EVALUATION AND LIMITATION OF IMPACTS SOCIAL AND ENVIRONMENTAL FOR ROAD NETWORKS AND TRANSPORT POLICIES

CONTENTS

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1. INTRODUCTION

1.1. The working group on evaluation and limitation of social and environmental impacts for road networks and transport policies

One work area of the PIARC Committee 14 on "Sustainable development and Road Transport" concerns the evaluation and limitation of impacts of road networks and transport policies.

The Road is life (Via Vita). This are the words contained in the logo of the World Road Association established in 1909.

Road networks are essential infrastructure that support the economic growth in a region and provide social benefits to the people.

With this as their moto most developed countries, and more precisely the engineers have through the years provided for the design, construction, maintenance, management and operation of roads. The primary need and in many cases the only point of interest was of transporting people and goods via the road network.

Meeting the increasingly higher demand for mobility, however, has in recent years required engineers to organise transport in a more sustainable manner and to conceptualise the infrastructure required for such with a better view toward its effect on the environment and on society.

We believe that transport, at the heart of the economy and the daily live of the citizens, can meet environmental requirements whilst contributing to the well being of society through an appropriate mix of policies.

In Europe, the environmental and transport Ministers of the fifteen European Member States have debated on the need to further integrate their respective policies in order to promote sustainable transport. Sustainable development is a very important concept to be incorporated in any transportation policy, and has been defined by the United Nations as a development that allows people to meet the needs of the present without compromising the ability of future generations to meet their own needs. This concept has been developed over the past ten years, and linked to a number of principles embracing the environment, the economy and society. Today, the integration of the social dimension as well as the initial environmental dimension has resulted in an underlying definition of sustainable development increasingly directed towards the implementation of a number of principles conductive to the improvement of well-being, greater social justice and the preservation of ecosystems.

As widely recognized, this new concept is becoming a priority. In 1998, more than two thirds of passengers in Europe were transported by road, and nearly fifty per cent of goods. The share of road transport is forecast to continue growing. These trends are worrying.

The rapid growth of transport demand has implications for mobility, congestion, as well as the efficiency and competitiveness of the economy in general. The consequences for the environment in particular are very significant as transport contributes an ever-growing share of CO_2 and other greenhouse gas emissions responsable for climate change. Transport was indeed responsible for nearly a third of CO_2 emissions in Europe in 1998 and is predicted to increase by another 40 per cent by 2020. More generally, transport has a growing impact on air quality, noise, biodiversity, cultural heritage, water pollution, nature protection, etc.

Worldwide growth of the economy and population will reinforce these trends, putting further pressure on the environment.

Fundamental and rapid decisions will therefore need to be made if we want transport to contribute positively to the economic growth in the world whilst complying with other obligations to integrate environmental concerns in our policies so as to improve the quality of environment.

During the meetings of the Technical Committee 14, the members discussed many issues related to the impact of Road Networks and Transport Policies on health, local pollution, biodiversity, landscapes, vehicle regulation and promotion of less polluting vehicles, and decided to design a questionnaire for respondents to gather information. This exercise fits well in the main aims of the Strategic Theme II of the World Road Association : “Transport, Livability, and Sustainable development".

The purpose of the questionnaire is to gain a better knowledge of the social and environmental impacts of transport policies, to improve processes enabling social acceptance through public debate, and to provide concrete answers to the questions highlighted by the survey.

The questionnaire was designed to obtain replies which will take into account the situations and specific requirements of developing countries, or countries in transition, and of rural of isolated areas.

In accordance with the goals of the World Road Association’s Strategic Plan, the following fields of action have been outlined by the Technical Committee 14:

Topic 1: To explain the effects of road networks and transport policies on **health** (as defined by the respondent, as related to transportation); explain any system in place for monitoring the effects on health, and do you have results of studies in this field ?

Topic 2: To explain the effects of road networks and transport policies on **local pollution** (air, noise, surface and ground water, soil, etc…); explain any system in place for monitoring the effects on local pollution; explain the results of studies on this field.

Topic 3: To explain the effects of road networks and transport policies on **biodiversity** (the number of living species and their habitats in one given space as related to floral and animal); explain any system in place for monitoring the effects on biodiversity; explain the results of studies in this field.

Topic 4: To explain the effects of road networks and transport policies on **landscapes** (surroundings that we experience including artificial, cultural, natural, etc); explain any system in place for monitoring the effects on landscapes; explain the results of studies in this field.

Topic 5: To explain the effects of road networks and transport policies **on vehicle regulation** (regulation on vehicle emissions through standards, fuel quality, maintenance and fleet composition); explain any system in place for monitoring the effects on vehicle regulation, and explain the results of studies in this field.

Topic 6: explain the effects of road networks and transport policies on **promotion of less polluting vehicles** (less polluting vehicles and alternative fuels, including recycling, noise, etc); explain any system in place for monitoring the effects of the promotion of less polluting vehicles, and explain the results of studies in this field.

In August 2001, the inquiry was sent to all PIARC countries and independent organisations, with a request to participate in the discussion about the six major topics.

More particularly the working group wanted to know which definitions, approaches of the problem or available information PIARC countries, and independent organisations considered important to be included in the final report.

1.2. General remarks

It's clear that the answers given by the countries that have been invited to reply to the inquiry are of different quality and value in regard to their structure and their contents.
A broad overview of the response to the survey is given by the table hereafter.

Some of their answers were very short and did not provide any available information for inclusion in our final report. Therefore some of the references that seemed to be relevant to the report are not mentioned.

We thank the following administrations and/or road research organisations for having provided information:

ACTIONS POINTS		**1**			**2**			**3**			**4**			**5**	
COUNTRY	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Australia	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Austria	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Belgium	X	X	X	X	X	X	X	X	X	X	X	_	_	_	X
Canada (Quebec)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Czech Republic	X	X	X	X	X	X	X	X	X	X	X	_	X	X	X
Denmark	X	X	X	X	X	X	X	X	X	X	X	X	_	_	_
Finland	X	X	X	X	X	-	X	X	X	X	X	_	_	_	_
France	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hungary	_	_	_	_	_	X	X	X	_	X	_	_	X	X	X
Japan	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Madagascar	X	X	_	X	X	_	X	X	_	_	_	_	X	X	_
Malaysia	X	X	X	X	X	-	X	X	X	X	X	X	X	X	X
Morocco	X	X	X	X	_	_	X	X	X	X	X	X	X	X	X
Mexico	X	X	X	X	X	X	X	X	X	X	X	_	X	X	X
Nicaragua	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Norway	X	X	X	X	X	_	X	X	X	X	X	X	X	X	X
Romania	X	X	X	X	X	_	X	X	X	X	_	_	X	X	X
Saudi Arabia	X	X	X	X	X	X	X	X	X	X	_	_	X	X	X
Spain	X	X	_	X	X	X	X	X	X	X	X	_	X	X	X
The Netherlands	X	X	_	X	X	X	X	X	X	X	X	X	_	_	_
Turkey	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
United Kingdom	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
United States of America	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

« Action items »:

1 Health
2 Local pollution
3 Biodiversity
4 Landscapes
5 Vehicle regulation and promotion of less pollution vehicles

« X » : 1 Effects on road networks and transport
2 Systems in place for monitoring the effects
3 Results of studies

2. HEALTH

2.1. Preface

On the question "Effects on road networks and transport policies on health", information has been received from 20 countries.

As there can be large differences in a country, there can also be differences in the urban and in the interurban approach.

It is important to note that it seemed impossible to make a general survey over the different countries, because of the differences in their replies in terms of structure and contents.

Some of the answers were very short and did not provide any available information for inclusion in the report. Therefore some of the references that seemed to be irrelevant to the report are not mentioned.

Nevertheless it's important to mention that only a few countries put an accent on the "positive aspects" of road networks: for instance easy access to all social-economic infrastructure, and more specifically access to the health centers. Most of the countries mentioned only the "negative aspects" of road networks: for instance road safety with road toll and road trauma, exposure to diverse air pollutants, noise nuisance, which all have impact on the health and well being of the people.

2.2. Effects of road networks and transport policies on health

2.2.1. Australia

Urban

One of the key health issues is improvement of road safety. Australia, overall, has a very good road safety record. Since 1970, the road toll has trended downwards, although in the last few years, it has plateaued somewhat. Road networks and transport policies can have an important effect on the incidence of road trauma.

Road transport can also either reduce or increase the level of physical activity by urban dwellers and so is related to a series of health conditions. However, it is difficult to separate this from the range of other causal contributors.

Exposure to traffic noise and vibration may result in adverse health effects such as physiological effects on the cardiovascular system, sleep disturbance and lack of concentration.

Air pollutants (including motor vehicle emissions) can impact on the health and well-being of some susceptible members of the community, by exacerbating existing illnesses such as respiratory or pulmonary disease.

Interurban
Driver fatigue and stress over long distances and long driving hours, and also road crash trauma are two major effects mentioned in the Australian report.

2.2.2. Austria

Urban and interurban
Exposure to diverse air pollutants may have a negative effect on human health. These effects include i.a. the irritation of outer mucous membranes, impaired lung fuction, damage to diverse other bodily organs and the immune system and may even cause malignant tumours and acute death. Based on the current knowledge, the main potential of cancerogeneic effects is attributed to four emission components of car exhaust gases:

- soot particles,
- benzene,
- polycyclic aromatic hydrocarbons (PAH),
- formaldehyde, acetaldehyde, 1,3-butadiene and ethene.

Suspended particulates will be one main problem of the future. More and more studies verify, what WHO assumed in 1997, that even very low concentrations of small particulates (e.g. PM 10 and PM 2.5) may have negative effects on one´s health, so that the identification of reference values is very difficult. On the other hand, in many agricultural areas the pre-contamination of dust particulates is currently exceeding new implemented limits, thus it would be very difficult to futher build on new roads in that pre-contaminated areas.

For noise, the nuisance is frequently accompanied by a feeling of powerlessness. The kind of experience made by persons with specific noise nuisances and their sources has strong influence on the subjective level of nuisance.

Continuous sound levels of up to 75 dB (A) generated by traffic give rise to extra-aural activation effects acting via the central nervous system. Discrete aural effects are only possible at sound levels from around 65 dB (A) on in the form of slower hearing recovery (in case of noise at work or due to leisure activities above 75 dB (A).

Apart from direct damage to the inner ear (temporary loss of hearing or permanently impaired hearing, regularly not caused by road traffic) there are a series of indirect effects of noise that may give rise to various health disorders or impaired well-being. In this context influences on autonomic functions are of prime concern. The entire organism is stressed by noise and may respond by narrowing capillaries, raising the heart rate and the blood pressure. The number of persons undergoing treatment due to elevated blood pressure can be significantly higher in areas subject to strong traffic noise compared to relatively quiet residental areas.

According to an assessment by an emission protection body, the relative contribution of the pollutants to the overall cancer risk due to air pollutants in urban centres is as follows: Diesel soot particles: 63.1%, PAH: 15.8%, benzene 8.1%. This means that almost 80% of the carcinogenic contributions to air pollutants are due to these three pollutant groups. These calculations also include the emissions of domestic heating and industrial sources that are difficult to exclude.

