THE FORESIGHT VEHICLE INITIATIVE RAPID HEALTH IMPACT ASSESSMENT

A report produced by IMPACT, the International Health Impact Assessment Consortium.

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CONTENTS

TABLES AND FIGURES

THE FORESIGHT VEHICLE INITIATIVE RAPID HEALTH IMPACT ASSESSMENT

Executive Summary

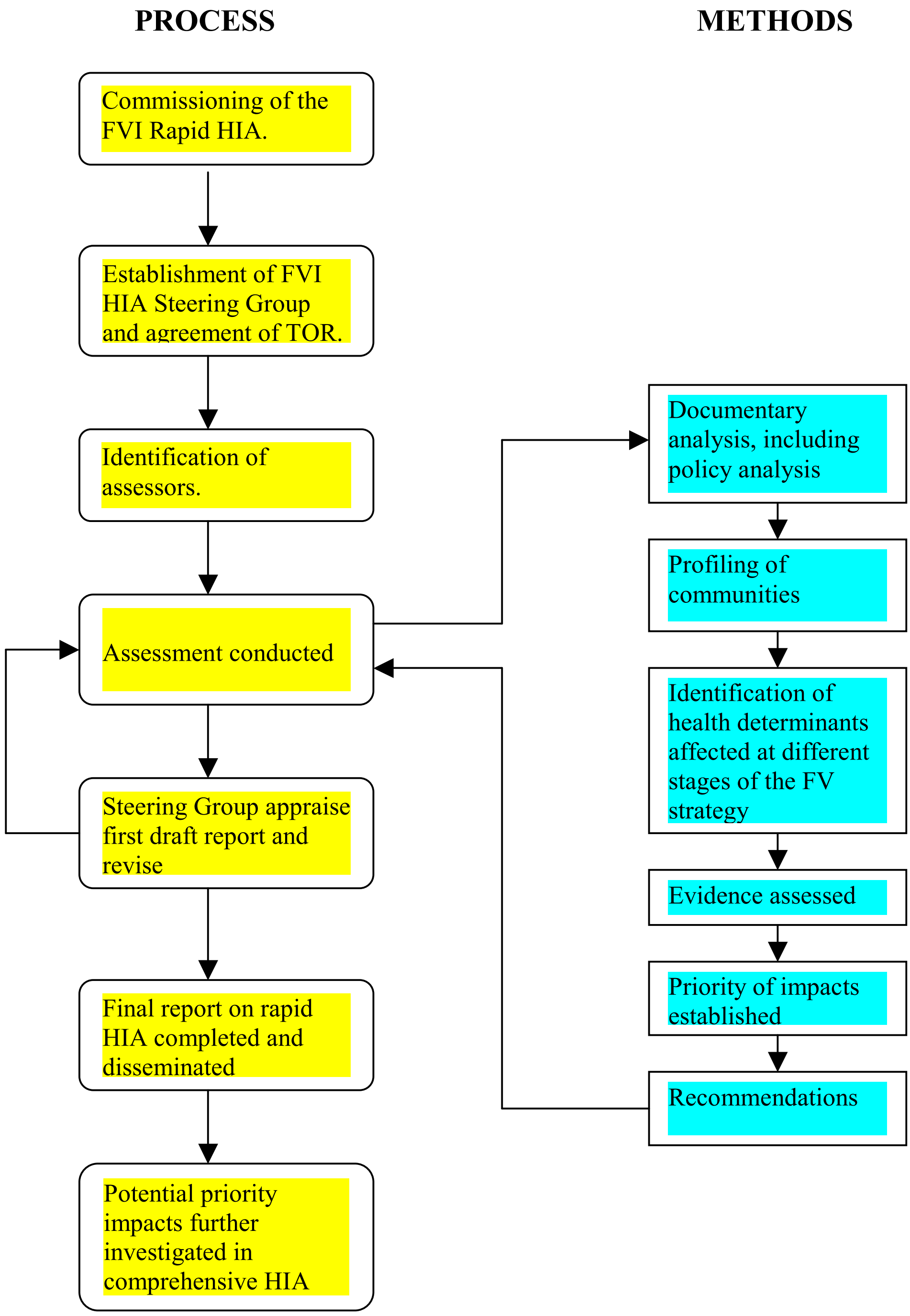
How was the HIA process initiated?
The following account summarises the rapid health impact assessment (HIA) of the Foresight Vehicle Initiative (FVI) undertaken by IMPACT, The International Health Impact Assessment Consortium, based in the University of Liverpool, as commissioned by the Department of Health, in association with the FV Strategy Group. This research was commissioned as part the Government's commitment to investigate the health impacts of departmental policies. The terms of reference (TOR) of the commission were to assess the health impacts of the FVI strategy to the year 2020 within the United Kingdom and,

> **'... to make recommendations to the Foresight Vehicle Steering Group for revising the strategy to maximise the potential health gain and minimise any harm.'**

The expected outcome of this process being the Department of Health's endorsement of the revised strategy.

What methods were used?
The purpose of a rapid HIA is to describe the health impacts of a policy, project or programme in broad terms, identifying, where appropriate, areas for further investigation in a comprehensive HIA. The main methods applied in the rapid HIA for the FVI involved a documentary analysis including a literature review of relevant research and profiling of the population within the defined geographical location (Figure 1). This reflected the 'Merseyside Guidelines for HIA' methodology. In this, health impacts that are assessed include potential or actual changes in health and well being in addition to changes in health determinants, such as health-related behaviour, the physical environment, and income.

Figure 1: Methods and Process Involved in the FVI HIA



What resources went into the HIA?

The first draft report of the rapid HIA was undertaken at the end of November 2000 and was completed in approximately 15 working days. Two assessors worked in a part-time capacity on the HIA: a research fellow with a background in public health and health promotion who undertook the documentary analysis and literature review, and a specialist registrar with experience in quantitative research methodologies who completed the profiling. Both of the assessors were involved in assessing the evidence, identifying priority impacts and making recommendations. The assessors' salary and overhead costs were the only financial costs for the rapid HIA.

What is the Foresight Vehicle initiative?
FVI is a Government sponsored programme, which has set out a strategy to develop and demonstrate new road vehicle technologies, for example alternatively fuelled vehicles. The primary mechanism for achieving this has been through the FVI LINK programme, a research fund of £80 million made up of contributions from the Department of Trade and Industry (DTI), Department of Environment, Transport and the Regions (DETR), Engineering and Physical Sciences Research Council (EPSRC), the Highways Agency and industry.

The health impacts of the FVI strategy were examined at four key stages of the strategy's process - strategic planning, new vehicle production and distribution, new vehicles 'on the road', decommissioning. The first stage was a concurrent assessment as the strategy has already been produced and is being updated, whereas the other stages involved prospective assessments. *The most significant health impacts occur in the production and operation of FVI technologies in new vehicles.*

What are the key findings and recommendations from the rapid HIA?
The findings and analysis, and the associated discussion and recommendations are summarised in the tables below:

Executive Summary: Table 1 - FVI Strategic Planning

FINDINGS & ANALYSIS	DISCUSSION & RECOMMENDATIONS
Population groups most affected by FVI strategy: • FVI research workers/communities • Wider communities adjacent to research • All groups likely to be affected by road transport in the future	• New, creative partnerships developed between industry and research • FVI steering group needs to involve a wider group of stakeholders, eg public transport sector • Insufficient data collated on LINK funded projects, eg proportion of funding directed to benefit public transport
Main health impacts - *Socio-economic environment factors* + employment opportunities + education/training opportunities - involvement in strategy development	Recommendations for FVI: • Extend membership of FVI steering group (defined in 5.2) • Revise FVI LINK application process to include *integrated environmental and health impact statements* of the research projects' implementation process and product outcomes • Monitor additional 'key project indicators' eg, resources allocated for research relevant to public transport technologies • Encourage wider breadth of applications for LINK funding (in areas outlined below)

Executive Summary: Table 2 - FVI New Vehicle Production

FINDINGS & ANALYSIS	DISCUSSION & RECOMMENDATIONS
Population groups most affected by new vehicle production: • Workers in road vehicle manufacturing and supply sectors, highways, sales and distribution, e.commerce • Communities adjacent to automotive-manufacturing plants	• Future employment issues need to be considered in more detail • Need to extend and strengthen evidence-base in the comprehensive HIA
Main potential health impacts - *Personal Factors* - increase in incidence of accidental injury, repetitive strain injury, and musculoskeletal disorders from increased automation -/+ change in incidence of contact dermatitis, respiratory disorders (including occupational asthma) with the introduction of new materials in manufacturing process -/+ changes in levels of stress, incidence of depression and anxiety from changing work practices, increased automation, fear of unemployment *Socio-economic environment Factors* - reduction in employment (automotive, freight) in manufacturing, supply sectors, resulting in increase in incidence of morbidity (physical, emotional) and premature mortality from a reduction in income and the psycho-social benefits of work + increase in production/employment in bus manufacturing sector - increase in high demand/low control occupations -/+ new working styles for design engineers, managers - effects on economies, social cohesion and support in, and crime levels of communities dependent on automotive manufacturing	Recommendations for the comprehensive HIA: • Involve transport economist in assessing likely trends in manufacturing and employment in the road vehicle sector, and the impact on local economies in particular • Involve occupational health specialist in assessing likely occupational health impacts on these workers • Involve environmental health impact specialist in assessing environmental impacts resulting from changes in manufacturing processes • Involve health economist in assessing likely impacts on health status and health and social care services, resulting from the above • Explore opportunities in UK & Europe for applying quantitative methods to enable estimation of probable risk • Apply qualitative methods to gain more detailed insight into the effects of these changes on the population groups most likely to be affected Recommendations for FVI: • Allocate resources from LINK for skills training of road vehicle workforce for the future, including sales & distribution staff, to ensure familiarity with new technological developments and work practices • Allocate resources from LINK to support organisational and technological developments, and enhance the sustainable competitiveness of indigenous UK suppliers to the road vehicle manufacturers • Plan education and training strategies to re-skill former road vehicle manufacturing operatives

Executive Summary: Table 3 - FVI New Vehicles 'On the Road'

FINDINGS & ANALYSIS	DISCUSSION & RECOMMENDATIONS
Population groups most likely to be affected by the use of new vehicle technologies: • Urban communities • Groups at risk from road traffic accidents (RTAs), poor air quality, social isolation, noise • Main potential health impacts - *Personal Factors* FVI will contribute to: +/- reductions in RTAs resulting from, eg, decreases in traffic congestion, new vehicle design and materials, exacerbates health inequalities between income groups? + increases in cycling, walking, from improved air quality, perceptions of increased safety – enhanced safety of cycle path use +/- changes in proportion of income spent on travel + enhancing mental well being, through social integration/support and other factors.	• Existing international/national trends through EC regulations, eg, Euro I, II, III & IV, other policies, eg, Transport 2010, will reduce adverse health & environmental effects, eg, air pollution from road transport emissions • Existing trends in developing new vehicle technologies, including £2 billion for research & development in EU • FVI likely to contribute to existing trends • Evidence on FVI technology outcomes and the specific contribution to existing trends, not available to rapid HIA; therefore resulting health impacts difficult to specify other than in terms of FVI's contribution to existing trends • Technological developments alone will not contribute to reducing adverse effects of road transport, or maintaining any improvements made • Potentially FVI could exacerbate health inequalities in the short term, by the unequal availability and use of these new technologies

Socio-economic environment Factors FVI will contribute to: + increase in accessibility to employment, goods + enhance social integration and support + reductions in transport-related costs to industry *Physical environment Factors* FVI will contribute to : + maintaining 2019/2020 air pollutant levels, stabilising premature mortality and morbidity levels, eg in asthma and other respiratory diseases. + reductions in CO_2, other greenhouse gases from use of alternative fuels + reductions in noise emissions + protection of land use from reduced congestion *Public Services & Public Policy* FVI will contribute to: + reductions in demand on health and social services from reductions in road transport- related morbidity and mortality + increase in reliability of vehicles resulting in reductions in capital, revenue costs for bus operators + decrease in capital, revenue costs for public service vehicles +/- reinforces some public policy priorities, but not all, eg reducing health inequalities.	Recommendations for comprehensive HIA: • Collate evidence on FVI technology product outcomes • Involve environmental health impact specialist in assessing environmental impacts resulting from use of FVI technologies, and health economist in assessing the likely impacts on health status and health and social services • Apply quantitative methods to enable estimation of probable risk • Apply qualitative methods to gain more detailed insight into effects of the changes identified on the population groups most likely to be affected • Assess the potential health impacts on all vulnerable groups, and the resulting effects on health inequalities Recommendations for FVI: • Analyse public policy priorities and integrate into FVI strategy and funding application process • Develop mechanisms to monitor potential environmental and health impacts from the use of new vehicle technologies on the population as whole and on vulnerable groups

FVI Decommissioning

Evidence on the health impacts of this stage of the FVI strategy process was very weak.

Recommendations for the comprehensive HIA:

- Obtain more substantive evidence on the potential impacts of the decommissioning of new vehicle technologies

Recommendations for FVI:

- Allocate resources from FVI LINK to investigate the decommissioning of FVI technologies

Conclusion

The FVI strategy is highly innovative. The technological outcomes of this strategy will undoubtedly have significant health benefits for the population as a whole. However it was felt that there were some areas where the potential health impacts of the strategy had not been considered, for example the occupational health implications of these developments. In addition, there is the opportunity to increase the potential health gain from the strategy, for example by developing a more inclusive strategy planning and implementation process and targeting research resources more appropriately. Finally, as a public funded body, the FVI infrastructure, the strategy and resource allocation needs to be more compatible with other public policy priorities, for example considering the potential health impacts on all vulnerable groups and the effects on inequalities.

THE FORESIGHT VEHICLE INITIATIVE RAPID HEALTH IMPACT ASSESSMENT

1 Introduction

This report describes the rapid, predominantly prospective, health impact assessment (HIA) undertaken on the Foresight Vehicle Initiative (FVI) strategy. The research was commissioned by the Department of Health, and was the first stage of the FVI HIA programme; the second stage will involve a detailed, comprehensive HIA of the FVI.

Prospective HIA is a process that considers potential changes in health determinants, and health, resulting from the introduction of a new policy, programme or project. It involves 'the estimation of the effects of a specified action on the health of a defined population' (Scott-Samuel, 1996). There are various models of HIA reflecting different health perspectives, and in turn, the methodology and methods used. The FVI HIA is applying a variation on the Merseyside HIA Guidelines, reflecting a socio-economic/environmental model of health. The process and methods that have been used in this rapid HIA are described in section 3.

An inter-sectoral steering group chairs the FVI HIA programme with membership from:

- The Department of Health
- The International Health Impact Assessment Consortium, Liverpool University
- The Foresight Vehicle Initiative
- The Department of Transport Science, Liverpool John Moores University
- Merseytravel
- The community, including people with disabilities

The terms of reference of the steering group (appendix 1) includes a description of the aims and objectives of the HIA programme, methodology, outputs and timetable. Within this it also defines the geographical boundaries for the HIA as the United Kingdom. The rapid HIA seeks to define the impacts the FVI programme will have on health effects in broad terms, examining the different stages of the FVI strategy, from now to 2020: strategy development, new vehicle production, new vehicle use and new vehicle decommissioning.

1.1 Road Transport and Health

The purpose of transport is to provide access to other people, goods and services, all of which are essential for a healthy life in our society. However, the manufacture, operation and support of road vehicles have many adverse effects on health that must be balanced against the health and social benefits. The health impact of the Foresight Vehicle Initiative will largely be determined by its influence on the future health effects of road transport, both positive and negative.

Table 1: Primary health impacts of road transport

Positive	Negative
Access to goods and services	Air pollution
Employment	Injury
Reduced isolation	Restricted activity and community severance
Social/mental well-being	Noise

The present transport system delivers unequal access to the positive health resources, and thus to their health benefits. More disadvantaged members of society have limited access to private transport, and are reliant on walking, cycling and a public transport system that is limited in its times of operation and can be expensive and unreliable. The negative health effects of transport activity are also largely unequally distributed, as they disproportionately affect those who benefit least from the transport system (Public Health Alliance, 1991).

2 Resume of the Foresight Vehicle Initiative

SUMMARY

- The Foresight Vehicle (FV) Steering Group was established in 1996 to 'help the UK automotive industry move to the forefront of world automotive design and manufacture'
- The FV Strategy aims to develop and demonstrate new vehicle technologies, and new design, manufacture and delivery practices, for 2020
- The FV Strategy shares the Foresight objectives of improving the quality of life and wealth creation in the UK
- £80m of funding from Government, research councils and industry has been invested in FV research projects between 1997 and 2000, in the following thematic areas:
  - Engines and powertrain
  - Hybrid, electric and alternatively fuelled vehicles
  - Telematics, advanced electronics, software and sensors
  - Advanced structures and materials
  - Design and engineering

2.1 Background

The FVI is a product of the Foresight exercise of the early 1990s. The aims of this exercise were to improve the nation's prosperity and quality of life by identifying new technologies and opportunities in future markets. Sixteen Foresight Panels were set up covering various disciplines including transport. They predicted the likely social, economic and market trends over the next 20 years.

The Foresight Transport Panel recommended focussed research activity in three areas (FVI strategy, 2000):

- Clear zones
- The Informed Traveller
- The FVI – 'to set a clear strategy to help the UK automotive industry move to the forefront of world automotive design and manufacture'

The FVI Steering Group established from this, was tasked ' ... to stimulate the automotive supplier base to develop and demonstrate product and systems which satisfy increasingly stringent environmental requirements while meeting mass expectations for safety, performance, cost and reliability'. The membership (appendix 2) of this consists of representatives from 24 agencies; their involvement was largely by self-selection, with members volunteering because of their personal or their agency's interest. The Steering Group recommended that the UK should undertake a programme to develop and demonstrate new road transport technologies that apply equally to cars, trucks, buses, and the supporting infra-structure, and which would meet the Foresight aims. It also recommended that this should be:

- supported by Government,
- reflect Government policies,
- link with research and development in academia and industry.

2.2 The Foresight Vehicle Initiative's strategy

The recommendations from the Foresight exercise were approved and the initial FVI strategy was developed.
The Steering Group's vision is to develop

> 'a globally competitive UK industry that meets the aspirations of the customer and society for mobility in the 21st century.'

The mission statement is

> 'to secure the vision by developing, demonstrating and promoting the adoption of the technology and the pursuit of the knowledge to design, manufacture and deliver to the market, vehicles for 2020.'

The FVI LINK programme, launched in November 1997, was then designed to further the development and demonstration of new technology. £80m of funding from the Department of Trade and Industry (DTI), Department of Environment, Transport and the Regions (DETR), Engineering and Physical Sciences Research Council (EPSRC), the Highways Agency, and industry could be bid for by industry and academia on a match-funding basis.

