**	**CO2**
Base								
2011 Base	2,395	161	108	833	-11.2%	-7.9%	-15.6%	1.9%
2015 Base	2,153	150	93	849	0.0%	0.0%	0.0%	0.0%
2020a Base	1,415	143	82	879	34.3%	4.4%	12.0%	-3.5%
2020b Base	2,542	152	90	908	-18.1%	-1.5%	3.1%	-7.0%
Measures								
EV2%	2,125	147	92	835	1.3%	1.7%	1.7%	1.7%
EV 5%	2,084	143	89	814	3.2%	4.2%	4.2%	4.2%
Bus 1 (E4)	2,133	149	93	849	0.9%	0.1%	0.2%	0.0%
Bus 1 (E6)	1,749	146	90	851	18.8%	2.3%	3.6%	-0.2%
Bus 2	2,143	149	93	846	0.4%	0.2%	0.2%	0.4%
HGV	2,147	149	93	846	0.3%	0.1%	0.1%	0.4%
Smart 3%	2,131	147	91	831	1.0%	1.4%	2.1%	2.2%
Smart 5%	2,116	146	90	818	1.7%	2.4%	3.5%	3.7%
LEZ_E4	2,129	149	93	849	1.1%	0.3%	0.5%	0.1%
LEZ_E6	1,512	143	87	851	29.8%	4.2%	6.4%	-0.2%
Bus X	1,968	131	82	745	8.6%	12.3%	12.0%	12.2%
Bus Idle	2,143	149	93	848	0.4%	0.2%	0.2%	0.2%
LES package	1,903	126	78	706	11.6%	15.7%	16.1%	16.9%
** italics of local AQMA measures*								

NO2 concentrations, ug/m3

	2011			2015		2015 LES		2020		% LES
Location	Measured	Modelled	Correction	Modelled	Corrected	Modelled	Corrected	Modelled	Corrected	Corrected
2 Station Road	34.30	29.11	1.18	29.39	34.63	29.02	34.19	22.84	26.91	1.3%
70 High Street	37.10	38.67	0.96	37.27	35.76	36.80	35.31	27.63	26.51	1.3%
79 High Street	37.70	42.97	0.88	41.42	36.34	40.89	35.88	30.56	26.81	1.3%
33 Castle Street	37.10	36.66	1.01	34.46	34.87	34.06	34.47	25.43	25.74	1.2%
52 St Mary's Street	34.60	34.66	1.00	31.64	31.59	31.37	31.32	23.32	23.28	0.9%
George Hotel	44.40	40.75	1.09	38.37	41.81	37.86	41.25	28.31	30.85	1.3%
20 High Street	46.40	42.13	1.10	39.83	43.87	39.29	43.27	29.42	32.40	1.4%
The Town Arms	34.60	39.28	0.88	36.93	32.53	28.17	24.81	27.54	24.26	23.7%
High St Automatic	41.00	40.62	1.01	38.62	38.98	38.12	38.48	28.53	28.80	1.3%

A6.2 Assessment results for Henley

Summary	Emissions in AQMA, kg/yr				% reduction against 2015 base			
	Nox	PM10	PM25	CO2 (tonnes)	Nox	PM10	PM25	CO2
Base								
2011 Base	12,255	896	606	4,255	-17.0%	-11.0%	-20.3%	1.8%
2015 Base	10,471	808	504	4,334	0.0%	0.0%	0.0%	0.0%
2020a Base	6,726	735	420	4,296	35.8%	9.0%	16.7%	0.9%
2020b Base	11,686	756	440	4,443	-11.6%	6.4%	12.7%	-2.5%
Area Wide								
EV2%	10,319	794	495	4,258	1.4%	1.7%	1.7%	1.7%
EV 5%	10,092	773	482	4,145	3.6%	4.4%	4.3%	4.4%
Bus 1 (E4)	10,320	802	499	4,332	1.4%	0.7%	1.0%	0.0%
Bus 1 (E6)	9,711	797	494	4,334	7.3%	1.3%	2.0%	0.0%
Bus 2	10,453	807	504	4,327	0.2%	0.1%	0.1%	0.2%
HGV	10,431	806	501	4,314	0.4%	0.2%	0.6%	0.5%
Smart 3%	10,307	791	494	4,241	1.6%	2.0%	2.0%	2.1%
Smart 5%	10,197	780	487	4,180	2.6%	3.4%	3.3%	3.6%
LEZ	10,163	793	490	4,329	2.9%	1.9%	2.8%	0.1%
Idle	10,458	807	504	4,328	0.1%	0.1%	0.1%	0.1%
LES package	9,790	760	468	4,134	6.5%	5.9%	7.2%	4.6%
* *italics of local AQMA measures*								

