Air Quality

Action Plan
2008-2010

action plan

Air Quality: Action Plan 2008-2010

September 2008

THE CITY OF EDINBURGH COUNCIL

Air Quality Action Plan: 2008-2011

Contents

1 EXECUTIVE SUMMARY

The Environment Act 1995 places a duty on local authorities to regularly carry out a programme of air quality management in their areas. A number of pollutants require to be assessed against targets which are prescribed in regulations and set out in The UK Air Quality Strategy. The key aim of the legislation is the protection of human health. Under the Act, if air quality targets are not going to be met, local authorities must declare an Air Quality Management Area (AQMA) and produce an action plan detailing the initiatives required to meet targets. The Act does not place an absolute obligation on local authorities to meet the prescribed air quality targets only to "act in the pursuit of achieving them".

The first AQMA was declared in December 2000 on the basis that levels for nitrogen dioxide (NO_2) would not be met. Based on 2007 monitoring data, of the fourteen sites in the central AQMA, the following eleven locations were predicted to fail the NO_2 target value by 2010:

- West Maitland Street/Palmerton Place
- Torphichen Place
- Princes Street
- Roseburn Terrace /Roseburn Street junction
- Roseburn Terrace.
- North Bridge South Bound
- North Bridge North Bound
- Gorgie Road/Murieston Road junction
- Gorgie Road
- Queen Street/Fredrick Street
- Queen Street/York Place

In addition, over the two year period, levels of NO_2 were shown to have deteriorated along St John's Road in Corstorphine, leading to the declaration of a second AQMA in December 2006 (Fig. 2 below).

Despite undertaking a number of transport and traffic management initiatives, a Progress Report covering the period 2005-07 has shown that over the two years progress has been variable. In addition, the second AQMA along St John's Road has hot spots, with some locations also failing hourly NO_2 objectives. Current monitoring indicates a deteriorating situation at some locations. Based on 2007 monitoring data all monitoring locations apart from site 39, which is located outside the canyon area are predicted to fail the NO_2 target by 2010.

Recognising that further work was needed, the Council commissioned a Low Emission Study which was carried out by Transport and Travel Research Limited (TTR) to review the various Low Emission Strategy (LES) options specifically looking at vehicles in Edinburgh. The study had two key objectives:

- assess the current fleet profile in Edinburgh and look at turnover; and
- Evaluate ways of achieving emissions reductions and recommending a preferred strategy for Edinburgh.

The study looked at a number of LES options namely:

- mandatory emission controls on:
    - buses;
    - road freight;
    - taxis and private hire vehicles;
- voluntary emission controls on:
    - buses;
    - road freight;

- taxis and private hire vehicles;
- retrofitting schemes to older vehicles; and
- scrappage schemes for older vehicles.

The study used a range of data to run the LUTI traffic model for Edinburgh which was used to generate a Business as Usual (BAU) scenario i.e. do-nothing. This scenario calculates a certain reduction in air quality emissions based on the natural turnover of fleet vehicles. The study then generated a number of other options scenarios to look at the improvements in air quality emissions over and above this BAU. More details on the study can be seen in Appendix 2.

The study evaluated a number of options to address air quality and recommend new actions to ensure that $NO_{2\ targets}$ were met. The LES concluded that while the best option would be mandatory schemes applied to both bus and freight operators; the better option in terms of cost and acceptability (as well as reductions in emissions) would be voluntary partnership agreements.

Consequently a new Action Plan has been developed covering the period 2008-2010 that focuses on the two AQMA's and builds on the LES study. Two new partnerships will be set up with bus and freight operators to review their fleet profiles and agree numbers of cleaner vehicles to operate within the AQMA's in Edinburgh. The new Action Plan will also focus on tracking development in the city and progress a number of transport and traffic management initiatives.

2 GLOSSARY OF TERMS

AQMA	Air Quality Management Area
CO	Carbon monoxide
CO_2	Carbon dioxide
Euro vehicles	European Auto Oil programme exhaust emission limits for new
HGV	Heavy Goods Vehicle
LAQM	Local Air Quality Management
LES	Low Emission Strategy
LGV	Light Goods Vehicle
LPG	Liquefied Petroleum Gas
LNG	Liquefied Natural Gas
LTS	Local Transport Strategy
NO	Nitric oxide
NO_x	Nitrogen oxides
NO_2	Nitrogen dioxide
PM_{10}	Particulate matter of less than 10 microns in diameter
SO_x	Sulphur oxides
$\mu g/m^3$	microgrammes per cubic metre

3 INTRODUCTION

Part IV of the Environment Act 1995 requires local authorities to review and assess air quality within their boundaries against prescribed objectives for a number of specific pollutants. This is done through a formal 'Local Air Quality Management' process (LAQM), which entails ongoing monitoring and a 3-yearly cycle of assessment and progress reviews. In locations where it is concluded that one or more objectives are not likely to be met, a local authority must establish an 'Air Quality Management Area' (AQMA) and publish an Action Plan to chart out how it proposes to tackle the situation.

This document sets out the City of Edinburgh Council's Air Quality Action Plan for the period 2008-2010.

The main pollutant of concern in Edinburgh is nitrogen dioxide and there are now two declared AQMAs within Edinburgh. The first comprises the city centre area (declared in 2000) and the second is a stretch of St John's Road covering the Corstorphine area (declared in 2007). This Plan covers the two AQMAs and for the sake of simplicity has incorporated them into the one Plan. The main aim of the Plan is to demonstrate how emissions of nitrogen dioxide will be reduced in the AQMAs and in particular to ensure that monitoring locations within the AQMAs meet objectives.

Air Quality Objective: Nitrogen Dioxide – 40μgm^{-3} - Annual Average

Information from a Low Emission Strategy Study for Edinburgh has been incorporated into the plan. This provides valuable information as to future options and potential actions for the Council.

Studies have shown that 88% of all NOx in Edinburgh originates from road vehicles. For this reason the Plan focuses heavily on transportation within the AQMAs, in particular buses and freight and cleaner vehicles as key mechanisms to improve air quality. Additional actions have also been identified to reduce emissions.

Monitoring of air quality is undertaken on a regular basis and reported within a statutory framework.

An annual report will be produced on the implementation of the action plan. This will outline progress and the inclusion of any additional actions into the plan.

4 BACKGROUND

Health Effects

The primary reason for local air quality management is to minimise any risks to human health. Despite general improvements in air quality in towns and cities, it has been estimated that between 12,000 and 24,000 premature deaths occur annually in the UK due to exposure to air pollution, compared with about 3,500 per annum from road accidents (Committee on the Medical Effects of Air Pollution, 1998 'Quantification of the effects of air pollution on health in the UK'). In addition, air pollution may trigger the onset of chronic illnesses, or exacerbate pre-existing medical conditions.

Apart from human health, air pollution can also result in the degradation of natural and semi-natural habitats, for example through increased acidity levels in precipitation. These effects may occur at considerable distances from sources of pollution, often crossing national boundaries. The World Health Organisation has identified a number of pollutants from vehicle exhaust emissions as carcinogens or potential carcinogens. Of these, benzene and small particles are considered to pose the greatest risk. Some researchers have suggested that there is evidence connecting higher particulate concentrations with a higher incidence of cardiovascular disease.

A consultation paper issued by the Department for the Environment, Food and Rural Affairs in 2006 concluded that the health impacts of particles cost the UK up to £21 million per annum, and reduced average life expectancy by 8 months. Existing controls are expected to reduce this to 5.5 months by 2020. (Defra, 2006).

Nitrogen dioxide, which is the pollutant of most concern in Edinburgh, has been shown to impair respiratory cell function, damage blood capillaries and weaken the immune system. It may also increase susceptibility to infection and aggravate asthma. However, these effects are only detectable when people are exposed to concentrations above 200 $\mu g/m^3$.

Air Quality Standards

The air quality standards which have been set for specific pollutants are based on the medical evidence of their effects on health. The concentration of a pollutant in ambient air, together with the target date for compliance, is known as an objective. Target dates have been set to take account of the costs and practicalities of attaining the air quality standard.

Air quality objectives are prescribed in Regulations under the Environment Act 1995, and are set out in the UK Air Quality Strategy. The relevant Regulations in Scotland are the Air Quality (Scotland) Regulations 2000, as Amended in 2002. Table 1 below summarises current national air quality objectives, including specific ones which apply only in Scotland.

(1) Objectives set in regulation			
Pollutant and geographical application	**Air Quality Objective**		**Date to be achieved by**
	concentration	**measured as**	
Benzene – UK wide	**16.25 $\mu g/m^3$**	**running annual mean**	**31st Dec. 2003**
England & Wales	5.00$\mu g/m^3$	**annual mean**	**31st Dec. 2010**
Scotland & N.I.	3.25$\mu g/m^3$	**running annual mean**	**31st Dec. 2010**
1,3-Butadiene – UK wide	2.25$\mu g/m^3$	**running annual mean**	**31st Dec. 2003**
Carbon monoxide – England, Wales & N.I.	10.0$\mu g/m^3$	**maximum daily running 8-hour mean**	**31st Dec. 2003**
Scotland	10.0$\mu g/m^3$	**running 8-hour mean**	**31st Dec. 2003**
Lead – UK wide	0.5 $\mu g/m^3$	**annual mean**	**31st Dec. 2004**
	0.25 $\mu g/m^3$	**annual mean**	**31st Dec. 2008**
Nitrogen dioxide – UK wide	200 $\mu g/m^3$not to be exceeded	**1-hour mean**	**31st Dec. 2005**
	40 $\mu g/m^3$	**annual mean**	**31st Dec. 2005**
Particulates (PM_{10}) (gravimetric) – UK wide	50$\mu g/m^3$ not to be exceeded	**24-hour mean**	**31st Dec. 2004**
	40 $\mu g/m^3$	**annual mean**	**31st Dec. 2004**
Scotland only	50$\mu g/m^3$ not to be exceeded	**24-hour mean**	**31st Dec. 2010**
	18 $\mu g/m^3$	**annual mean**	**31st Dec. 2010**
Sulphur dioxide – UK wide	350 $\mu g/m^3$ (24	**1-hour mean**	**31st Dec. 2004**
	125 $\mu g/m^3$ (3	**24-hour mean**	**31st Dec. 2004**
	266 $\mu g/m^3$ (35	**15-minute mean**	**31st Dec. 2005**
(2) Objectives not set in regulation			
Ozone (for protection of human health)	100 $\mu g/m^3$ not to be exceeded	**daily maximum of running 8-**	**31st Dec. 2005**

Nitrogen dioxide (for protection of vegetation &	30 µg/m^3	**annual mean**	**31st Dec. 2000**
Sulphur dioxide (for protection of vegetation & ecosystems)	20µg/m^3	**annual mean** ***and*** **winter average**	**31st Dec. 2000**
PAHs	0.25 nano g per	**annual mean**	**31st Dec. 2010**

Source : Netcen

Table 1 Air Quality Limits and Standards

Sources of Air Pollution

Some pollutants can be formed by natural processes – for example lightning in the case of nitrogen dioxide and sea spray in the case of small particles. However, man-made combustion processes account for the largest share by far. Many of the pollutants listed above present much less of a problem than in previous decades, due to specific controls such as limitations on the lead content of petrol. The imposition of smoke control areas in Edinburgh between 1958 and 1996 greatly reduced emissions of sulphur dioxide and particulates from domestic sources.

As a result of changing emission trends, road vehicles now contribute a very high proportion of airborne pollutants in most towns and cities, including Edinburgh. Investigations carried out in 1999 estimated that mobile sources accounted for 96% of nitrogen dioxide emissions in Edinburgh – 88% from road vehicles and 8% from aircraft (Review and Assessment of Air Quality Stage 1 & 2, 1999). Buses and heavy good vehicles are known to contribute disproportionately to road vehicle emissions, especially when idling. In 2002 it was estimated that buses contributed as much as 63% of all NOx emissions at Haymarket (Review and Assessment of Air Quality Stage 4, May 2002). However, this has to be viewed in the context that buses create less pollution per passenger mile than private vehicles under typical occupancy rates

More efficient engines are helping to combat vehicle emissions, including those from buses. However, these improvements are being undermined by increasing traffic volumes. A characteristic of vehicular pollution is that it tends to be very geographically concentrated along the major arterial traffic routes, with air quality improving dramatically even a few metres away from the carriageway through natural dispersal and air circulation. However these pollutants can also make a significant contribution to the growing problem of ground level ozone in the urban areas. Pedestrians and cyclists may be exposed to such pollution, although research has found that the highest levels of benzene, carbon monoxide and nitrogen dioxide are generally endured by vehicle occupants themselves.