2.2.3. Belgium

Urban and Interurban
Following effects have been mentioned by the Flemish Authority:

- especially respiratory disease
- same effects of traffic noise may give rise to various health disorders, stress, sleep disturbance and possible cardiac disease;
- possible links from road maintenance chemicals impacts on groundwater and soil to human health;
- direct health effects of road networks due to accident fatalities and injuries.

2.2.4. Canada (Quebec)

Urban and Interurban
The Ministry of Transport of Quebec has mentioned the following effects:

- *Seed plants containing pollen grains*
  These are yearly plants, pollen of which are the main causes of allergic seasonal pollinosis in north east of North America. Pollinosis or hay fever touches more than 10% of the population of Quebec and causes economical damages of over 49 million dollars on a yearly basis.

- *Smog*
  Atmospheric pollution caused by ozone emission can only be observed during summer (from May to September). The problem is a regional issue since it covers a territory of 69 000 km² (4.5%) of the total territory of Quebec. Transportation sector is the main cause for NO emissions, counting for 74% of total emission out of which 35% are to be attributed to cars and other lightweight means of transport.

  For COV emission, the transportation sector is responsible for more than 30% of total emission in 1990, and cars and other lightweight means of transport represent 76% of total emission. A smog period in Montreal may increase the number of hospitalisations of elderly people over 65 by 20%, and the number of deaths related to respiratory problems by 6%.

2.2.5. Czech Republic

Urban: Air pollution impacts, traffic noise and water contamination.

Interurban: Soil contamination, water contamination.

2.2.6. Denmark

Urban and Interurban

In Denmark, no formal definitions of health issues have been defined explicitly connected to transport. Nevertheless, 3 issues are at least implicitly mentioned as health issues:

- *Traffic accidents*
  In 1999, the Danish Government published the Governments Health Care Programme 1999-2008. Road traffic accidents were here treated together with for example tobacco, alcohol and overweight as one of 17 primary health risks.

  In 2000, approximately 500 persons were killed and approximately 4 300 persons were seriously injured in road traffic accidents in Denmark. The problem is not normally divided into an urban an interurban problem on a national scale. Nevertheless, statistics show that approx. Two thirds of all accidents with persons injured occurs in urban areas.

  The government has initiated an action plan to reduce the number of accidents and fatalities. The Ministry of Transport aims to improve safety and improve the road network. The Road Safety Commission advises the Ministry of Transport on road safety and furthermore an Accident Investigation Team for road accidents has been established. Encouraged by the Government action plan for road safety, the Road Safety Commission has established a national vision for road safety work: 'Every accident is one accident too many'.

- *Noise*
  Noise is traditionally dealt with only implicitly as a health problem even though the primary impact is a health issue. The Danish Environmental Protection Agency has a desire to emphasise focus on the health part of the problem. Traditionally, the impact is expressed in terms of the number of dwellings exposed to a certain noise level from transport. The problem is biggest in urban areas but exists wherever dwellings are close to traffic giving a certain noise level. No calculations of the direct health impact have been carried out.

- *Air pollution*
  In recent years, pollution from particles has been in focus as a health problem. Also pollution with substances like nitrogen dioxide, ozone and some groups of hydrocarbons are treated as health issues. The problem is only relevant in urban streets with neighbouring buildings.

  The health impact is only described implicit. The way of dealing with the problem can be described as follows: emissions - air quality (concentration of substances in the air) - exposure - dose and impact. The main knowledge is concentrated on the first three items, and no overall knowledge exist regarding the last two items.

2.2.7. France

Urban and Interurban

a. The management of health issues caused by pollution started with the introduction in France of the air quality law, dated 30 December 1996. This new law modified the law of 10 July 1976 on the protection of nature and on impact assessment. Any impact assessment, and in particular any road project, must include from now on a health part, representing:

   - the analysis of potential effects of this project on human health (and more specifically effects on the local population). This study has to state the direct and indirect impact on water, air, noise, climate, etc. These impacts have to be measured and considered from a relative as well as a cumulated point of view, and a study has to be provided on the number of local people implicated by the works.
   - a study and a concrete definition on what measures are being taken to limit the effects of the project on health.

b. On the issue of the strategic environmental evaluation and the impact of the new plans and programs on the environment:

   - the health aspect/element is already present in the urban domain for urban mobility plans and the reports on city roads, and more particularly by air pollution studies, studies of noise exposure and evaluation studies on energy consumption.
   - a European decision, which is now still on the way, will expand this preoccupation to all plans or programmes concerning transportation.
   - as yet no plans have been made to evaluate the effect of transport policies on health.

2.2.8. Finland

Urban and Interurban

The foremost and most direct health effects are due to accidents: fatalities and injuries. Indirect impacts result from air pollution (especially respiratory disease) - in a longer time trame, also from greenhouse gas emissions (through the consequences induced by climate change) - from noise (annoyance, sleep disturbance, possible cardiac and other disease) and through social/psychological responses.

There are also possible links from road maintenance chemicals use (for instance deicing salt, solvents) impacts on groundwater and soil to human health. For most chemical impacts, noise-related disease and social/psychological impacts, however; the causal chains are very long and to some extent speculative, and it can be very difficult to identify road transport impacts in the framework of overall lifestyle or land use impacts, especially in urban areas. Social isolation and neurotic behaviour can be caused by heavy traffic in the neighbourhood, but also by fragmented lifestyles or bad town planning. Lack of physical exertion, leading to overweight and cardiac problems, may follow from car dependency, but also from many other causes.

2.2.9. Japan

Urban and Interurban
Recent court rulings stated that vehicular emissions of particulate matters had been the cause of local health problems. The road safety situation is a matter of serious concern, considering the fact that annual death toll of automobile accidents remains about 10.000 in recent years due to the inadequate provision of safe pedestrian sidewalks in Japan. The 1997 fatality accident rate was 1.53 deaths per hundred million vehicule-kilometres traveled.

2.2.10. Madagascar

Urban and Interurban
Exposure to traffic has effects on health. The road infrastructure and the quality of the vehicles are concerned. Roads and existing vehicles have for the moment a negative effect on the environment, and of course for the health of the people.

2.2.11. Malaysia

Urban
Traffic noise, disturbance and annoyance.
Emission of noxious gases, for example carbon monoxide, lead, etc.

2.2.12. Morocco

Urban and Interurban
The road network allows a fast and easy access to the decentralised zones, and provides access to all social-economic infrastructures, and more specifically with health centres. This in turn will increase the level of frequency and thus will reduce the mortality rate for deaths caused more specifically by complications in giving birth and poisoning.

2.2.13. Mexico

Urban and Interurban
No regulation exists for noise generated by traffic operation on the federal road network. The Instituto Mexicano del Transporte (IMT) (Mexican Transportation Institute) has initiated local studies for noise level measurements. With the total results among several studies, we intend to achieve a federal regulation or estándar in order to contribute to minimizing this impotant effect on health.

2.2.14. Nicaragua

Urban
There is a law on gas emission by cars. There doesn't exist a systematic control on the monitoring of gas emission by cars. Car concentration in certain city zones is causing health problems to local inhabitants. A certain part of the population (men, women, children and elderly people) suffers from health hazards due to respiration problems. More specifically, the people who trade on the streets, sometimes during 8 to 10 hours

daily, are concerned. The car park has grown in a disproportional manner in comparison to the viability in the cities.

Interurban
The number of accidents occurred in inter urban areas has had an important impact on the health and the mortality rate of the population. The main reason for these accidents is speeding, especially on the motorways or roads that were recently built.
Another important role was played by the mechanical state of the vehicles implicated in these accidents.

2.2.15 Norway

Urban
Road safety is given high priority in Norway and is health problem number 1 as related to roadtraffic. About 1200 people died or were serious injured in traffic in 2001. Air pollution is a health problem in cities in terms of lung and asthmatic diseases. Noise annoyance is a major problem for which it is set up a national target.

2.2.16. Romania

Urban
- air pollution
- traffic noise
- stress by disturbing of pedestrian traffic and the difficult access to the habitat, and to the agricultural areas.

Interurban
- traffic noise
- air pollution.

2.2.17. Saudi Arabia

Urban
The rapid expansion of the road network in the Kingdom of Saudi Arabia, and the reliance on motorized transport, in particular road transport, continues to increase in Saudi Arabia, resulting in adverse environmental and health effects. In addition, traffic-accident statistics in the Kingdom reveal a significant increase in the total number of fatalities and severe injuries due to the increase in the number of accidents.

Interurban
The rapid expansion of the road network in the Kingdom of Saudi Arabia, and the reliance on motorized transport, in particular road transport, continues to increase in Saudi Arabia, resulting in adverse environmental and health effects. In addition, traffic-accidents statistics in the Kingdom reveal a significant increase in the total number of fatalities and severe injuries due to the increase in the number of accidents.

2.2.18. Spain

Urban

The followings effects have been mentioned by the Spanish authorities.

a. Air pollutants

- Particles
  These penetrate the body through the respiratory system. Their toxicity varies according to their size and chemical composition. The smallest are the most dangerous, since they can reach the alveoli of the lungs, where they remain for a long time.
- *Sulphur dioxide (SO_2)*
  The majority of its effects are linked to the irritation of the respiratory system. Concentrations in excess of 25 p.p.m, cause an immediate cough and severe irritation of the eyes.
- *Carbon monoxide (CO)*
  This is a toxic gas which, in high concentrations, can cause death, due to the way in which it combines with the haemoglobin in the blood, causing a reduction in the capacity of the latter to transport oxygen.
- *Nitrogen Oxides (NOx)*
  These constitute a potential threat to health. Their effects are not usually significant in so far as concerns the concentrations which may be produced as a result of the vehicle traffic. When high concentrations occur, alterations take place in the respiratory tract, affecting the sense of smell, and causing nasal irritations, discomfort, acute respiratory pain, pulmonary oedema and, sometimes, death.
- *Ozones (O_3)*
  The presence of ozones in the lower part of the atmosphere is due, above all, to the photochemical action of solar radiation on nitrogen oxides and hydrocarbons. Their impact on the health of human beings varies according to the concentration. The first symptom caused is nasal and throat irritation. In higher concentrations they cause acute fatigue, lack of co-ordination and pulmonary oedema. Exposure on a long term basis may cause chronic respiratory diseases.

b. Noise:

The effects of noise are threefold:

- *Physiological*:
  - Auditory: - Loss of hearing
  - Non-auditory: - Increased blood pressure
    - Increased heart rate
    - Increased respiratory movement
    - Muscular tension
    - Release of hormones into the bloodstream.
  - On activities: - Difficulty in oral communication
    - Sleep disturbance
    - Difficulty in carrying out tasks
    - Low performance at work.

- *Psychological et psycho-sociological:*
  - Irritability
  - Agitation
  - Fatigue.

c. Traffic accidents

Interurban
The effects on health on the areas lying between cities are much less significant, due to the fact that it is very difficult for the same levels of pollutions to be reached as are produced in the urban environment. The effects on the health of humans are similar to those produced in urban areas, under equal levels of pollution.

2.2.19. The Netherlands

Urban and Interurban
Transport has an influence on the health of children when they live in the neighbourhood of the road (400 m). The symptoms are bronchitis, coughing up phlegm, wheezy breathing and allergy.

2.2.20. Turkey

Urbain
Within the cities private vehicles and public busses are mostly used. While in Ankara and Istanbul, underground metro and railroad transportation also has a very important place.