The FVI Steering Group has defined the choice of technologies that are being supported, using the following sets of criteria to select and rank them:
(i) Technologies requirements:

- 'they must provide the basis for profitable products that are relevant to the global automotive market but are particularly relevant to the UK in terms of geography'
- expertise and facilities to develop the technologies must exist in the UK
- exploitation by companies operating in the UK must be possible
- technologies must be able to deliver solutions that are believed to be consistent with likely public opinion and Government policy in the future.

(ii) expert analysis of likely developments in the field, the capability of the UK science base and the ability of UK manufacturers to exploit the developments
(ii) meeting the 'characteristics of road transport in the UK and the UK motor industry', that is the technologies must be able to address UK problems.

The selected technologies, which have been grouped into the following themes, include:

- Telematics
- Advanced structures and materials
- Hybrid, electric and alternatively fuelled vehicles
- Engine and powertrain
- Advanced electronics, software and sensors
- Design and engineering
- Retail and customer support

Each technology area is co-ordinated by a thematic group. Each thematic group is responsible for recommending the content of calls for proposals, which are then authorised by the Steering Group. Proposals for LINK funding are then submitted to the Programme Management Panel (PMP), which reviews and recommends funding of proposals. The FV administrator monitors the selected projects' progress with assistance from the thematic groups.

'Beacons' have been identified from the results of LINK projects. The 'beacons' show how a particular combination of technologies could be used in future road vehicles. The following 'beacons' have been set up:

- Vehicle functional efficiency
- Vehicle adaptability
- Social responsibility
- Efficient delivery
- Urban delivery
- Urban people transport
- Inter-modal efficiency
- Efficient haulage
- Efficient design & manufacture
- Efficient selling & customer support

There are four defined output areas or products of the FVI strategy:

- Research – LINK and associated programmes, eg Innovative Manufacturing Initiative (IMI), Foresight Vehicle Initiative, SMART (DTI support for small businesses)
- Networks – Steering Group, Thematic Groups
- Information – Website, database, events, Cleaner Vehicle Task Group, International Technology Overseas Mission scheme, Partnership for New Generation Vehicles (PNGV)
- Education – Young Foresight, Eco-Design Challenge.

3 Summary of Methodology and Methods

SUMMARY

- This was a rapid, prospective health impact assessment (HIA) using a methodology adapted from the 'Merseyside Guidelines for HIA'
- A FVI HIA Steering Group was established to oversee this HIA
- The methods used were qualitative and involved an analysis of evidence from documents and published literature, as well as developing profiles from routinely collected data
- The first draft of the report was completed in 15 working days

3.1 Background

The methodology adopted for this rapid HIA has been based on the 'Merseyside Guidelines for Health Impact Assessment' (Ardern, Birley, Scott-Samuel, 1998). This HIA methodology reflects an socio-economic model of health, which emphasises the interaction between different layers of health determinants, including individual factors (fixed eg genetic make-up and variable, eg lifestyle), social factors (eg family and community life), living and working conditions (eg unemployment, work environment, transport) and general socio-economic, cultural and environmental conditions, (eg fiscal policies, Governmental policies) (Whitehead & Dahlgren, 1991).

A rapid HIA has been defined as

> 'a systematic assessment of the health impact of a policy, programme or project by a number of experts, decision-makers and representatives of those potentially affected by the proposed policy. It is based on an exchange of the existing knowledge of the participants involved, including knowledge gained from previous similar exercises and research.' (Lehto & Ritsatakis, 1999).

Even within this definition, there are various permutations to the methods and process that could be applied, for example the involvement of stakeholder communities or vulnerable population sub-groups. The main methods used for this rapid HIA were documentary analysis and community profiling, with input from stakeholders and key informants through the FVI HIA Steering Group. In addition to this, the FVI HIA Steering Group played a key role in defining the terms of reference for the HIA, providing advice on methods, access to key informants and relevant research documentation, and critically reviewing the draft reports. Fifteen days were assigned to this rapid HIA, including producing the first draft report.

3.2 Boundaries and Timing

A key element of the HIA's terms of reference is the setting of boundaries. This includes temporal, spatial and contextual boundaries. The temporal and spatial boundaries have been defined as 2020 and the United Kingdom, respectively. The contextual boundary was defined as assessing the health impacts of the different stages of the FVI strategy:

1. FVI Strategy Development
2. FVI Implementation 1 (new vehicle production)
3. FVI Implementation 2 (new vehicles 'on the road')
4. FVI Decommissioning

The strategy development stage of the rapid HIA is described as concurrent or 'in-project', that is the HIA is being conducted on a strategy that already exists, but is being continually updated. However, the other stages of the HIA are prospective, that is the assessed health impacts are based on the effects of the strategy's implementation in the future. This has required projections to be made to 2020 of, for example the likely demography in the UK, and the context for road traffic, such as national road traffic forecasts, transport modes and splits, transport policies. The health impacts for the FVI can then be superimposed onto this projected scenario.

3.3 Sources of Evidence

The documentary analysis undertaken involved the following:

(i) An analysis of the FVI strategy documents (editions 1 & 2), FVI presentation material and documentation calling for proposals for the FV/IMI(Road Transport) LINK Programme.

(ii) A review of information from general computerised databases on the road vehicle manufacturing industry, current and future, with particular reference to the automotive sector.

(iii) A review of official documents and current national policies on transport, including road transport.

(iv) A review of the scientific evidence on the current impacts of road transport on health and health determinants, and the future impacts of new vehicle technologies. This involved a search of published literature from relevant computerised databases, for example, BIDS: IBSS, Medline, CAB Health, Ingenta; Web of Science.

(v) An analysis of publications on strategy development and implementation.

(vi) A review of publications on occupational health and the impacts of manufacturing and mass production on health in particular.

Additional information was also provided from semi-structured interviews with key informants represented on the FVI HIA Steering Group.

3.4 Profiling

The Foresight Vehicle Initiative is a long-term strategy that aims to deliver its vision by the year 2020. The profile that follows presents data from a number of existing projections, for the UK population in 2020 and the future of road transport. The projections are principally derived from models produced by The Government Actuary Department, the Department of the Environment, Transport and the Regions, and the Office for National Statistics. These represent the best available data sources on the future population and the future of road transport. There are, however, limitations to any strategic modelling and analysis, and even with sensitivity testing all model forecasts are subject to uncertainty. The forecasts derive from many inputs and depend upon predicting the activities of many different organisations, such as local authorities, public transport operators and the Highways Agency. The transport decisions of businesses, individuals and households reflect a wide range of social, demographic and economic factors, and it is not possible to model all the outcomes that are of interest. More confidence can be placed in the relative forecasts for different scenarios than in their absolute levels.

Many national and international strategies on transport and the environment have set targets for 2010, and several forecasts therefore look to this date. Later forecasts are subject to greater uncertainty, and so for certain parts of this rapid appraisal projections for 2010, rather than 2020, have been used.

4 Profile

SUMMARY

By 2020:

- The UK population is projected to rise to over 63 million, with 1.3 million more pensioners and 800,000 fewer children than in 1998.

By 2010:

- Road traffic is projected to increase by 17%, but if Government initiatives succeed there will be a 6% reduction in road congestion.
- The 285,000 km road network will support over 400 billion km of vehicle journeys each year.
- Despite a planned 40% reduction in the number road injuries, over 26,000 people will be killed or seriously injured on the roads, including 2,500 children.
- Road traffic CO_2 emissions are projected to rise by 2%, with a reduction of 58% in NO_2 emissions and 45% in PM10 emissions.

4.1 The UK Population of 2020

The UK population is projected to rise from the 1998 baseline of 59.2 million to 63.4 million in 2020, with an estimated annual growth rate of 0.27%, and a Total Fertility Rate[i] of 1.8. This is the principal projection based on the fertility, mortality and migration assumptions outlined in **appendix 3.** Given an alternative scenario of low fertility, low inward migration and low life expectancy between 1998 and 2020, the UK population could be as low as 60.3 million. Conversely, given high fertility, high inward migration and high life expectancy, the population could be as high as 66.9 million.

Table 4.1: Population of United Kingdom in 2020

	Total	**Males**	**Females**
Total population	63 470 000 (100%)	31 628 000 (100%)	31 842 000 (1000%)
Children (0-15)	11 290 000 (17.8%)	5 786 000 (18.3%)	5 504 000 (17.3%)
Working age (16-64)	40 142 000 (63.2%)	20 366 000 (64.4%)	19 776 000 (61.9%)
Pension age (65+)*	12 038 000 (19.0%)	5 477 000 (17.3%)	6 562 000 (20.6%)
EOL† at birth		78.5	82.7
EOL at age 50		30.7	34.0
EOL at age 65		17.9	20.8
EOL at age 80		8.2	9.8

Source: Government Actuary's Department

* The pension age of 65 will apply to both men and women in 2020.

†Expectation of life (years)

[i] Average number of children that would be born alive to a group of women during their lifetimes if they passed through their childbearing years conforming to the age-specific fertility rates of a given year.

The mean age of the population is projected to rise from 38.6 to 41.7 between 1998 and 2020. A greater proportion of the population will be of pension age in 2020: 19% as compared with 18.1% in 1998, with 1.3 million more pensioners. Conversely, despite an overall rise in the size of the population, there will be 800,000 fewer children.

The life expectancy at birth in 2020 is projected to be 3.6 years higher for males and 3.0 years higher for females, compared with 1998 baselines. This assumes that historical trends for reduction in mortality rates will continue. The discrepancy in life expectancy between males and females will therefore persist, although the gap will narrow slightly.

Table 4.2: Population of the UK in 2020 by sex and age group (1,000s)

Age	Males	Females	Total	Age	Males	Females	Total
0-4	1 827	1 741	3 568	**55-59**	2 349	2 294	4 643
5-9	1 807	1 719	3 525	**60-64**	1 917	1 951	3 868
10-14	1 791	1 701	3 492	**65-69**	1 623	1 700	3 323
15-19	1 836	1 755	3 591	**70-74**	1 560	1 715	3 275
20-24	1 929	1 867	3 796	**75-79**	1 049	1 244	2 293
25-29	2 108	2 044	4 152	**80-84**	692	920	1 612
30-34	2 130	2 077	4 207	**85-89**	369	574	944
35-39	2 041	1 979	4 019	**90-94**	144	285	429
40-44	1 925	1 838	3 763	**95-99**	35	102	136
45-49	2 124	2 030	4 154	**100 +**	4	22	26
50-54	2 368	2 285	4 653	**All ages**	**31 628**	**31 842**	**63 470**

Source: Government Actuary's Department (2000)

Within the population there will be those financially dependent on the working population for support: children, pensioners and those of working age not in paid employment. Whilst it is not possible to predict the numbers in work, it is possible to relate the projected number of children and people of pension age in 2020 to the "working population", i.e. those aged 15-64. From the principal projection there will be 581 dependants per 1,000 working age population.

Table 4.3: Dependency ratios

Dependent	No. per 1,000 working population in 1998	No. per 1,000 working population in 2020
Children	333	281
Pension age	295	300
Total	628	581

Source: Government Actuary's Department (2000)

Despite the generally ageing population and the greater number of people of pension age, there will actually be fewer overall dependants in 2020, due to the increase in the working population and the decrease in the number of children.

Road transport

National transport policy

Government policy, as outlined in the **New Deal for Transport** White Paper and **Transport 2010, the 10 Year Plan**, is to make travel safer, more attractive and universally accessible, whilst tackling the problems of congestion and pollution. Up to £180 billion is due to be invested between 2000 and 2010, an increase of 75% compared with 1990 to 2000. An integrated approach, with improved planning, easier connections, and better traffic management, is planned in an attempt to ensure all forms of transport work better together. The Government also intends to exploit the latest technological advances, through schemes such as the Foresight Vehicle Initiative.

Box 4.1: Aims of the New Deal for Transport White Paper

- faster, safer, more reliable, modern transport system;
- contribution to a cleaner environment;
- fairer society, through better access to jobs and services;
- an improvement in the quality of life for all.

There are a number of planned initiatives for achieving these aims, including: new public transport schemes; light rail or tram lines in major cities; comfortable, reliable bus services, including guided bus schemes; new park and ride services; increased funding for councils' Local Transport Plans; giving local authorities the power to introduce congestion charging; and a new Urban Bus Challenge Fund to offer new bus links to under-served urban areas. In rural areas the Government intends to encourage innovative schemes to expand rural public transport and to invest in safer roads with less impact on the environment. Their objectives include: new bypasses; at least an hourly bus service within a ten minute walk for a third more rural households; and support for a wide range of flexible, community transport projects such as minibus and taxi-based schemes.

It is envisaged that hundreds of new projects countrywide, with many decisions being taken locally, will address current and future transport problems. Although there is an overarching central vision, as embodied in the White Paper, the devolution of many decisions to local bodies makes prediction of the future of road transport problematic. For example, building in accessibility for disabled people is a condition of public money being spent, but local interpretations of accessibility will differ, as will the success of local initiatives to meet this condition.

Although the Foresight Vehicle Initiative concentrates on road transport, it is important to acknowledge its place an integrated transport system. There will be a particular focus on improving rail transport over the next 10 years, and the success or otherwise of the Government's rail strategy will have a profound influence on road congestion.

Infrastructure

The current UK road network covers 285,000 km, supporting 345 billion km of car and lorry journeys, and 4 billion km of bus and coach journeys each year. The

Government proposes to expand the network, particularly with respect to building new bypasses, but it is not clear how much larger the resultant network will be in 2010 (or 2020). In addition to lengthening the road network, there are other proposed changes to infrastructure over the next 10 years:

- widening 360 miles of trunk roads (~5% of the network);
- 80 schemes to improve safety and traffic flow at junctions;
- removing the maintenance backlog on local roads;
- new technology for better traffic management and real-time information.

Table 4.4: English road network, 1999

	Local roads	**Motorways & trunk roads**
Total length of network (km)	274,500	10,500
Traffic: cars (billion vehicle km)	216	105
Traffic: lorries (billion vehicle km)	8	16
Safety: total killed and seriously injured	32,956	5,189
Safety: children killed and seriously injured	4,854	306

Source: Transport 2010

Table 4.5: Buses and coaches

Number of vehicles in fleet	67,600
Local bus patronage (million passenger journeys)	3,720
Local bus services (million km run per day)	5.94
Non-local bus services including coaches (million km run per day)*	4.54

Source: Transport 2010

Table 4.6: UK rail network, 1999

Total route length of network (km)	16,600
Total passenger rolling stock (units)	10,400
Number of passenger trains run daily	18,600
Patronage: passengers (billion passenger km)	38.3
Freight moved (billion tonne km)	18.4
Reliability (% of trains run against timetable)	98.8
Punctuality (% of trains arriving on time)	91.9
Satisfaction (% of passengers fairly or very satisfied)	76

Source: Transport 2010

Although not the focus of the Foresight Vehicle Initiative, the rail network and its future development will have a profound influence on road transport. In addition to the conventional rail network, five UK cities have light rail networks, with 194 km of track supporting 90 million passenger journeys. The car is, however, by far the most common mode of transport, being used in over 60% of journeys. The road system is also essential for the movement of freight, carrying nearly two thirds of the country's freight traffic.

Table 4.7: Modal share (% of journeys), England 1999

Mode of transport	% of journeys
Walk	27
Cycle	2
Car	61
Local bus	6
Rail including London Underground	2
Other (includes taxi, motorcycle, coach and air)	2

Source: Transport 2010

Table 4.8: Modal share for freight (% of total tonne km), UK 1999

Mode of transport	% of freight
Road	65
Rail	7
Water	23
Pipeline	5

Source: Transport 2010

People in the UK are travelling more now than at any time in the past, and they are increasingly reliant on the car as their primary mode of transport. The proportion of journeys undertaken by car and the distance travelled has been rising over the past 20 years, with a simultaneous reduction in the distance travelled by foot and bicycle (**table 4.9**). Since 1975/76 the average annual distance travelled by car has increased by 65%, from 3,199 to 5,292 miles. This represents 82% of average annual mileage, and is over 18 times the distance travelled by rail, usage of which has hardly changed. Over the same period the average distance travelled by foot and bicycle has dropped by a quarter, to 193 miles and 38 miles respectively.

Table 4.9: Average distance travelled per person per year by mode of travel: 1975/76, 1985/86 and 1996/98 (miles)

	1975/76	1985/86	1996/98	% change 1975/6 to 1996/8	% change 1985/6 to 1996/8
Walking	255	244	193	-24	-21
Bicycle	51	44	38	-25	-13
Private hire bus	150	131	103	-31	-21
Car	3 199	3 796	5 292	65	39
Motorcycle	47	51	30	-37	-42
Van/lorry	183	228	244	33	7
Other private	16	33	35	119	7
Buses in London	57	39	52	-10	31
Other local bus	372	258	197	-47	-24
Non-local bus	54	109	95	76	-13
LT underground	36	44	51	45	17
Rail	289	292	290	-	-
Taxi/minicab	13	27	50	279	85
Other public (inc. air)	18	22	57	212	159
All modes	4 740	5 317	6 728	42	27
Percentage by car	**71**	**76**	**82**		

Source: National Travel Survey

Table 4.10: Journey distance per person per year by main mode* and purpose: 1996/98 (miles)

	Walk	Bicycle	Car/van driver	Car/van passenger	Motor-cycle	Other private	Buses in London	Other local bus	Non-local bus	LT under-ground	Rail	Taxi/ minicab	Other public	All modes
Commuting	14	14	919	144	13	20	12	46	2	24	121	5	7	1 343
Business	3	1	522	61	-	14	1	1	1	3	36	3	35	681
Education	18	1	27	51	1	25	8	39	3	3	11	3	1	190
Escort education	10	-	60	21	-	-	1	1	-	-	-	1	-	95
Shopping	38	3	398	312	2	4	13	58	2	3	21	4	2	860
Other escort	5	-	241	132	-	2	1	4	1	1	3	1	-	391
Other personal business	15	2	244	134	1	5	4	15	2	4	19	4	5	453
Visiting friends at home	17	4	543	506	3	2	6	21	11	4	37	6	2	1 164
Visiting friends elsewhere	8	-	86	98	2	8	1	5	9	2	6	10	-	236
Social/ Entertain-ment	7	4	197	183	2	19	2	8	7	3	15	4	3	454
Holidays/ day trips	2	8	242	390	6	39	1	4	60	2	50	5	8	817
Other, including just walk	32	-	9	3	-	1	-	-	-	-	1	-	-	47
All purposes	168	38	3 489	2 035	30	140	51	202	98	49	321	46	63	6 725

Source: National Travel Survey

*Main mode is that used for the longest part of the journey.

In addition to the increased use of private cars, there has been an almost four-fold increase in the use of taxis and minicabs between 1975/76 and 1996/98, from 13 to 50 miles per person per year. In contrast, use of local buses has almost halved over the same period. This trend towards increased car use accounts for the increased congestion on the UK's roads.