Legislation

Part IV of the Environment Act 1995 requires local authorities to review and assess air quality within their boundaries against prescribed objectives for a number of specific pollutants. This is done through a formal 'Local Air Quality Management' process (LAQM), which entails ongoing monitoring and a 3-yearly cycle of assessment and progress reviews. In locations where it is concluded that one or more objectives are not likely to be met, a local authority must establish an 'Air Quality Management Area' (AQMA) and publish an Action Plan to chart out how it proposes to tackle the situation.

Air Quality objectives for nitrogen dioxide are:

Annual mean concentration of 40 $\mu g/m^3$ to be achieved by the end of 2005

1 hour mean concentration of 200 $\mu g/m^3$ not to be exceeded more than 18 times per year to be achieved by the end of 2005

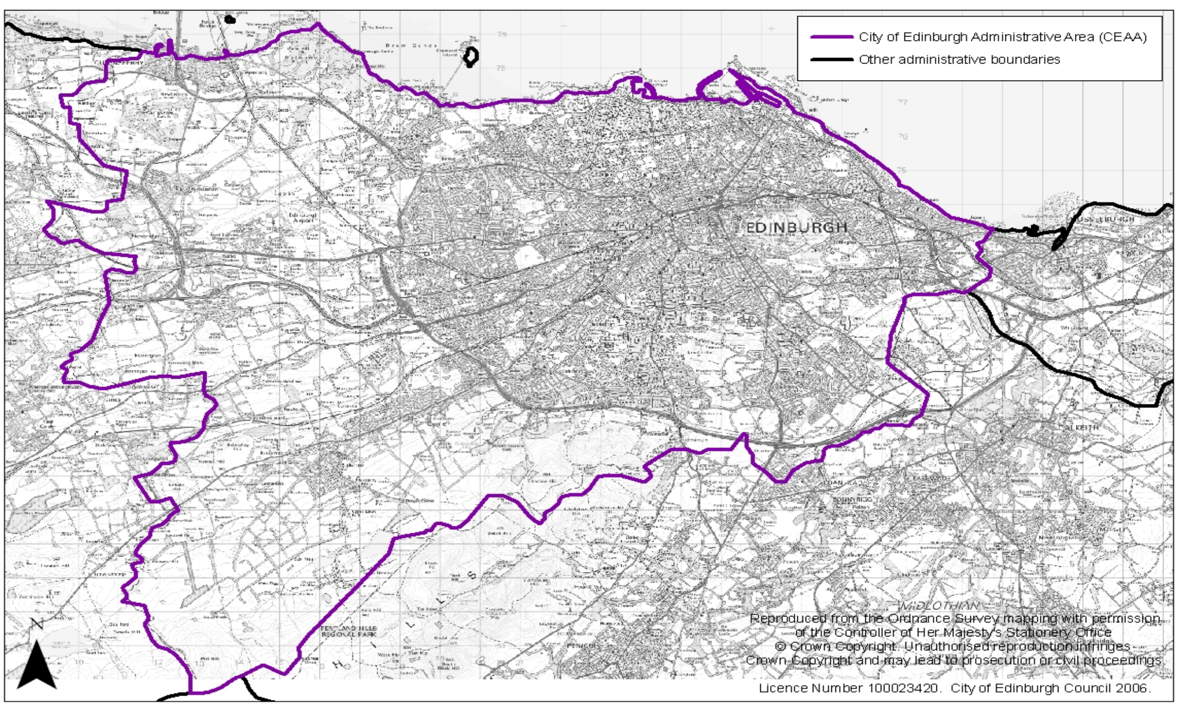
5 AIR QUALITY MONITORING

General Monitoring

The city's urban structure and layout are key factors contributing to highly localised pockets of poor air quality, with tenement buildings restricting air circulation alongside high volume routes, and historic street layouts necessitating stop / start traffic movements. Large numbers of residential properties with frontages close to the carriageway are typical of these densely built-up areas. Breezy conditions may help to alleviate the build-up of pollutants, but this depends on the alignment of the road in relation to the wind direction.

Map 1 below shows the City of Edinburgh Council administrative area (CEAA). The total base case emissions from the CEAA for 2010 are estimated to be 1750 tonnes of NO_x, and 85 tonnes of PM_{10}.

Map 1: The City of Edinburgh Council Administrative Area



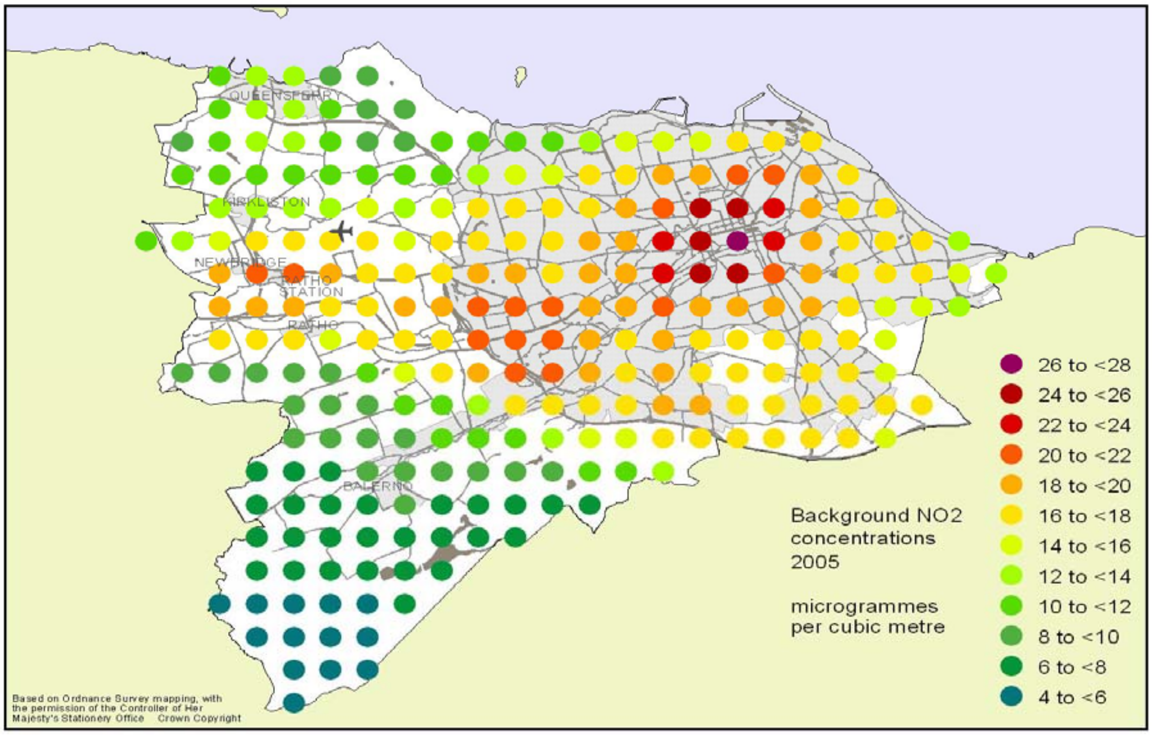
Sourced from the Low Emission Study for Edinburgh 2007

Nitrogen dioxide (NO_2) is monitored at various locations across the city using a network of passive diffusion tubes and real-time sophisticated analysers. The monitoring locations are within and outside the AQMA boundary.

Nitrogen dioxide (NO_2) has been identified as the least 'compliant' pollutant in Edinburgh and has been the main focus for monitoring, although all pollutants are kept under review. Small airborne particles (PM_{10}) have also been the subject of detailed investigation, but it has been concluded that these meet with both the 2004 UK objective and the new, stricter, Scottish objectives for 2010.

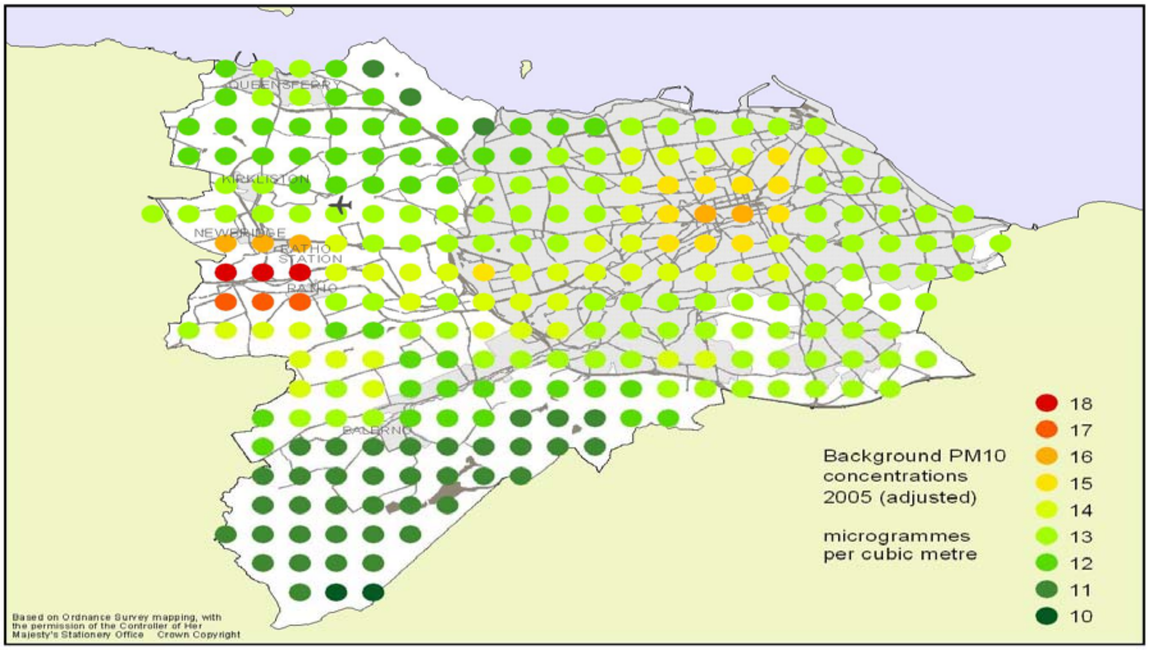
Background levels of the main pollutants have been estimated at the local level for the whole of the UK by NETCEN, on behalf of the UK government. Maps 2 and 3 show the levels of nitrogen dioxide and PM_{10} particles respectively in Edinburgh, on a 1 km by 1 km grid square basis. However, it must be emphasised that these are modelled, background levels which exclude the highly localised effects of traffic emissions, street layout and built form. Local variations are obviously important to people who live or work close to the main traffic routes, or who use them regularly.

Map 2 below shows that background nitrogen dioxide levels throughout the city are well below the national standard annual mean of 40 $\mu g/m^3$. Concentrations are highest in and around the city centre, which is most prone to traffic congestion and has the highest density of bus services. However, there are also secondary peaks related to the City By-pass and arterial traffic routes to the west of the city.



Map 2 Background Nitrogen Dioxide Levels 2005

Map 3 below incorporates adjustments to the modelled NETCEN figures, to reflect actual local measurements of small particle concentrations from the background monitoring site at Currie. Once again the concentrations are compliant with national objectives for 2004, and are expected to comply with the stricter Scottish objective set for 2010 (annual mean of 18 $\mu g/m^3$). In the case of small particles, the highest background levels occur close to the motorway junctions at Newbridge, with slightly lower levels in and around the city centre, and a further peak where the City By-pass joins the A8 at South Gyle.



Map 3: Background PM_{10} Levels, 2005 (adjusted)

The City of Edinburgh Council monitors and assesses air quality in accordance with government guidance on the Local Air Quality Management regime. This advises that monitoring should be undertaken where there is relevant public exposure, i.e. usually where people live. Real-time continuous measurements of nitrogen dioxide are carried out at Roseburn Terrace, Haymarket Terrace, Queen Street, St. Leonards, Gorgie Road, St. Johns Road (from Dec. 2006) and Currie High School ('background' site). Particulates are also monitored continuously at the same locations, apart from Gorgie Road and St. Johns Road. In addition, nitrogen dioxide levels are monitored at over 50 locations on a sample basis, using passive diffusion tubes.