Interurban
The transport policy gives the greatest importance to the highways in Turkey. Mostly the highway projects are in the form of rehabilitations projects, since the road network is almost completed. Also there is a new motorway construction study.

2.2.21. United Kingdom

Urban
Transport has positive and negative impacts on health. Positive effects are through enabling access to employment, shops, recreation, social support networks, health services and the countryside and through physical activity. Negative effects occur due to traffic injuries, air pollution, noise and vibration, stress and anxiety, danger, loss of land and planning blight and severence of communities by roads.

Interurban
As for urban but some adverse impacts may be less marked due to a lower population density near interurban transport routes.

2.2.22. United States of America

a. Answer given by the United States Federal Government

A number of vehicle emissions are associated with adverse human health impacts including particulate matter (PM), carbon monoxide (CO), ozone (combination of volatile organic compounds or VOCs and oxides of nitrogen or NOx), and air toxics.

- *Particulate Matter*

PM is the term for solid or liquid particles found in the air. Some particles are large or dark enough to be seen as soot or smoke. Others are so small they can be detected only with an electron microscope. Major concerns for human health from exposure to PM-10 include: effects on breathing and respiratory systems, damage to lung tissue, cancer, and premature death. The elderly, children, and people with chronic lung disease, influenza, or asthma, are especially sensitive to the effects of particulate matter.

- *Carbon Monoxide*

CO is a colorless, odorless, poisonous gas. Carbon monoxide enters the bloodstream through the lungs and forms carboxyhemoglobin, a compound that inhibits the blood's capacity to carry oxygen to organs and tissues. Persons with heart disease are especially sensitive to carbon monoxide poisoning and may experience chest pain if they breathe the gas while exercising. Infants, elderly persons, and individuals with respiratory diseases are also particularly sensitive. Carbon monoxide can affect healthy individuals, imparing exercise capacity, visual perception, manual dexterity, learning functions, and ability to perform complex tasks.

- *Ozone*

Ozone damages sensitive lung tissue, reduces lung function, causes lung inflammation, increases susceptibility to respiratory infection, and increases sensitivity of asthmatics to allergens (e.g., pollen) and other bronchoconstrictors. Symptoms from short-term exposure to ozone can include coughing, eye and throat irritation, and chest pain. Long-term health effects from ozone exposure can include accelerated aging of the lungs, reduced elasticity of the lungs, and scarring of lung tissue.

- *Air Toxics*

Air toxics, which are know as “hazardous air pollutants” (HAPs), are those pollutants known or suspected to cause cancer or other serious health or environmental effects.
A number of adverse non-cancer health effects, such as eye, nose, and throat irritation, have also been associated with exposure to elevated levels of these air toxics. Nonroad mobile sources (such as tractors and snowmobiles) emit air toxics as well.

- *Noise*

Noise levels in areas immediately adjacent to highways in the United States are not intense enough to create permanent hearing damage. These traffic noise levels are typically in the range of 60-80 dBA $L_{eq}(h)$. It is recognized that highway traffic noise can create other health-related effects, such as stress, an increased heart rate, decreased rest, etc. However, information on these types of health effects is only available through the medical community.

b. Answer given by the Washington State Department of Transportation (WSDOT)

- *Road Rage*

WSDOT publicizes not only incidents of road rage on the web and on news casts, but offers strategies to combat road rage incidents, such as providing alternate routes. WSDOT also addresses the causes of road rage. WSDOT's transportation newsletter, The Express, discusses what can be done about road rage in the following issue.
http://www.wsdot.wa.gov/communications/express/archives/9709-EXP.pdf

- *Landscape Buffers*

Landscape buffers, as opposed to noise walls, not only absorb and decrease noise, they reduce the anxiety suffered by many motorists, as vegetative landscaping buffers can be aesthetically pleasing. The WSDOT Roadside Manual discusses the effect of the roadside landscape on driver fatigue, and integrating vegetation with noise walls, and can be accessed at
http://www.wsdot.wa.gov/eesc/cae/design/roadside/RoadsideManual.pdf

- *Air Quality*

In the 1980's, the EPA set air pollutant limits at pm_{10} (particulate matter with microns less than 10 in aerodynamic size). Through scientific research, the pm level is now pm2.5. However, these standards have not been implemented by WSDOT because of a lawsuit brought on by industry groups charging the new pm levels do not take into consideration economic factors for businesses. As such, WSDOT is still adhering to the pm10 levels.

c. Answer given by all United States Respondents

- *Wisconsin*

Urban and Interurban

Road development may affect ground water by discovering or releasing pollutants that have leaked into the soil. Once a pollutant reaches the groundwater, it is more difficult to clean up. WisDOTs policy is to avoid contaminated property acquisitions and to clean up contaminants within properties it owns. Noise from the road may disturb adjacent property.

- *Kentucky*

Urban and Interurban

Leaking of aging underground storage tanks (UST) containing oil, gasoline and diesel fuels sited on Kentucky Transportation Cabinet (KYTC) facilities.

- *Utah*

Urban

The state Division of Air Quality monitors for the standards list of pollutants (CO, SO_2, NOx, Ozone, PM10, PM2.5). The Division maintains approximately 25 monitors across the four urban county areas. The state has installed a traffic monitoring system for Salt Lake County. A highway Incident Management Team has responded to spills in the interest of public health and safety.

Interurban
Div. of Air Quality performs sparse monitoring outside of urban areas, and also assists the U.S.Forest Service and National Park Service with selective monitoring in high use areas. Emergency management and security systems in place for both urban and interurban areas with particular emphasis on international events (2002 Olympics, World Cup Races, etc).

- *New-York State*

Urban and Interurban
Ozone Forecast and ozone action days program initiated by NYSDOT to provide community awareness/information and promote alternative activities on potentially high ozone days. See:
http://www.dec.state.ny.us/website/dar/bts/ozone/oz4cast.html

- *Florida*

Urban and Interurban
Florida does not have any programs or policies that differ substantially from other state DOTs in this area; the primary area relating to public health and transportation deals with crashes. Crash data is collected and monitored through safety programs much like other states, and improvements are implemented to reduce crashes based on identified causes and by the applications of uniform standards that meet driver expectations. Another area effecting health and transportation is air quality, and the programs in Florida again, are similar to those in other states.

- *Connecticut*

Urban
Possible effects of air pollutants on low income, or minority populations especially with regard to asthma.

Interurban
Effects of roadways upon sole source aquifers is of concern (two in Connecticut) as is the impact upon water supplies from crashes involving vehicles carrying hazardous materials.

2.3. Systems in place for monitoring the effects

2.3.1. Australia

Urban
At the Commonwealth level systems for monitoring the effects on health are mainly in relation to road trauma and are undertaken by the Australian Transport Safety Bureau (ATSB).

Monitoring for other health effects is mainly undertaken at State level and it is anticipated that States/Territories would be in a better position to respond to this.

Monitoring of ambient air quality is undertaken by the individual States to varying degrees and also targeted monitoring around specific road projects to ensure compliance with the appropriate air quality standards

The National Environment Protection Measure for Ambient Air Quality defines national standards that are based on health risk assessments.

Austroads currently publish national performance indicators on:

- fatalities per population and vehicle kilometres travelled
- persons hospitalised per population and vehicle kilometres travelled
- social costs of serious casualty crashes per population and vehicle kilometres travelled persons hospitalised per population and vehicle kilometres travelled
- other monitoring is done through hospital data collection of injury, attendances and admissions for respiratory and cardiovascular disease and death certificates.

Road crash trauma and pedestrian injury statistics extensively monitored and analysed. Other monitoring is done through hospital data collection of injury, attendances and admissions for respiratory and cardiovascular disease and death certificates.

Interurban
National studies of driver fatigue and stress factors.
Less monitoring is undertaken in interurban areas.
Road crash trauma and pedestrian injury statistics extensively monitored and analysed

2.3.2. Austria

Urban and Interurban
No direct monitoring of the effects on health is currently done in Austria, only studies. An Austrian National Health Plan was carried out in order to indentify and summarize all the effects on health and suggesting possible ways for solution. Directly only air pollution and water contamination is monitored in a network of measuring stations.

2.3.3. Belgium

Urban and Interurban
Traffic noises, detected by the administration of Publics Roads or by the population are systematically measured. Emissions of air pollution are measured in two separated ways, in order to have the possibility to interprete the results and to detect the air pollution by traffic.

2.3.4. Canada (Quebec)

- *Seed plants containing pollen grains*

The effects of pollen of lice grass are well known in literature. In order to determine the importance of allergic pollinosis in Quebec, Quebec has made inquiries on health and well being of the inhabitants of Quebec. Population is informed during summer periods on the quantity of pollen in the air by means of meteorological bulletins (on radio and on television) and through newspapers. Pollen counts are installed in Montreal and in Quebec.

- *Smog*

A network of ozone measuring in Quebec allows us to state on pollution levels. Smog periods are announced in weather reports, on the radio, on television and in all written media.

2.3.5. Czech Republic

Urban and Interurban

Measuring data, modeling data, GIS presentation, evaluation with health protection limits.

Typical examples:

- A*ir pollution.* Periodical complex air pollution modeling in Prague in period 1992-2001-ATEM project. (http://www.wmap.cz/atlaszp) (http://www.atem.cz) (Including emissions and concentrations from transport-CO, Nox, PM,SO2).
- *Noise*. Prague noise modeling EKOLA : (http://www.wmap.cz/atlaszp)

2.3.6. Denmark

Urban and Interurban

- *Traffic accidents*

Statistics are produced on a regular basis with background in police reports from all police registered accidents on the roads. Furthermore, some hospitals register on a voluntary basis all traffic accidents based on the patients coming to emergency units at the hospitals.

- *Noise*

No specific monitoring of health impact is carried out. Monitoring of the noise exposure and the impact on dwellings are carried out systematically on all national roads and on many county and municipal roads. The monitoring is based on calculations based on the Nordic method for prediction of road traffic noise.

- *Air pollution*

Monitoring of health impact is only monitored implicit by having measurements of the concentration of certain substances in selected urban areas in a national monitoring programme. Furthermore, a few scientific research programmes include measurements of air pollution concentrations. Finally, scientific research is going on aiming at creating valid explanations on the link between exposure and the health impact.

2.3.7. France

Urban and Interurban

Such measures generally follow other measures taken in the field of limiting and checking effects of local pollution causing health problems. But it is not enough to respect limits or norms imposed on each type of pollution. For instance:

- as to noise, it is not the medium norm that is important, but the peak values registered during the night that are disturbing people's sleep;

- as to gas emission (air), it isn't important whether the medium of permitted values is reached or not, but the accumulated effects of exposure that have an influence on health.

The same goes for water, soil, etc.
Limitation and check-up methods thus have to be related to indications that are new, adapted and to the point, and based on epidemiological studies.

Some measures to be considered:

- Restrictions on heavy traffic by night
- Treatment of streaming water
- Reduction of gas pollution by imposing limits on traffic volumes and on speed

- Restriction of agriculture in the immediate surroundings (<40 m) of the most heavily circulated motorways.

2.3.8. Finland

Urban and Interurban
Traffic accidents and their impacts are monitored within the traffic safety surveillance system. Other health impacts are monitored only as part of overall public health, not specifically related to transport. However, noise and air pollution levels, as well as groundwater salt levels, are followed and the data is used, together with specific surveys in public health and studies.