4.2 Impact of transport

Traffic congestion

It is generally accepted that reducing traffic congestion is likely to benefit people, businesses and the environment, as well as reducing the response time for emergency services. There is, however, no widely accepted definition of congestion. The definition used by the DETR is based on the difference between the travel times road users would achieve in free-flowing traffic conditions and the travel times they are forecast to encounter at the levels of traffic, road capacity and speeds forecast in DETR models. This measure is expressed in terms of the average time lost per kilometre driven.

Total road traffic in Great Britain has grown by over 70% over the last twenty years, largely reflecting rising incomes and increased car ownership. Goods vehicle traffic has also grown strongly with the economy. The growth in traffic has led to increasing congestion on the road network, particularly in urban areas, and traffic congestion is projected to increase by a further 15% over the next 10 years. The Government plans to *reduce* congestion across England by 5% by 2010, with bigger reductions in major cities. Based on studies in cities such as Edinburgh, Bristol and London, the DETR predicts a reduction in public and private transport peak journey times of as much as 20-25% in centres of the largest urban areas by 2010.

Over the past 30 years road traffic growth has risen directly in line with GDP growth. In more recent years this relationship has eased, averaging less than 1:1 since the 1989 peak of the economic cycle. This reflects: higher levels of car ownership – and hence reduced scope for further growth – amongst those household groups who previously had low levels of ownership (for example the elderly and young adults); rising congestion; and, arguably, the application of policy measures that increase the attractiveness of public transport, walking and cycling.

The forecast of the impact of policies on traffic growth and congestion in England in different areas and on different road types (and on road traffic emissions) is based on the National Road Traffic Forecast (NRTF) framework. This involves:

- forecasting the underlying growth in car traffic from changes in car ownership and car use by household type;
- forecasting the underlying growth in goods vehicle and van traffic by commodity sector from projections of trends in load factors, empty running, length of haul, and vehicle type split;
- changes to these underlying forecasts to take into account responses to increased journey times due to congestion and changes in money costs (for example fuel costs and congestion charges);

- changes to the forecasts to reflect the impact of other policy measures, including:
  - o improvements to the attractiveness of public transport and rail freight (using, for example, the outputs of the LTS, passenger rail and rail freight models);
  - o land use planning policies; and
  - o sustainable distribution policies, influencing, for example, goods vehicle load factors and empty running.

Table 4.11: Estimated congestion in 2000 by area/road type compared with all-England average

	Index of time lost per km (All road average = 100)	Traffic forecast 2010 (% change on 2000)	Congestion forecast 2010 (% change on 2000)
All Roads			
All areas	100	22	15
London	367	14	13
Conurbations and Large Urban	212	16	15
Other Urban	98	21	15
Other	35	24	36
Inter-urban Trunk Roads	57	29	28

Source: Transport 2010, Background Analysis

The underlying assumptions for these baseline forecasts are:

- no change in car ownership costs, non-fuel running costs or fuel duty in real terms;
  - improvements in new car fuel efficiency sufficient to deliver the EC voluntary agreements with car manufacturers, resulting in an average reduction in motoring costs per car kilometre across the car fleet of 20% in real terms between 2000 and 2010;
- no significant change in the quality of public transport;
- completion of the 37 trunk road schemes in the Targeted Programme of Improvements as set out in the Government's roads review document.

The key points in the baseline forecasts are:

- traffic growth is lower in urban areas, in part because congestion is already very high;
- traffic and congestion rise most rapidly outside urban areas, with congestion rising by 28% on the inter-urban trunk road network;
- overall traffic growth (22%) is lower than forecast GDP growth (26%), which implies a ratio of around 0.8:1.

Illustrative scenarios

The DETR has devised several illustrative scenarios to explore the potential impact of different assumptions about future policy choices and road charges:

1. Constant motoring costs and additional investment scenario: assumption that motoring costs per kilometre remain constant in real terms, rather than falling by 20%, and that there is additional transport investment;
2. Wider take-up of local charging powers: assumption that by 2010 local charging is introduced in the centre of around 80 cities outside London the size of Winchester and above – congestion charging in central London and 8 other large urban areas, workplace parking levies elsewhere. All net revenues are recycled into transport improvements in the urban areas concerned;
3. Limited inter-urban charging scenario: assumption that by 2010 there are charges on the trunk road network, only at the times and places where congestion is highest. The illustrative charges assumed vary with the level of congestion, with a maximum of 10 pence per kilometre on those parts of the network where there is daily queuing;
4. All three illustrative scenarios combined.

Table 4.12: 2010 traffic in England: baseline, Plan and illustrative scenarios (% change on 2000)

	Baseline	**Plan**	**Plan + constant motoring costs**	**Plan + wider local charging**	**Plan + inter-urban charging**	**Plan + all 3 scenarios**
All Roads						
All areas	22%	17%	13%	17%	17%	12%
London	14%	5%	-3%	5%	5%	-3%
Conurbations and Large Urban	16%	10%	6%	10%	8%	5%
Other Urban	21%	17%	14%	17%	17%	13%
Other	24%	21%	17%	21%	21%	16%
Inter-urban Trunk Roads	29%	26%	21%	26%	23%	18%

Source: Transport 2010, Background Analysis

Table 4.13: 2010 congestion in England: baseline, Plan and illustrative scenarios (% change on 2000)

	Base-line	**Plan**	**Plan + constant motoring costs**	**Plan + wider local charging**	**Plan + inter-urban charging**	**Plan + all 3 scen-arios**
All Roads						
All areas	15%	-6%	-12%	-7%	-9%	-15%
London	13%	-15%	-26%	-15%	-15%	-26%
Conurbations and Large Urban	15%	-8%	-11%	-8%	-12%	-15%
Other Urban	15%	7%	4%	7%	7%	2%
Other	36%	16%	9%	16%	11%	5%
Inter-urban Trunk Roads	28%	-5%	-11%	-5%	-20%	-25%

Source: Transport 2010, Background Analysis

The Government's 10 Year Plan results in a 5% reduction in overall traffic growth compared with the baseline forecast, with the reduction being most pronounced in areas where congestion is worst. The ratio of traffic growth to GDP growth over the Plan period is around 0.6:1 (compared to around 0.8:1 under baseline assumptions).

Despite this increase in traffic, the 10 Year Plan aims to achieve an absolute reduction in overall congestion compared to today, taking it to 6% below 2000 levels. If successful, the reduction in congestion will be most significant in urban areas with reductions against the baseline of 28% in London and 23% in conurbations and large urban areas. Congestion is forecast to be still above 2000 levels only in smaller urban areas and on non-trunk roads outside urban areas, which currently have below average congestion.

Those large urban areas that introduce local charges are forecast to benefit from reductions significantly greater than these averages, as a result of both the direct impact of the charges themselves and the additional spend on local transport improvements funded through charge revenues. The reductions within the charged central areas, where congestion is currently worst, will be even greater; with congestion on the inter-urban trunk road network reduced by 33%, taking it to 5% below 2000 levels.

Under the constant motoring costs scenario the all-areas congestion measure is reduced by an extra 6 points compared with the Plan forecast, taking it to 12% below 2000 levels. Congestion on the inter-urban trunk road network would also be reduced by an additional 6%, taking it to 11% below 2000 levels.

The principal impact of wider local charging would, as expected, be in urban areas. Congestion in medium and small-sized urban areas would be reduced by less than a percentage point overall compared with the Plan forecast. The impact in the medium sized areas introducing charges would be greater, however, with absolute reductions on 2000 levels being achieved.

The limited inter-urban charging scenario reduces congestion on the inter-urban trunk road network by an additional 15% compared with the Plan forecast, 9% more than the constant motoring costs scenario. Diversion would be limited because charges are targeted at congested sections of the network; this ensures that the congestion reductions on trunk roads are not offset by increases elsewhere; and under the combined scenario the outcomes on all road/area categories would be improved compared to the constant motoring costs scenario, with the reduction on 2000 congestion levels on the inter-urban trunk road network rising to 25%, a 20% improvement over the Plan. The all-areas congestion index would be reduced by 9%, taking this index to 15% below 2000 levels.

Safety

Each year there are nearly 240,000 accidents on roads in the UK, resulting in over 300,000 casualties, with around 3,500 people killed and 40,000 seriously injured. A further 3,500,000 incidents occur each year without resulting in injury. The direct economic cost of road accidents involving deaths or injuries is estimated to be ~£3 billion a year (DETR, 2000). Despite this, road safety in the UK is relatively good compared with other countries and with its own past record. In 1930, when there were only 2.3 million motor vehicles on the roads, over 7,000 people were killed in road accidents. The 27 million vehicles currently on the roads result in far fewer road deaths, and in the face of increasing traffic there has been a 39% reduction in road deaths and a 45% reduction in serious injury since 1987. At the same time there has been an increase of over 60% in the number of slight injuries among car users, suggesting that improvements in car design are responsible for much of the improvement.

The UK also has a *relatively* good overall record on child road safety compared with other European countries, but has a high rate of child pedestrian death and injury. There are also significant inequalities with respect to child road casualties:

- boys are more frequently injured than girls;
- children in the lowest socio-economic group are five times more likely to be killed as pedestrians than their higher socio-economic group counterparts. This pattern is repeated for all types of accident;
- there is a higher casualty rate among children from ethnic minority backgrounds;
- children are more likely to have accidents if they travel on main roads; if they go out without adults before they have good road sense; and if they are prone to taking risks.

In **Tomorrow's Roads: Safer for Everyone**, the Government has proposed road safety targets for 2010, based against averages for 1994-98:

- a 40% reduction in the number of people killed or seriously injured in road accidents;
- a 50% reduction in the number of children killed or seriously injured;
- a 10% reduction in the slight casualty rate, expressed as the number of people slightly injured per 100 million vehicle kilometres.

The stated means of achieving these targets are through improving driving skills; creating a safer infrastructure; better law enforcement; and promoting safer road use. Even if these targets are achieved, however, there will still be over 26,000 people killed or seriously injured on the roads in 2010, including 2,500 children.

A major contribution to road safety has been, and will continue to be, the evolution of safer vehicles. The Government road safety strategy acknowledges the important role of innovative technology in producing vehicles that are easier to control in normal driving, reliable and predictable in emergency situations, and protect against injury in a crash. The Foresight Vehicle Initiative identifies numerous technology areas that could have a significant impact on road safety, both for passengers and pedestrians. As the primary goal of the Foresight Vehicle Initiative is to produce technologies that confer a competitive advantage, it is likely that safety improvements will only be incorporated into vehicle designs if consumers demand them. The Government has a role in communicating the need for improved vehicle safety to the public and pressing for the incorporation of safety improvements in international motor industry regulations.

Environment

Physical
It can be difficult to predict the impact of changes in transport infrastructure and provision on an area, as the link between transport provision and local regeneration is ambiguous (SACTRA, 1997). While in certain circumstances transport schemes may bring added economic benefits to an area needing regeneration, in others the opposite might occur. Better communications will enlarge markets for goods, services and workers: the area as a whole may gain or lose from this depending on the structure and competitiveness of the local economy.

Emissions
Road vehicles, and the industries involved in their manufacture, emit a cocktail of potentially hazardous chemicals into the atmosphere with several adverse health effects. Airborne particles, hydrocarbons, nitrogen oxides, sulphur dioxide and carbon monoxide are not only hazardous in themselves, but the resultant smog also reacts with sunlight to produce ozone, a potent respiratory irritant. In an attempt to reduce the impact of pollution, air quality objectives for 2004-06 have been set by the DETR:

Wider European initiatives on vehicle and fuel standards also have the aim of reducing busy central urban area road traffic nitrogen oxide emissions to 67% and particulate emissions to 70% of 1996 levels by 2010. The UK Government intends action at the local level to tackle congestion by bringing together user charges and complementary public transport packages, as well as promoting cleaner buses and lorries. Reductions in particulate emissions of up to a half may be possible.

Reducing urban road traffic emissions should make towns and cities healthier places to live and work, bringing particular benefits to those suffering from respiratory disorders, including the increasing number of children with asthma. Better air quality will also benefit drivers and passengers who are currently exposed to high levels of pollution in busy city centres. As the DETR’s strategy to reduce congestion and pollution is particularly targeted at inner city areas, if successful it should address some of the health inequalities that currently exist, whereby urban dwellers are disproportionately affected by traffic emissions.

Table 4.14: Effects of pollutants and air quality objectives

	Airborne particulates	Sulphur dioxide	Nitrogen oxides	Carbon monoxide	Ozone	Benzene
Source	Diesel exhaust, coal burning	Fossil fuels, power stations (73%), diesel exhaust	Motor vehicles (45%), power stations (35%)	Incomplete combustion fossil fuel, tobacco smoke	Photochemical reaction between nitrogen oxides and hydrocarbons	Engine emissions
Health effects	Carry acidic gases and volatile hydrocarbons into lungs. May be carcinogenic	Bronchitis, bronchospasm (especially in asthmatics)	Respiratory irritation	Reduces oxygen carrying capacity of blood. Causes headaches, impairs concentration, exacerbates angina, precipitates arrhythmias, retards foetal growth	Coughing; impaired lung function; eye, nose, and throat irritation; headaches. Aggravates asthma and bronchitis	Causes leukaemia
Environmental effects	Soiling of buildings, reduced visibility, odour	Main constituent of acid rain. Damages plants and aquatic life	One third of acidity of rainfall	Oxidises to carbon dioxide, contributing to greenhouse effect	Greenhouse gas. Damages crops, trees, plastics, rubber and paints	
Air quality objectives:			NO_2:			
1h mean		350 µg/m^3	200 µg/m^3			
8h mean				11.6 mg/m^3		
24h mean	PM_{10}[ii]: 50 µg/m^3	125 µg/m^3				
1 year mean	PM_{10}: 40 µg/m^3		NO_2: 40 µg/m^3			16.25 µg/m^3

Source: *Air Quality Briefing Sheet.* Friends of the Earth, 1991.
Air quality objectives: The Air Quality (England) Regulations 2000

DETR forecasts have been used estimate the impact of the Government's 10 Year Plan on concentrations of local air pollutants, taking into account emissions from non-transport sources in the UK and elsewhere. The national scale empirical model used is a development of that described in the Air Quality Strategy and supporting technical documents. It is estimated that the Government's strategy will result in improvements in air quality by 2010, with an average 30 days of moderate or higher air pollution in urban areas per year, and in carbon dioxide emissions from surface transport, with 37 million tonnes of carbon emitted per year.

Table 4.15: Forecast road and rail CO_2 emissions in England (2000 and 2010 baseline) in MtC[iii].

	2000	2010	10 Year Plan	Plan + constant motoring costs	Plan + wider local charging	Plan + inter-urban charging	Plan + all three scenarios
Road traffic CO_2 emissions	30.3	31.0	29.1	28.1	29.1	29.0	27.9
Rail traffic CO_2 emissions	0.7	0.7	1.0	1.2	1.0	1.0	1.2
Total	31.0	31.7	30.1	29.3	30.1	30.0	29.0
% change on 2000	-	+2.2	-2.9	-5.5	-2.9	-3.2	-6.5

[ii] PM_{10}: Airborne particles of <10µm diameter.
[iii] Mega-tonnes of carbon

The baseline forecast reflects an estimated 4 MtC saving in 2010 UK emissions due to the EC voluntary agreements with car manufacturers. Overall road traffic CO_2 emissions would rise by only 2% (0.7 MtC) despite a 22% increase in traffic. Increased train loadings and the introduction of more fuel-efficient trains are also projected to offset the growth in rail use.

- The 10 Year Plan reduces emissions by a further 1.6 MtC. This comprises a 1.9 MtC saving in road traffic emissions, partially offset by a 0.3 MtC increase in rail emissions arising from the forecast impact on rail use.
- The narrow scope of both the inter-urban and wider local charging illustrative scenarios means that their incremental impact would be low. An extra 0.03 MtC would be saved under the wider local charging scenario and 0.14 MtC under the inter-urban charging scenario. Under the constant motoring costs scenario, road traffic CO_2 savings would increase by 1 MtC, but there would be a 0.2 MtC increase in rail emissions resulting from the extra rail passenger and freight demand levered in by the higher costs of motoring and additional transport investment.
- With all three illustrative scenarios together, the total reduction on baseline emissions would be 2.7 MtC, an additional 1.1 MtC compared with the 10Year Plan.

Table 4.16: Forecast road and rail NO_2 emissions in England (2000 and 2010 baseline) in KtN [iv]

	2000	2010	10 Year Plan	Plan + constant motoring costs	Plan + wider local charging	Plan + inter-urban charging	Plan + all three scenarios
Road traffic NO_2 emissions	487	198	188	182	188	187	180
Rail traffic NO_2 emissions	14.4	15.4	20.5	23.6	20.5	20.5	23.6
Total	501	213	208	206	208	207	204
% change on 2000	-	-57.5	-58.5	-58.8	-58.5	-58.7	-59.4

Table 4.17: Forecast road and rail PM_{10} emissions in England (2000 and 2010 baseline) in KtPM$_{10}$

	2000	2010	10 Year Plan	Plan + constant motoring costs	Plan + wider local charging	Plan + inter-urban charging	Plan + all three scenarios
Road PM_{10} emissions	19.7	10.5	10.1	9.8	10.1	10.0	9.7
Rail PM_{10} emissions	0.63	0.62	0.87	1.01	0.87	0.87	1.01
Total	20.3	11.1	11.0	10.8	11.0	10.9	10.7
% change on 2000	-	-45.3	-45.8	-46.8	-45.8	-46.3	-47.3

The reductions in emissions are dominated by the impact of tighter road vehicle emission standards incorporated in the baseline. Reductions in road emissions due to the measures in the 10 Year Plan are partly offset by increased rail emissions resulting from higher freight and passenger rail growth. In total, the measures in the 10 Year Plan are estimated to reduce NO_2 emissions by about a further 1.0% and PM_{10}

[iv] Kilo-tonnes

emissions by about a further 0.5% compared with the baseline forecast, with the biggest reductions at roadsides. The reductions are larger under the illustrative scenarios. There would still be areas in London and possibly other large cities (centrally and near very busy roads) where the EC NO_2 limit value and the Air Quality Strategy objective would not be attained.

There are two sets of EC Directive limit values for PM_{10} concentrations: mandatory Stage 1 limit values for 2005, and more stringent non-mandatory 'indicative' Stage 2 limit values for 2010. The 10 Year Plan will contribute to achievement of the latter limits, however they are likely to be widely exceeded across the country in 2010, with highest levels generally occurring next to heavily trafficked roads. The estimated reductions arising from the 10 Year Plan will make a small contribution to the broader strategy of reducing PM_{10} levels, which involves addressing non-transport sources in the UK and emissions from the rest of Europe.