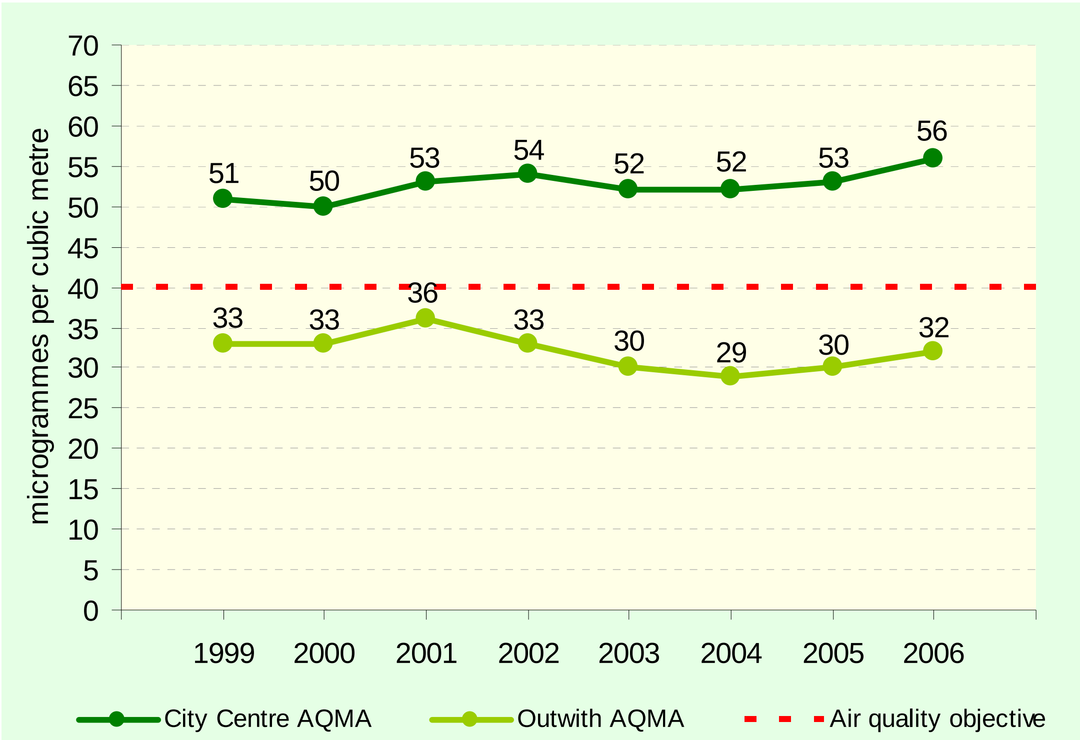
Longer Term Trends

Where longer-term monitoring has been carried out, the evidence indicates mixed trends. The 'Updating and Screening Assessment 2006' concluded that air quality has been gradually improving outwith the City Centre AQMA, mainly due to the introduction of cleaner and more efficient internal combustion engines. However, within the AQMA the data up to 2005 indicated a deterioration at four out of the ten long-term monitoring sites, an improvement at four others, and no change at the remaining two.

Subsequent to the publication of the Updating and Screening Assessment 2006 data for 2006 and 2007 has become available. In general these reveal an unexpected deterioration in NO_2 levels within the AQMAs and at some other locations. This has effected the longer-term trends noted above, with more locations now likely to be experiencing a sustained reduction in air quality.

A city wide Detailed Assessment was undertaken for small airborne particles (PM_{10}) in 2004 which concluded that the 2004 UK objective and the new stricter, Scottish objectives for 2010 would be met. However monitoring data for 2006 and 2007 has shown that city centre locations fail to meet with the Scottish annual objective and therefore it will be necessary to undertake further work to determine if an AQMA is needed for this pollutant.

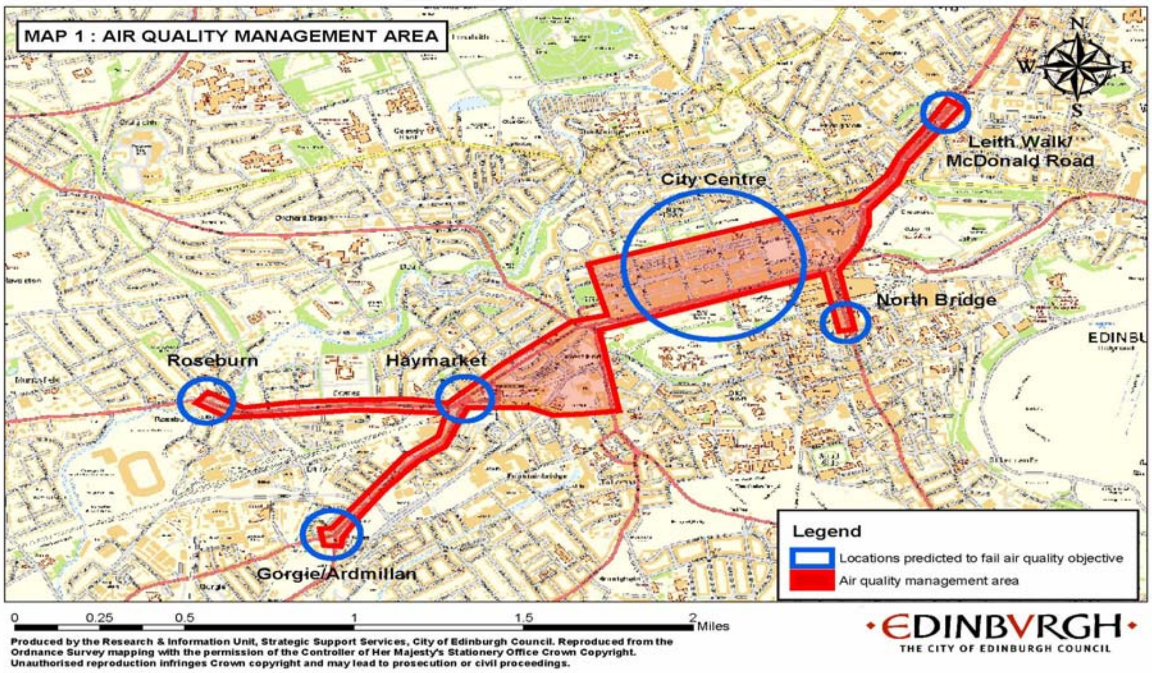
Graph 1 below summarises overall trends in nitrogen dioxide concentrations by averaging the annual readings for all sites where long-term monitoring has been carried out (10 sites in the City Centre AQMA, 8 sites elsewhere). The graph shows an increase since 2004, both within the AQMAs and more generally throughout the city however it exemplifies the longer term trend as still downward outside the AQMAs. However inside the AQMAs nitrogen dioxide levels appear to be rising. However, the use of this methodology does not reflect the magnitude of increase or decrease observed at some of the hot spots within the AQMAs.



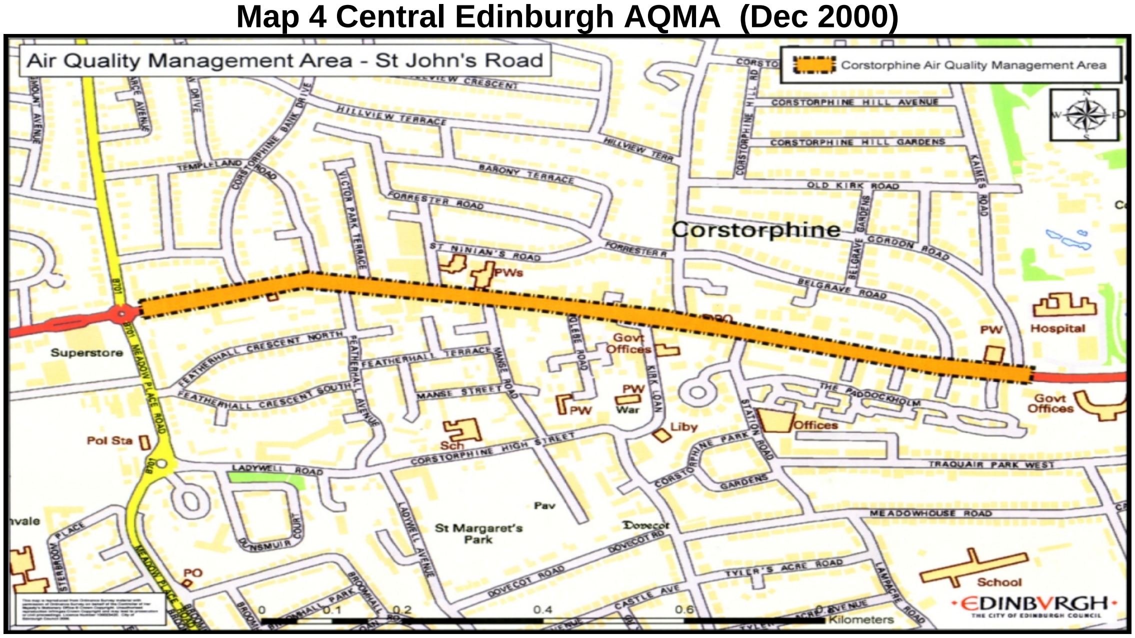
Graph 1 : Summarised Annual Mean NO_2 Readings for Established Monitoring Sites Within and Outwith the City Centre AQMA

Monitoring Within the AQMA's

Map 4 shows the central AQMA declared in 2000. Additional investigation of NO_2 levels at St. John's Road in Corstorphine advised that objectives were not likely to be met leading to the designation of a second AQMA extending along part of St. Johns Road in December 2006 (see Map 5).



Map 4 Central Edinburgh AQMA (Dec 2000)



Map 5 : St John's Rd AQMA (Dec 2006)

Monitoring

Table 2 below shows the annual average nitrogen dioxide levels as measured by passive diffusion tubes within the two AQMAs for the period 2003 to 2007, with projections to 2010. The significant variations resulting from very localised factors are immediately clear. Several locations fell short of the national air quality objective in 2006.

Most of these are predicted to fail the EU limit which national governments are required to meet by 2010 which is a target concentration of 40 $\mu g/m^3$.

It is important to note that the 2010 figures are trend-based projections based on measured 2007 concentrations. They allow for trend such as vehicle fleet improvement. However they do not take account of new large scale developments which have been planned for Edinburgh or policy interventions.

Table 2: Annual Mean Nitrogen Dioxide Concentrations 2004 - 2006 (microgrammes per m^3, corrected values), From Passive Diffusion Tube Sampler Readings
(grouped by AQMA and ordered by values for 2007)

Location	ID	2004	2005	2006	2007	2010 projected
Monitoring locations in City centre AQMA						
West Maitland St. / Palmerston Pl.	2	69	77	86	94	84
Torphichen Pl.	3	68	83	74	82	73
Princes St.	24	64	63	65	70	63
Roseburn Terr. / Roseburn St.	22	73	69	77	69	62
Roseburn Terr.	23	38	46	49	67*	60
North Bridge (northbound)	27	54	49	52	56	50
North Bridge (southbound)	26	48	45	51	50	45
Gorgie Rd. / Murieston Rd.	5	42	48	51	52	47
Queen St. / Frederick St.	33	40	40	41	48	43
Gorgie Rd.	18	43	43	48	47	42
Queen St. / York Pl.	36	38	41	39	47*	42
Leith Walk / Brunswick Rd.	21	38	36	40	45	40
Leith Walk / MacDonald Rd.	20	38	39	39	43	39
Ardmillan Terr.	6	35	33	30	33	30
Monitoring locations in St Johns Road AQMA						
St John’s Rd. (westbound)	1f	68	90	95	94	84
St John’s Rd. (westbound)	1d	76	72	77	96	86
St John’s Rd. (westbound)	1c	69	78	82	82	73
St John’s Rd. (westbound)	1e	71	74	79	80	72
St John’s Rd. (eastbound)	1	43	48	54	52	47
St John’s Rd. (eastbound)	1b	41	59	51	51	46
St John’s Rd. (eastbound)	39	32	33	37	37	33

Source of data in Table 2: City of Edinburgh Council, Services for Communities

Notes: * less than 75% data capture

National Air Quality Objective = annual mean of 40 microgrammes per m^3 by end of 2005

EU Limit Value = annual mean of 40 microgrammes per m^3 by end of 2010

Only limited inferences about trends can be made can be made from Table 2, as a minimum of six years data is required to provide reliable evidence of trends. Not all locations have been monitored for this length of time. Figures for individual years may fluctuate due to weather conditions, roadworks and other factors which can affect traffic flows and congestion.

Based on the latest 2007 monitoring data, the following locations are predicted to fail the EU limit value by 2010:

- West Maitland Street/Palmerston Place
- Torphichen Place
- Princes Street
- Roseburn Terrace /Roseburn Street junction
- Roseburn Terrace.
- North Bridge South Bound
- North Bridge North Bound
- Gorgie Road/Murieston Road junction
- Gorgie Road
- Queen Street/Fredrick Street
- Queen Street/York Place
- St Johns Road

Due to notable increases in nitrogen dioxide at some locations and the fact that roadside concentrations are not falling as initially predicted, there are now locations within the AQMA which are likely to fail the 1- hour objective. These sites are West Maitland Street, Torphichen Place, Princes Street and Roseburn Terrace/Street junction.