NO2 concentrations, ug/m3

	2011			2015		2015 LES		2020		% LES
Location	Measured	Modelled	Correction	Modelled	Corrected	Modelled	Corrected	Modelled	Corrected	Corrected
66c Bell Street	41.20	44.22	0.93	37.48	34.92	36.34	33.86	26.75	24.92	3.0%
33 New Street	32.90	35.07	0.94	30.27	28.40	29.40	27.58	22.18	20.81	2.9%
Northfield End	32.50	30.10	1.08	25.67	27.72	25.00	26.99	18.84	20.34	2.6%
Station Road	34.30	30.03	1.14	27.60	31.52	26.76	30.57	20.35	23.24	3.0%
178 Reading Road	34.20	32.16	1.06	28.35	30.15	27.56	29.31	20.93	22.26	2.8%
Reading Rd / St Andrews Rd	43.60	37.83	1.15	32.46	37.41	31.48	36.28	23.87	27.51	3.0%
35 Reading Road	38.10	37.17	1.03	35.20	36.08	33.99	34.84	25.85	26.50	3.4%
2 Greys Road	43.60	45.75	0.95	41.10	39.17	39.66	37.80	29.84	28.44	3.5%
4 Duke Street	58.50	60.99	0.96	56.36	54.06	54.12	51.91	41.21	39.53	4.0%
Café Uno Hart Street	44.70	43.70	1.02	35.20	36.01	33.99	34.77	25.48	26.06	3.4%
23 Market Place	34.10	28.42	1.20	22.92	27.50	22.33	26.79	17.15	20.58	2.6%
31 Bell Street	42.00	42.46	0.99	38.10	37.69	36.85	36.45	27.60	27.30	3.3%
45 Duke St	37.00	35.07	1.06	46.29	48.84	44.66	47.12	33.77	35.63	3.5%

A6.3 Assessment results for Watlington

Summary	**Emissions in AQMA, kg/yr**				**% reduction against 2015 base**			
	Nox	**PM10**	**PM25**	**CO2 (tonnes)**	**Nox**	**PM10**	**PM25**	**CO2**
Base								
2011 Base	3,501	231	157	1,109	-25.1%	-12.9%	-22.8%	-0.4%
2015 Base	2,798	205	128	1,105	0.0%	0.0%	0.0%	0.0%
2020a Base	1,918	203	116	1,202	31.4%	0.9%	9.5%	-8.8%
2020b Base	3,499	215	127	1,242	-25.1%	-4.8%	1.0%	-12.4%
Measures								
EV2%	2,771	202	127	1,090	1.0%	1.3%	1.3%	1.4%
EV 5%	2,731	198	124	1,067	2.4%	3.3%	3.2%	3.4%
Bus 1 (E4)	2,754	203	127	1,104	1.6%	0.8%	1.2%	0.0%
Bus 1 (E6)	2,637	202	126	1,104	5.7%	1.2%	1.9%	0.0%
Bus 2	2,793	205	128	1,104	0.2%	0.1%	0.1%	0.1%
HGV	2,785	204	128	1,098	0.5%	0.2%	0.2%	0.6%
Smart 3%	2,757	201	126	1,082	1.4%	2.0%	1.9%	2.0%
Smart 5%	2,731	198	124	1,067	2.4%	3.3%	3.2%	3.4%
LEZ	2,704	200	124	1,103	3.4%	2.3%	3.5%	0.1%
HGV1	2,086	194	118	851	25.4%	5.2%	7.9%	22.9%
HGV2	2,597	198	123	1,063	7.2%	3.6%	3.7%	3.8%
LES package	1,899	182	109	817	32.1%	11.4%	14.6%	26.0%
Notes - italics are Watlington measures								
LES package has been specifically modelled in EFT								

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