4.3 Summary of Government Targets

Summary of Government Targets

The Department's objective is to promote modern and integrated transport for the public and industry and to reduce the impact of transport on the environment. The 10 Year Plan will contribute to the achievement of the following targets in the DETR's Public Service Agreement:

- to reduce road congestion on the inter-urban network and in large urban areas in England below current levels by 2010;
- to increase rail use in Great Britain (measured in passenger kilometres) from 2000 levels by 50% by 2010;
- to increase bus use in England (measured by the number of passenger journeys) from 2000 levels by 10% by 2010;
- to double light rail use in England (measured by the number of passenger journeys) by 2010 from 2000 levels;
- to improve air quality by meeting our National Air Quality Strategy targets for carbon monoxide, lead, nitrogen dioxide, particles, sulphur dioxide, benzene and 1-3 butadiene;
- to reduce greenhouse gas emissions by 12.5% from 1990 levels, and move towards a 20% reduction in carbon dioxide emissions by 2010;
- to reduce the number of people killed or seriously injured in Great Britain in road accidents by 40% by 2010 and the number of children killed or seriously injured by 50%, compared with the average for 1994-98.

Summary of other 10 Year Plan targets and indicators:

Rail

- increase in rail freight's share of the freight market by 2010 from 7% now to 10% by 2010 - an 80% increase in rail freight.

Local transport

- to triple the number of cycling trips compared with a 2000 base by 2010. The National Cycling Strategy target of quadrupling cycling trips by 2012 on a 1996 base will also be retained;
- to achieve a one-third increase (from 36% to 48%) in the proportion of households in rural areas within about 10 minutes walk of an hourly or better bus service by 2010;
- no more than 0.5% of services cancelled for reasons within operator's control by June 2001;
- bring down average age of buses to eight years by June 2001.

Roads

- maintain the strategic road network in optimum condition;
- halt the deterioration in the condition of local roads by 2004 and to eliminate the backlog by the end of the Plan period.

Investment in schemes will be assessed on a case-by-case basis using the New Approach to Appraisal (NATA), which summarises transport problems and solutions against environmental impact, safety, economy, accessibility and integration.

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- to reduce road congestion on the inter-urban network and in large urban areas in England below current levels by 2010;
- to increase rail use in Great Britain (measured in passenger kilometres) from 2000 levels by 50% by 2010;
- to increase bus use in England (measured by the number of passenger journeys) from 2000 levels by 10% by 2010;
- to double light rail use in England (measured by the number of passenger journeys) by 2010 from 2000 levels;
- to improve air quality by meeting our National Air Quality Strategy targets for carbon monoxide, lead, nitrogen dioxide, particles, sulphur dioxide, benzene and 1-3 butadiene;
- to reduce greenhouse gas emissions by 12.5% from 1990 levels, and move towards a 20% reduction in carbon dioxide emissions by 2010;
- to reduce the number of people killed or seriously injured in Great Britain in road accidents by 40% by 2010 and the number of children killed or seriously injured by 50%, compared with the average for 1994-98.

5 Findings and Analysis

SUMMARY

- The population as a whole as well as 'vulnerable' or 'special interest' groups associated with each stage of the FV Strategy 'life cycle', will be affected by the FV strategy
- The main health impacts from the FV Strategy were identified to occur during the production and use of new road vehicle technologies
- The priority impacts from the production stage are a potential to:
  - Increase in the incidence of accidental injury, repetitive strain injury, and musculoskeletal disorders from increased automation
  - Increase in high demand/low control occupations with enhanced automation, resulting in increased risk of anxiety, hypertension, cardio-vascular disease
  - Increase in stress, anxiety resulting from new working styles/practices for design engineers, managers, with potential short-term but with longer-term benefits from increased efficiency in production
- Areas of uncertainty concerning impacts at the production stage, and for more detailed investigation in the comprehensive HIA, include the occupational health effects of using new substances and materials, and the implications for employment, economic growth and inward investment from the development of new products and engineering approaches
- The priority impacts from the operational stage are the potential to:
  - Reduce RTAs by, eg decreases in traffic congestion, new vehicle design and materials, telematics and sensors
  - Stabilise 2019/20 air pollutant levels, and the morbidity and mortality levels, such as asthma and chronic bronchitis, related to road traffic
  - Contribute to reductions in noise emissions from road traffic
  - Increase in cycling, walking, from perceptions of increased safety, improved air quality, reducing incidence of respiratory and circulatory diseases
- Areas of concern, and for further investigation in the comprehensive HIA, include the extent of these positive impacts as well as the potential for the FVI strategy to exacerbate health inequalities between different socio-economic groups

5.1 Introduction

As indicated above, four discrete and sequential stages of the FVI strategy have been identified for the purposes of the rapid HIA, each with specific health impacts to consider:

(i) FVI Strategy Planning – the development of the strategy and the implementation of the outcomes of the strategy.

(ii) FVI Implementation 1 – the implementation of new technologies in the road vehicle production and distribution process, and in the supporting infrastructure.

(iii) FVI Implementation 2 – the use of new technologies by road vehicles and in the supporting infrastructure.

(iv) FVI Decommissioning – recycling of vehicles with new technologies.

Each stage considers the health impacts on the population at large as well as 'vulnerable groups'. Although the effects of road transport impact on the population as a whole, there is strong evidence indicating the disproportionate impact of different effects of road transport on a number of population sub-groups (Davis, 1998; Rural Development Commission, 1998; Ong & Blumenberg, 1998; Roberts & Powers, 1996). From this it has been possible to identify the main groups who are most likely to be affected, positively and negatively, by FVI at the different stages. These groups include:

- UK road vehicle component manufacturers/suppliers (managers/employees),
- UK road vehicle manufacturers/distributors/dealers (managers/employees),
- Highways contractors (managers/employees),
- Hauliers
- Local Authority Transport planners,
- Public transport commissioners and operators,
- Research communities (academic and private-sector),
- Urban communities,
- Groups at risk from road traffic accidents – motor cyclists, cyclists (children), pedestrians (children, social class V, boys), motorcyclists, car occupants (children),
- Groups at risk from poor air quality – car/bus users, pregnant women, people with existing heart or respiratory disease, older people, ‘responders’ (people who are susceptible to allergic responses from pollutants), children,
- Socially isolated groups – older people, ethnic minority groups, people with disabilities or limiting long term illness (LLTI), people on low incomes,
- Groups at risk from noise pollution – children, shift workers.

5.2 FVI Strategy Planning.

Introduction.

Assessing the impacts of the strategic planning process is an important first step in this HIA. Firstly, it enables the relevance of the strategy to the wider transport context to be assessed, gaps to be analysed with the potential health impacts of these gaps described. Secondly, it provides an indication of the likely success of the longer-term implementation of the strategy’s developments. Finally, it enables the actual and likely impacts of the strategy’s research, funded through the LINK programme, to be analysed.

Stakeholders

The population sub-groups most likely to be affected by the strategy development and implementation process in the short term include the personnel involved and employed in the approved research programmes. To a lesser extent, there will also be impacts on the wider communities adjacent to the research programmes’ bases. However, it is clear that the strategy planning process and the priorities resulting from this has much wider and longer-term ramifications, which will also influence the population groups affected in the future. Of particular importance are the implications for those population groups disadvantaged by the current road transport system.

Summary of Health Impacts of FVI Strategy Planning

Identifying health impacts at this stage has involved a review on documentation on strategy development, and the impacts on strategy implementation, and a critical analysis of the FVI strategy - content, methods and process.

Health Impacts – Physical Environment

Table 5.1 Health Impacts – Physical Environment Factors

	Health Impacts	Evidence	Risk of Impact	Measur-ability	Priority
-	Depletion of natural resources, production of CO_2 & other greenhouse gases, during R&D process, contributing to global warming.	Crombie, 1995; Green-peace, 1994.	Probable	Qualitative	Low
-	Potential pressures on the availability of accommodation in areas where 'clustering' of R&D activity.		Speculative	Qualitative	Low

The implementation of the FVI research projects will involve the use of raw materials and energy in the production of models for these new technologies. Although the quantities may not be significant, they will be adding to the depletion of natural resources and the production of CO_2 and other greenhouse gases, contributing ultimately to global warming and climatic changes. The long-term impacts on health resulting from these changes have been previously documented (Crombie, 1995; Greenpeace, 1994).

The migration of research workers to 'centres of excellence' for vehicle technology research and the reported clustering of research activity in specific geographical areas may impact on the availability of accommodation. However no data were available on the numbers of people who have been employed through the 80 projects FVI/IMI LINK has funded, or which areas they were based. The availability of affordable accommodation is a key health determinant. In certain areas of the UK, for example Merseyside, there are serious concerns about the supply and demand for rented stock, social and private. Health issues relating to supply and demand issues include homelessness, overcrowding and a mismatch between household needs and property needs, all of which have significant physical and psychosocial impacts on health. Similarly the transport patterns of research workers, although marginal, may also impact on the local environment; there is evidence that professional and technical occupations are more likely to own cars!

Health Impacts – Socio-economic environment Factors.

Table 5.2 Health Impacts – Socio-economic environment Factors.

	Health Impacts	Evidence	Risk of Impact	Measur-ability	Priority
+	Increase in employment opportunities for research workers, resulting in health gain.	FVI Steering Group, 2000. Key Informant.	Definite	Quantitative	Medium
+	Increase in education/training opportunities, eg research/industry secondments.	FVI Steering Group, 2000. Key Informant.	Definite	Quantitative	Low/ medium
-	Involvement in strategy development has implications at the strategy implementation stage, eg, potential occupational health risks associated with new technologies.	FVI Steering Group, 2000.	Probable	Qualitative	Low

The main health impacts resulting from the FVI/IMI LINK programme are the employment opportunities for engineering research staff. However, as already mentioned, information was not available as to where these sites of employment were, and the impact on the local economy can only be speculated on. For example, the positive impact of employment would be even further enhanced if this income was spent in a deprived area, helping to reduce the income and related health inequalities (Wilkinson, 1993). Employment and income are key health determinants. Employed people are more likely to report that they are in good health and have lower rates of morbidity and disability (Blaxter, 1992). This is primarily through indirect mechanisms such as being able to afford good housing and leisure activities, and having a good diet (Benzeval & Webb, 1996; Bartley, 1994). Other economic impacts include the attraction of other research funding to the UK as a result of FVI.

There was evidence of some positive social impacts resulting from the implementation of the research projects. This included the closer working arrangements between industry and research institutions, for example secondment opportunities between these sectors. This networking was seen as beneficial at an organisational and individual level. However data were not available to describe the detail or extensiveness of this practice. The networking and information 'products' of FVI are also important outcomes, developing dialogue between the different road transport sectors, which may ultimately help identify areas for co-operative working and sharing of resources. Similarly, the education 'product' including the Young Foresight programme may provide opportunities to raise the profile about road transport issues, now and in the future. However, the details of this were not available.

Although it is apparent that there has been involvement and strong commitment from Government departments, industry and academia in the strategy development process, this process could be enhanced even further by the inclusion of representatives from the following:

- Transport workers, eg Transport & General Workers Union,
- Department for Education and Employment,
- Public Transport – manufacturers, commissioners, operators,
- Department of Health
- Occupational health specialist
- 'Lay' members – providing a perspective of different vulnerable groups

This approach at the development stage will ensure the following positive short and long-term impacts:

(i) The context or situational analysis for setting the strategy's objectives and priorities will reflect all potential scenarios; for example the implications of new technologies on the health and well being of road vehicle operators, issues of organisational behaviour and performance,
(ii) The strategy's priorities are comprehensive and appropriate,
(iii) The road transport needs of those groups of the population currently disadvantaged, for example low income groups, will be addressed,
(iv) The move from research to production will be enabled,
(v) The needs of the indigenous supply chains for their long term viability will be addressed,
(vi) Inequalities in income, quality of life and health will be prevented.

Evidence of Health Impacts from Documentary Analysis.

> 'Formulating strategy is difficult enough. The more problematic task ....is the successful implementation of strategy.' (Hrebiniak, 1990).

There has been much research into strategy development or planning, managing change and organisational development over the last 20 years in particular. There are many definitions of strategy; generally a strategy defines the vision and strategic goals of an organisation, together with how they will be achieved, that will enable it to operate successfully within environmental constraints (Hardy, 1994). This involves:

- Defining the business
- Situational analysis (organisation and operating environment)
- Future planning assumptions/premises
- Objective-setting and prioritising
- Action planning and resource allocation.

(Andrews, 1980).

In addition there are different models on the methods and process to use for planning and managing change. These can be broadly grouped into three main types – empirical-rational, power-coercive and normative-re-educative. Empirical-rational models emphasise the closer integration between the development and implementation of new knowledge in the change process, often referred to as Knowledge, Production and Utilisation (KPU). Power-coercive approaches effect change directly through the exercise of power. Normative-re-educative strategies emphasise organisational self-renewal, and the need for organisations themselves to adapt to the changing environment, rather than have this imposed externally. The latter approach reflects organisations operating as ‘open’ socio-technical systems, with a participative organisational climate and developmental management style (Owens, 1987).

Research into new strategic planning models that facilitate strategic change suggest that when there is broad involvement of stakeholders in generating and testing hypothetical futures, firstly in a cognitive loop, and then implementing these ideas in a behavioural loop, there is a potential positive impact on the organisation’s performance (Liedtka, 2000).

Other evidence from organisational behavioural research in the 1980s indicates that effective organisations have certain common characteristics. These include, an organisational culture with clear and shared values that are reflected in the operation of the organisation, value and commitment between employees and the organisation, developmental management styles, participative decision-making, and a positive approach to change (self-renewal characteristics) (Pedler et al, 1991; Kanter, 1983; Waterman & Peters, 1982; Ouchi, 1982).

Previous studies have shown that the Japanese and German manufacturing sector have longer-term objectives than their British and US counterparts, which is attributed to the difference in corporate ownership and governance systems. More recently it has been postulated that these relationship-based systems may facilitate the adoption of more risky long-term investments by Japanese and German subsidiaries. There are also reported differences in strategic and operational planning between Japanese, German and British small and medium-sized enterprises operating in the UK, which may effect success in international markets (Peel & Bridge, 2000).

A recent case study has shown the effectiveness of using collaborative technology in environmental strategy development (Jones & De Vreede, 2000). This has enabled large groups of stakeholders – Government Ministries, community leaders, the private sector, NGOs – to be involved in environmental strategy development and action planning. In addition to this there is a growing evidence-base of the positive health impacts of community involvement in health-related decision-making (Health Gain Conference, 1992).

The FVI documentation and stakeholder information describes the vision for FVI and the overarching aim of contributing to the Foresight objectives. It describes who has been involved in its development acknowledging this is not comprehensive, or exhaustive. However the approach adopted has clear implications in terms of the overall focus of the strategy, and the ultimate successful implementation and use of the research developments.

Another factor influencing the direction of the strategy is the current and future environmental context analysis, including the assumptions made about this. This analysis was described in the FVI strategy and presentation documents as follows:

- The need to achieve the Foresight objectives of wealth creation, sustainable development and improving the quality of life for the population as a whole, but especially considering older people and people with disabilities.
- The recognition of the important role the transport sector plays in the UK economy – the industry as a whole contributes 20% GDP, 7% employment; the

automotive components industry exports £6 billion of goods and has a turnover of £15 billion.

- The demand for the mobility of goods and people.
- The competing expectations of society, the travelling public and hauliers for future road transport.
- The recognition of the negative impacts of road transport – pollution, use of energy/production of CO_2, land use for transport infrastructure, road traffic accidents.
- The recognition that road transport issues affects some population sub-groups more adversely than others.

The strategy also describes 16 measures and targets towards which the new technologies will need to contribute to when in use:

Table 5.3 Measures for FVI Technology User Requirements.

Accessibility of transport	Convenience
Availability of transport	Crime reduction
Journey duration	Efficient use of the road network
Reliability of arrival time	Air quality
Pride of ownership	Energy use
Cost of travel	Noise levels
Safety of traveller	Equitability
Safety of pedestrians	Vehicle security

5.3 FVI Implementation 1

Introduction

This section is analysing the main potential impacts of the implementation of the outcomes of the FVI strategy, for example, the introduction of new technologies or technology 'beacons' into the road vehicle manufacturing, distribution and sales process.

As indicated in section 3, the methods and process involved in this stage of the rapid HIA have involved examining the evidence on:

- The current status of road vehicle production and distribution, and the supporting infra-structure
- The impacts on health and health determinants (direct and indirect)
- Factors likely to influence this status in the future, and there associated health impacts
- The population groups most likely to be affected by these changes.

From this, the specific changes emanating from the FVI programme can be added, and the health and health determinant impacts analysed.

Stakeholders

The particular population sub-groups affected by the introduction of new vehicle technologies into the road vehicle production process will be:

Operators, managers and employers of the manufacturing and vehicle component supply companies – car, bus, and freight
Construction workers, engineers (electronic, civil), and managers of highways contractors
Car sales executives and maintenance technicians of car dealerships
Website designers of ecommerce companies.

The general population will also be effected primarily from the transport sectors impact on employment, GDP and exports.

Summary of the Health Impacts of FVI Implementation 1.

The potential health impacts of the FVI programme have been identified by, firstly, considering the evidence of current and future trends in road vehicle manufacturing and distribution as well as in the supporting infrastructure; and, secondly, considering the potential impacts of these changes on health (see below). Finally it was possible to consider the effects that the FVI programme itself would have on these impacts.

Personal, Family and Lifestyle Factors

Table 5.4 POTENTIAL HEALTH IMPACTS (Road Vehicle Manufacturing) – Personal, Family and Lifestyle Factors

	Potential Health Impacts	Evidence	Risk of Impact	Measur-ability	Priority
-	Increase in incidence of accidental injury, repetitive strain injury, and musculoskeletal disorders from increased automation.	HSC, 1997.	Probable	Quantitative	High/ Medium
-/+	Change in incidence of contact dermatitis, respiratory disorders (including occupational asthma), with the introduction of new materials in manufacturing process.	HSC, 1997.	Speculative	Qualitative	Medium
-/+	Changes in levels of stress, incidence of depression and anxiety from changing work practices, increased automation, fear of unemployment.	HSC, 1995.	Speculative	Qualitative	Medium/low

Work impacts on both physical and psychosocial health. Work related morbidity and mortality varies from industry to industry. Estimates from the Health and Safety Commission (HSC, 1997) indicate that the manufacturing sector is a high-risk sector for fatal and major industrial injuries. With the increase in automation in the road vehicle manufacturing sector there is a potential risk that this rate will rise unless precautionary steps are taken, eg to develop work practices that reduce production-line fatigue. The developments from the FVI will tend to add to this increase in automation and therefore the potential increase in risk of accidental injuries. These injuries will not only impact on the individuals and their families, but also on the communities associated with the vehicle manufacturing plants as a result of their impact on public services, eg health and social care services. Other impacts on physical health associated with the increased automation of the production line include repetitive strain injuries, inflammation of the tendon and other musculo-skeletal disorders. The FVI's introduction of new materials into the road vehicle production process may effect the incidence of contact dermatitis – the manufacturing industry as a whole is considered one of the risk industries for this disease. Similarly, these new materials may also act as sensitisers, impacting on the incidence and prevalence of occupational asthma and other work-related respiratory diseases.