2.3.9. Japan

Urban and Interurban
Environment will be improved through aiming at achievement of environmental quality standards for air quality and noise.

For details on improvement measures, see the section below on Local Pollution.

In those localities where courts adjudicate the causal effects of roadside environmental hazards, the environmental quality standards need to be achieved earlier than elsewhere or some special measures such as those under Automobile-Nox/PM Law need to be applied.

2.3.10. Madagascar

Urban and Interurban
Environmental studies have been undertaken for recent road projects.
The "National Madagascar transport Plan 2003-2015" will take in account the results of studies concerning environmental problems of road networks.

2.3.11. Malaysia

Urban
Conduct social survey and monitor physical traffic noise.
Encourage the use of unleaded petrol and impose higher rates for leaded petrol (indirect action).
Encourage car pooling and impose higher tolls on single occupancy vehicles (indirect action).

2.3.12. Morocco

Interurban.
Enquiries at the level of health services before and after having realised a road project.

Enquiries made among the people who use the roads.

2.3.13. Mexico

Urban and Interurban
In case of the Federal Transport Passenger Carriers, the operator of each unit is required to have a medical test before they start their travel, for monitoring their health condition. The Federal Transport Freight Carriers, operator are required to approve a medical test in order to obtain the driver license and each time renewal is required.

2.3.14. Nicaragua

Urban and Interurban
Before programming and constructing new roads, studies on the Environmental Impact must be carried out which include recommendations on strictly monitoring gas and dust production during construction. It is compulsory to apply hygiene and safety rules in order to safeguard the health of the workers and occupants of the construction area during the works. Even though no systematic monitoring system exists, the University for Engineering -and even other organisations have carried out several air quality studies. The result has been that various sites were mentioned that presented a high risk profile for human health.

2.3.15. Norway

The costs concerning deaths and major injuries are calculated. Health costs (welfare costs) from air pollution are calculated for road projects. Methods for cost calculation are being further developed. Noise: costs for very annoyed persons are calculated for road projects.

2.3.16. Romania

The law on Public Health Assistance contains the rules concerning the quality of the air and the level of noise.

The Environment Protection law also contains a component concerning national health by stipulating that a preliminary evaluation is necessary of the possible effects any transport activity may have on health.

Urban and Interurban.
Each year a national synopsis is made of the air quality in all residential zones of the mayor urban concentrations. This synthesis makes no distinction as to what causes air deterioration: road traffic or other activities (industry, construction).

Each year a synopsis is made of the noise level due to traffic in the residential areas of the department.

A methodology to evaluate the risks and the impact of irritating polluting materials on the population's health is being developed (on azotic oxides, sulphuric dioxides, ozone, air particles…).

An information system concerning the effects of air pollution on the population's health is also being developed.

2.3.17. Saudi Arabia

Urban and Interurban
The Kingdom of Saudi Arabia has recently enforced the wearing of seat belt into its law. The Kingdom of Saudi Arabia is in the process of eliminating the use of leaded gasoline by motorists.

2.3.18. Spain

Urban
In all large cities there are control stations for the monitoring of atmospheric pollution, which enable the identification, at any given time, of the status of pollution in so far as concerns the most significant pollutants. This enables the adoption of the necessary means, (e.g. reduction or prohibition of traffic) to avoid the levels of pollution exceeding the maximum levels set by law.

Interurban
Broad legislation exists on the protection of the atmosphere.
In order to control pollution levels, Spain has the Spanish Network for the Monitoring of Atmospheric Pollution, residual or background, on a regional level, which aims to meet the objectives set in the EMEP programmes (European Monitoring Evaluation Programme), BAPMON (Background Air Pollution Monitoring Network) of the World Meteorological Organisation, and of the CAMP Program (Comprehensive Atmospheric Monitoring Programme), deriving from the Oslo and Paris Conventions. The measurements obtained through this network enable the identification of the levels of residual or background pollution, in a region, as well as the evaluation of transport from sources located at great distances.

2.3.19. The Netherlands

No system in place.

2.3.20 Turkey

Urban
Ministry of health continuously monitors the SO_2 and Particulate Matter (PM) emissions in every province all over Turkey.

Interurban

2.3.21. United Kingdom

Urban

The Integrated Transport White Paper (1998) sets the framework to reduce pollution from transport, improve air quality, encourage healthy lifestyles by reducing reliance on cars and making it easier to walk and cycle more, reduce noise and vibration from transport, and improve transport safety.

Local transport plans are key to the delivery of integrated transport. Local authorities consult widely (including health care providers) on the production of these plans. The plans set out strategies for promoting cycling and walking, measures to reduce social exclusion, green transport plans and improvements to local transport.

Local Agenda 21 is the mechanism for promoting sustainable development locally. All local authorities have been asked to produce these strategies, many of these address transport (access and air pollution) as a priority.

Health Improvement Programmes are the formal mechanism for recording how the health and local authorities and their partner organisations plan to take forward the objectives of the Government's health strategy. These include addressing health inequalities. Many of the these include transport goals.

The National Cycling Strategy and National Walking Strategy have set targets to increase the number of trips by these modes.

Interurban

As for urban, although obviously there is less scope for walking and cycling.

2.3.22. United States of America

a. Answers given by the United States federal government

The health effects of transportation-related pollutants are determined by special epidemiological and clinical studies as well as routine monitoring of health statistics for chronic pulmonary infection, heart disease, and cancer.

The main method the U.S. uses to protect and assess air quality is through the EPA's Ambient Air Monitoring Program. Air quality samples are generally collected for one or more of the following purposes:

- To judge compliance with and/or progress made towards meeting combient air quality standards;
- To activate emergency control procedures that prevent or alleviate air pollution episodes;
- To observe pollution trends throughout the region, including non-urban areas; and,

- To provide a data base for research evaluation of effects: urban, land-use, and transportation planning; development and evaluation of abatement strategies; and development and validation of diffusion models.

The EPA monitors the states' progress in meeting air quality standards by measuring concentrations of criteria pollutants. State and local government monitoring stations across the nation collect direct measurements of pollutants in the air and submit this data to EPA's Aerometric Information Retrieval System (AIRS). The vast majority of these measurements represent the country's heavily populated urban areas.

Highway traffic noise does impact people in local communities. However, the extent of the impact, i.e., the percentage of the population impacted, is unknown. Effective control of the undesirable effects of highway traffic noise requires that land use near highways be controlled, that vehicles themselves be quieted, and that mitigation of noise be undertaken on individual highway projects. The first component is traditionally an area of local responsibility. The other components are the joint responsibility of private industry and of Federal, State, and local governments.

The Environmental Protection Agency (EPA) has established noise emission standards for trucks used in interstate commerce (vehicles used to transport commodities across state boundaries). Noise emissions for all other vehicles, including automobiles, are not regulated.

The FHWA regulations for mitigation of highway traffic noise in the planning and design of federally-aided highway projects are contained in Title 23 of the United States Code of Federal Regulations Part 772. The regulations require the following during the planning and design of a highway project:

1. identification of traffic noise impacts; examination of potential mitigation measures;
2. the incorporation of reasonable and feasible noise mitigation measures into the highway project;
3. coordination with local officials to provide helpful information on compatible land use planning and control.

The regulations contain noise abatement criteria, which represent the upper limit of acceptable highway traffic noise for different types of land uses and human activities. The regulations do not require that the abatement criteria be met in every instance. Rather, they require that every reasonable and feasible effort be made to provide noise mitigation when the criteria are approached or exceeded. Compliance with the noise regulations is a prerequisite for the granting of Federal-aid highway funds for construction or reconstruction of a highway.

b. Answer given by the Washington State Department of Transportation

The Washington State Department of Transportation has initiated a lot of programs and databases concerning following aspects of road safety related to health:

- workzone safety campaign
- mountain pass conditions
- state ferries
- elk crossing
- deer kill
- special needs transit
- roadside garbage and pickup

- rest areas
- noxious weeds
- hazard trees
- dust control
- groundwater protection
- stormwater
- noise
- terrorism.

c. Answer given by all United States Respondents

- *Wisconsin*

Urban and Interurban

Monitors its infrastructure developments by surveying each property to be acquired for contamination. WisDOT may place monitoring wells to help determine whether contaminants from a property have migrated into the publicly owned right-of-way. Noise from the roadway is predicted using FHWA approved standard noise estimation procedures.

- *Kentucky*

Urban and Interurban

Statewide groundwater and stream water quality monitoring by state environmental protection agency.

- *Utah*

Urban and Interurban

Improved traffic flow has contributed to improved air quality in urban areas. The traffic monitoring system reduces congestion, improves commute time, aids in accident investigations, and reduces stress. Nonattainment areas for ozone, CO and particulate matter have been established across the four county urban area in and around Salt Lake City that require transportation projects to conform with SIP.

- *Connecticut*

Urban

The Connecticut Department of Environmental Protection has air quality monitoring stations in some urban areas. Certain size projects require State Indirect Source Air Quality Permits. All projects must meet conformity requirements.

Interurban

Best Management Practices to reduce contaminants in roadway runoff are utilized. In some cases, closed drainage systems are utilized.

2.4. Results of studies

2.4.1. Australia

Urban
Large volume of National and International data on adverse health effects of pollution from road traffic and some Australian studies of urban areas. Details can be provided through the Austroads C14 Representative if required. They collectively show linkages between fine particles, nitrogen dioxide and ozone and negative health outcomes. A recent study covering the health impacts of emissions was undertaken by the New South Wales Environmental Protection Agency. Road trauma studies are used to design safer roads, high-light vehicle defects and develop strategies to reduce the trauma. The Roads & Traffic Authority, NSW competed a study on the effects of road traffic noise on sleep in 2000. Some preliminary results indicate that there were:

- increased heart rate related to noise level but not noise type
- increased blood pressure related to noises of sudden onset but not noise level
- likelihood of awakening related to noise level but not noise type.

Interurban
Road trauma studies provide evidence for improved road design, driver attitudes and vehicles defects and design limitations and adverse health effects.

2.4.2. Austria

Urban and Interurban
As pointed out in the conclusion of the Austrian National Health Plan, great emphasis in research work and technical development should be laid on regenerative filter technology for soot filters and by improving the diesel fuel. Additionally should the reduction of pollutant concentrations to a as low as technical possible level (and not only to meet the limits) be a sort of prevention principle.

For noise the percentage of homes exposed to noise should be reduced below 25% by means of noise protection and traffic-calming measures. Special emphasis should be laid on risk groups and sensitive situations of noise exposure. Intensified research for the application of measurement methods adequate to human hearing (psychoacustics).

2.4.3. Belgium

Urban and Interurban
The Flemish Government decided to increase the use of biocide (reduction of 50% - 1990-2005).

The recycling of used materials is imposed by law, and re-using of recycling materials as well as the valorisation of wastes is a nowadays practice.
The construction of noise barriers is become a current practice to avoid nuisance.

2.4.4. Canada (Quebec)

- *Seed plants containing pollen grains*

The ministry of Transport of Quebec (MTQ) takes part in the Round Table of Quebec on Seed plants containing pollen grains, which main objective is to establish a straight line between many organisations. Their aim is to improve the efficiency of their interventions aiming at checking seed plants containing pollen grains, promoting efficient environmental practices and thus improving the quality of life of allergic individuals.