Therefore, the Central AQMA will need to be amended to take account of a failure to meet the 1–hour objective and the new Action Plan will need to reflect this.

Real Time Monitoring

The real-time monitoring stations are set back from the roadside and are not in a canyon or junction location, which is why concentrations at these sites are much lower compared with passive diffusion tube monitoring. This data is seen below in Table 3. The passive diffusion tube monitoring represents likely exposure at the facades of residential tenement property.

Table 3: Real -time monitoring nitrogen dioxide concentrations ($\mu g/m^3$).

Location	1999	2000	2001	2002	2003	2004	2005	2006	2007
Gorgie Mean μ/m^3 Number of exceedences	**42** **0**	**38** **0**	**40** **0***	**38** **0**	**39** **0**	**37** **0**	**34** **0**	**41**** **0**	**40** **0**
Haymarket Mean μ/m^3 Number of exceedences	**38** **0**	**37** **0**	**42** **10**	**42** **0**	**41** **0**	**37** **0**	**38** **0**	**39** **0**	**42** **1**
Queen St/ North Castle Mean μ/m^3 Number of exceedences	**42** **0**	**38** **0**	**39** **6**	**44** **0**	**41** **0**	**37** **0**	**35***** **0**		
Queen St/ Wemyss Pl Mean μ/m^3 Number of	**Site relocated from North Castle Street to Wemyss Pl Monitoring commenced 08/04/05**						**31***** **0**	**34** **0**	**35** **0**

Location	1999	2000	2001	2002	2003	2004	2005	2006	2007
exceedences									
Roseburn Mean μ/m^3 Number of exceedences	**Site commenced 18/07/03**					**33** **0**	**32** **0**	**35** **0**	**33** **0**
St Johns Road Mean μ/m^3 Number of exceedences	**Site commenced 19/12/06**								**93** **362**

Source: City of Edinburgh Council, Services for Communities

Notes:

Gorgie * **Analyser fault during December 2001 when exceedences occurred**

** **Less than 80% of data capture for year (new analyser installed)**

Queen St *** **Incomplete year of data at both sites due to relocation.**

National Air Quality Objective:

Annual mean of 40 microgrammes per m^3 by end of 2005

1 hour mean concentration of **200** microgrammes per m^3 not to be exceeded more than **18** times per year by the end of **2005**

EU Limit Value

Annual mean of 40 **microgrammes per m^3 by end of** 2010

1 hour mean concentration of **200** microgrammes per m^3 not to be exceeded more than **18** times per year by the end of **2010**

Locations within the AQMA which currently meet the air quality standard concentration for nitrogen dioxide are:

- Leith Walk
- Queen Street /Wemyss Pl
- Ardmillan Terrace
- Roseburn

The nitrogen dioxide trends vary within the central AQMA; six of the thirteen monitoring locations show an upward trend, indicating an increase in concentration. Five show a downward trend indicating a decrease in concentration and two remain the same. The nitrogen dioxide trend within the St Johns Road AQMA is upward. See Table 4 below.

Table 4 Annual average nitrogen dioxide trends at locations within the AQMAs

Location	Monitoring Method	Trend
West Maitland St/Palmerston Place	PDT	Upward trend
Princes St	PDT	Upward trend
Roseburn Terrace/Street junction	PDT	Upward trend
Gorgie Rd/Murieston Rd junction	PDT	Upward trend
Haymarket Terrace	Real-time	Upward trend

Location	**Monitoring Method**	**Trend**
York Place Queen Street	PDT	Upward trend
St Johns Road	PDT	Upward trend
North Bridge	PDT	Downward trend
Queen St/Fredrick St junction	PDT	Downward trend
Queen Street	Real time	Downward trend
Leith Walk	PDT	Downward trend
Ardmillian Terrace	PDT	Downward trend
Gorgie Road/White Park	Real time	No change
Roseburn	Real time	No change
PDT = Passive Diffusion Tube Method Upward trend = increasing concentrations Downward trend = decreasing concentrations		

Current Pollution Trends and Monitoring

The latest Air Quality Monitoring report (to be approved by Scottish Government and SEPA) has indicated that there are an increasing number of NO_2 ‘hotspots’ within the AQMA area and a number of sites are now believed to be unlikely to meet 2010 limit values. St John’s Road is a main focus with a large number of daily exceedences. This problem relates to the absolute volume of traffic present, the local ‘canyon’ townscape and the proximity of residential properties to the pollution source i.e. traffic. Locations within the central AQMA are also subject to large volumes of traffic, particularly buses. The progress report also indicated that particulates are also pollutants of increasing concern and it is likely that a city-wide AQMA for PM_{10} will have to be declared in a year or so. Some of this pollution is associated with traffic but most of it is trans-boundary in nature.

The Detailed Assessment air quality report undertaken for Great Junction Street and West Port in April 2007 identified that both these locations required to be designated as AQMAs, for failure to comply with nitrogen dioxide objectives. The Council is now at a stage of recommending that both these areas are covered by AQMA orders.

6. LOW EMISSION STUDY FOR EDINBURGH

In 2007 a study was carried out by Transport and Travel Research Limited (TTR), Consultants commissioned by the Council to review the various Low Emission Strategy (LES) options. This study was made possible by a grant from the then Scottish Executive and provided valuable information in the development of a further Air Quality Action Plan. The study had to recommend the most beneficial options in terms of reducing air quality emissions as well as their cost effectiveness. An Executive Summary of the report is seen in Appendix 2.

The Edinburgh LES has provided crucial information to enable the assessment of options for the Council and the subsequent development of actions.

The study looked at a number of LES options, namely:

1. Mandatory emission controls on:

- buses
- road freight
- taxis and private hire vehicles

2. Voluntary emission controls on:

- buses

- road freight
- taxis and private hire vehicles

3. Retrofitting schemes to older vehicles

4. Scrappage schemes for older vehicles

The local data used in the study is summarised in Appendix 2. Where local data were unavailable or incompatible, national data from the National Atmospheric Emissions Inventory (NAEI) and the DfT were used. Data sources included local traffic count data provided by the Council; information provided by the bus operators, registration information from the Department of Transport via the DVLA and taxi data. Where possible, information on the age profile of the vehicles was used. The LUTI traffic model for Edinburgh was used to generate a Business As Usual (BAU) scenarios i.e. a "do nothing" approach. This scenario calculates a certain reduction in air quality emissions based on the natural turnover of fleet vehicles. The study then generates a number of other options scenarios to look at the improvements in air quality emissions over and above this BAU.

The Euro standard is the definition of emissions from vehicles with manufacturers meeting certain categories of Euro standards in order to sell within the EU. Vehicles made in 1993 are given a Euro I standard with all vehicles expected to meet Euro IV categories by 2008. The Edinburgh study used Euro standards.

The objectives of this study were to:

i) Assess the current fleet profile in detail and quantify the potential emissions benefits of increasing the turnover of the vehicle fleet.

ii) Evaluate various methods of achieving fleet emissions reductions and recommend a preferred strategy for Edinburgh, based on cost-effectiveness assessments and issues of practicability.

In the study two pollutants only have been assessed NO_x and PM_{10}. The study focused on the potential emissions benefits of the options considered as well as the cost effectiveness. Cost effectiveness is the ratio of the total costs of the option to the emission benefit obtained (i.e. £ per tonne abated). In this study estimates of both the lifetime and year one cost-effectiveness were done.

Scoping

Table 5 below shows a summary of the all the options scoped into the first stage of the study. A mandatory scheme requiring certain Euro engines to be fitted was evaluated in comparison to a voluntary scheme. Another option looked as a mandatory approach to freight vehicles including HGV's and LGV's requiring two types of Euro engines to be fitted. For comparison purposes a voluntary scheme was also evaluated. Finally options evaluating retrofitting or scrappage schemes where older more polluting vehicles are either upgraded or removed through an incentive scheme was looked at.

The mandatory schemes from buses would be implemented through the Traffic Regulation Conditions (TRC's) and the Traffic Commissioner's powers while mandatory schemes for freight would be through Traffic Regulation Orders (TRO's). Voluntary schemes would be through Bus Emission Partnerships (for buses) and Freight Quality Partnerships (for freight).

It can be seen from Table 5 below, that taxis and private hire vehicles (PHV's) have been scoped out of the study. This is because data supplied from the Council on the age of the fleet showed that the majority of taxis in Edinburgh are already less than 8 years old, and the majority of PHV's are already less than 10 years old. In fact, the average taxi age in the Edinburgh fleet is 4.4 years, and 95% of taxis are 8 years old or less. The average PHV age is 4.1 years and 96% of PHV's are 10 years old or less.

These data suggest that the existing Council policy to maintain the fleet by the control of the quality of the vehicle is effective, and therefore options to investigate emissions controls on the taxi and PHV fleets have been scoped out and not considered further in the study. This is also an important factor in the new Action Plan whereby taxis and PHV's are subsequently not targeted for action.

Option	**Scenario Code**	**Vehicles**	**Scenario**	**Area**[1]	**Year**
Mandatory emissions controls for buses	-	Bus	Euro 3 min (Mandatory)	CEAA	2009
Voluntary emission controls for buses	-	Bus	Euro 2 retrofit (Voluntary)	CEAA	2009
	-	Bus	Euro 3 retrofit (Voluntary)	CEAA	2009
Mandatory emission controls for road freight vehicles	A	HGV+LGV	TRO Euro 3 min (Mandatory)	LES	2010
	B	HGV+LGV	TRO Euro 4 min (Mandatory)	LES	2010
Voluntary emission agreements with freight operators	C.1	HGV+LGV	Euro 3 min (Voluntary) – no incentives	CEAA	2010
	C.2	HGV+LGV	Euro 3 min (Voluntary) – with incentives	CEAA	2010
Mandatory emissions control for taxis and phvs	Not considered past scoping phase				
Voluntary	Not considered past scoping phase				

Option	**Scenario Code**	**Vehicles**	**Scenario**	**Area**[1]	**Year**
emissions control for taxis and phvs					
Retrofitting older vehicles	D	LGV	Retrofit Pre-Euro and Euro 1 vans	CEAA	2008
Scrappage of older vehicles	E.1	Cars+LGV	Scrappage of Pre-Euro vans and cars – PT pass	CEAA	2008
	E.2	Cars+LGV	Scrappage of Pre-Euro vans and cars – replacement vehicles	CEAA	2008
	F.1	Cars+LGV	Scrappage of Pre-Euro & Euro 1 vans and cars– PT pass	CEAA	2008
	F.2	Cars+LGV	Scrappage of Pre-Euro & Euro 1 vans and cars– replacement vehicles	CEAA	2008

Table 5: Summary of LES options and variations

Emissions Benefits

In the study, the focus for scheme benefits was on reductions in transport emissions in absolute terms (kg or tonnes per year) against a future business as usual baseline. The reduction in emissions is therefore the reduction over and above any reduction that would occur due to the natural turnover of the fleet.

Emissions benefits were calculated for a number of years between 2006 and 2016 and the benefits for other years were interpolated from these values. Hence the total lifetime benefit and the Year 1 benefit has been assessed for each option.

The study concluded that the greatest emissions benefits are produced by the following options:

- **Mandatory bus emissions controls:** Produces the most emission benefits of all the investigated options, by some considerable margin. Estimated to achieve annual reductions in bus emissions of 87.5 tonnes of NO_x and 4.5 tonnes of PM_{10}; (24% and 42% of bus fleet emissions, respectively) comprising ~ 5% of the total transport fleet emissions in 2010. Most of these reductions are focussed in the AQMAs.