There are also psychosocial health impacts resulting from mass production and automation, as described in 4.3.2. Stress, depression and anxiety was the second most prevalent self-reported work-related illness, after musculo-skeletal disorders (HSC, 1997). The psychosocial effects of increased automation are likely to be further exacerbated by FVI. These psychosocial impacts that are likely to be added to even further by the fear of unemployment as the automotive industry in particular reduces production in the UK.

It is unclear from the FVI documentation how the initiative will directly impact on the health, well being and lifestyle of employees in the highways construction sector. The main impacts will be from the increase in investment, and therefore employment opportunities, in the transport system overall and not specifically from FVI.

Similarly, the main direct health impacts of FVI on sales and distribution staff are also unclear from the evidence available. However FVI will add to the trend towards an increase in sales over the Internet rather than inter-personal sales, with an increase in VDU users with their associated health risks.

Physical Environment Factors

Table 5.6 POTENTIAL HEALTH IMPACTS – Physical Environment Factors

	Potential Health Impacts	Evidence	Risk of Impact	Measur-ability	Priority
+	Potential reduction in industrially-related air, noise, soil & water pollution, as a result of reductions in auto manufacturing base.		Speculative	Qualitative	Low
+	Potential reduction in energy consumption by auto manufacturing sector with reduced car production levels, resulting in fewer greenhouse gas emissions.		Speculative	Qualitative	Low
+	Potential reduction in land use for vehicle lots.		Speculative	Qualitative	Low

The potential reduction in the UK road vehicle-manufacturing sector as a result of saturation levels of car ownership in the UK and Europe, diversion of manufacturing to developing countries and policy trends to reduce road traffic growth, will probably reduce the energy consumption and negative environmental impacts of the manufacturing processes, eg poor air quality, noise pollution, waste production, water pollution. The impacts of poor air quality and noise on health are well known and will be described in section 5.4. Waste management and soil pollution can have significant impacts on health; it has been estimated that 12% (12 million tonnes) of industrial waste is either toxic or dangerous (Crombie, Ord, Ashton, 1991); reducing these impacts will be therefore be beneficial to health. Drinking water contaminated from industrial discharges also has health implications; again the reduction in vehicle manufacturing may reduce the risk of contamination. This could potentially be further enhanced by FVI by the introduction of more sustainable manufacturing processes, eg increasing energy efficiency in production by reducing waste and emissions, increasing the use of recycled products involving a lifecycle assessment and economic evaluation. There is evidence, eg from waste minimisation programmes (Knowsley MBC, 1998), of the additional economic benefits to industry from introducing sustainable practices. However, it is unclear from the FVI documentation available what investment from the programme has been targeted in this area.

With the introduction of the FVI's new more efficient vehicles with a longer life-span, there may be a shift in consumer purchasing behaviour and a reduction in the frequency of vehicle purchasing; this would further impact on the volume of road vehicles produced and their associated environmental impacts.

It is also possible that the decrease in land use as a result of a shift of emphasis in the sales and distribution sector will be added to by the FVI. The programme is studying and promoting the concept of 'lean distribution' implying a further reduction in this sector. However, the alternative distribution mechanisms are unclear and therefore have not had their environmental impacts assessed. Similarly although the direct health impacts of land use and open space on mental health and healthy lifestyles are well known, it is unclear how the land currently used for vehicle storage would be used in the future.

Socio-economic Factors

The potential reduction in UK automotive manufacturing will impact not only on employment in this sector but also in the supply chains. This will, in turn, effect the local economy of communities surrounding these plants, and the population at large through the impact on GDP and exports. There is strong evidence on the impact of unemployment and low income on health. The negative health effects of unemployment – poverty, hardship, social exclusion and changes in health-related behaviour, result in poor mental and physical health (Benzeval & Webb, 1996; Bartley, 1994). People living on the lowest incomes tend to have higher rates of morbidity and disability compared with the population as a whole (Wilkinson, 1992; Wilkinson, 1993). There will also be impacts on health inequalities, created by the income differential between those in employment and those who are not (Wilkinson, 1996).

It is unrealistic to expect the FVI to be able to reverse this decline, which is not, and will not be, just an UK phenomenon. It is also unclear how FVI would necessarily contribute to the existing research programmes of the multinationals and ultimately their performance. However assuming it does, it is likely to further impact on unemployment as further efficiencies are made in enhanced automation. As described above, once these new vehicles are in use, there may be a further impact on production resulting from a change in purchasing behaviour. FVI may have further employment-related impacts, including training for likely occupational changes, eg for operators (skills and technological developments), design engineers (cross-organisational partnerships) and managers (participative, 'open' organisational behaviour). This may be an area that FVI might consider targeting resources into.

Table 5.7 POTENTIAL HEALTH IMPACTS – Socio-economic Environment Factors

	Potential Health Impacts	Evidence	Risk of Impact	Measur-ability	Priority
-	Potential reduction in employment (automotive, freight) in manufacturing, supply sectors resulting in an increase of morbidity (physical, emotional), premature mortality as a result of reductions in income and other benefits associated with work.	Employ-ment & health: Benzeval & Webb, 1996; Bartley, 1994.	Speculative	Qualitative	Medium
+	Potential to support increase in productivity and performance in bus manufacturing sector.	DETR, 1999.	Speculative	Qualitative	Low
-	Increase in high demand/low control occupations with enhanced automation, resulting in increase in risk of anxiety, hypertension, cardio-vascular disease.	Siegrist, 1987.	Probable	Qualitative	Medium/ High
-/+	New working styles for design engineers, managers, with potential short-term increase in stress, anxiety, but longer-term benefits from increased efficiency.	FVI Steering Group, 2000.	Definite	Qualitative	High/ Medium
-	Potential effects on economies of communities dependent on automotive manufacturing, including social cohesion and support, and, as a result, crime levels.		Speculative	Qualitative	Low

The FVI may potentially provide a competitive advantage to indigenous UK vehicle component suppliers and tool manufacturers. Through the research programme, the FVI may be able to investigate both productions in specific areas and the process for these developments. There is evidence to suggest that these suppliers tend to be small and medium sized businesses, where historically there has not been a focus in

research and development, and long term planning. FVI research to support new product areas and enhance the self renewal capability of these businesses will have significant impacts on their future viability, and therefore on employment, GDP and exports. However, it is unclear what FVI resources have been targeted towards suppliers and tool manufacturers, either towards new products and technologies or to developing business planning skills and enhancing adaptability.
Once again the FVI initiative may be able to further enhance the productivity and performance of the bus-manufacturing sector. However it was unclear from the evidence what research funding has been committed to the needs of the public road transport sector, or how they will exploit the 'generic' technologies developed since there are no representatives on the FVI Steering Group. These comments also apply to road haulage manufacturers.

Similarly, the future changes in sales and distribution, have employment and training implications for sales and servicing staff. However, it is unclear what specific impacts the FVI will add to this as the investment in this area are unknown.
The social impacts from the likely changes in the road vehicle-manufacturing sector will impact on workers at every level of the industry. Firstly, the operators on the production line may feel more isolated and alienated from the organisation; the high demand/low control environment of a production line may affect not only the motivation and productivity of the employee, but may also increase the risk of anxiety, hypertension and heart disease (Siegrist, 1987). Secondly, design engineers will be working across several companies in virtual and actual teams, requiring a co-operative and open style of working with potentially greater emphasis on inter-personal skills. This approach to working may be unfamiliar and stressful to these employees, impacting on their psycho-social health. Finally, managers and employers will also need to work in partnership with other companies, but also more participatively within their companies. This style of working may also be new to these managers, but will have beneficial impacts on employee health, productivity and quality. Once again the precise role the FVI will have in facilitating these changes, is unclear.

There will also be social impacts particularly on those communities surrounding automotive-manufacturing plants. With a decline in production and employment opportunities for operators, there may be an outward migration of these workers in search of employment, this will not only affect the local economy, but also the social cohesion of these areas. Poor social cohesion has been indicated to be a contributory cause of crime (Kennedy, Kawachi et al, 1997; 1998). A lack of perceived social support has also been postulated to be one of the social variables contributing to the inequality of heart disease prevalence (Marmot, 1997). The importance of social support mechanisms in ameliorating the effects of stress, and promoting psychological well being is well documented (Siegrist, 1986; Power et al 1996).

Mass Production in Road Vehicle Manufacturing: Background

The mass production of automobiles has been refined over the last century, and consists of manufacturing and assembly facilities throughout the world. In addition to automobile companies manufacturing their own components directly, a number of subsidiaries also supply components. Tyres, batteries and dashboard instruments are generally procured from outside sources. There is a variable degree of outsourcing according to the particular company, eg General Motors in the United States produces half of its own parts. In addition to the supply of components, there is the need for the supply of elaborate tooling and machinery to handle assembly parts and to aid operators in their tasks. The final assembly plant receives sub-assemblies such as the automobile chassis, the engine, major body components, such as doors, panels and many electronic, electric and hydraulic systems, usually manufactured at another factory.

The final assembly line involves both human and mechanical resources, eg a robot welder may weld body parts together unaided, at another point an operator mounts the motor onto the chassis with machinery. This multi-tasked process requires the operator to have a narrow range of specialised skills. The total operation is paced by the speed of movement of the conveyor. The number of operators, machine stations and the flow of materials have been planned for optimal effectiveness and productivity.

Health Impacts of Mass Production

Since the early production lines, the mass production process has become increasingly automated whilst also being able to produce more highly customised products. This has required an increase in specialisation and adaptability of operators as they apply detailed engineering specifications for a wide range of tasks. With this increased automation and mass production, there have been a number of social impacts on the workforce. For example, an increase in job dis-satisfaction due to a loss of identity of their productive functions, alienation from their employers due to the large numbers of employees in manufacturing plants, role ambiguity and low status in society. These, in turn, have impacted on the psycho-social well being of operators, in addition to their motivation and productivity in the job. Other aspects of these jobs, such as the division and specialisation of labour, may lead to a narrow range of highly defined skills, but repetitive operations. This often results in tedium and fatigue, with an increased risk of accidental and repetitive strain injuries. There is strong evidence from industrial psychologists and others (Womack, 1990; Tasker, 1987; Matsumoto, 1970) that operators working in teams, involved in decision-making, eg about the pace of their work, able to rotate jobs and who are well trained, tend to be more motivated with positive consequences for productivity, quality and sickness absence.

In addition to the effects of mass production on employees, there are also significant effects for managers as the complexities of management have increased substantially. This has necessitated longer-term planning approaches and a focus on the co-ordination of large human and capital resources. Similarly, there is the need for adaptability and on-going development as new materials and technologies, production techniques and management aids are generated. The investment requirements and risks faced by owners have also become much greater. With new technological developments there is the need for the support of a sizeable technical staff in advance of production, and later for production facilities. Increased levels of capital may need to be committed years before production and the true market for the product can be established, greatly increasing the risk to investors. This has led to a concentration of major manufacturing firms, eg Ford, General Motors, Chrysler, Toyota, Nissan, Volkswagen, Mercedes, Renault, Peugeot, Fiat, Rover. Recent evidence (Peels & Bridge, 2000) suggests that those manufacturing firms with relationship based systems were more likely to succeed in the implementation of more ‘risky’ long-term objectives.

Trends in UK Automotive Industry

The automotive industry in the UK employs approximately 100,000 people with 17 out of the 23 multi-nationals based here. Collectively the industry makes up 5.3% of GDP and 11% of export sales. However, in addition to the trend towards a reduction in the number of manufacturing firms to a few large multi-nationals that produce most of the vehicles, there are other factors that are influencing automotive production, now and in the future. There are high levels of car ownership in the UK and Europe (although not uniformly distributed across all income groups) reflecting growth in the economy as a whole. As a consequence, it has been suggested that there is little scope for growth in this market in the future. In addition, although the National Road Traffic Forecasts for Great Britain (DETR, 1997a) indicates a reduction in the rate of growth of road traffic, reducing even further as the link to GDP declines, key assumptions outlined in the Background Analysis paper (DETR, 2000b) to the Government's White Paper, Transport 2010 (DETR, 2000a) suggests that this may be further reduced as a result of the Plan's interventions. For example, measures to reduce congestion, increase rail, bus and light rail use, and increase cycling trips. Other national and international policies that are also seeking to reduce the rate of road traffic growth and its negative impacts on health and the environment include:

The World Health Organisation's 'Charter on Transport, the Environment and Health' (WHO: Europe, 1999)
'A New Deal for Transport: better for everyone' (DETR, 1998a)
'Guidance on Local Transport Plans' (DETR, 1998b)
'Guidance on Provisional Transport Plans' (DETR, 1999a)
'National Air Quality Strategy' (DETR, 1999b)
'A better Quality of Life: A strategy for sustainable development in the UK' (DETR, 1999c)
'The Road Traffic Reduction Act' (DETR, 1997b)

Based on this and other evidence (The Economist, 1998; Turner, 1999) it is likely that there will be less automotive manufacturing in the UK and the associated supply companies, as manufacturing is diverted to developing countries the market in the UK and Europe levels off and alternative transport choices are provided. This will impact on employment in this sector and also on GDP and exports.

Trends in UK Bus and Road Haulage Manufacturing

Little evidence was obtained on the bus and road haulage vehicle-manufacturing sector. Dennis is the main manufacturer of both chassis and bodywork. Northern Coaches , East Lancashire Coaches, Plaxton, Alex and Wright Brothers are also UK bus body builders. The policies described above will also influence the future public transport sector, particularly local transport planners, commissioners and operators. In addition, the policy document, 'From Workhorse to Thoroughbred: a better role for bus travel' (DETR, 1999d) details the main bus policy changes. These will not only require increased integration, co-ordination and partnerships between operators and other transport systems, but also minimum standards for concessionary fares. The recent Bus Summit also agreed to bring down the average age of buses to eight years. The impacts of these drivers for change on the bus-manufacturing sector is that potentially there will be a slight growth in the market with a resulting rise in operator and design engineering employment opportunities. However there will also be the demand for reducing vehicle operating costs which will influence the direction of future engineering developments in bus-manufacturing. It is appreciated that the evidence provided here is incomplete and the impacts therefor speculative.

ERF, Sanderson and Leyland are the main road haulage manufacturers, with Ford and LDV manufacturing light vans and minibuses. Targets set in 'Transport 2010' aim to shift the transport of freight from road to rail, increasing the market share by 10% by 2010. This has significant implications for road haulage manufacturing, with a potential reduction in future markets, and a knock on impact on employment prospects in this sector. More documentary evidence in this area needs to be compiled.

Other targets set in 'Transport 2010' indicate an increase in employment opportunities within the light rail manufacturing sector as 25 new projects are to be introduced, and potentially for the cycle manufacturing industry as three times more cycling journeys are made.

Trends in Highways Construction

There is a similarly incomplete evidence-base on the current status, health impacts and drivers for change on the construction of highways. However, 'Transport 2010' clearly defines the developments to the strategic road network - £21 billion (a significant proportion of which is new money) to:

- widen 360 miles of congested roads,
- invest in the electronic motorway,
- 100 new by-passes,
- new low-noise surfaces on 60% of trunk roads,

and £30 billion for local transport maintenance programmes, as well as reductions in congestion on different road types as priorities. The policy report 'Breaking the Log Jam' (DETR j, 1998) also describes potential changes to the highways in terms of restricting vehicle access and charging on motorways and trunk roads. These changes in themselves will have key impacts for highway construction, particularly in employment opportunities for civil engineering, electronics and construction. However, there are also likely to be negative impacts on the environment and other determinants linked to construction work.

Trends in Sales and Distribution

Associated with mass production is an elaborate distributive mechanism, which usually fulfils the role of providing after-sales servicing and support. This tends to operate on a franchise dealership arrangement whereby dealers only sell a particular make of new car, must accept a quota of cars specified by the manufacturer and pay cash on delivery. In return, the dealers receive some guarantee of sales territory and may be assisted by the manufacturer, eg in advertising. Contracts may also specify that dealers maintain service facilities according to the manufacturer's standards. The used car market is also an important part of the distribution system as it affects the styling and sales of new cars, however, no data were available on this. More recently there has been a move towards new car purchasing by customers over the internet, eg EGM at General Motors. This has implications for dealerships in the future. It is likely that vehicle sales by viewing lots of vehicles on dealer lots will decline in the future, with an emphasis on after-sales care, including up-grading options and components, eg ‘infotainment’ systems (LaMonica, 2000). The potential impacts on health determinants with this trend include a reduction in employment opportunities in traditional car sales, but a potential growth in ecommerce sales, and in IT support for manufacturers to maximise ‘hits’ to their website. Similarly, car mechanics current skills will need to diversify to be able to upgrade the technologies of the future. A positive environmental impact resulting from this change would be a potential reduction in land-use by vehicle lots, although it is unclear what the new manufacturer-customer delivery mechanism would be.

5.4 FVI Implementation 2 (New Vehicles 'On the Road’)

Introduction

This section is analysing the potential health impacts of the use of new vehicle technologies. This has involved examining the documentary evidence on:

- Road traffic and the current impacts on health and health determinants
- Trends in road transport and its effects
- Trends in new vehicle technology development, production, and use
- The population sub-groups most likely to be affected by changes in the effects of road transport.

To this, the specific outcomes of the FVI programme can be added, and the potential health impacts analysed.

Stakeholders

The population as a whole will be affected by changes in road transport. The population sub-groups currently most vulnerable to the adverse effects of road transport are:

- Urban communities,
- Groups at risk from road traffic accidents – motor cyclists, cyclists (children), pedestrians (children, social class V, boys), motorcyclists, car occupants (children),
- Groups at risk from poor air quality – car/bus users, pregnant women, people with existing heart or respiratory disease, older people, ‘responders’ (people who are susceptible to allergic responses from pollutants), children,
- Socially isolated groups – older people, ethnic minority groups, people with disabilities or limiting long term illness (LLTI), people on low incomes,
- Groups at risk from noise pollution – children, shift workers.

Summary of Health Impacts of FVI ‘On the Road’

Having considered the general trends in road transport, policies and measures to reduce its effects, as well as technological developments it is possible to consider the likely health impacts of these and, in turn the contribution of FVI.