MTQ has revised its level of exposure in order to take this question in consideration. MTQ has already realised some research projects and is developing other ones in view of an integrated and durable managing of green dependencies. These projects will permit a more ecological managing of green dependencies, and will allow the use of different techniques for the control of seed plants containing pollen grains like for instance the establishment of a competitive vegetal protection.

- *Smog*

MTQ participates in the actions undertaken by Quebec on climatic changes. It also participates with the environmental Committee of the Regional Development Council of the Isle of Montreal as to transport and sustainable/durable development. As a result, an action plan will be put into place. On the other hand, MTQ will participate in the governmental report on the state of the environment.
The subject of smog will be treated in a popular document that will be published on a governmental Internet site by the end of the year 2001.

2.4.5. Czech Republic

Air pollution
*A*ll pollutions total concentrations is decreasing. The share of air pollution from transport is increasing (mainly NOx).

Urban
The sum of emissions from transport does not change rapidly. Increasing volume against technological improvements.

Interurban
Decreasing sum of all kinds of emissions.

2.4.6. Denmark

Urban and Interurban

- *Traffic safety*

Direct information is available in the statistics for road traffic accidents.

- *Noise*

Calculations of noise exposure and number of effected dwellings are made for all national roads, the main part of the regional roads and a major part of urban municipal roads in major towns and cities with the Nordic prediction model.

- *Air pollution*

A monitoring programme covering measurements in the 3 major cities are in function. The actual connection to the impact on health is only dealt with in scientific studies.

2.4.7. France

Urban and Interurban

Some literature already exists: "Air" law dated 30 December 1996 and the ministerial decision 19 on its application (Decision taken by the Environmental Ministry dated 17 February 1998); Methodological description "Air" and its technical appendix.

Adapted exposure indices are being established in all different fields concerned. The indices on what can be tolerated and what can't be tolerated in the matter of health are not yet available in an operational manner, nor are the precise elements of what is at stake as far as health is concerned, based on a scientific study.

2.4.8. Finland

Urban and Interurban

In addition to the large body of traffic safety studies and research, other studies have mainly looked at noise impacts. They confirm international research conclusions (cf the appended abstracts). Some air pollution health impact studies have beem made, identifying the effects of raised pollution levels and dust concentrations in spring (from winter sanding, particulate exhaust emissions and studded tyre pavement wear) on mortality in especially sensitive population groups.

In the study by A Pönkä, M Savela and M Virtanen (Helsinki environment centre publications 2/97), it is held that in Helsinki, in the period 1987-93, taking account of a 5 - 7 day delay in impacts, daily mortality increased by 0,35% when particle pollution levels rose by 10 micrograms/m³, cardiac mortality by 0,41% and cancer mortality by 0,67%. A 10 micrograms/m³ ozone level increase raises cardiac mortality by 0,48%. For persons over 65 years of age, corresponding increases in particulate levels, SO and ozone levels increase daily mortality by 0,08%, 0,52% and 0,35% respectively.

2.4.9. Japan

Urban and Interurban
Lawsuits on roadside environmental problems:

- Nishi-Yodogawa air pollution lawsuit (sentenced at Osaka High Court on July 5, 1995, compromised on July 29, 1998)
- Kawasaki air pollution lawsuit (sentenced at Tokyo High Court on August 5, 1998, compromised on May 20, 1999)
- Amagasaki air pollution lawsuit (sentenced at Kobe District Court on January 31, 2000, compromised on Dec. 1, 2000)
- Southern Nagoya air pollution lawsuit (sentences at Nagoya District Court on November 27, 2000, compromised on Aug. 8, 2001)
- Tokyo air pollution lawsuit (sentenced at Tokyo District Court on October 29, 2002).

According to the ruling, the diesel-powered vehicle manufacturers have no legal responsibility and road administrators are obliged to pay reparations for some plaintiffs living within 50 meters from arterial roads. The Government and Metropolitan Expressway Public Corporation appealed against the ruling.

2.4.10. Malaysia

Urban
Medical records (if any) to study correlation between health and transportation, for example, asthma cases and level of noxious gases due to road traffic.

2.4.11. Mexico

Urban and Interurban
The first pilot noise study generated by the transport operation on federal roads, along Querétaro State highways, noise levels were observed in diurnal periods between 75.0 and 81.1 dB(A), and these levels are highers than other countries regulations. However, it is neccesary to continue to obtain more measurements along other roads in Mexico in order to propose an adequate regulation or national standard.

2.4.12. Morocco

Urban and Interurban.
A recent study realised by the World Bank on rural roads some ten years after their construction shows the following results:

a. The frequency rates in the medical centres have doubled after the roads had been constructed;
b. Road improvement has facilitated medical access and has allowed a better service quality.

2.4.13. Nicaragua

Urban and Interurban
Not many studies are available. Nevertheless, some of those that do exist indicate the areas with major air pollution in some cities. Pollution levels that exceed maximum levels include especially Managua.

Some documentation on this subject is also available in the end term thesis prepared by university students from UNI-UNAN-UCA.

Attempts were made to establish inter ministerial links between MTI-MARENA-MINSA-MECD in order to try to establish capacity and follow up in this matter through the commission on car emission.

The Health Department has registered the increase in respiratory diseases among the population living in the neighbourhood of contaminated places and among people working openly in the street. These surveys were carried out in the hospitals.

2.4.14. Norway

Existing methods for safety, air pollution and noise is documented in Hand book 140 “impact analysis”, Public road administration Norway.

New report on health effects and air pollution costs: SFT Report 1718/2000.

2.4.15. Romania

In Romania no studies have been carried out on the subject of the effects on the population's health.

Urban and Inter urban.
Some studies have been made in a number of cities, which were specifically aiming at high-risk population groups (children between 1 and 9 years old) that were exposed to lead emission caused by road traffic.

2.4.16. Saudi Arabia

Urban
Reduction of accident fatalities and severe injuries.

Interurban
Reduction of accident fatalities and severe injuries.

2.4.17. Turkey

Urban
The measured SO_2 and PM concentrations exceeding the Air Quality Standards are determined and necessary precautions are taken in that specific province to decrease the concentrations.

2.4.18. United Kingdom

Urban and Interurban
There are numerous documents detailing the Government's policy on transport, health and the environment. Further information is available at:

- www.dft.gov.uk/itwp/ncs/ncs.htm on the cycling strategy,

- www.local-transport.dft.gov.uk/travelplans/index.htm on travel plans,
- www.local-transport.dft.gov.uk/schooltravel/index.htm on school travel,

- www.dft.gov.uk/itwp/susdist/index.htm on sustainable distribution,
- www.dft.gov.uk/itwp/logjam/index.htm on road user and workplace charges,

- www.local-transport.dft.gov.uk/walking/index.htm on walking.

2.4.19. United States of America

a. Answer given by the United States federal government

Transportation agencies in the U.S. do not routinely monitor health effects studies, therefore, we are unable to provide extensive information regarding this question. However, listed below are some of the efforts currently being undertaken by the EPA and the Health Effects Institute (HEI) in this area.

The U.S. EPA's Office of Research and Development is responsible for risk assessment, which is the process used to evaluate the degree and probability of harm to human health and the environment from such stressors as pollution or habitat loss. More information concerning studies on various pollutants can be found at:
http://cfpub1.epa.gov/ncea/cfm/nceahome.cfm

In July 2000 the EPA Office of Research and Development issued a "Health Assessment Document for Diesel Exhaust"
(website: http://cfpub1.epa.gov/ncea/cfm/diesel.cfm)

This revised draft assessment of the possible health hazards from human exposure to diesel engine exhaust emissions updates two earlier drafts (1998 and 1994) that were reviewed by the Agency's Science Advisory Board (SAB) Clean Air Scientific Advisory Committee (CASAC). The current draft assessment focuses on health hazards (hazard identification and dose-response analysis for the purpose of characterizing the risk of diesel exhaust exposure), and also provides background information about diesel engine emissions and exposure that is useful for putting the health information into context. EPA risk assessment methods and practices have been followed in identifying possible human chronic health hazards for adverse noncancer effects as well as carcinogenicity hazards.

The HEI is an independent, nonprofit corporation chartered in 1980 to provide high-quality, impartial, and relevant science on the health effects of pollutants from motor vehicles and from other sources in the environment. Supported jointly by the U.S. Environmental Protection Agency (EPA) and industry, HEI has funded over 170 studies and published over 100 Research Reports, and several Special Reports, producing important research findings on the health effects of a variety of pollutants, including carbon monoxide, methanol and aldehydes, nitrogen oxides, diesel exhaust, ozone, and most recently, particulate air pollution. HEI has also been called upon periodically to produce special reports reviewing an entire area of scientific literature on topics such as the health effects of asbestos, diesel exhaust, and oxygenates in fuel. Information concerning HEI reports can be found at the following website :
http://www.healtheffects.org/index.html

c. Answer given by the Washington State of Transportation

- *Bridge Seismic Retrofit*
  A significant amount of research has been conducted to develop retrofit strategies for all types of bridges.

- *Landslides/Unstable Slopes*
  The WSDOT document *Soil Bioengineering for Upland Slope Stabilization* explored alternatives called soil bioengineering in order to stabilize unstable slopes and shallow rapid landslide stabilization along different roadside mountainous environments.

b. Answer given by all United States Respondents

- *Wisconsin*

Urban
Has gained a great deal on knowledge of contaminant flow through the soil and bed rock regimes native to the State of Wisconsin. Noise studies have resulted in the construction of noise barriers where criteria are exceeded and the adjacent property owners desire noise abatement.

Interurban
Same as for Urban regarding contaminated properties. Noise is more problematic in that any reasonable abatement measures may be ineffective.

- *Kentucky*

Urban and Interurban
Soil contamination found at some sites-area cleaned. No long-term unhealthful water pollution was found. Studies are ongoing.

- *Connecticut*

Urban

All DOT projects must be found to be in conformance with the State Implementation Plan for air quality.

Interurban

With regard to stormwater run off, the DOT cannot receive water resource permits unless, appropriate Best Management Practices are in place.

3. LOCAL POLLUTION

3.1. Preface

The problem of local pollution has been a concern of many countries. 23 countries responded to the questionnaire.

In urban environments, noise, vibration and air pollution are taken into account with priority.

Out of the cities, local impact concerns mostly the pollution level of soil and water.

Along roads, urban as well as interurban, tidiness is a perpetual concern.

Countries facing heavy winters, are of course interested in the effects of deicing salt.

Some countries are demonstrating the temporary problems involving road construction technology, and therefore road traffic accidents.

The importance of pollution varies with the country. The same goes for the means, used to limit impact. Some countries establish the problems, unfortunately without possessing the means to deal with it.

Generally spoken, performed studies are mostly concerned with the establishment and the deployment of measuring networks. Adapted methodologies, specific to road impact, are developed in particular for noise and atmospheric pollution.

3.2. Effects of road networks and transport policies on local pollution

3.2.1. Australia

Urban

- *Air pollution* increased by road traffic. Some 60% to 80% of urban air pollution is caused by road traffic in Australian urban areas, although in winter, wood heating can be a dominant source of fine particles in the southern half of the continent.