- **Mandatory freight emissions controls:** Is the next most effective options (i.e the HGV+LGV TRO schemes). The Euro IV scenario gives the most emission reductions of 52.66 tonnes of NO_x and 2.58 tonnes of PM_{10} in the first year. The Euro III Scenario produces a significantly lower emissions benefit of 16.37 tonnes of NO_x and 0.744 tonnes of $PM_{10.}$ The Euro IV produces a reduction in total transport emissions of 3.3% for NO_x and 3.5% for PM_{10}. This percentage is estimated solely from the vehicle emission reduction taking place within the area of the Traffic Regulation Order and therefore the total benefit is underestimated. Emission reductions can be anticipated from journeys made in all other parts of the road network

- **Voluntary bus emission reductions:** The voluntary bus scheme assumes a small proportion of the oldest buses are upgraded (compared to the mandatory scheme, which assumes that all the oldest buses are upgraded). Interestingly, the voluntary option (despite only 10% assumed take up) is calculated to produce virtually the same emission benefits as the Scenario III and to do so a year earlier (in 2009). The voluntary bus scheme gives emissions reduction of 15.3 tonne of NO_x and 0.9 tonne of $PM_{10.}$ In terms of total transport emissions a 10% take up is not very significant on its own; this underlines the importance of aiming for higher levels of take up and/or combining with other LES options

- **Voluntary freight emission reductions:** Voluntary (incentivised) HGV options (Scenario C1) produce around half the emission benefits of the voluntary bus options: 6.69 tonne of NO_x and 0.24 tonne of PM_{10} if only HGVs are included. This figure rises to 7.65 tonne of NO_x and 0.37 tonne of PM_{10} if LGVs are included as well. In terms of total transport emissions this option provides around a 1% reduction, but this is based on just 10% of the potentially eligible vehicles being upgraded. The objective if picking this option would be to design an approach that raised this proportion greatly

The remaining scenarios i.e. the car and van scrappage options and the van retrofit option produce a significantly lower level of emission benefits. The best performing of the variations is the scrappage scheme for pre-Euro and Euro I vans plus cars. This produces a reduction in first year emission of 2.77 tonnes of NO_x and 0.46 tonnes of $PM_{10.}$

Cost Effectiveness

The study also evaluated the cost effectiveness of the various options with the key advantage being that it allows a direct comparison of variations with different vehicles and emission abatement equipment or replacement. It also enables the integration of any scheme set-up costs to be monetised over the life of the option. The cost-effectiveness of each measure (i.e. the cost per tonne abated) can be used to prioritise the most efficient options.

For both NO_x and PM_{10} the study showed that the mandatory and voluntary bus options are the most cost-effective, particularly when the potential lifetime benefits are considered. Several of the LGV scrappage and voluntary HGV scenarios come next in order of cost-effectiveness for both NO_x and PM_{10}, however they are significantly less cost-effective than the bus scenarios when assessed over the lifetime of the option.

Table 6 below shows a summary of the LES emission benefits and cost effectiveness in £ per tonne. Figures in red highlight the main options in reducing emissions.

LES option	**No veh affected**	**Total Year 1 emission reduction (t/yr)**		**% emission reduction over total baseline CEAA Year 1**		**Lifetime cost – effectiveness £ per tonne**	
		NO_x	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x £/t**	**PM_{10} £/t**
Mandatory bus (Euro 3 min)	233	**87.5**	**4.5**	5.0	5.3	1.9 – 3.3	74 - 120
Voluntary bus							
Euro 2 retrofit	22	**9.1**	**0.5**	0.5	0.6	2.7 – 6.0	26 - 37
Euro 3 retrofit	22	**6.2**	**0.4**	0.4	0.5	3.9 – 8.6	29 - 43
Combined Euro 2 & Euro 3	44	**15.3**	**0.9**	0.9	1.1	3.2 – 7.0	27 - 40

		Total Year 1 emission reduction (t/yr)		**% emission reduction over total baseline CEAA Year 1**		**Lifetime cost – effectiveness £ per tonne**	
Mandatory freight							
A Euro 3 min	5271	**16.4**	**0.7**	0.9	0.8	218 – 7,746	5,325 – 31,970
B Euro 4 min	9534	**57.2**	**3.1**	3.3	3.6	50 – 4,138	862 – 14,606
Voluntary freight							
C1 Euro 3 min no incentives	57	1.53	0.07	0.1	0.1	15 - 938	267 – 2,111
C2 Euro 3 min incentives	578	**7.65**	**0.37**	0.4	0.4	16 - 925	274 – 2,256
D Retrofitting LGVs	263	0.41	0.08	0.02	0.1	1,294 – 2,358	1,667 – 2,143
Scrappage							
E1 – PT pass	796	0.82	0.12	0.05	0.1	27 - 651	140 – 500
E2 - replacement	796	0.7	0.1	0.04	0.1	245 – 5,587	2,500 – 18,855
F1 – PT pass	3191	2.77	0.46	0.2	0.5	20 - 643	108 – 5,087
F2 - replacement	3191	1.63	0.29	0.1	0.3	234 - 1828	1,240 – 39,724

Table 6: Summary of LES emission benefits and cost-effectiveness

Practicability

To properly assess the potential LES options, it was also essential to consider the practicability and acceptability of schemes, to try to capture other effects not included in the quantitative assessment. The key reasoning was to see whether any additional aspects change the relative attractiveness of different options. An assessment of the acceptability and practicality of the options is given in the table below, together with the total lifetime cost of the option. Total lifetime costs are the total scheme and operator costs.

LES option	Practicability /feasibility	Acceptability Industry/ commerce	Total lifetime costs[1]
HGV&LGV TRO Euro 3	Low	Low	High
HGV&LGV TRO Euro 4	Low	Very low	High
Bus (mandatory)	High-Low	Low-Very Low	Medium
Bus (voluntary)	High	Medium-High	Low
HGV (voluntary)	High	High	Low
Scrappage (car & LGV)	High	Medium	Low
Retrofit older diesel van	Medium-high	Medium	Low

[1] Lifetime costs - low = £0-3M; Medium = £3-10M; High = >£10M

Table 7: Rating of different scheme types against other criteria

Recommendations

The study identified that the implementation of mandatory schemes would incur the highest capital and revenue costs both for buses and freight. The mandatory freight scheme in particular was not thought to be feasible at the present time because of a lack of legislation required for civil enforcement of the TRO. In addition there would be high costs for operators to comply with if the option of Euro IV was imposed. Similarly, the mandatory schemes for buses was thought to have low acceptability with operators as well as also high costs although it offers the best option of reducing emissions and therefore meeting air quality objectives.

The study concluded that a low emission strategy for Edinburgh could be formed from a number of complimentary options in the following order of preference:

1. **Mandatory or voluntary bus emission strategy, setting a minimum emission standard of Euro 3.**
   This gives significant emissions benefits from targeting a small number of highly polluting vehicles. For the mandatory option there is likely to be a framework for implementation and enforcement, with the use of Traffic Regulation Conditions to local bus services, by the Scottish Traffic Commissioner. It is anticipated that the costs of this stage of a mandatory scheme to the council would be low. However, if additional capital and revenue incentives cannot be externally sourced this option may result in social and economic disbenefits to the city. If a mandatory bus scheme proves to not be acceptable or feasible, then a voluntary bus scheme to retrofit Euro 2 and Euro 3 vehicles would be a cost effective alternative, and efforts should be focussed on improving its effectiveness through higher levels of take up.

2. **Voluntary, incentivised, HGV retrofit scheme for older vehicles**
   aiming to encourage a Euro 3 minimum amongst the uptake.

This option scored well in the cost effectiveness assessment, however the total emissions benefits will depend greatly on the level of take-up of the scheme.

3. **Car scrappage (with public transport pass)** offered to all pre-Euro and Euro 1 car owners.

4. **Van replacement (pre-Euro and Euro 1) with newer vehicles,** Removing the oldest diesel vans from the fleet is more cost-effective than retrofitting the same vehicles.

Council Response to the LES Study

The LES Study provided valuable information on a range of low emission strategy options for the Council.

Having evaluated all the options in terms of emission reduction, cost effectiveness, cost to implement and practicability, the Council concluded that the key recommendation of a mandatory bus emission strategy would be too expensive currently and possibly result in economic disbenefits to the city. However this has to be weighed against continuing deterioration of air quality in the city centre and potentially at other sites in the city. In addition, the latest progress reports showed little real progress in meeting air quality objectives. Instead the Council will pursue the two options of voluntary partnerships and ensure the highest uptake of fleet replacement and turnover by operators, namely:

- **A Voluntary Bus Emission Strategy**

This option performed well in terms of practicability and acceptability. For a voluntary scheme, emissions reduction is more likely to be achieved by retrofitting rather than replacement of buses with newer buses. The emissions standards are to achieve a higher standard of emissions by retrofitting Euro 2 and/or Euro 3 buses with DPF and NO_x filters. The scheme is not compulsory and therefore the take-up rates will be lower.

Scenario & vehicle type	**2009**		**Lifetime**	
	NO_x (t)	**PM_{10} (t)**	**NO_x (t)**	**PM_{10} (t)**
Base Case	367.6	10.7	2573	74.9
Bus scheme Euro 2 retrofit (voluntary)	358.5	10.2	2509.5	71.4
Benefit	-9.1	-0.5	-63.5	-3.5
Benefit (%)	-2	-4	-2	-4
Bus scheme Euro 3 retrofit (voluntary)	361.4	10.3	2529.8	72.1
Benefit	-6.2	-0.4	-43.2	-2.8
Benefit (%)	-2	-5	-2	-5

Table 8: Total NO_X and PM_{10} emissions year 1 and over scheme lifetime (BUSES).

The option to voluntarily retrofit 10% of Euro 2 buses is estimated to achieve bus annual emission reductions of 2% and 4% while the equivalent reduction for the Euro 3 case is 2% and 5%. These figures are for NO_x and PM_{10} respectively. These are fairly small reductions but would be equivalent to a 20% to 45% reduction for NO_x and PM_{10} respectively if the whole fleet were to make this voluntary upgrade. Compared with the total year 1 emissions for the Edinburgh area, the voluntary bus controls could reduce total NO_x emissions by up to 0.9% and total PM_{10} emissions by up to 1.1%, if retrofits to both Euro 2 and Euro 3 are included. Potential emission reductions of this scale are only likely to contribute significantly towards achieving the air quality objectives if compliance rates are closer to 100%.

- **A Voluntary Freight Quality Partnership**

Voluntary emissions agreements could be brokered through forums such as Freight Quality Partnerships, and by offering incentives to comply with voluntary agreements. The level of take-up will vary depending on the level of commitment on all sides of the partnership. This could be increased by incentives in the form of a subsidy or tax reductions/rebates.

Less stringent emissions standards than those considered for a formal LEZ scheme are recommended; i.e. a minimum standard of Euro 3 for NO_x and PM_{10}. However, as the scheme is not compulsory the take-up rates will be lower, and may depend upon the types / levels of incentives offered.

Scenario & veh. type	**2010**		**Lifetime**	
	NO_x (t)	**PM_{10} (t)**	**NO_x (t)**	**PM_{10} (t)**
HGV subtotal	*885.39*	*19.83*	*4472.14*	*89.69*
LGV subtotal	*103.07*	*10.07*	*798.93*	*57.11*
Base Case Total	988.47	29.90	5271.07	146.80
HGV subtotal	*884.05*	*19.78*	*4468.12*	*89.54*
LGV subtotal	*102.88*	*10.05*	*798.29*	*57.02*
Scenario C.1 Total	986.94	29.83	5266.41	146.56
Scenario C.1 Benefit	-1.53	-0.07	-4.66	-0.24
Scenario C.1 Benefit (%)	-0.2	-0.2	-0.1	-0.2
HGV subtotal	*878.70*	*19.59*	*4452.07*	*88.96*
LGV subtotal	*102.11*	*9.94*	*795.71*	*56.68*
Scenario C.2 Total	980.82	29.53	5247.78	145.64
Scenario C.2 Benefit	-7.65	-0.37	-23.29	-1.16

	2010		**Lifetime**	
Scenario C.2 Benefit (%)	-0.8	-1.2	-0.4	-0.8

Table 9: Total NO_x and PM_{10} emissions: year 1 and over scheme lifetime (FREIGHT)

7 ACTION PLAN

Previous Action Plans

In July 2003 the City of Edinburgh Council published an Air Quality Action Plan which proposed a number of measures to reduce NO_2 levels within the AQMA. These included traffic management improvements, public transport promotion, the adoption of cleaner engine technologies in buses, taxis, goods vehicles and council vehicles, use of new powers to deter running of engines in stationary vehicles, promotion of green travel plans etc. If fully implemented, it was estimated that these and similar measures would reduce NO_2 levels by 40%, on top of the expected 40% reduction by 2010 which could occur without intervention. A key element of the Plan was the introduction of congestion charging which would provide considerable revenue to implement a further number of actions. However, the referendum result in 2005 meant that this did not proceed. Consequently the revenue that was expected from this initiative did not materialise and as a result this 40% reduction not been achieved.

A further progress report covering 2005-2007 showed that there were still a number of sites within the AQMA that would not meet air quality objectives despite a number of initiatives undertaken. Clearly some of the initiatives have not been effective in reducing air pollution. The LES study has provided a valuable piece of research into the options that may be available to the Council. Consequently this Action Plan looks for more focused actions based on the LES study to address continuing concerns over air quality.

ACTION PLAN 2008-2010

This new Action Plan presents a number of initiatives and actions designed to mitigate air quality impacts and assist in the meeting of air quality objectives.

The initiatives are ranked in order of priority and grouped under a number of headings.