Personal, Family and Lifestyle Factors – Potential Health Impacts

Table 5.8 Potential Health Impacts - Personal or Family Circumstances and Lifestyle Factors

	Potential Health Impacts	Evidence	Risk of Impact	Measur-ability	Priority
+/-	Reduction in RTAs from, eg decreases in traffic congestion, new vehicle design and materials, telematics and sensors.	Turner & Austin, 2000; Berube, 2000; Chatterjee & Mc Donald, 1999; Hojer, 1998; DMRB, 1997.	Probable	Estimable	High
	Exacerbates health inequalities between income groups?		Speculative	Qualitative	
+	Increase in cycling, walking, from perceptions of increased safety, improved air quality, reducing incidence of respiratory and circulatory diseases.	BMA, 1992; Dora, 1999; BMA, 1997.	Probable	Qualitative	High/ medium
	Potential to increase physical activity further through actual improvements in safety conditions for walking and cycling.		Probable	Qualitative	
+	Reduction (or reduced rate of increase) in proportion of income spent on travel.		Speculative	Qualitative	Low/ medium
+	Enhances physical health, eg CHD, and mental well being, through social integration/support, increased physical activity and other factors.	BMA, 1997; Appleyard & Lintell, 1972; Glenister, 1996; Green-wood et al, 1996; Heming-way & Marmot, 1999.	Probable	Estimable/ qualitative	Medium/ low

'Transport 2010' has a target to decrease road traffic accidents by 40% for adults and 50% for children. This will involve various community-based interventions, such as 'Safer Routes to School', as well as the re-allocation of road space for pedestrians and cyclists, speed management policies and planning of traffic flows. Vehicle design to enhance the protection of occupants and others involved in these collisions, is another important intervention. FVI will potentially contribute to this increase in safety through the application of electronic sensors and in-vehicle information systems; although the safety of Human Machine Interfaces (HMI) in-car systems is currently being scrutinised. The development of new materials for road vehicle body panels offers other potential safety benefits. However, since these technologies will be developed for new cars, consideration needs to given as to whether this will exacerbate the health inequalities in accident rates between income groups that currently exist.

Various targets and measures through 'Transport 2010' will improve traffic congestion in urban areas and the local infrastructure enabling more active transport such as cycling and walking; this will reduce the risks associated with heart disease and stroke, whilst enhancing mental well being. The FVI may indirectly contribute to this by helping to further reduce air pollution and accidents, major barriers to walking and cycling.

It is not clear from current evidence what the likely distribution of travel/motoring costs amongst the different household income groups will be. More efficient fuel and power sources, resulting in less fuel being used, would not necessarily mean a reduction in total motoring costs because of increased costs in other areas such as fuel prices and congestion charges. It is unclear also what the impact on public transport fares would be; FVI would need to be consider this in order to avoid exacerbating inequalities between income groups and inadvertently supporting the use of private transport in preference to public transport.

There was insufficient evidence to comment on other factors impacted on by FVI, such as reducing travelling time and unreliability of public transport, and how these would impact on health.

Socio-economic Environment – Potential Health Impacts

Table 5.10 Potential Health Impacts – Socio-economic environment Factors

	Potential Health Impacts	Evidence	Risk of Impact	Measur-ability	Priority
+	Increase in accessibility of services (including emergency services), resulting from reduced travelling time.	Hojer, 1998.	Probable	Qualitative	Medium
+	Enhance social integration and support as a result of reduced traffic volumes in urban/residential areas.	Appleyard & Lintell, 1972; BMA, 1997.	Probable	Qualitative	Medium
+	Contribute to reduction in crime as a result of greater social cohesion.	Kennedy, Kawachi et al, 1998.	Probable	Qualitative	Low
+	Reductions (or reduced rates of increase) in transport-related costs to industry, commerce, through alternatively powered vehicles, reductions in congestion & travelling time.		Speculative	Qualitative	Medium

Increasing the accessibility to transport as outlined in 'Transport 2010' will help to reduce social isolation and promote positive mental well being. Similarly transport systems which consider access issues in a holistic way, will also help to promote mobility and positive mental well being. The FVI has a 'mobility for all' target as well as transport availability and accessibility targets. It may potentially contribute to enhancing psychosocial well being through this. However, there is evidence indicating that some groups lack access to transport more than others, for example women, children, disabled people, people from ethnic minority groups and households on low income (especially those in rural areas). The FVI will need to consider the implications for these groups and how this particular health inequality may be addressed.

'Transport 2010' measures will potentially reduce congestion and the volume of traffic in urban areas, which will help to regenerate communities enabling social interaction and the development of social support mechanisms. As indicated above this will contribute not only to psychosocial well being, but also to reducing heart disease risk. The FVI could add to this through advances in telematics, such as routing and guidance systems. Once again it was unclear from the FVI how these systems could be used to the advantage of more deprived, congested and polluted areas. Increasing the social cohesion in communities and reducing traffic congestion may also contribute to reductions in vehicle related crime. A recent HIA on burglary reduction measures has described the negative impact on the mental health of burglary victims (Abrahams & Hirschfield, 2000).

By developing a more efficient, integrated transport system, as detailed in 'Transport 2010' and the 'Integrated Transport Strategy', the long-term economic growth of the UK is assured. In addition in certain circumstances transport projects can help economic regeneration of an area (DETR, 2000a). The FVI's work on alternative power sources and technologies such as telematics, may help reduce commercial and industrial transport costs from fuel, and delays due to congestion. As such these developments may contribute indirectly to positive economic impacts such as employment.

Physical Environment – Potential Health Impacts

Table 5.11 Potential Health Impacts – Physical Environment Factors

	Potential Health Impacts	Evidence	Risk of Impact	Measur-ability	Priority
+	Contribute to stabilising 2019/20 air pollutant levels, and morbidity and mortality levels, such as asthma and chronic bronchitis, related to road traffic.	NETCEN, 1997.	Probable	Qualitative	High
+	Contribute to reductions in CO_2, other greenhouse gases from use of alternative fuels.	DETR, 1997.	Probable	Qualitative	Medium/ low
+	Contribute to reductions in noise emissions.	DETR, 1999.	Probable	Qualitative	High/ medium

There is evidence to suggest that there will potentially be a reduction in the incidence of premature deaths and hospital admissions each year, from traffic-related air pollution. Forecasts in air pollution from road traffic as a result of European policy measures and technological developments predict reductions in NOx, PM_{10}, VOCs and CO emissions and ambient pollutant levels to 2019/2020. These may be further enhanced by the measures adopted in ‘Transport 2010’. Further technological advances from FVI, in terms of alternative fuels and power sources, may potentially contribute to air pollutant reductions post-2020, and in turn sustaining levels of morbidity and mortality levels of cardio-vascular and respiratory diseases. However this is in the context of growth in road traffic. It has been postulated that technological developments will not be enough to reduce the effects of air pollution from this growth; in addition based on current evidence there is unlikely to be a switch in consumer behaviour from conventional road vehicle power/fuel sources in the short term. Deprived, urban areas tend to be worst affected by traffic-related pollution; it is unclear the contribution the FVI will make to reduce the health inequalities resulting from this.

Similarly, the production of CO_2 and other greenhouse gases is set to fall to 12.5% by 2010 as a result of these policies, to which advances in FVI technologies, such as alternative power sources for alternative fuels, is contributing.

Through the development of alternative power sources there are opportunities for the FVI to contribute to reducing noise emissions from vehicles, reducing the negative physical and psychosocial health impacts of noise. This will be particularly beneficial in urban areas, where engine noise is the major source of noise.

Other impacts on the physical environment include land use and planning. The policy measures described in ‘Transport 2010’ to reduce congestion and the rate of growth of traffic together with plans for the highways and local transport infra-structure will help to protect the use of land from unnecessary highway widening and construction. The FVI through its advanced telematics programme will contribute to this congestion reduction, and indirectly to more effective land use.

Public Services and Public Policy – Potential Health Impacts

With the potential reduction in morbidity from fewer, less severe accidents, lower air pollutant emissions, and increased physical activity, this may slow down the growing rate of demand for primary, acute and tertiary health services. Similarly, by contributing to social integration, enhancing social support mechanisms and helping mobility and independent living, demands for social care may also be recede.

‘Transport 2010’ clearly describes the target and measures to increase public transport use: buses by 10%, and trains by 50%. FVI technological developments may help reduce bus-running costs through fuel efficiency measures and the use of lighter weight materials for body panels. Through telematic developments, FVI may contribute to other bus efficiency improvements such as accurate information on arrival and departure times. In addition FVI’s target to make transport more accessible by reducing journey times may contribute to making other public services more accessible. However, FVI does not make explicit its contribution to developments in bus technologies, which makes these health impacts speculative.

Table 5.12 Potential Health Impacts – Public Services and Public Policy

	Potential Health Impacts	Evidence	Risk of Impact	Measur-ability	Priority
+	Reductions in demand on health and social services as a result of lower levels/stabilisation of road-transport related morbidity and mortality.	COMEAP, 1998.	Probable	Qualitative	Low
+	Increase in performance of emergency services as a result of reduced traffic congestion, eg, ambulance attendance times.		Speculative	Qualitative	Medium
+	Increase in reliability of vehicles resulting in reductions in capital, revenue costs for bus operators.		Speculative	Qualitative	Low
+	Decrease in capital, revenue costs for public service vehicles, enabling greater flexibility in public spending.		Speculative	Qualitative	Medium
+/-	Reinforces some public policy priorities, but not all, eg reducing health inequalities.	DETR, 2000; FVI Steering Group, 2000; DoH, 1999.	Definite	Qualitative	High

In addition, there may be significant savings on the lifespan and running costs for public service vehicles by the introduction of FVI technologies, which will have positive impacts for public spending as a whole.

The FVI has the potential to impact on:

- Economic policy – economic growth, public spending, inward investment
- Education and employment - vocational training, training to support development and diversification of industries.
- Trade and Industry policy - GDP, exports
- Environment and sustainability policy – Transport 2010, NAQS, Sustainability Development strategy, Integrated transport policy,
- Health policy – ‘Saving Lives’, National Priorities Guidance
- Crime prevention – Crime & Disorder strategy

However although there are links with these policy initiatives, these need to be more clearly defined and strengthened. Similarly, although the links may also appear compatible, this is not always the case. For example a key objective of public health policy is to reduce health inequalities between population groups. Although FVI has considered the impact of the strategy on the population as a whole, it needs to define more clearly the impacts on those groups disadvantaged by current transport arrangements, and identify how they will address the health inequalities that may be effected.

Evidence of Health Impacts from Documentary Analysis and Profiling

There is much evidence of the positive and negative health impacts of road transport. These include:

Table 5.13 Health Impacts of Road Transport (adapted from the Public Health Alliance, 1991).

POSITIVE IMPACTS	NEGATIVE IMPACTS
Enabling access to: • Employment • Education and training • Shops • Recreation • Social support networks • Health and other services • Countryside	• Traffic injuries • Air Pollution • Noise and Vibration • Stress and anxiety • Danger • Loss of land and planning blight • Severance of communities by roads • Reduction in physical activity

In addition to these main impact areas, road traffic also contributes to climactic change. It accounts for a significant proportion of CO_2 emissions to the stratosphere (25% in European countries) and is therefore directly responsible for some of the global changes in the environment. These changes are predicted to have important health implications for populations well beyond the location of the traffic (McMichael, Haines & Sloof, 1996).

Road Traffic-related Accidents and Injuries

3,559 people were killed and 42,967 were seriously injured on the UK's roads in 1997. In total, there were over 300,000 road casualties, resulting from nearly 240,000 accidents (DETR, 2000). Of the deaths, 180 were child pedestrians, one of the highest rates in Europe (1.22 deaths per 100,000) (DETR, 1998). This toll of death and injury is widely tolerated, whilst far fewer casualties resulting from other modes of transport are deemed unacceptable.

Road-related injuries affect certain groups disproportionately, with pedestrians, cyclists and motor-cyclists at higher risk of death and injury than other road users. In 1997 for every 100 million kilometres travelled 150 motorcyclists were killed compared with 89 cyclists and 4 drivers. Some social groups are also disproportionately affected: for example, children from the "lowest" socio-economic group are five times more likely to be killed as pedestrians than those in the highest (Roberts et al, 1996) whilst men over 65 years born in the Indian sub-continent and Ireland are more likely to die on roads than those born in the UK (Acheson et al, 1998). There are also geographical inequalities: in 1996 death rates from motor vehicle traffic accidents varied from 59 per 100,000 in London to 122 per 100,000 in the East Midlands.

Whilst the health effects of pollution are more pervasive, the impact of road-related injury is more dramatic and grievous for those involved: the effects of a sudden violent death on the bereaved can be devastating. Those who survive road traffic accidents are frequently left with permanent disability, as well as feelings of guilt or anger, the consequences of which also affect their families and the services that assist them after the event.

Advances in car design, particularly over the past two decades, have resulted in much safer vehicles and have no doubt reduced the number of fatalities and serious injuries on the roads. Traffic calming measures and safety campaigns, particularly against drink-driving, have also contributed to saving lives. However, no matter how sophisticated vehicle design becomes and how much assistance is given, the ability of the driver will remain a key determinant of the safety of road transport for as long as they retain ultimate control over the vehicle. Speed in particular increases the risk and severity of accidents; research has demonstrated that a 1% reduction in speed results in a 3% reduction in the frequency of accidents (European Transport Safety Council, 1995). In addition to this, length, flow level, number/type of junction and links are also road traffic accident determinants (DMRB, 1997).

Health Impacts of Road Traffic-related Air Pollution.

The industrialised world is perennially draped in a shroud of photochemical smog, discharged from factories, power stations and motor vehicles. Although clean air legislation in the UK has consigned the acutely lethal sulphurous winter fogs of the fifties to history, modern smog continues to contribute to acute and chronic cardiorespiratory disease (Godlee, 1991). Vehicle exhaust fumes contain a potent mix of toxic chemicals: airborne particulates carry acidic gases into the lungs; sulphur and nitrogen oxides irritate the airways, causing bronchospasm and bronchitis; carbon monoxide reduces the capacity of blood to carry oxygen, causing headaches, precipitating arrhythmias, and retarding foetal growth; and benzene causes leukaemia. When smog reacts with sunlight it produces ozone, which causes coughing, nausea, headache, irritation of the eyes, and, at higher concentrations, damages lung function. Although most car-related air pollution is worse in inner cities, levels of ozone are often highest in rural areas, which lack the ozone-scavenging urban pollutant nitric oxide.

Much of the constituent chemicals in smog are produced by motor vehicles and the industries involved in their manufacture (Royal Commission on Environmental Pollution, 1994). Road traffic produces over a fifth of the carbon dioxide, a third of the airborne particulates and volatile organic compounds, half of the oxides of nitrogen and virtually all the carbon monoxide in the air. A 1999 WHO report concluded that car-related pollution kills twice as many people each year as car accidents (WHO, 1999). Long-term exposure to this pollution results in thousands of premature deaths from respiratory or heart disease each year, and causes hundreds of thousands of extra hospital admissions for bronchitis and asthma attacks.

Car-related pollution is, predictably, most severe close to roads and junctions and in urban areas; these areas may be doubly disadvantaged in that they are often deprived areas as well (Hedley et al, 1998; DETR, 1997; DETR, 1993). Transport-users most prone to exposure from air pollutants are car-users, followed by bus-users and then pedestrians and cyclists. Long term exposure to air pollutants is associated with respiratory and cardiovascular diseases, including in children, and may lead to reductions in life expectancy. Potentially, and actually carcinogenic substances, such as particulates and benzene, can increase long term cancer risks (WHO Europe, 1999).

The main pollutants are particulates (PMs), sulphur dioxide (SO_2), ground level ozone (O_3), nitrogen oxides (N0x), carbon monoxide (CO), volatile organic compounds (VOCs) and lead.

Recent evidence indicates that particulates in urban areas is responsible for 8,100 premature deaths (all causes) per year, and for 10,500 hospital admissions (brought forward and additional) for respiratory diseases per year (COMEAP, 1998); an estimated 20-50% of PM_{10s} (particulates with diameters of less than 10um – the most harmful to health) in urban areas are from motor vehicles (NETCEN/DETR, 1997). A long-term study in the US has associated death rates from lung cancer, heart and respiratory disease with long-term exposure to particulates (EPA, 1996). Black smoke from diesel engines contributes to neoplasmic and non-neoplasmic diseases, such as asthma and has been classified as probably carcinogenic (IARC, 1996). Approximately 60% are from road transport.

SO_2 is one of the principal pollutants associated with acid deposition. Inhalation of SO_2 can cause problems such as broncho-constriction and bronchitis; it is estimated to be responsible for 3,500 premature deaths (all causes) per year and an equivalent number of hospital admissions for respiratory disease (COMEAP, 1998). Most emissions are from fossil-fuelled power stations, but in urban area such as London road traffic may contribute to over 20% of these emissions

Ozone, which is formed by the action of sunlight on nitrogen dioxide, is estimated to be responsible for 700-12,500 deaths and 500-9,900 hospital admissions (COMEAP, 1998). In the UK 50% of NO2 is produced by motor vehicles, with the highest concentrations in busy, urban streets (SNAP, 2000).

90% of outdoor CO emissions are from petrol engines when idling or decelerating; this is particularly associated with high volumes of slow-moving traffic. There is evidence of the independent effect CO has on admissions to hospital for cardiovascular disease (Morris et al 1995) and mortality from this cause (Burnett et al, 1998).

VOCs such as benzene and 1,3-butadiene, pose air pollution problems because of their potential for generating ozone. Most benzene comes from petrol combustion, representing 65-80% emissions (NTECEN/DETR, 1997); ambient UK levels are 1-40 ppb hourly. At levels above 25-30 ppm there is an increased risk of leukaemia. 1,3-butadiene comes mainly from exhausts, representing 77-97% of emissions (NETCEN/DETR, 1997); maximum UK levels are 10 ppb. Evidence from occupational exposure in the rubber production industry indicates an increased risk of leukaemia and lymphoma at levels between 1-10 ppm (SNAP, 2000).

About 60% of lead in air are from petrol combustion (NETCEN/DETR, 1997). However human exposure to lead is highly dependent on other sources such as food, water and dust, for example absorption rates are enhanced by poor diet. Children are at particular risk from exposure as it is more readily absorbed and impairs normal intellectual development (British Lung Foundation, 1998).

Air pollutants are also believed to exacerbate the symptoms of chronic asthmatics and provoke acute asthmatic attacks, however it is believed to be relatively unimportant compared with other factors such as infections and allergens. They are also not believed to cause asthma (COMEAP, 1995).

In addition, to the direct effects of air pollutants on health, there are impacts on the quality of life of people affected by air pollution in terms of their inability to carry out their usual activities, or go to work. In a recent trans-national study it was estimated that the total cost in 3 countries including loss of quality of life from illness or premature mortality, cost to the health services, loss of production and the intangible costs of pain, grief and suffering was E27 billion per year (Kunzli, 2000).

Health Impacts of Road Transport on Community Networks.