- *Road traffic is the major urban noise source.* Exhaust gas emissions, oil and fuel spills and leakage, component and tyre wear and road crashes cause pollution of water and soil. Sediment from construction and maintenance works need to be carefully controlled to avoid adverse effects on water quality and aquatic organisms.

- *Road side litter is an important issue in some areas.* Transport policies and network planning can influence the location of roads in less sensitive locations, and the level and types of emissions from vehicles.

Interurban.
The major problem for long distance is road crashes, litter and accidental load spillage. Exhaust gas emission and noise pollution is diluted by long distances.

Road side litter is a significant issue on interurban roads, particularly in holiday seasons.

3.2.2. Austria

Urban and interurban.

a. Air

The national objective, the "Immissionsschutzgesetz-Luft" (Air emission protection act) specifies in line with the WHO-targets (the sustained protection of human health in its current version limit values for the pollutants SO_2, NO_2, CO, suspended particulates, benzene, lead and dust precipitation (and its constituents) as well as an ozone target value. Additionally, the "Immissionsschutzgesetz-Luft" contains the authorisation to issue an ordinance defining exposure limit values for further pollutants that threaten human health.

In accordance with the prevention principle, which has been laid down by law in Austria, the reduction of pollutant concentrations to a as low as possible level is not only sensible, but also necessary. For example the EU annual average reference value of 40 µg/m^3 for NO_2 (for the protection of human health) is newly difined in the Austrian IG-L with 30 µg/m^3 (to be reached in the year of 2010). Very strong effort are to be made to reach this criteria, because the are showing a slightly decreasing tendency in recent years, but on the other hand the current WHO targets of 40 µg/m^3 are mainly exceeded in urban centres and near heavy trafficked roads.

Suspended particulates will be the main problem of the future. More and more studies verify, what WHO assumed in 1997, that even very low concentrations of small particulates (e.g. PM 10 and PM 2.5) may have negative effects on one´s health, so that the identification of reference values is very difficult. On the other hand in many dry agricultural areas the number of dust particulates is currently exceeding expected new limits, thus it would be very difficult to build new roads in that pre-contamined areas. For sulphur dioxide and carbon monoxide a significant decrease can be reported. Caused is this for sulphur dioxide by severe regulations and technical improvements at industrial sites and for carbon monoxide by the use of catalyst converters.

For benzene the lowering of the limit from 10 - 5 µg/m^3 is a necessary measure to avoid health risks. The occurring problem here is, how to technically fullfill the reduction criterias.

b. *Noise*
Among environmental problems noise has a special position because personal experience is decisive for realising the problem. The subjective perception of the local environment conditions is significantly shaped by being personally affected by noise. In this context, an important fact is that vulnerable groups of people (e.g. poor, sick and elderly persons) are less mobile and therefore less able to escape an unbearable noise level at least temporarily by a short or long change of place.

c. *Surface and ground water*
Most of the surface waters running into the community storm-water systems is treated (cleaned) together with the waters from other origins (households, industry etc.).

Interurban
Surface and groundwater
Since groundwater and spring water are almost exclusively used for drinking water supply without any considerable treatment processes in Austria, the main focus is on keeping creeks, lakes and groundwater clean. According to this legislation it is necessary to avoid any harmful impact by noxious contents of road surface water on ground water and existing surface waters.

3.2.3. Belgium

Urban and interurban
Effects are related to:

- noise in urban areas
- light nuisances
- air pollutions
- emitted dust and particles from tire abrasion
- soil and water pollution by :
    - fuel
    - oil (in case of accidents)
    - construction and road maintenance waste
    - litter (mostly along interurban roads)
    - reaping products, pesticides, deicing salt
    - streaming water decanting basin mud.

3.2.4. Canada (Quebec)

Urban and interurban
a. *Polluting emissions*
In spite of all measures, pollution emissions –mostly caused by vehicles- are actually increasing. The ministerial action plan on climate changes contains measures to reduce transport Greenhouse Gas (GG). These measures are based on 4 principles: energetic efficiency, modal transfer (increasing public transport instead of automobile), area planning including urban areas (accessibility with limited transfer), and public awareness and education. Transport plans exist for the major cities (Montreal, Québec) and for the larger conurbations (regional communities). These plans deal with environmental questions regarding transport, including polluting emissions.

b. *Road noise*
Traffic noise constitutes a major environmental problem affecting lifestyle and health quality of the population living along road networks. In general, noise repercussions on environment and health are underestimated, partly because of the local character and the subjective valuation of the phenomenon, partly because of the constraints and cost related to noise amelioration measures. Québec has more or less 135 km of problem zones in which an important noise level (65 dBA $L_{eq,\ 24\ hours}$ or more) has been registered along highways and access roads. Under this circumstances, the Ministry of Transport of Québec has adopted, in march 1998, the Politic on road noise.

Urban

Atmospheric pollution

Many pollutants are emitted by the transport sector (essentially roads): CO_2, CO, NOx, VOC, etc, causing smog and ozone problems. On the territory of the urban community of Montreal, the ozone concentration at ground level, measured by 11 stations, frequently crosses the target air quality (160 µg/m^3) every summer.

Interurban.

- *Energy consumption*
  The Québec transport sector represents more than 60% of global petrol consumption and almost 30% of energy consumption.
- *Greenhouse Gas (GG) emissions*
  Transport was responsible for 39% of total emissions in 1996 (2011 prediction: 40.5%). The Québec government has engaged to reduce GG emissions by 6% according to the Kyoto Protocol.
- *Natural environment disruptions*
  Arise under road construction (erosion) and maintenance (erosion, deicing salt). Impact on the natural environment is caused by damaging biodiversity, perturbation of soil and water, modifying hydrous systems, surface water, etc.

- *Accidental spillage*
  Dangerous goods transport can influence the local pollution level.

3.2.5. Czech Republic

Urban and interurban

- *Air.* Pollution: emissions of pollutants: CO_2, CO, Nox, PM10, PM2,5, SO_2, CnHn (VOC, NMVOC…), O_3. Logical impacts on concentrations. Health care limits and Laws (Law 309/92 Clean Air Act).
- *Noise* impacts.
- *Soil and water contamination* (mostly from winter maintenance).

3.2.6. Denmark

Urban

Air

Local air pollution is dealt with in the national transport policy. In connection with the Government's Transport Action Plan, published in 1990, specific targets were formulated with a view to reducing the environmental impact of the transport sector. According to these targets, which were confirmed for instance in connection with the publication of the "Traffic 2005" transport plan in 1993, there must be a reduction of 60 per cent of nitrogen oxides (NOx) and hydrocarbons, benchmarked against 1988 levels, by the year 2010. The target for particles, which are emitted especially by diesel-powered vehicles, is to cut the emissions in cities by half over the period 1988 to 2010. The carbon dioxide target is a stabilisation at the 1988 level before 2005 and a subsequent reduction of 25 per cent by the year 2030. No specific national targets exist for the reduction of the actual exposure (the air quality). Nevertheless, existing limit values for the concentration of NO_2 exist.

Noise pollution

The transport sector has a very taxing impact on the environment in the shape of noise, emissions. In the Government's Transport Action Plan, specific targets were formulated with a view to reducing the environmental impact of the transport sector. The target for noise is that not more than 50,000 residences may be exposed to a noise impact exceeding 65 dB(A) by the year 2010. A national strategy on traffic noise is to be implemented. A number of municipalities have defined local policies on environment and traffic and do implement these policies according to financial means.

Water and soil

In recent years, hazardous chemical substance have become a central issue in Danish environmental policy and regulation. With regard to the environmental impacts of such substances, especially the problems related to discharges of urban wastewater, and therefore runoff water from roads and other paved surfaces, into the aquatic environment have received attention.

Interurban

Air

The problem is only considered relevant in urban streets with neighbouring buildings.

Noise

The effect of the Danish Governments policy on Road Traffic Noise reduction is that 9,000 housings in 1998 located next to the state highway system and with a noise impact level more than 65dB is expected to be reduced to 3,000 housings in 2010.

Water and soil

The consequences of the continuing increases in road transport are a growth of pollution to the water and soil near the road.

3.2.7. Finland

Urban and interurban
Road network land use is the most pervasive local impact, shared with all other urban land use, changing the landscape into a built-up townscape. In urban areas in Finland, noise is the most notable local impact, in rural areas fragmentation.

Air pollution is especially a concern for our 5-10 larger cities and towns, primarily Helsinki, Espoo, Vantaa, Turku, Tampere and Oulu, but also along heavily trafficked main roads in other towns and urban areas.

Deicing salt use is a risk for the groundwater areas along main roads (145 km priority areas).

3.2.8. France

Urban and interurban
a. Fields of impact of roads and their operation at local level are:

- quality of surface, subterranean and groundwater, collectings, moist zones, road sanitation, …
- hydrology
- natural environments (fauna, flora, ecosystems)
- air and near pollution by air
- noise
- agriculture and sylviculture
- historical heritage and archeology.
- climate and microclimates
- litter
- regional development and urbanism
- natural and technological risks

In addition to the sectorial approach, a systemic approach can be asked.

b. Regarding plans and programs

- On the national level, localisation of infrastructure not being defined, the only available elements are traffic perspectives and therefore energetic consummations and corresponding gas pollutants (CO_2).

- On the local urban level, principal study objects are: air, noise, water, litter and urban development.

3.2.9. Japan

Urban and interurban
Air

- NO_2
  Out of 399 roadside monitoring stations in Japan, 79.4% achieved the environmental quality standard for nitrogen dioxide in 2001.

  Out of 200 roadside monitoring stations in the areas specified by the "Law Concerning Special Measures for Total Emission Reduction of Nitrogen Oxides from Automobiles in Specified Areas", 64.5% achieved the environmental quality standard for NO_2 in 2001.
- SPM (PM10)
  Out of 319 roadside monitoring stations in Japan, 35.7% achieved the environmental quality standard for SPM in 2001.

Noise
38.2% of the nation-wide roadside monitoring stations achieved the environmental quality standard for noise, while the percentage for large cities was 36.1%.(in 2000)

3.2.10. Madagascar

Urban and interurban
Air
Exhaust gas emissions pollute the air of the population living along roads. At present, this pollution is increasing together with the growth of road traffic. Existing road structure is subject to traffic congestion.

Noise
The noise of vehicles is considered to be a major nuisance. Road infrastructure is influencing the level of noise pollution.

Water
Transport is source of water pollution.

3.2.11. Malaysia

Urban

- Reduce water quality due to oil, grease and hydraulic spills both during construction and operation.
- Noise disturbance, spills (contamination to soil) and leaks.
- Dust, reduced air quality, erosion and sedimentation in waterways.

- Flooding upstream of structures and stream degradation downstream.
- Safety / accidents during road usage.
- Community severance.

Interurban

- Reduce water quality due to oil, grease and hydraulic spills both during construction and operation.
- Alteration of surface hydrology, effect on aquatic flora and fauna during construction when temporary drainage are constructed.
- Erosion and sedimentation in waterways.
- Flooding upstream of structures and stream degradation downstream.
- Community severance.

3.2.12. Mexico

Urban and interurban

In order to improve and to develop more environmental culture, the first step is covering the *Secretaría de Comunicaciones y Transportes* (SCT) (Communications and Transport Ministry), which is responsible for the project, construction, maintenance and operating the federal transport network; in order to achieve that purpose, it has been developed some environmental policies, such as: include in the infrastructure projects environmental criteria for ecologic reserve zones, and total respect for the economic and cultural aspects of affected communities.