Cleaner Vehicles (Non Council Fleet)

The European Union, through legislation for road vehicles and fuel has substantially reduced individual vehicle emissions. For example, a car built in 2000 produces around five percent of the emissions of pollutants relevant to local air quality management of a car manufactured in the 1970s. However, for air quality objectives to be achieved emissions from road transport will have to be reduced much further. Cleaner technologies have the potential to reduce emissions by the required levels.

Air quality will improve as older vehicles are replaced by newer vehicles which meet lower exhaust emission limits however, this rate of replacement, needs to happen faster to achieve national air quality objective for NO_2.

NO_2 emissions from cars are already relatively low, the impact of improving all cars to Euro IV standards has only a minimal effect on NO_x emissions in 2010. Consequently the main focus of activity on cleaner vehicles is buses and freight and in line with the recommendations made in the LES Study. Efforts will be made on reducing emissions from these vehicle types. However efforts will be made through transport planning initiatives to reduce the number of cars as detailed above to address the sheer volume of projected new cars in the city.

Actions on Buses

Bus Quality Partnership

There is currently a voluntary agreement between the City of Edinburgh Council and Lothian Buses. The Council will extend and develop its current voluntary agreement with a view to involving all major operators in the city. This initiative may be a means of agreeing targets for the minimum percentage of buses operational in the AQMAs (for each operator) to conform to the highest emission reduction technology. Further work needs to be undertaken to determine a bus baseline of what proportion of buses passing through the *NO_2* 'hotspots' are pre-Euro II. If a baseline is established it might be possible to determine whether removing or re-routing such vehicles would significantly improve conditions in the AQMAs. Some relevant information is contained within the LES study but further liaison with the bus companies is necessary

1. Cleaner Vehicles : Actions on Buses				
Action	**Aimed At**	**Lead**	**Timescale**	**Effectiveness/Comment**
1.1 Establish baseline of bus fleet composition in relation to NO_2 'hotspots' from	Bus operators Lothian, Stagecoach and First Bus	Transport Policy/SDU	2008	Important to establish the type of Euro engine in AQMAs May assist in determining whether removing or re routing vehicles would improve conditions within AQMA.
1.2 Host a seminar with bus operators	Bus Operators	SDU/Transport	2008	Raise awareness of current air quality issues.
1.3 Extend the Bus Emission Partnership to all bus operators in the city.	Bus Operators	SDU/Transport Policy	Launch Sep 2008	Brings all bus operators on board.
1.4 Agree minimum requirements of the Partnership and evaluate retrofitting options	Bus Operators	SDU/Transport	2008	Crucial to ensure the cleanest buses operating within the AQMAs.

<u>Actions on Freight</u>

Freight Quality Partnership

As a way of working towards a sustainable freight distribution network, a Freight Quality Partnership (FQP) will be developed. Through this Partnership, measures will be developed in relation to freight distribution to achieve a balance between improving the local economy and protecting the environment. These measures may include the production of freight route maps, zoning systems in urban areas to direct heavy goods vehicles, defining and enforcing delivery times, reviewing parking and loading restrictions, consolidation areas where goods are transferred to smaller deliver vehicles, and reducing the amount of HGV traffic through environmentally sensitive areas e.g. AQMAs. Such a strategy may also include encouragement to switching from road to rail for the movement of freight.

2. Cleaner Vehicles : Actions on Freight				
Action	**Aimed At**	**Lead**	**Timescale**	**Effectiveness/Comment**
2.1 Host a seminar with freight operators	Freight Operators	SDU/Transport	2008	Raise awareness of current air quality issues.
2.2 Establish a Freight Quality Partnership in the city	Freight Operators	SDU/Transport	2008/09	Important to ensure that Freight vehicles operating in the AQMAs are the cleanest.

Policy Initiatives: Planning and Application Assessment

Context

Local air quality is a key consideration in the integration between planning and transport. The Edinburgh City Local Plan establishes the need for air quality assessment and mitigation. This gives the policy context for negotiation with developers, transport companies etc. It is important that Planning officers are aware of current issues around air quality within the AQMAs but more importantly, are aware of potential new hot spot areas within the city e.g. West Port and Great Junction Street.

It is also important that the cumulative effect of development is closely monitored in terms of air quality impacts. In particular there are still some concerns in relation to air quality impact assessment work carried out as part of the EIA process. Internal modelling work using the Transport Model for Scotland indicates that there will be significant future negative traffic and associated air quality impacts arsing from planned development. It was noted that modelling suggests that mitigation measured aimed at promoting a modal shift in travel patterns can, in fact, result in negative air quality impacts – eventually the sheer cumulative volume of new and existing traffic will overwhelm any positive impacts from mitigation measures.

Actions

Consequently new actions in this area are:

3. Policy Planning and Assessment				
Action	**Aimed At**	**Lead**	**Timescale**	**Effectiveness/Comment**
3.1 Run a series of internal seminars on Air Quality Monitoring	Planning DQ Transport Planning	SfC (support from SDU)		Does not contribute directly to reducing air pollution but important work in relation to future hot spots.
3.2 Establish a city wide inventory of development sites		Planning (support from SfC)		Useful data.
3.3 Develop further modelling of air quality impacts around current developments		SfC	2008	Useful data.

Policy Initiatives: Transport Planning

Local transport policies that aim to reduce congestion will also help to improve air quality. The Local Transport Strategy (LTS) is a formal document outlining Council's transport policies, plans and projects for Edinburgh Transport System. It contains items such as our aims and objectives, our specific strategy with both long-term plans and short-term schemes that may or may not have already secured funding. The strategy also presents ways in which Council hopes to obtain funding and how that funding will be spent. The strategy is a requirement in order to bid for funds from the Scottish Government for transport related schemes. Some key initiatives for the LTS include the introduction of tram lines and investigating new options for the interchange area around Haymarket Station.

Park and Ride

The introduction of a Park and Ride and associated Bus Priority facilities can reduce traffic growth and traffic congestion in the City Centre, much of which is designated as an Air Quality Management Area, and by this means help to reduce pollution associated with traffic. This is particularly the case as parking controls, promotion and other measures which complement the Park and Ride sites are also being progressed.

Differential Parking

Differential parking charges are a means of encouraging people to think about the effect their journeys and their private vehicles have on the environment and of encouraging drivers to change their behaviour in favour of more environmentally friendly personal transport.

Cycle Share Scheme

Cycle share schemes provide for greater mode choice and flexibility by facilitating short term cycle hire and provide the opportunity for single trips to be made by enabling users (residents, visitors or commuters) to hire a bike from one location and leave it at another.

Cycle Share Schemes have proved popular in a number of European capitals as an additional means of sustainable travel for residents, tourists and commuters. In addition, evidence suggests that they are also helpful in raising awareness of the impact of travel on the environment.

Tram Line One

Trams will be zero emission at the point of use and offer a means of accommodating part of the demand for transport within the AQMA with zero emission vehicles. Construction commenced in 2007 with the first tram to be operational in 2010.

The trams will result in a reduction in car journeys to the city centre, therefore, reducing emissions of NO_x, particulate matter and carbon dioxide directly from reduced vehicle numbers and indirectly as a result of reduced congestion experienced by bus and other road users. Tram routes will pass through a number of air quality hot spots within the AQMA. These include Leith Walk / MacDonald Road, Queen Street, and Haymarket.

Actions

Consequently new actions in this area are:

4. Transport Planning				
Action	**Aimed At**	**Lead**	**Timescale**	**Effectiveness/Comment**
4.1 Local Transport Strategy	Planning Transport	Transport Planning	From 2007 - 2011	Incorporates a wide range of existing and

Range of Initiatives	planning			proposed traffic and transport initiatives which collectively will have a significant impact on traffic management and some associated beneficial impact on air quality can be anticipated.
4.2 Park and Ride Completion of two new sites	Transport Planning	Transport Planning	2008 and Ongoing	Expected to result in a reduction of cars entering the city centre with associated positive effects on air quality.
4.3 Report into the potential for Differential Parking	Transport Planning	Transport Planning	Summer 2008	Might be anticipated to result in a reduction of larger, more polluting cars entering the city centre with associated positive effects on air quality.
4.4 City-Wide Bike Scheme Commission an initial study to assess the potential feasibility of introducing a cycle share scheme in Edinburgh	Transport Planning	Transport Planning	Summer 2008	Might be anticipated to result in marginal improvements in air quality by extending the number of sustainable travel modes available to residents, visitors and commuters.
4.5 Tramline One Construction of tram	City Development	Transport Planning	Operational by 2010	Expected to result in improvement in air

line (location will include AQMA area)	Transport Planning			quality as trams will be zero emission at point of use.

Traffic Management

This section of the action plan focuses on reducing vehicle exhaust emissions through the use of traffic management. Changes to traffic management offer the potential to reduce vehicle emissions primarily by smoothing flows and reducing congestion at a particular part of the network. Reducing the number of times that vehicles need to stop and start and change speed can have a significant impact on air quality. Traffic management also offers some potential to reduce the impact of emissions by moving traffic streams further from critical junctions and increasing bus priority.

SCOOT

The Council has primarily focused on the use of SCOOT***** to control networks of traffic signals in the city centre and on approaches to the city along St John's Road. SCOOT has built-in logic to optimise signal timings to minimise the effects of traffic sourced emissions.

* Split Cycle Offset Optimisation Technique (a demand responsive urban traffic control system)

Controlled Parking Zones

Controlled parking zones reduce commuter parking, freeing up spaces and reduce congestion. This reduces pollution and improves air quality, which benefits the health of the community. An ongoing roll out of CPZs will be completed in 2008.

Central Edinburgh Traffic Management Scheme (CETM)

The Central Edinburgh Traffic Management Scheme was designed to facilitate more efficient pedestrian, bus and cycling movement within central Edinburgh and is a key element of the Council's Local Transport Strategy which sets out the blueprint for managing traffic in the city. It was assumed from its inception that the CETM scheme would help the council meet the terms of by helping to improve air quality.

Actions

Consequently new actions in this area are:

5. Traffic Management				
Action	**Aimed At**	**Lead**	**Timescale**	**Effectiveness/Comment**
5.1 Review SCOOT at St John's Road to assess its value as a traffic pollution mitigation tool on this site and at new sites throughout the city	Planning Transport Planning	Transport Planning	2008	It is assumed that smoothing of traffic flows will have positive air quality impacts.
5.2 Integrate actions contained within the recently completed North Edinburgh Transport Action Plan with those contained within the Local Transport Strategy	Transport Planning	Transport Planning	2008	Successful management of traffic flows to and from expanding developments on the north of the city are essential to avoid new air quality problems and to mitigate existing ones in the city centre.

5.3 Review the current impact of the CETM scheme on air quality	Transport Planning	Transport Planning	2008	The CETM scheme will be an important factor in ensuring the initiatives contained within the Local Transport strategy can achieve air quality benefits.
5.4 Extension of Controlled Parking	Transport Planning	Transport Planning	2008	Completion of the current roll out of CPZs is expected to achieve marginal improvements in air quality in and around the AQMAs.

5. Cleaner Vehicles (Council Fleet)

Greening the Council fleet has been an important consideration in the selection of fleet vehicles over several years. The Council has actively sought grants and fitted particulate traps to older vehicles. The Council's intention is to keep the average age of its fleet as young as possible to ensure that where fleet vehicles enter an AQMA they contribute as low an impact as possible. New actions have been identified through the Council's recent participation on the Carbon Trust's Carbon Management Programme to further green the fleet. The council will investigate any new "after market" technologies that can give an increase in fuel consumption efficiency and, investigate new and alternative fuel technologies as they arise and challenge the acquisition of all vehicles at Departmental level to ensure that they are properly utilised.

Driver Training

The Council intends to progress the training and re-training drivers to ensure that they drive in a more efficient way linked to the introduction of Driver CPC's (certificate of professional competence). To achieve this the Council will either develop its own training centre, or use outside agencies.

Fleet Routes and Travel Patterns

The Council intends to fit a GPS telematics device to all Council vehicles, with the capacity to monitor different aspects of CEC operations, e.g. meet the different requirements of services as diverse as street sweeping to passenger operations. This will allow managers to accurately check the effectiveness of their vehicle fleet, and vehicle based operations. In addition, further evaluation of travel patterns will be undertaken to ensure efficiency along routes.

Actions

Consequently new actions in this area are:

6. Cleaner Vehicles : Action on Council Fleet				
Action	**Aimed At**	**Lead**	**Timescale**	**Effectiveness/Comment**
6.1 Develop Driver Eco Training Programme	All Departments Corporate Transport	Corporate Transport	From 2008 and continuous	Expected to result in a marginal reduction in polluting emissions from Council vehicles.
6.2 Evaluate use of telematics technology to fleet.	All Departments Corporate Transport	Corporate Transport	From 2008 and continuous	Expected to result in only a marginal reduction in polluting emissions from Council vehicles in addition to significant

				improvements already gained.
6.3 Review fleet routes and travel patterns	All Departments Corporate Transport	Corporate Transport	From 2008 and continuous	Expected to result in only a marginal reduction in polluting emissions from Council vehicles through reduction in total mileages.