The road network provides access for people to educational, health, social and leisure services. Children are increasingly reliant on road transport, both public and private, for travelling to and from school. In terms of access this may be a positive effect, and has potential benefits in terms of safety, however, it also reduces the amount of physical exercise undertaken by children and increases congestion. The NHS relies heavily on road transport, as do all the emergency services. It has been estimated that NHS related journeys, by staff, patients and visitors, account for 5% of all car journeys in the UK (Mindell, 1999). Whilst the number of journeys necessary may be reduced through better planning and organisation, the NHS and social services will for the foreseeable future require road transport to function.

The growth of car user-orientated retail and leisure developments, and the consequent closing down of local facilities such as cinemas, shops and post-offices, has increased reliance on road transport for access to these services. Whilst this trend is in many ways regrettable, and although the balance may be redressed, it is likely that in the immediate future the out-of-town developments will remain the focus of many peoples' leisure activities.

In addition to providing access to services, roads also provide access to the countryside, national parks, estates, the seaside and other valuable resources for living. They allow people to maintain family and social networks, both local and national; to visit other parts of the country; and to travel to the continent. Whilst rail, air and sea links also have an important role in this regard, road transport affords a higher level of access than any other mode of transport.

In providing access to services and people road transport has an important role in maintaining the social and mental well being of the population. In addition to this purely functional role, road transport is also in itself a pleasurable activity for many. It could be argued that such benefits are more likely to accrue at the luxury end of the car market with vehicles that are less economical, so that only the more affluent gain the benefit, whilst everyone suffers from the damage to the environment. However, even cars at the economy end of the scale can provide their owners with satisfaction, and this needs to be recognised.

The access to services afforded by road transport in general, and cars in particular, is not universal. The ability to gain access to other people, goods and services and the countryside is reduced for people without a car: they are dependent on walking, cycling or a public transport system which could be cheaper and better, especially outside normal working hours. Access to a car is unevenly distributed between groups in the population: women, young people, older people, people belonging to ethnic minority groups, people with a disability and people experiencing poverty are less likely than others to own a car. Restricted activity results in less social interaction among residents living on streets with heavy traffic compared with those living where traffic is light, leading to less “social capital”. In the case of very busy roads, people become reluctant to even cross them, leading to “community severance”. Reluctance to walk and cycle exacerbates the restricted access to people, goods and services of those without a car, and encourages more car journeys among those with a car, including escort journeys to school.

A study in San Francisco (Appleyard & Lintell, 1972) found that residents in a street with light traffic (2000 vehicles per day) had three times as many friends in the same street, and twice as many acquaintances as residents with heavy traffic (16000 vehicles per day). People in streets with less traffic felt very much at home and part of the community, compared with those on streets with heavy traffic (BMA, 1997).

The importance of social support mechanisms in ameliorating the effects of stress, and promoting psychological wellbeing is well documented (Siegrist, 1997; Siegrist, 1986; Power et al). Lack of social support has been postulated to be one of the social variables contributing to heart disease prevalence (Greenwood et al, 1996; Hemingway & Marmot, 1999). Poor social cohesion may be a contributory cause of crime, and increase the risk of depression or susceptibility to infection (Kennedy, Kawachi et al, 1997; 1998).

In addition to the volume of traffic affecting social networks, there are other road transport factors that also contribute to social exclusion: the cost of transport, vehicle design, infrequent and inaccessible public transport services, road safety.

Health Impacts of Road Traffic-related Noise Pollution.

The volume of noise generated by road transport, whilst generally not reaching levels injurious to hearing, does impact on health in several ways. It causes annoyance, speech interference, sleep disturbance, impairment of educational performance, and mental health effects. Deleterious effects are related to the duration, frequency and timing of the sound, and relatively low noise volumes can still impact on health. These health effects can be difficult to quantify, however, as they are highly subjective.

Exposure to sound levels between 55-65 dB, can cause serious annoyance, interference with speech, potential learning problems in children and sleep disturbance (DETR j, 2000; WHO, Europe, 1999). With very loud sound levels (65-75 dB) there is a slight increase in risk of cardiovascular disease and hypertension (Babish, 1998; Olsen & Kristensen, 1991), and at high frequencies (4,000+ Hz.) noise-induced hearing loss occurs (DETR j, 2000).

Road traffic is often the main source of noise, except for people living near airports or railways (Stanners & Bordeau, 1995). It is known that in addition to there being a different response to specific noise levels from different individuals, there are also different health effects according to the environment people are in, for example school, work, or home; sensitive time periods, such as week ends or night time; and to locations that amplify the effects of noise, for example streets with high buildings (Dora, 1999).

Health Impacts of Road Transport on Physical Activity

One detrimental effect that is perhaps more common in the case of car drivers and passengers is lack of physical activity. To counterbalance this, people in higher social classes are more likely to be physically active in their leisure time: they are more likely to drive to a gym and peddle a stationary bicycle. Physical activity has health benefits in reducing the incidence of coronary heart disease, diabetes, obesity, hypertension, osteoporosis and depression. Overall in England in 1990-91 only a third of men and a quarter of women achieved the minimum level of exercise recommended[v] by the Health Education Authority (HEA, 1992).

Children, particularly girls, tend to spend less time engaged in physical activity as they get older: two-thirds of girls have low levels of activity by the age of 15 (DOH, 1998). The increase in road traffic volumes has led to growing restrictions on the independent mobility of children (Appleyard and Mintell, 1972). The perceived road safety dangers, primarily from increased traffic volumes, have also influenced behaviour, resulting in less physically active adults and children (BMA, 1992). Poor air quality is another road transport factor influencing physical activity – people are less likely to cycle or walk in polluted environments. Land use and planning has also favoured access for private vehicles, contributing to this reduction in physical activity levels (HEA, 1999).

A low level of physical activity is one of the four main risk factors for heart disease and stroke. It has been estimated that if the population as a whole exercised at the frequency and intensity levels recommended, one third of all coronary heart disease and stroke could be avoided. Physical activity can also reduce the risk of non-insulin dependent diabetes, osteoporosis, obesity, hypertension and cancer of the colon. In addition physical activity can reduce the symptoms associated with anxiety and mild depression, as well as enhancing self-esteem and cognitive function (Glennister, 1996). By increasing flexibility, balance, strength and co-ordination with exercise it can enhance the independence of people with mobility issues (Morris & Hardman, 1997, Rejiski, 1996; HEA, 1995; Shepherd, 1995). It has been estimated that the health gains from cycling, in particular out weigh the health risks from, for example accidents and pollution, by twenty to one (Hillman, 1993). Other studies have also indicated that the benefits of cycling far outweigh the risks from accidents (BMA,

[v] Moderately intense physical activity for at least 30 minutes on at least five days of the week.

1997). Hillman asserted that this could be increased even further by the provision of safer cycle routes. If walking and cycling are to become more common means of transport, a culture shift towards a more active style of living is needed, supported by appropriate national policies to improve the safety of pedestrians and cyclists (National Forum for Coronary Heart Disease Prevention, 1995).

Health Impacts of Road Transport on Employment

Whilst work can also be injurious, it is in general good for a person's health, offering a purpose and structure to life, income, social support and a means of participating in society (Jahoda, 1992). The automotive industry employs over 100,000 people in the UK, and accounts for over 5% of GDP and 10% of exports. Thousands more are employed in haulage, construction, repair and servicing, public transport and other road-related industries. In addition, the road network provides a means of commuting for millions of people who do not directly rely on the automotive industry for employment.

This reliance of many jobs on the motor industry can cause problems, for example when the demands of the car market and the decisions made by large multinationals lead to job losses. It can also be problematic when attempts are made to tackle the negative health effects of motor vehicles, such as pollution, as there are many vested interests in maintaining high levels of production. However, for those whose livelihood is provided by road transport, the health impacts are generally positive.

Other Health Impacts of Road Transport.

Historically, changes in land use and planning have favoured access by private vehicles at the expense of other modes of transport, particularly cycling and walking (HEA, 1999). The development of land for the construction of new, or widening of existing highways is another example of the impact of road transport on the environment, and ultimately health.

The primary purpose of transport, including road transport, is to enable access to people, goods and services; however, lack of transport may damage health by denying access to these. The 1991 Census (ONS, 1991) showed that one third of households have no car, and these tend to be households on lower income. People in rural areas tend to have access to a car, whereas people in urban areas tend to rely on public transport more. In addition to this geographical inequality in access to transport, certain population sub-groups are disproportionately disadvantaged:

- Women
- Children
- Disabled people
- People from ethnic minority groups
- Older people
- People with low socio-economic status (especially in rural areas).

As a consequence, their opportunities for work and training are limited (Power, 1996; Ong et al, 1998), they tend to pay higher prices, and have a restricted range of goods available to them (Piachaud & Webb, 1996), and have limited access to health care facilities, particularly in rural areas (Watt et al, 1994).

The cost of rail and bus fares has increased by nearly one third in real terms since 1980, whereas motoring costs have decreased by 5% (DOT, 1995), further impacting on these disadvantaged groups.

Trends in Road Transport.

As described in section 4, the movement of people and freight has increased dramatically in recent decades, with an increase in private car use of 2.6% and a reduction in rail use by 0.4% in Europe during the 1990s (EUROSTAT, 1997). There has been a post-war decline in walking and cycling in the UK, partly as a result of a sense of increased danger from the rise in motor vehicle volume. Cycling accounted for nearly 25% of all road traffic in 1951, but in 1991 was just 1% (BMA, 1997). The number of miles walked has also declined, on average by 17% between 1975/6 and 1994.

In the UK, the 1997 National Road Traffic Forecasts (DETR, 1997a) predicted road traffic growth between 24% and 51% by 2016.
The Government's White Paper, 'Transport 2010: The Ten Year Plan' (DETR, 2000a) seeks to reverse this growth and forecasts a reduction of traffic from these levels in all areas by 2010, to:

- +17% based on the Plan's measures being introduced
- +13% based on the Plan and constant motoring costs - scenario 1
- +17% based on the Plan and charging (inter-urban and local) – scenario 2 & 3
- In addition to reductions in traffic, there are also forecasts of reductions in congestion, currently forecast to be 15%:
- - 6% based on the Plan
- -12% based on the Plan and constant motoring
- -7% to -9% based on the Plan and charging

The introduction of all three illustrative scenarios would reduce these even further, +12% for traffic and –15% for congestion.

The Plan's measures to achieve this include,

- increasing rail use by 50% of 2000 levels
- increasing bus use by 10%
- tripling the number of cycling trips
- increasing rail freight's share of the freight market to 10%

There are a number of other policies that underpin, support or are dependent on 'Transport 2010' to reduce the rate of traffic growth and the negative effects on the environment and health. These are described in section 4.3.

Trends in Road Traffic-related Air Pollution

In response to the trends of increasing air pollution, as well as the growing scientific evidence and public concern about the adverse effects of air pollution, the National Air Quality Strategy (NAQS) was published (DETR, 1997b). This has set standards for air pollutants from all sources, including road traffic. Exhaust emissions are the predominant source of air pollutants from road traffic, although tyre and brake emissions are estimated to be responsible for approximately on tenth of all PM_{10} emissions. There have been a number of policy measures taken in the 1990s to reduce this through the introduction of mandatory vehicle emission and fuel quality standards, including Euro I & II. These European directives have had a significant effect on reducing emissions of CO, hydrocarbons, PM_{10} and NOx from road transport.

Euro III & IV resulting from the Auto-oil research programme, are two further European directives that have set even tighter:

i. limits for emissions from particulates, CO, hydrocarbons and NOx for cars and light vans
ii. specifications for cleaner petrol and diesel, including the prohibition of leaded petrol from January 2000, and lower sulphur (reduced by 10%) and benzene (reduced by 20%) levels in petrol and diesel.

A further Directive is currently being prepared concerning emissions for buses and HGVs.

As a result of the requirements under Euro I there have been various developments in technology, to meet these new standards. The mandatory fitting of three-way catalytic converters to new cars and vans has reduced the emissions of CO, hydrocarbons (including VOCs) and NOx from an individual car by 75%. This reduced overall emissions of CO and VOCs from road transport by 30-40% in the last decade, in spite of the growth in traffic. As more pre-Euro I cars are phased out, these reductions in emission levels are expected to grow. Diesel cars and vans have been subject to similar controls, reducing the level of emissions of PM_{10} and NOx from new vehicles. HGVs and buses have also reduced their emissions by approximately half.

The new Euro III & IV standards will require even better catalytic converters for petrol cars and exhaust after-treatments for diesel cars. Heavy diesel buses and lorries will almost certainly be required to be fitted with particulate traps to meet Euro IV standards. The adoption of these will reduce emissions of NOx by a further 35% and PM_{10} by 40%. However the trend of declining NOx and PM_{10} emissions is expected to slow down after 2010, coming to a halt at 2020 and increasing again as engine and fuel improvements are offset by continuing traffic growth. There is a similar trend for VOCs and CO, with an expected fall to 2015 and a rise after 2019.

Different vehicle and fuel types have different emission profiles. Diesel cars produce more PM10 and NOx compared with similar petrol cars fitted with a catalytic converter. There has been an increase of diesel vehicles into new car sales from 4% in 1986 to 18% in 1996. Petrol cars tend to produce more CO, CO_2 (as they are less fuel-efficient) and hydrocarbons. Their emissions for all pollutants are currently higher than diesel engines in the first few minutes of operation due to the time needed for the catalyst to warm up. However from 2000, new cars fitted with more efficient catalysts to meet Euro III standards will take no more than a few seconds to warm up. According to current forecasts, by 2006 HGVs will have the largest share of NOx emissions. Collectively, by 2005 HGVs and LGVs will be the biggest source of particulates, although the introduction of particulate traps will lead to reductions from this source. Buses are also know to be a significant source of NOx and particulate emissions; added to this is that they tend to be kept on the road longer than other vehicles.

These projected emissions do not take into account the policy measures included in ‘Transport 2010’, other policies for emission or fuel standards, or further technological developments.

New Technologies and Fuels affecting Air Quality

Several alternative fuels and technologies that may reduce air pollutant levels are already available (Cleaner Vehicles Task Force, 1999a). These include:

- Ultra low sulphur petrol (ULSP) and Ultra low sulphur diesel (ULSD)
- Natural gas (LNG and CNG)
- Liquefied petroleum gas (LPG)
- Electricity

ULSP is only available at a few sites currently, but will reduce NOx emissions. Very importantly it allows the introduction of the direct injection petrol engine technologies, which also enhances fuel efficiency, reducing CO_2 emissions. ULSD can result in reductions of up to 40% in emissions of particulates from existing vehicles. Because of its low sulphur content, it also offers the opportunity to use technology, such as particulate traps, which can further reduce emissions. It is believed that these are the fuels most likely to be in use ‘well into the next century’ (Cleaner Vehicles Task Force, 1999b).

Alternative fuels, such as LNG, CNG and LPG, have the potential to reduce emissions from PM_{10} and NOx as they are considerably lower from gas-powered vehicles than their diesel counterparts. Evidence suggests that the use of LPG in buses can reduce PM_{10} emissions by 61%, NOx by 76%, CO by 33% and hydrocarbons by 44% (NSCA, 1998). There are also benefits for switching from petrol, but these are not as significant.

Electric vehicles can also offer environmental benefits, producing zero emissions from their point of use, but increased emissions at power stations. However they currently have a relatively limited range. Some evidence from Japan, however, indicates they can be used as a source (25%) of electrical power during peak demand periods (Kempto & Kubo, 2000).

Hybrid electric vehicles use both electric motors and a petrol or diesel engine to drive the vehicle. Hybrids are currently on the market in Japan with plans to introduce them into the UK. Manufacturers’ evidence indicate a 10% reduction in emissions and fuel savings of 50% compared to conventionally powered vehicles (Cleaner Vehicles Task Force, 1999b; Nakata, 2000). There is also no need for dedicated recharging infrastructure as the petrol or diesel engine can recharge its battery.

The development of hybrid vehicles has necessitated technological developments in drivetrain system components such as high-efficiency high-specific power electric motors and controllers; load levelling devices such as ultracapacitors and flywheels; direct injection diesel and Otto cycle engines; and advanced batteries, such as lithium-ion and Nickel/metal hydride.

Further developments in hybrid vehicles indicates that series hybrid vehicles have lower emissions while parallel hybrid vehicles can significantly reduce fuel consumption. Currently cost and market considerations favour parallel hybrid vehicles (Gutmann, 1999).

Fuel cell technologies are continuing to develop. They generate electricity by combining oxygen from the air with hydrogen, which is stored onboard the vehicle either in compressed form or in a hydrogen-rich fuel such as petrol or methanol. When the fuel is pure hydrogen the emissions are just water vapour. If it is petrol or methanol, the emissions are CO_2 and very low levels of NOx and CO. As well as their air quality advantages they are also very energy efficient and quiet. There are still some safety and commercialisation issues to overcome before their introduction into the market place (Cleaner Vehicles Task Force, 1999).

In addition to the above, improvements to conventional engines through particulate traps, catalytic converters and more efficient combustion, as well as the introduction of light weighting will also help to improve air quality. However, it needs to be noted that the development of new technologies has not always resulted in benefits to health and the environment. For example newly developed diesel engines with lower CO_2 emissions produce many ultra-fine particles, which it is now suggested are responsible for the adverse health effects of particulate matter (Peters et al, 1997).

Trends in Road Traffic- related Noise Pollution

Historically, setting noise emission standards for new vehicles has been the method of restricting noise pollution from traffic and other sources. A series of European measures has meant that since 1990 maximum noise limits have been halved from the previous decade. Additional reductions in traffic noise were realised through the implementation of a further EU directive in 1996. Future vehicle noise standards are currently being developed. The reductions in noise emissions from the vehicles is important in urban areas where the mechanical operation of the vehicle is the major source of noise; however with the continuing growth of traffic the reductions in noise levels are likely to be eroded. In the future improvements in noise levels for vehicles travelling at high speed will need to look at the noise generated from the impact between the tyres and the road surfaces.

Noise emissions vary with vehicle type; typically the noisiest are the largest vehicles, because of the large engines, but also diesel engines tend to be noisier. Gas powered vehicles can considerably reduce noise levels, for example an HGV running on gas can be up to 6 dB(A) quieter.

The Government is trying to get a better understanding of the impacts of traffic noise and has commissioned a 3 year study to examine the health and related effects of noise.