In support of this important task, the IMT has elaborated some studies that involve planning, environmental impacts of roads projects and it's mitigation measurements, and every year make an environmental and roads training course.

3.2.13. Morocco

Interurban

The level of traffic on road networks is generally weak and causes therefore no pollution or noise nuisance.

3.2.14. Nicaragua

Urban

Air

A high percentage of vehicles is old and in bad condition or imported after being rejected or having exceeded their life cycle, thus causing a high degree of air pollution.

The concentration of vehicles at traffic lights and bottle necks increases the pollution level.

Low visibility, created by certain public transports, exhausting contaminated gas, causes accidents.

Noise

Noise pollution increases, due to the exaggerated and systematic use of horns and to vehicles selling goods using loudspeakers.

Water
Water pollution is caused by misusing water in cleaning vehicles and in washing motors on the streets, causing oil and fat contamination. The same effects are reached in working places where oil is changed, causing pollution of local soil and ground water.

Interurban
Air
Almost all public transport violates existing regulations on the construction of exhausts in order to reduce the direct impact of exhaust gas on the surrounding traffic.

Noise
Noise pollution is to be found in urban areas, especially in garage and bus stop areas.

3.2.15. Norway

Urban and interurban
Air
A very few are exposed to concentrations of PM10 and NO_2 exceeding the Pollution law targets (300 ug/m^3).
PM10 is a problem due to use of studded tires, which is now reduced in the cities as a result of regulations. Further action is needed to reach target values.

Noise
90.000 persons (2%) are very annoyed, and about 8000 are exposed to more than 42 dBA (pollution law target) inside their house. The number of exposed is reduced each year in spite of traffic growth, as a result of noise barriers and measures on houses. Further action, for instance on open-graded asphalt and better vehicles, is needed to reduce the number of annoyed.

3.2.16. Romania

Urban
- Water pollution by urban storm-water systems.
- Chemical pollution (heavy metal, hydrocarbons, toxic gasses and seasonal pollution by melting salt).
- Physical pollution : noise, light, vibrations.

Interurban
- Acidification of soil and water.
- Strong concentrations of pollutants in surface and ground water due to road traffic.
- Temporary deposit of construction material and litter.
- Chemical pollution : heavy metal, hydrocarbons, toxic gasses.

3.2.17. Saudi Arabia

Urban and Interurban

The Kingdom of Saudi Arabia remains to have relatively low traffic volumes in interurban areas when compared to other developed countries with similar size roadway network. However, in urban areas, traffic volumes are approaching levels where certain measures are needed to monitor development effects of road system on local pollution.

3.2.18. Spain

Urban

a. Atmospheric Pollution

The most common atmospheric pollutants, generated by vehicle traffic, and the impact of the same on man, plants, materials, visibility and solar radiation, are as follows:

Particles

Their action varies according to their size and origin (combustion or dust from the ground). The smallest are the most harmful to man. They form a layer on the leaves of plants, interfering with the process of photosynthesis. They form deposits on materials, requiring frequent cleaning. They cause and accelerate the corrosion of metals, particularly those which contain sulphur. Visibility is reduced due to the way in which the particles disperse the light, particularly if the length of the same is close to that of the wavelength of the visible spectrum (between 0.4 and 0.8 μm). They absorb a part of the occurring solar radiation and disperse another part towards space. It is estimated that urban areas, due to the higher levels of particle pollution in the atmosphere, receive between 15 and 20 percent less total solar radiation that rural zones, this reduction being potentially increased up to 30% on occasions.

Sulphur dioxide (SO_2)

This is produced in combustion engines (diesel). It most significantly affects human beings, as mentioned above, and plants and materials. With plants, the effects depend on the concentration and the duration of exposure, and are of an accumulative nature. In small concentrations, the plants are capable of absorbing and metabolising certain quantities of sulphur. Its damaging effects on plants can be seen in the form of leaf injuries running along the vein structure; if the concentrations are low and prolonged, a gradual chronic yellowing appears which runs from the point of the leaf towards the base; if the concentration is high but last only for a short period, dead zones appear on the leaves, which dry out and take on a whitish-yellowish tone. Not all plants react in the same way, the most sensitive being fungi and lichens. We have carried out studies for their use as bio-indicators The next most sensitive group are conifers, herbaceous plants and deciduous trees. Among cultivated plants, the fodder species are more sensitive than cereals. The more long-lived a species, the greater its potential to be affected, due to the cumulative effect.

Materials, in general, also suffer the effects of sulphur oxide pollution, caused mainly by the vapour from the sulphuric acid produced when the sulphur oxides oxidise catalytically in drops of water. The concentrations of sulphuric acid attack various materials such as marble, limestones, slate and mortar. The carbonates of these materials are converted into soluble sulphates in water, and so dissolve in the rain. This sulphuric acid vapour gives rise to a phenomenon known as “acid rain”.

Carbon Monoxide (CO)
This is most abundant in large cities. It affects humans and plants. In normal concentrations no significant effects are observed on vegetation. In high concentrations, there may be some inhibition of the fixing capacity of nitrogen.

Nitrogen oxides (NOx)
The most significant effects of nitrogen oxides occur on humans, plants and materials. By means of the process known as the “NO_2 photolitic cycle”, which occurs as a result of the interaction between sunlight and NO_2, the molecule is broken, producing molecules of NO and ozone (O_3), which in turn react with the NO to produce NO_2 and O_2. The nitrogen oxides damage the plants. The effects on materials can be observed fundamentally on copper nickel alloys and material dyes, which lose colour on exposure to the NOx. As a result of the photolytic process, high concentrations of ozone (O_3) may be produced.

Hydrocarbons (HC)
The number of hydrocarbons involved in air pollution is very high. In the urban environment, more than one hundred different hydrocarbons may be present. The most reactive are the olefins. No proof exists that these are harmful to humans, at the concentrations currently present in the air. Ethylene is the only hydrocarbon which has been proven to damage vegetation: causing growth inhibition, the death of floral parts and the change in the colour of the leaves.

Carbon Dioxide (CO_2)
This is produced as a result of the combustion of fossil fuels. It is not a toxic gas, nor is it considered a pollutant as such, being a natural component of the air. Its significance derives from the fact that increasing concentrations of CO_2 may produce, by means of the greenhouse effect, an increase in the temperature of the earth, therefore originating climatic changes. It is, for this reason, the only gas which is the object of policies for emissions reductions.

b. Noise and vibrations

Vehicle traffic is the most significant source of noise in urban areas. This circulation of traffic causes vibrations. It is one of the most serious environmental problems in cities, and constitutes one of the greatest concerns of the citizens.

Interurban
Many of the situations of pollution which occur in the urban environment occur equally in inter-urban environments. It is in the case of the latter, however, that pollution has an impact on a greater number of environmental factors.

It could be said that environmental problems related to road transport comprise climatic change, the degradation of woodlands, acidification, the fragmentation and destruction of habitats, atmospheric pollution, the loss of biodiversity and genetic resources, the bio-accumulation of heavy metals, the production of residues, soil erosion, the loss of agricultural soil, noise and the impact on the landscape.

Although all that has been said in respect of the urban environment is equally applicable to the inter-urban environment, we would emphasize some considerations obtained through experience in Spain.

Atmospheric pollution
The studies and checks carried out demonstrate that the sections of road between the cities (inter-urban) never exceed the values set as the legally established maximum atmospheric pollution levels, due, possibly, to the ease of dispersion of the pollutants offered by these open spaces.

According to studies carried out on the borders of Spanish highways, the area of influence of the atmospheric pollution on the vegetation was around 60 m. The impact of the sulphur compounds was very high in the first 5 metres, then descending rapidly until practically disappearing at 20m.

Surface and subterranean water
The pollution of surface water may occur as a result of activity originating in the construction of the highway (disturbance, erosion of the banks, etc.), or in the operational phase of the infrastructure, due to the dragging of elements which remain on the road surface (wear of tyres, brakes, substances used in welding, herbicides, etc.) or due to those produced in accidents.

A barrier effect may also take place, when the throughways designed for the water are of an insufficient size, causing floods.

Subterranean waters may be affected as a result of the interruption of the aquiferous system during the construction of tunnels and levelling operations. The refilling water system may also be affected as a result of the highway, which can block off the refilling area.

3.2.19. The Netherlands

Urban
Due to the traffic it is possible that the concentration of NO_2 and fine dust will exceed the limits.

Interurban
Due to the traffic on busy roads, the verges could be polluted by heavy metals, PAH and mineral oil.

3.2.20. Turkey

Urban

Transportation policy in urban areas aims to serve cheap, convenient and available transport modes for public. The municipalities are responsible for this public transportation. Public transportation would create lesser pollution than use of private cars.

Traffic law also brings about speed limitation both in urban and interurban areas. The purpose of these rules is both to improve air pollution and decrease the accidents.

Interurban

Public transportation (buses) are available in between each location. For some places railroad transportation and most of the places airplanes are available. Marine transportation is rarely available in between some locations. But people mostly prefer private cars for recreational purposes.

3.2.21. United Kingdom

Urban

Within urban areas the main pollution of concern is vehicle tailpipe emissions and noise. Within the UK the National Air Quality Strategy is a policy designed to provide the framework for the management of air quality and in particular human exposure. The objectives of the strategy are primarily based upon the relevant EU legislation. In most urban areas transport emissions are the greatest local emission of the key pollutants CO_2 and particulate. In areas of poor air quality the local authorities are required to draw up action plans to pursue improvement. This effort is over and above that which may be delivered by tighter vehicle emission standards agreed at EU level. Other policies exist to encourage the use of cleaner vehicle technology and fuels together with the use of low emission zones as a means of access control to urban areas. The UK Government has just published a strategy 'Powering Future Vehicles' which sets targets for shifting mainstram motoring over to low –carbon technology.

Road traffic noise is also a problem in urban areas and many of the recent advances in mitigation techniques such as `quieter road surfacings' are relatively ineffective compared to the rural situation where speeds are higher and the interaction between tyres and road surface is the major noise source.

Interurban

For interurban routes the problems of local air quality are less dominant than in the urban areas simply because population exposure is much lower. However at urban fringe locations or where frontage developments exist the problem can be severe. Currently in the UK approximately 50% of those areas forecast to be in breach of the National Air Quality Strategy objectives include an interurban road, although sometimes a low number of properties. Noise problems from the interurban network are being addressed through a comprehensive programme of mitigation using quiet surfaces. By 2010 the national network in England will have no concrete surfaced roads and 60% of

this network in total will have a quieter surfacing. The impact of the network on water quality both surface and ground waters is an area of increasing concern. In the UUs view there is a lack of basic data to allow the assessment of the impacts of road surface run off and we are currently embarked on a major research effort to bridge this knowledge gap.