6. Other Initiatives

Campaign to Raise Awareness of Air Pollution

The decisions people make about the way they travel have an impact on air quality in the city and even small changes could help reduce pollution. If people are well informed about the air pollution problem and the solutions they will be more likely to do their bit to help improve air quality. Building public support to improve air quality must be an integral part of the AQAP. It is considered that when personal travel choices are taken in isolation they may appear ineffective. However, it is starting to be recognised that the widespread adoption of ‘smart choices’ for alternative travel can offer genuine long-term benefits in their contribution to pollution reduction. Initiatives such as the annual, “Car Free Day” offer a means o raising the profile on alternatives to travel by car, and helping the wider public to recognise the choices we all face that can have an impact on the environment. In Edinburgh, public awareness of air pollution will be linked to the development and promotion of the Councils Climate Change strategy and over-arching Sustainable Development Strategy.

However cost effectiveness does not indicate how far an option will contribute in progress towards achieving air quality objectives.

State of the Environment Report

The Council has drafted a comprehensive 'State of the Environment Report' which already includes information on air quality monitoring and trends. It is essential that this document is proactive in highlighting existing or potential problems in terms of air quality arising from current and planned development throughout the city and by this means identifies and facilitates opportunities for the mitigation of air quality problems and the avoidance of future problems.

Actions

Consequently new actions in this area are:

7. Other Initiatives				
Action	**Aimed At**	**Lead**	**Timescale**	**Effectiveness/Comment**
7.1 Run a series of internal seminars on Air Quality Monitoring (liked to Carbon Management Programme.	Planning DQ Transport Planning	SfC (support from SDU)	Commencing 2008	Does not contribute directly to reducing air pollution but important work in relation to future hot spots.
7.2 Staff Awareness Training (as part of Carbon Management Programme).	All Departments SDU	SDU	Commencing 2008	Does not contribute directly to reducing air pollution but sustained awareness raising programmes are effective in bringing about behavioural changes that have positive environmental effects.

8. STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)

Strategic Environmental Assessment (SEA) is key legislation designed to protect the environment. It requires local authority plans, programmes and strategies (PPS) to be assessed for significant environmental effects and if any arise to propose mitigation. The legislation requires screening reports to be undertaken and submitted to the "Consultation Authorities" (Historic Scotland, SNH and SEPA). These Screening Reports set out the views of the local authority as to whether the PPS will have significant effects or not and whether a full SEA is to be undertaken or not.

The Air Quality: Action Plan 2008- 2010 has been assessed under the SEA legislation and it is the view of the Council that the Action Plan is not likely to have any significant environmental effects within the context of the Environmental Assessment (Scotland) Act 2005. SEA is therefore not required. Formal opinion on the necessity for a SEA of the Action Plan has been sought from the SEA Gateway at the Scottish Government and a Screening Report has been submitted. A response has been received from the SEA Gateway (SEPA, Scottish Natural Heritage, Historic Scotland) confirming that the new action plan has no significant environmental effects.

9 FURTHER INFORMATION

Monitoring of the new Action Plan will be carried out by the Council's corporate air quality working group and reported on annually.

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10. APPENDICES

Appendix 1: Edinburgh Low Emission Study

Carried out by TTR Ltd – (Transport and Travel Research Ltd) May 2007

Executive Summary

Background

A single AQMA was declared for Edinburgh City Centre in December 2000, and as a result of the Council's ongoing Review and Assessment of Air Quality a second AQMA to the west of the central area of the city was declared for St Johns Road on 31st December 2006.

Study aims and objectives

The overall aim of the study is to review various Low Emission Strategy (LES) options and recommend the most cost-effective emissions management strategy for Edinburgh. The study includes an assessment of the implementation, operation, enforcement and air quality impacts of various LES options, as well as an assessment of their costs, benefits and practicability. This will allow the City of Edinburgh Council to determine which, if any, low emission management measures or combination of measures are viable options for progression as part of the strategic approach to air quality management in the City of Edinburgh.

The objectives of this study are to:

iii) Assess the current fleet profile in detail and quantify the potential emissions benefits of increasing the turnover of the vehicle fleet.

iv) Evaluate various methods of achieving fleet emissions reductions and recommend a preferred strategy for Edinburgh, based on cost-effectiveness assessments and issues of practicability.

The study examined the benefits, feasibility and cost-effectiveness of the following LES options:

1. Mandatory emissions controls for buses e.g. use of Traffic Regulation Conditions.
2. Voluntary emission controls for buses e.g. through Emissions Partnerships.
3. Mandatory emission controls for road freight vehicles e.g. use of Traffic Regulation Orders.
4. Voluntary emission agreements with freight operators e.g. through retrofitting CRT and / or De-NO_x systems, possibly as part of a Freight Quality Partnership.
5. Mandatory emissions control for taxis and private hire vehicles licensed by the City of Edinburgh Council (not taken past scoping phase);
6. Voluntary emission controls for taxis and private hire vehicles licensed by the City of Edinburgh Council (not taken past scoping phase);
7. Retrofitting catalysts and filters to older cars that are likely to remain in fleet for at least several years (changed to vans only in scoping phase);
8. Scrappage schemes for older vehicles (vans and cars);
9. Any other options that may be suitable

The first part of the study comprised a scoping phase, to consider each of the options above and determine which options would be taken forward to a detailed technical assessment. An overview of the options determined through the scoping phase is presented in Table 0.1.

Summary of LES options and variations

Option	**Scenario Code**	**Vehicles**	**Scenario**	**Area[1]**	**Year**
Mandatory emissions controls	-	Bus	Euro 3 min (Mandatory)	CEAA	2009

Option	**Scenario Code**	**Vehicles**	**Scenario**	**Area[1]**	**Year**
for buses					
Voluntary emission controls for buses	-	Bus	Euro 2 retrofit (Voluntary)	CEAA	2009
	-	Bus	Euro 3 retrofit (Voluntary)	CEAA	2009
Mandatory emission controls for road freight vehicles	A	HGV+LGV	TRO Euro 3 min (Mandatory)	LES	2010
	B	HGV+LGV	TRO Euro 4 min (Mandatory)	LES	2010
Voluntary emission agreements with freight operators	C.1	HGV+LGV	Euro 3 min (Voluntary) – no incentives	CEAA	2010
	C.2	HGV+LGV	Euro 3 min (Voluntary) – with incentives	CEAA	2010
Mandatory emissions control for taxis and phvs	Not considered past scoping phase				
Voluntary emissions control for taxis and phvs	Not considered past scoping phase				
Retrofitting older vehicles	D	LGV	Retrofit Pre-Euro and Euro 1 vans	CEAA	2008
Scrappage of older vehicles	E.1	Cars+LGV	Scrappage of Pre-Euro vans and cars – PT pass	CEAA	2008

Option	Scenario Code	Vehicles	Scenario	Area[1]	Year
	E.2	Cars+LGV	Scrappage of Pre-Euro vans and cars – replacement vehicles	CEAA	2008
	F.1	Cars+LGV	Scrappage of Pre-Euro & Euro 1 vans and cars– PT pass	CEAA	2008
	F.2	Cars+LGV	Scrappage of Pre-Euro & Euro 1 vans and cars– replacement vehicles	CEAA	2008

[1] CEAA = City of Edinburgh Administrative Area; LES = Low Emissions Strategy cordon area

Results

The emissions benefits, cost-effectiveness and practicability of each option were considered in the detailed technical assessment.

i Emission benefits

The focus for scheme benefits was on reductions in transport emissions in absolute terms (kg or tonnes per year) against a future business as usual baseline. The reduction in emissions is therefore the reduction over and above any reduction that would occur due to the natural turnover of the fleet. Emissions benefits have been calculated for a number of years between 2006 and 2016 and the benefits for other years have been interpolated from these values. Hence the total lifetime benefit and the Year 1 benefit has been assessed for each option.

The greatest emissions benefits are produced by the following options:

- Mandatory bus emissions controls.
  The mandatory bus option produces the most emission benefits of all the investigated options, by some considerable margin. This option is estimated to achieve annual reductions in bus emissions of 87.5 tonnes of NO_x and 4.5 tonnes of PM_{10}; 24% and 42% of the total bus fleet emissions, respectively. These are significant reductions, and comprise around 5% of the total transport fleet emissions in 2010. In addition, the concentration of bus km in the central Edinburgh area means that these emission reductions are focussed in the AQMAs and on key corridors.

- Mandatory freight emissions controls (Option B followed by Option A).
  In terms of total emission reduction, the next most effective options are the HGV+LGV TRO schemes (Scenarios A and B in Table 0.1 above). Scenario B (minimum emission standard for HGVs and LGVs of Euro 4 in 2010) gives an emission reduction of 52.66 tonnes of NO_x and 2.58 tonnes of PM_{10} in the first year of operation. Removing vans from this option and targeting just HGVs still achieves most of these benefits, illustrating the dominance of heavy duty engines in total transport emissions. Scenario A (minimum emission standard for HGVs and LGVs of Euro 3 in 2010) produces a significantly lower emissions benefit of 16.37 tonnes of NO_x and 0.744 tonnes of $PM_{10.}$ Scenario B produces a reduction in total transport emissions of 3.3% for NO_x and 3.5% for PM_{10}. This percentage is estimated solely from the vehicle emission reduction taking place within the area of the TRO, and therefore the total benefit is underestimated. Emission reductions can be anticipated from journeys made in all other parts of the road network

- Voluntary bus emissions controls
  The voluntary bus scheme assumes a small proportion of the oldest buses are upgraded (compared to the mandatory scheme, which assumes that all the oldest buses are upgraded) Interestingly, the voluntary option

(despite only 10% assumed take up) is calculated to produce virtually the same emission benefits as the Scenario A HGV+ LGV TRO option, and to do so a year earlier (in 2009). The voluntary bus scheme gives emissions reduction of 15.3 tonne of NO_x and 0.9 tonne of $PM_{10.}$ In terms of total transport emissions a 10% take up is not very significant on its own; this underlines the importance of aiming for higher levels of take up and/or combining with other LES options.

- Voluntary freight emissions controls (Option C2)
  Voluntary (incentivised) HGV options (Scenario C1) produce around half the emission benefits of the voluntary bus options: 6.69 tonne of NO_x and 0.24 tonne of PM_{10} if only HGVs are included, rising to 7.65 tonne of NO_x and 0.37 tonne of PM_{10} if LGVs are included as well. In terms of total transport emissions this option provides around a 1% reduction, but this is based on just 10% of the potentially eligible vehicles being upgraded. The objective if picking this option would be to design an approach that raised this proportion greatly

The car and van scrappage options (Scenarios E1, E2, F1, F2) and van retrofit option (Scenario D) produce a significantly lower level of emission benefits. The best performing of the variations is the scrappage scheme for pre-Euro and Euro 1 vans plus cars (Scenario F2). This produces a reduction in first year emission of 2.77 tonnes of NO_x and 0.46 tonnes of $PM_{10.}$

The most feasible combination (of those examined) to target light duty vehicles would be to combine the van retrofit option (Scenario D) with a car-only scrappage scheme where a public transport pass is offered instead of a replacement vehicle (a variation of Scenario E1 or F1). This option would produce emission benefits of 0.68 tonnes of NO_x and 0.68 tonnes of PM_{10}. In the absence of a workable HGV+LGV TRO scheme, the van replacement scheme may provide an option for including the oldest vans in the strategy, should this be thought useful.

The light-duty vehicle voluntary/incentivised options have an estimated potential start date of 2008, so could provide benefits relatively quickly. However, none of them provide significant emission reductions in the total transport baseline on their own, and would need to be considered in combination (with a bus option) to enhance the cumulative effect of a strategy and spread the contribution across the vehicle parc.

A summary of the number of vehicles affected by each option, year 1 emission benefits and percentage emission reduction relative to the total baseline emissions is shown in the table below, together with the lifetime cost effectiveness of the option.