Trends in Road Vehicle Technology Development affecting Safety and Congestion: Telematics

Pressure on the transport networks from increased traffic volume and reduced investment in highway infrastructure has led to interest in transport telematics. These systems consist of the application of communication and advanced control systems within vehicles and highways. Within the vehicle sensors can be used to control the powertrain (engine fuelling, ignition and transmission), and suspension, braking and traction control. They are currently used to enhance safety, for example through airbag deployment, and are likely to be introduced on wheels and tyres for safety purposes, as well as to disconnect fuel pumps and batteries in the event of a crash. There is also development in vehicle mounted devices to sense the environment, such as radar and image-based systems, which will enhance safety even further. Highway-based sensors for measuring speed and vehicle presence will aid safety and will also provide driver information on traffic congestion (Turner & Austin, 2000). This includes routing and guidance functions, such as the Global Positioning System (GPS) for in-car navigation (Ochienig, 1999); area traffic control and electronic tolling are other applications (Chatterjee & McDonald, 1999). However there have also been concerns about the safety and usability of in-vehicle systems, which is currently being addressed through standards, codes of practice and design guidelines (Stevens, 2000). The impact of these systems on travelling patterns and behaviour is limited (Chatterjee & McDonald, 1999) although evidence from the US suggests they may reduce the extent of injury (Berube, 2000). There is also broad international agreement that transport telematics will limit certain transport problems and that extended public transport information should be a priority (Hojer, 1998). The European Union's project SAVE has used product scenarios and computer demonstration/simulation of the human machine interface (HMI) to enable conceptualisation of the HMI of in-car systems (Bekiaris & Dangelmaier, 2000). Other programmes include Prometheus and Drive II (advanced transport telematics programme) in Europe, Intelligent Highway Vehicle System (IVHS) in the US and the Advanced Safety Vehicle (ASV) in Japan (Keller, 1994).

Other New Vehicle Technologies affecting Air Quality: Lightweighting

Other technological developments that impact on safety and fuel consumption, and so ultimately on air pollutant emissions, include the production of new light weight materials for road vehicle body panels. New interstitial free (IF) steel grades containing low levels of carbon and nitrogen have been developed with high levels of formability to make body panels (Hoile, 2000). Earlier developments included aluminium sheet manufacture for car body panels (Decaillet et al, 1990).

International Research into New Road Vehicle/Transport Technologies

Across Europe the motor industry is investing more than £2 billion a year on research and development with world-wide budgets running into tens of billions of pounds ((DETR j, 1999). Investment in UK research is geared to help meet the industry's environmental responsibilities. However, evidence from the Organisation for Economic Co-operation and Development (OECD) suggests that while many technologies already exist, for example to increase fuel efficiency, there is little incentive for manufacturers to build them, since the available technologies can also be used to build larger vehicles for a given level of fuel intensity. It is the latter approach that appears to sell cars in North America and increasingly in Europe and Japan (OECD, 2000). Further evidence in the UK suggests that the public's knowledge-base on transport issues is low and as a consequence consumer behaviour is unlikely to change sufficiently to reduce road transport-related pollution in the short term (Lane, 2000).

5.5 *FVI Decommissioning*

There was insufficient evidence to complete a more detailed analysis of the health impacts of FVI decommissioning.

Although the FVI vehicles will potentially have longer lives than vehicles currently, there will still need to be a vehicle-decommissioning phase. The two options that currently exist are scrap or salvage. Scrapping vehicles has a number of environmental impacts, with potential long-term consequences to health such as land contamination. The evidence on vehicle recycling and the associated health impacts is weaker. Vehicle recycling today is capable of recovering and reusing 75% of the weight of scrap vehicles. The recovery materials such as steel, iron, zinc, aluminium and copper is well established and highly profitable. Non-metallic materials had historically discarded to landfills, however plastics, non-metallic materials, including fluids are also now being recycled, although its profitability is yet to be established. Some trends in the automotive industry may assist in recycling, such as the applications of recycled plastics. Recent research into vehicle recycling initiatives may also help.

6 Discussion and Recommendations

SUMMARY

- There are many positive attributes to the FVI strategy
- There are a number of significant steps that can be taken *immediately* to enhance the health gain of the FVI strategy and minimise the potential health risks
- Priority recommendations are:
  - Extend membership of FV Steering Group, for example bus manufacturers and convene reference groups, for example on occupational health issues
  - Include integrated health and environmental health impact assessment statements on research proposals
  - Ensure compatibility between FVI strategy and Government policy, including health and health inequalities

6.1 Introduction

The FVI strategy is highly innovative. The technological outcomes of this strategy will undoubtedly have significant health benefits for the population as a whole. However it was felt that there were some areas where the health impacts of the strategy had not been considered, for example the occupational health significance of these developments. In addition, there is the opportunity to increase the potential health gain from the strategy, for example by developing a more inclusive strategy planning and implementation process and targeting research resources more appropriately. Finally, as a public funded body, the FVI infrastructure, the strategy and resource allocation needs to be more compatible with other public policy priorities, for example considering the potential health impacts on all vulnerable groups and the potential inequalities exacerbated.

6.2 FVI Strategy Planning

The FVI development process had made significant in-roads to creating new and productive partnerships between industry and research, particularly in academia. However, from the available evidence, it was felt that there is the need to have even wider involvement at the Steering Group level, which would benefit the strategy as a whole. In addition there were data available on a number of areas, such as:

- the number of people employed through the LINK programme,
- the locations of research projects,
- the percentage of resources allocated to projects with a public transport technology relevance,
- the percentage of resources allocated to projects relevant to indigenous road vehicle component suppliers, including organisational development projects,

which would help to monitor the health impacts and public policy-relevance of the FVI.

FVI recommendations:

(i) the membership of FVI Steering Group is extended (as described in 5.2)

(ii) the FVI/IMI LINK research project application process is revised to include integrated *health and environment impact assessment statements* of the project's operation and products/technologies outcomes (relevance to public policy is included in this)
(iii) the FVI management monitor key additional project indicators, for example numbers employed, project locations, resource allocation for public transport relevant technologies, suppliers
(iv) a wider breadth of applications for LINK funding is encouraged.

6.3 FVI Implementation

Consideration needs to be given to the occupational health significance of these technological developments, and their integration into the production/distribution process. It is recognised that the evidence-base on the potential health impacts described above (5.3) needs to be strengthened during the comprehensive HIA and, where appropriate, quantified; this will support or refute the assessments made from the rapid HIA. In addition there are specific gaps in evidence, for example on bus and haulage manufacturing, which need to be addressed in the comprehensive HIA.

Recommendations for the comprehensive HIA:
(i) involve transport economist in assessing likely trends in manufacturing and employment in the road vehicle sector, and the impact on local economies
(ii) involve occupational specialist in assessing likely occupational health impacts on these workers
(iii) involve environmental health impact specialist in assessing environmental impacts resulting from changes in manufacturing processes
(iv) involve health economist in assessing likely impacts on health status and health and social care services, resulting from above
(v) explore opportunities in the UK and Europe for applying quantitative methods to enable estimation of probable risk
(vi) apply qualitative methods to gain more detailed insight into the effects of these changes on the population groups most affected.

Recommendations for FVI:
(i) allocate resources from LINK for skills training of the road vehicle workforce for the future, including sales and distribution staff, to ensure familiarity with new technological developments
(ii) allocate resources from LINK to support organisational and technological developments, and enhance the sustainable competitiveness of indigenous UK suppliers
(iii) plan education and training strategies to re-skill former road vehicle manufacturing operatives

6.4 FVI 'On the Road'

The FVI 'on the road' is likely to contribute to the reduction of accidents, respiratory and heart disease morbidity and mortality, and to the increase in social cohesion and support through reductions in traffic congestion. However, there was no evidence available on the specific outcomes of FVI developed technologies or technology 'beacons', for example on air pollutant emissions or traffic decongestion through simulation modelling, scenario testing or evaluations. As such the specific contribution of the FVI strategy to the existing trends in road vehicle technological development, the impacts on the effects of road transport and the resulting health impacts, is difficult to assess. It was also not clear whether this comparatively small research budget compared to the total European or international research programme budget, was exploiting particular niches in these technology areas. Furthermore, the effect of the use of these technologies on all vulnerable groups (as described in 5.4), and the potential exacerbation of health inequalities needs to be given more thought.

Recommendations for comprehensive HIA:

(i) evidence on FVI technology outcomes is assessed as part of the comprehensive HIA, including working co-operatively with the FVI EIA team

(ii) involve environmental health specialist in assessing environmental and health impacts resulting from the use of FVI technologies, and health economist on the likely impacts on health and social services

(iii) apply quantitative methods to enable estimation of probable risk

(iv) apply qualitative methods to gain detailed insight into effects of the changes identified on the population groups most likely to be affected

(v) the potential health impacts of FVI 'On the Road' on all vulnerable groups is assessed in the comprehensive HIA, with particular reference to the effects on inequalities.

Recommendations for FVI:

(i) analyse public policy priorities and integrate into FVI strategy and funding application process

(ii) identify measures and develop mechanisms to monitor potential environmental and health, including quality of life and well being, impacts from the use of new vehicle technologies on the population as a whole and on vulnerable groups.

6.5 FVI Decommissioning

This is the weakest stage of all with apparently no consideration from FVI, and no evidence on the health impacts of vehicle decommissioning obtained during this rapid HIA.

Recommendations for the comprehensive HIA:

(i) obtain substantive evidence on the potential health impacts of decommissioning new technologies.

Recommendations for FVI:

(i) allocate resources from FVI LINK to investigate the decommissioning of FVI technologies.

Appendix 1: Terms of reference for FVI HIA Steering Group

Appendix 2: Membership of FVI Steering Group

Bath University
Cranfield University
Deawoo Motor Company (now TWR)
DTLR
DTI
EPSRC
European Commission
Federal Mogul
Gren Tek
Highways Agency
Jaguar Cars
Landrover
Lucas Varity
MoD
MIRA
Nissan European Technology Centre
PERA Technology
RAC
Rover Group
SMMT
TRL

Appendix 3: Population projections

Basis for projections

The projections are based on the Registrars General's estimate of the resident population of the United Kingdom at mid-1998 of 59.2 million. This estimate is based upon 1991 Census results, with allowance for subsequent births, deaths, migration and ageing of the population.

The population includes all usually resident persons, whatever their nationality. Members of HM armed forces in the United Kingdom are included, but members of HM armed forces and their families who are abroad are excluded and are treated as migrants when they return home. The opposite applies to foreign armed forces in the United Kingdom.

Table A.1: Base populations for individual countries

Country	Population
England	49 495 000
Wales	2 933 000
Scotland	5 120 000
Northern Ireland	1 689 000
United Kingdom	59 237 000

Source: Government Actuary's Department

Method of projection

The projections are made for successive years running from one mid-year to the next. For each age, the starting population plus net inward migrants less the number of deaths produces the number in the population, one year older, at the end of the year. To this has to be added survivors of those born during the year. Age is defined as completed years at the last birthday.

Migration is assumed to occur evenly throughout the year. For computing purposes, this is equivalent to assuming that half the migrants in a given year at a given age migrate at the beginning of the year and half at the end of the year. The number of net migrants to be added to obtain the population aged x+1 at the end of the projection year therefore consists of half of those migrating during the year at age x and half of those migrating during the year at age x+1.

The number of deaths in a year is obtained by adding half of the net inward migrants at each age to the number in the population at the beginning of the year and applying the mortality rate.

The number of births in the year is calculated by multiplying the average number of women at each single year of age during the year (taken as the mean of the populations at that age at the beginning and end of the year) by the fertility rate applicable to them during that year. The total number of births in a year is assumed to be divided between the sexes in the ratio of 105 males to 100 females, in line with recent experience.

The number of infants aged 0 at the end of the year is calculated by taking the projected number of births, deducting the number of deaths found by applying the special infant mortality rate (indicated by ‘birth’ in the mortality rate tables) and adding half the number of net migrants aged 0 last birthday.

The projections are computed for each of the component countries of the United Kingdom and the results are added together to produce projections for England & Wales, Great Britain and the United Kingdom.

Fertility assumptions

The numbers of births for the projections are obtained by applying the appropriate fertility rate to the average number of women at each age during each year of the projection period. The mid-year to mid-year fertility rates used, and a summary for five year age groups are given in the results section. Because cohort fertility rates are more stable than those for calendar years, the fertility rates used in the projections are derived from assumptions relating to the year in which women were born. The assumptions are summarised in the tables below.

The assumptions about completed family size are based on family building patterns to date, from the General Household Survey about the number of children women expect to have and other relevant evidence. The family sizes to be achieved by younger cohorts are highly conjectural, but for this projection it has been assumed that average completed family size, for the United Kingdom as a whole, will continue to decline until around the 1975 cohort and eventually level off at 1.80 children per woman.

The timing of births within the reproductive periods of each cohort also has an impact on the number of births in any particular year. For the United Kingdom as a whole, the average age at motherhood was 26.0 years for women born in 1945, but with the childbearing of more recent cohorts falling at younger ages and rising at older ages, it has been assumed that the average age will rise to 28.5 years for those born in or after 1975.

Mortality assumptions

The mortality rates for the first year of the projection, 1998-99, are based on the best estimates that could be made in the autumn of 1999 of the numbers of deaths at each age in 1998-99. The mortality rates for later years are based on the trend of the rates in the years up to 1998-99 in England and Wales, but assuming that the proportionate differences between the levels of mortality in the four countries of the United Kingdom, as shown by their experience in 1995-97, will continue unchanged. It is assumed that the rates of reduction in mortality rates, which currently vary considerably from age to age, will tend towards a reduction of about 0.5 per cent a year by 2032-33.

The mortality rates used in the projections represent the probabilities of death between one mid-year and the next, according to a person’s age last birthday at the beginning of the period. The top line marked ‘birth’ gives the appropriate rate of "infant mortality", i.e. the probability of a new-born child not surviving until the following mid-year. This is about 85% of the full, first year of life infant mortality rate used in official statistics.

Migration assumptions

Table A.2: Assumed net migration totals for the United Kingdom and constituent countries

Country	1998-99	1999-2000	2000-01	2001-02 & later
England	+182 000	+161 000	+111 000	+91 000
Wales	+9 000	+7 000	+5 500	+5 500
Scotland	-3 000	-1 500	-1 000	-1 000
Northern Ireland	-3 000	-1 500	-500	-500
United Kingdom	+185 000	+165 000	+115 000	+95 000

Source: Government Actuary’s Department

These assumptions have been derived from analyses of recent trends in civilian migration to and from the United Kingdom as well as cross border migration between the constituent countries of the UK. Age and sex distributions have been calculated according to data from the International Passenger Survey (for migration to and from the United Kingdom) and from the National Health Service Central Register (for migration between the constituent countries of the UK). Separate age distributions are applied for each sex. Equal numbers of male and female migrants are assumed for the long-term.

Appendix 5: Transport projections

Transport models

The projections outlined in this rapid appraisal are largely based on data used by the DETR in compiling **Transport 2010, the 10 Year Plan.** This data was in turn derived from the following models:

- a new model of passenger rail demand prepared by the Department;
- recent modelling work for the shadow Strategic Rail Authority (sSRA) on the future demand for rail freight;
- the London Transportation Studies (LTS) model;
- the National Road Traffic Forecasts (NRTF) framework of models;
- new models of rail emissions prepared by the Department; and
- models of concentrations of key local air pollutants developed from those used to inform the Government's Air Quality Strategy for England,
- Scotland, Wales and Northern Ireland ('Air Quality Strategy')

Assumptions

Predictions in the 10 Year Plan are based on some key influences and core assumptions:

1. Economic growth will increase demand for business and personal travel as well as increase the requirement for freight movement. In line with the latest HM Treasury assumptions, it is assumed that the economy will grow at 2.5% per annum between 2000 and 2005, and by 2.25% per annum between 2005 and 2010.

2. The predictions are based on the latest Government projections for population growth (0.3% pa), household growth (0.7% pa) and household composition.

3. Decisions about the amount of travel and the choice of mode are also affected by the relative costs of different means of transport. These costs include both money costs (for example fuel and fares) and the costs associated with, for example, travelling time, unreliability and overcrowding. The measures in the 10 Year Plan influence many of these costs. But there are other costs that cannot be directly influenced and on which assumptions are made. These include the world price of oil. The industry consensus is that the long run sustainable price lies between $14 and $18 per barrel at 1999 prices. Modelling assumes that the price of oil falls from $28 in 2000 to $16 in 2010 (at 1999 prices).

The Government’s 10 Year Plan for transport also makes several assumptions when estimating the level and phasing of private investment and the revenue from congestion charging over the 10 Year Plan period.

Total private sector transport investment over the ten-year period is estimated to reach £56 billion. Where investment decisions are taken wholly by the private sector with little or no direct subsidy from Government, the estimates are those of an industry body or reflect actual orders placed. Where investment decisions are taken jointly by the private and public sector with direct subsidy from the Government, estimates reflect assumptions about the levels and mix of public and private investment.

The mix and profile of public and private investment will be subject to change as specific projects emerge from the railways refranchising process and the SRA's Strategy, Local Transport Plans, the Mayor's Transport Strategy and multi-modal studies. All public investment will be assessed using the New Approach To Appraisal.

The 10 Year Plan includes £9 billion of private investment in local public transport and roads. Assumptions include:

£5 billion of private investment in buses and coaches. These estimates have been taken from information provided by the Confederation of Passenger Transport (CPT). They reflect increases in patronage expected as a result of the bus infrastructure investment expected in Local Transport Plans;
Around £1.3 billion, about 50% of the assumed total investment in light rail projects, is expected to be provided from local authorities, developer contributions and from the concession value of schemes. Some of the local authority contribution is expected to fall outside of the 10 Year Plan period. Actual spend will depend on the particular schemes that come forward in Local Transport Plans;
Increases in local transport investment through Private Finance Initiative (PFI) schemes, assumed to rise to £200 million by 2003/04 and to £500 million by the end of the period. No assumptions are made about the types of project that will be carried out under PFI schemes. However, these could include investment in bus infrastructure, light rail, road schemes, road maintenance, and street lighting. The assumptions have been informed by discussions with Public Private Partnerships Programme Limited ('the 4Ps').

Multi-modal studies and roads
The 10 Year Plan provides the resources to fund the outcome of the multi-modal and roads-based studies. The outcome is likely to be a mixture of improvements to road, rail and other public transport infrastructure or services. On roads, the level of resources identified in the 10 Year Plan would be sufficient to fund a targeted programme of road widening of around 5% (360 miles) of the trunk road network. The Plan assumes that around 25% of new investment by value will be funded by the private sector using Design, Build, Finance and Operate contracts. Combined with private finance projects already in the pipeline this gives total private investment of £2.6 billion. Other types of transport solutions could be expected to involve a similar proportion of private finance.

Local and London charging
The 10 Year Plan assumes that London and a number of local authorities will introduce local congestion charging or workplace parking levy schemes from 2004/05 onwards. The net revenues include:

- £1.5 billion in London. Actual numbers and timing will depend on decisions taken by the Mayor as part of his transport strategy. He is currently aiming to introduce congestion charging before the date assumed in the Plan;

- £1.2 billion income to local authorities in the rest of England. This assumes that 8 of the largest towns and cities introduce congestion charging schemes and a further 12 bring in workplace parking levies. This is assumed to be spent on a mix of local public transport and road investment. It excludes charging revenue assumed to cover local authority contributions to light rail projects of around £200 million.

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