Summary of LES emission benefits and cost-effectiveness

LES option	No veh affected	Total Year 1 emission reduction (t/yr)		% emission reduction over total baseline CEAA Year 1		Lifetime cost – effectiveness £ per tonne	
		NO_x	PM_{10}	NO_x	PM_{10}	NO_x £/t	PM_{10} £/t
Mandatory bus (Euro 3 min)	233	87.5	4.5	5.0	5.3	1.9 – 3.3	74 - 120
Voluntary bus							
Euro 2 retrofit	22	9.1	0.5	0.5	0.6	2.7 – 6.0	26 - 37
Euro 3 retrofit	22	6.2	0.4	0.4	0.5	3.9 – 8.6	29 - 43
Combined Euro 2 & Euro 3	44	15.3	0.9	0.9	1.1	3.2 – 7.0	27 - 40

		Total Year 1 emission reduction (t/yr)		% emission reduction over total baseline CEAA Year 1		Lifetime cost – effectiveness £ per tonne	
Mandatory freight							
A Euro 3 min	5271	16.4	0.7	0.9	0.8	218 – 7,746	5,325 – 31,970
B Euro 4 min	9534	57.2	3.1	3.3	3.6	50 – 4,138	862 – 14,606
Voluntary freight							
C1 Euro 3 min no incentives	57	1.53	0.07	0.1	0.1	15 - 938	267 – 2,111
C2 Euro 3 min incentives	578	7.65	0.37	0.4	0.4	16 - 925	274 – 2,256
D Retrofitting LGVs	263	0.41	0.08	0.0 2	0.1	1,294 – 2,358	1,667 – 2,143
Scrappage							
E1 – PT pass	796	0.82	0.12	0.0 5	0.1	27 - 651	140 – 500
E2 - replacement	796	0.7	0.1	0.0 4	0.1	245 – 5,587	2,500 – 18,855
F1 – PT pass	3191	2.77	0.46	0.2	0.5	20 - 643	108 – 5,087
F2 - replacement	3191	1.63	0.29	0.1	0.3	234 - 1828	1,240 – 39,724

ii Cost-effectiveness

Examining the costs of an option in isolation does not capture the necessary information for prioritising measures, as it does not assess the cost against the benefit of each option. Cost-effectiveness is one approach to do this.

The key advantage of expressing different options in terms of cost-effectiveness is that it allows a direct comparison of variations with different vehicles and emission abatement equipment or replacement. It also enables the integration of any scheme set-up costs to be monetised over the life of the option. The cost-effectiveness of each measure (i.e. the cost per tonne abated) can be used to prioritise the most efficient options.

For both NO_x and PM_{10} it is observed that the mandatory and voluntary bus options are the most cost-effective, particularly when the potential lifetime benefits are considered.

Several of the LGV scrappage and voluntary HGV scenarios come next in order of cost-effectiveness for both NO_x and PM_{10}, however they are significantly less cost-effective than the bus scenarios when assessed over the lifetime of the option.

Considering the mandatory freight options for regulating HGV and LGV emissions several conclusions can be made:

- The minimum Euro 4 scheme (Scenario B) is more cost-effective than the minimum Euro 3 scheme (Scenario A);
- It is considerably more cost-effective to have a HGV only scheme than one that also regulates LGV emissions;
- There are variations in how the schemes are implemented and these give variation in scheme cost-effectiveness. A manual scheme has lower

capital costs but does not perform as well as other methods over the scheme lifetime due to its high operating cost;

- All TRO schemes are worse in cost-effectiveness terms than the bus schemes.

iii Practicability

To properly assess the potential LES options, it is also essential to consider the practicability and acceptability of schemes, to try to capture other effects not included in the quantitative assessment. The key reasoning is to see whether any additional aspects change the relative attractiveness of different options. An assessment of the acceptability and practicality of the options is given the table below, together with the total lifetime cost of the option. Total lifetime costs are the total scheme and operator costs.

Rating of different scheme types against other criteria

LES option	**Practicability /feasibility**	**Acceptability** Industry/ commerce	**Total lifetime costs**[1]
HGV&LGV TRO Euro 3	Low	Low	High
HGV&LGV TRO Euro 4	Low	Very low	High
Bus (mandatory)	High-Low	Low-Very Low	Medium
Bus (voluntary)	High	Medium-High	Low
HGV (voluntary)	High	High	Low
Scrappage (car & LGV)	High	Medium	Low
Retrofit older diesel van	Medium-high	Medium	Low

[1] Low = £0-3M; Medium = £3-10M; High = >£10M

The key messages from this assessment build on some of the results from the cost-effectiveness analysis:

- The HGV TRO is probably not feasible at this present time, due to lack of legislation required for civil enforcement of the TRO. Were the feasibility to be higher, it still has lower acceptability than other options for reducing heavy duty vehicle emission (i.e. compared to bus and voluntary freight schemes). Within the HGV TRO option the practicability and acceptability are lowest for stricter (Euro 4) variation, as this will be more costly for operators to comply with.
- The mandatory bus scheme has potentially a high practicability, but low acceptability from the bus industry.
- The voluntary bus scheme performs even better in terms of practicability and acceptability, as it would be more acceptable to the bus industry, but a question remains about whether the estimate on how many bus operators would *actually* join in such a scheme is borne out by reality.
- The voluntary freight scheme is also practicable and would probably be highly acceptable to industry/commerce.
- The mandatory bus, voluntary bus and voluntary freight schemes are recommended as the most favourable LES options from those considered in practicality terms. However, in the absence of additional capital funding or revenue support to facilitate, for example, bus upgrading, the practicality and acceptability of these schemes may be considerably lower in practice than indicated in Table 0.3. That is to say, they may incur both industry resistance and additional social and economic disbenefits to the city, the detailed consideration of which is outwith the scope of this study.
- The retrofit and scrappage schemes lie somewhere between the other LES options, with a relatively high practicability (they have been implemented successfully elsewhere) and good acceptability from those groups affected (i.e. the public). This is largely because they are foreseen as working on a voluntarily/incentivised basis.

In addition, we have considered the relative merits of the NO_x and PM_{10} reductions. Overall, it is not thought that weighting NO_x over PM_{10} (or vice versa) will radically change the conclusions from the cost-effectiveness analysis.

Recommendations

A comparison of the results of the emissions benefit and cost-effectiveness assessments shows that the mandatory control on buses to achieve a Euro 3 minimum standard by 2009 is clearly the best all-round option in terms of air quality improvement. It offers significant year 1 and lifetime benefits and is among the best cost-effectiveness for both PM_{10} and NO_x when assessed in year 1 and particularly over the potential lifetime of the scheme. Practicability is high and acceptability among public and businesses is likely to be high. Acceptability among the bus industry is likely to be low however. The Traffic Commissioner is independent of local authorities and is not obliged to agree with these recommendations, therefore the attitude of the Traffic Commissioner will be absolutely key to the feasibility of implementing this option. Moreover, the practicality and feasibility of mandatory controls may be considerably lessened if additional capital funding and revenue support were not available from the Council or another source to finance such a scheme. In the absence of additional funding, resultant social and economic disbenefits to the travelling public and commercial interest cannot be ruled out. These issues are outwith the scope of this study and require further research.

Voluntary emissions controls for buses are the most cost effective option, and produce some reasonable benefits compared to next-best remaining options. A key recommendation is that serious consideration should be given to methods of raising the take up rate well beyond the 10% estimate. The variation of retrofitting both Euro 2 and Euro 3 vehicles delivers the greatest emissions benefits of the voluntary bus options, and is one of the most cost effective options overall. Practicability, at these conservative take-up estimates, could be reasonable, and certainly acceptability would be high. Costs may fall to the Council however (i.e. part-grant funding) to make a scheme successful.

The best TRO option for HGVs & LGVs produces about two-thirds the mandatory bus schemes emission benefits, but has much poorer cost-effectiveness values than many other options. The most cost-effective option is the Euro 4 HGV scheme. However, the feasibility of this option is currently low in the absence of enabling legislation in Scotland to carry out civil enforcement of moving traffic contraventions. Were a greater emission reduction needed, and other more cost-effective options planned for implementation already, then this option could be worth trying to progress because of its significant contribution to total transport emissions in the area of the city centre AQMA. Lobbying of the Scottish Executive to adopt the required legislation would be a first step in this process.

The voluntary HGV options are more cost effective than the mandatory variations. The voluntary options without incentives are most cost effective, however the schemes with incentives are preferable because they are expected to have a greater overall emissions benefit and are only slightly less cost effective.

The scrappage scheme for pre-Euro and Euro 1 LGVs also performs well in the cost effectiveness assessment, and is amongst the most effective light duty vehicle option for emission reduction. However, this would potentially achieve little in terms of total transport emission abatement. Looking solely at van based options, replacement with newer vehicles is a more effective option than retrofitting abatement technology to old vans, and more realistic than offering public transport passes (which should be reserved for car owners).

On the basis of the technical assessment, evaluation of cost-effectiveness and consideration of practicability we recommend that a low emission strategy for

Edinburgh could be formed from a number of complementary options, in the following order of preference:

5. **Mandatory or voluntary bus emission strategy, setting a minimum emission standard of Euro 3.**

This gives significant emissions benefits from targeting a small number of highly polluting vehicles. For the mandatory option there is likely to be a framework for implementation and enforcement, with the attachment of Traffic Regulation Conditions to local bus services, by the Scottish Traffic Commissioner. It is anticipated that the cost of this stage of a mandatory scheme to the council would be low. However, if additional capital and revenue incentives cannot be externally sourced this option may result in social and economic disbenefits to the city. If a mandatory bus scheme proves to not be acceptable or feasible, then a voluntary bus scheme to retrofit Euro 2 and Euro 3 vehicles would be a cost effective alternative, and efforts should be focussed on improving its effectiveness through higher levels of take up.

6. **Voluntary, incentivised, HGV retrofit scheme for older vehicles** aiming to encourage a Euro 3 minimum amongst the uptake.

This option scored well in the cost effectiveness assessment, however the total emissions benefits will depend greatly on the level of take-up of the scheme.

7. **Car scrappage (with public transport pass)** offered to all pre-Euro and Euro 1 car owners.

8. **Van replacement (pre-Euro and Euro 1) with newer vehicles,**

Removing the oldest diesel vans from the fleet is more cost-effective than retrofitting the same vehicles.

Appendix 2 Cleaner Vehicle Technologies

Box 4.2: Available Cleaner Vehicle Engines, Technologies and Fuels.

2 Retrofit technologies

Particulate traps reduce particulate matter by up to 95%. Some traps have a catalytic action which reduce up to 90% of carbon monoxide and 90% of hydrocarbon emissions.

Oxidation catalysts are fitted to all new diesel passenger cars, car based vans and light duty trucks. Emission reductions of up to 90% for carbon dioxide, 90% for hydrocarbons and 25% for particulates.

Re-powering (re-engine to higher specification emissions performance). Significant reductions in both NOx and particulates are normally realised when an old engine is replaced. Buses are a suitable vehicle to be re-powered.

Exhaust gas re-circulation (EGR) has been fitted to all light duty vehicles in Western Europe for some years, but will not be used on medium heavy duty applications until Euro 4 standards. EGR as a retrofit on existing heavy duty engines has been fitted to 200 buses in Stockholm and has been shown to reduce NO_x by around 50%.

Selective Catalytic Reduction (SCR) catalysts use ammonia / urea as the agent to reduce NO_x by around 70%. Typically these are used in conjunction with oxidation catalysts.

2.1.1 Cleaner Fuels

Liquefied Petroleum Gas (LPG) is used increasingly as a fuel in bi-fuel vehicles most commonly with petrol. If a diesel engine is removed from the donor vehicle (such as a taxi) and replaced by a new bi-fuel engine significantly improved emissions can be obtained. LPG in the UK is mainly comprised of propane and is also used for cooking and heating.

Natural Gas (NG) is available in two forms Liquefied Natural Gas (LNG) or Compressed Natural Gas (CNG). Natural gas is mainly comprised of methane. It can significantly reduce output of nitrogen oxides and particulates compared to diesel. NG vehicles are typically much quieter than diesel, and it is a suitable fuel for cars through to heavy goods vehicles.

Hydrogen can be used to power vehicles either in a conventional style engine as a cleaner fuel or in hydrogen fuel cell vehicles. Hydrogen vehicles emit water and carbon dioxide. Hydrogen as a fuel is currently in the development stage and vehicles are not commercially available.

2.1.2 Cleaner Conventional Fuels

Low sulphur fuels give lower emissions and allow more advanced engine and exhaust after-treatment technology. European legislation is progressively requiring the removal of sulphur from both diesel and petrol.

Fuel additives can improve emissions of petrol and diesel. Water-diesel emulsion reduces NOx, particulate as well as carbon dioxide emissions and can be used as a direct substitute for diesel.

2.1.3 Cleaner Vehicle Types

Dedicated vehicles have gas as their only fuel.

Bi-fuel vehicles can operate on either gas or petrol alone, and can switch from one to the other.

3 **Dual-fuel vehicles** operate by burning a mixture of both gas and conventional fuel together in the engine, e.g. diesel and natural gas.