3.2.22. United States of America

a. Answer given by the United States Federal Government

The EPA publishes an annual report entitled "The National Air Quality and Emissions Trends Report". The latest edition of this report contains data from 1999 and can be found at: (http://www.epa.gov/air/aqtrnd99/toc.html). The report contains information related to air quality trends of the six criteria pollutants. Listed below are the percentage decreases for those pollutants normally associated with on-road mobile sources:

- VOC's – 29%
- NOx – 34%
- CO – 51%
- Lead – 1%
- PM10 – 19%

Recently, there has been concern with one of the additives (methyl tertiary-butyl ether (MTBE)) used in the "cleaner burning" fuel programs described below. The use of MTBE in the nation's fuel supply has created a significant and unacceptable risk to drinking water and ground water resources. As a result of these concerns, EPA commissioned a Blue Ribbon panel on MTBE and Oxygenates in Gasoline. In July, 1999 the Panel issued recommendations on ways to maintain air quality while protecting water quality from the risks associated with MTBE. Specifically, the Panel called for a substantial reduction in the use of MTBE as well as action by Congress to remove the 2 percent oxygenate requirement from the Clean Air Act (CAA). EPA endorsed the Panel's recommendations and committed to work with Congress to make targeted amendments to the CAA. Due to these concerns, the US EPA is considering a limit or ban on the use of MTBE as a fuel additive.

b. Answer given by the Washington State Department of Transportation

Air
When small airborne particulate matter falls, or gets deposited, on roadways, it can be lifted by rains and deposited in nearby aquatic systems. There are a number of methods of deposition:

- Tailpipe emissions.
- Tire wear. During dry periods, small, light particles can be picked up by air currents and deposited.
- Sanding of roads. The deposition process is the same process for deposition as for tire wear; and Fugitive dust.
- Particulate matter can be generated from activities that disturb the soil from non-combustion forces. An example of this could be the tracking of mud curing construction. WSDOT looks at a variety of BMPs to address fugitive dust, such as

- maintaining vegetative strips and land use buffers.

c. Answer given by all United States Respondents

Wisconsin
Urban and interurban
Wisconsin road networks and policies are intended to avoid, minimize, and compensate for local pollution caused by a WisDOT administered project. Noise barriers are considered whenever required minimums are exceeded. An erosion control plan is required in every facility's design and the contractor must develop (and follow) a plan that implements the erosion control plan for a given project.

Kentucky
Urban and interurban.
In the 1990's, the KYTC established a policy to remove USTs from KYTC facilities to prevent contamination to water supplies and streams. This effort is funded by a 14.4-cent tax per gallon on motor fuels.

Utah
Urban
Utah has two large (200,000+) Metropolitan Planning Organizations (MPOs) covering the four most highly populated counties. In each of these counties, the MPOs are required to prepare twenty-year transportation plans which conform to the state's air quality plans. Roadway construction and maintenance may impact vegetation, streams, and wetlands. Soil erosion, increased noise, ground water may also be affected.

Interurban.
Roadway construction and maintenance may impact vegetation, streams, and wetlands. Soil erosion, increased noise, ground water may also be affected.

New York
Urban and interurban
The NYSDOT Environmental Initiative strives to enhance, improve and protect the environment in conjunction with NYSDOT's transportation system mission.
Policy: http://www.dot.state.ny.us/eab/eabinit.html
General Initiative Web Site: http://www.dot.state.ny.us/eab/envinit.html
General project examples: http://www.dot.state.ny.us/eab/eiexampl.html
Guidelines and Procedures Paper: http://www.dot.state.ny.us/eab/eitrbdot.pdf
Environmental Handbook for Operations to highlight.

New Hampshire
Urban and interurban
Poorly designed transportation facilities can lead to inefficient motor vehicle operation and resultant air quality concerns. The Department strives to maintain free-flowing traffic conditions, providing sufficient capacity and eliminating bottlenecks. Construction activities and operation of vehicles can contribute to the degradation of water quality through erosion and siltation and the introduction of pollutants.

3.3. Systems in place for monitoring the effects

3.3.1. Australia

Urban
Air quality monitoring stations & mobile monitoring unit for roadside locations. Road traffic noise monitoring is undertaken in many areas to evaluate compliance with standards, which are different in each State. Water quality survey of road run off sites. Road crash data analysis.

Interurban
Road crash data analysis.
Some monitoring of water quality near road construction projects.

3.3.2. Austria

Urban and interurban
Air
There is a continous monitoring of the relevant pollutants (SO_2, NO_2, CO and ozone as a reaction gas) in a network of more than 150 permanent measure stations.

Noise
No continous monitoring is done overall the country. Only on a particular place at A 2 motorway near Graz a permanent monitoring of noise emissions will start in november as a part of a research project. The target of the project is the implementation of a system with temporary speed limits only in that times, when the noise limit is exceeded at the monotored places. The advantage is, that no permanent speed limitation or heighten of the existing noise barriers will be necessary.

Ground water
Since 1991 the Federal Ministry for Environment, the Federal Environmental Agency, the Water Management Register as well as the relevant provincial departments have jointly monitored the Austrian groundwater areas.

3.3.3. Belgium

Urban and interurban
Air
Surveillance networks permanently monitoring air quality exist.
In Brussels, road tunnel pollution is compared to fixed standards together with forced ventilation.

Noise
Brussels disposes of 7 stations permanently measuring noise pollution. Other measures are taken whenever complaints are received.
The amount of deicing salt is regulated and measured.

3.3.4. Canada (Québec)

Urban and interurban.
Road noise
The Québec traffic noise policy aims to prevent and correct noise pollution caused by road traffic. Means to lessen road noise are based on existing regulations (loi sur l'aménagement et l'urbanisme) and on the Ministry's expertise acquired in the environmental evaluation of its projects and in the construction of noise lessening screens.

Noise lessening policy is based on two recommendations: a corrective approach regarding the principal noise pollution problems, and a preventive approach regarding the same problems.

Urban
The Montreal urban community (www.cum.qc.ca) air pollution measuring network (RSQA) contains 16 measuring stations. These stations inform about nature, degree, extent of the pollution, efficiency of measurement means to reduce the level and allow to forecast periods of excessive pollution. Several types of pollutants are measured, e.g. gas, polluting particles, and volatile organic compounds (VOC).

Measuring stations are part of the réseau de surveillance nationale de la pollution atmosphérique (SNPA) d'Environnement Canada.

Interurban
Extrapolations are to be made in order to measure the effects of transport on local pollution. Those extrapolations are based on indicators, like the number of kilometres/car by day, the average car consumption (litres/100km.), GG emissions by car (gram/km-passenger).

3.3.5. Czech Republic

Urban and interurban
Air pollution
AIM (Automatic concentration monitoring in Prague, CMHU – monitoring all over CR (maximal and annual mean concentrations).
Modelling dispersion studies using Czech software (ATEM of Symos). GIS and dBase presentation.

Noise
Noise urban maps. Data from measuring and from modelling. Czech software Hluk+. GIS presentation.

Water and soil local chemical analysis.

3.3.6. Denmark

Urban
Air
The emissions are on a national scale monitored by using a reference model where traffic load segregated on different vehicle types are used together with specific emissions factors to calculate the total emission.

On a local level, some municipalities have carried out calculations of the concentration of NO_2 in some urban streets using a Nordic prediction method that includes a dispersion model. The model calculations are considered subject to some uncertainty and at the moment a revised model is being prepared in Denmark.

For example, in Copenhagen, such calculations have been made for all main streets. As the vehicle fleet changes over time (more and more cars with catalytic converters), the results changes. No new results have been collected for this questionnaire. Nevertheless, the calculations from 1997 showed that approx. 1.200 dwellings were exposed to a higher value than the desired local maximum level of 135 ug/m^3.

Noise
The Danish Environmental Protection Agency delivers national statistics on the total number of housings exposed to a high noise level.

Water and soil
Until now, toxic chemical substances in urban stormwater and road runoff have not been a matter of concern, although the Danish Environmental Protection Agency (Danish EPA) actually in 1997 published a study on heavy metals and organic micro-pollutants in surface runoff from urban areas.

However, a study concerning the possible adverse biological effects of such discharges was initiated to indicate the risk of such effects to occur.

In the autumn of 2000, a field study was conducted in which road runoff from two selected areas was sampled and tested. The areas studied were a motorway section and a road system in an adjacent residential area, both located in northern Copenhagen. Firstly, it was attempted to elucidate whether the degree of toxic effect and traffic density are correlated and, secondly, if a correlation between toxic effects and types of rain events exists. In addition to this, the toxicity of runoff water contaminated with municipal wastewater, and the toxicity of road runoff after sedimentation of particulate matter was investigated.

Finally, sediments from two retention basins at two major motorways in the Copenhagen area were analysed and tested to give an indication of the possible toxicity of the particulate phase in surface runoff.

Interurban
Noise
The Danish State road network has been mapped in order to overview the expected noise level in 2010 in residential areas. The number of housings with a noise impact level from 55 to 60, 60 to 65, and above 65 dB is periodically recalculated to monitor the effect from former noise reduction projects along the existing state highway system.

Water and soil
During the spring of 1998, two study sites were established to study the pollution of groundwater and soil by road and traffic. The Danish field study sites are a part of the European project POLMIT, where six other countries from Finland in the north to Portugal in the south each have two field study sites established along similar principles. It is therefore possible to compare results from 14 field sites in Europe.

Results are available for 18 months from the two sites. The sites were closed 2000.

The sites were on 4 lane motorways in the country. The ADT for 1997 at the one site (Rud) was counted at 22,000 vehicles with a lorry percentage of 19; trafficked for more than twenty years. The ADT for 1997 at the other site (Vejenbrod) was counted at 29,000 vehicles with a lorry percentage of 6 percentage; trafficked for some few years.

3.3.7. Finland

Urban and interurban
Air quality is monitored in a large number of towns. Public road, rail and air traffic noise is surveyed by the respective administrations, but urban area street and other noise is monitored in a few cities.

3.3.8. France

Urban and interurban

Many sectorial guides on treatments (water, litter), reduction at the source or in transmission (noise), preservation (heritage, landscape, natural environments), restoration of functional relations (biodiversity, urbanism), protection (natural or technological risks, hydrology), management or exploitation (regulation or limitation of flow and speed, taxation,…), in order to reduce local impact on the environment.

3.3.9. Japan

Urban and interurban
Roadside noise levels: Achievement of the night time requirement of 65dB or less.

- achievement rate along national highways (2001): 66%
- target for the year 2007: 73%
- long-term target: almost 100%.

Various measures need to be implemented to achieve the environmental quality standards for air quality and noise specified by the Basic Environment Law.

Vehicle structure regulation (see the section below on Vehicle Regulation).

Road networks: By-passes, ring roads and major trunk roads need to be systematically developed to remove traffic concentrations and congestions in certain parts of the networks and thereby to improve roadside environments.

In accordance with the Environmental Impact Assessment Law and the respective prefectural ordinances on impact assessment, the preparation of road projects larger than a certain designated scale will be made to follow the procedure of preliminary study, prediction and evaluation.

Roadside air quality measured at more than 400 monitoring stations nation-wide to check the status of roadside air pollution.

Measures on road structures: buffer zones (80km), noise barriers (730km), low-noise pavements (3,400km), greening along roadways, subsidization of soundproofing of roadside houses, roadside buffer buildings have been implemented to improve roadside environments.

About 5,000 roadside stations have been established to monitor road traffic noise.

A variety of preferential treatment for less-polluting vehicles is introduced, such as preferential access to parking space and other economic incentives (*Report on the Future of Road Environment Policy*, June 1997).

- Promotion campaigns on the performance of less-polluting vehicles (*Report on the Future of Road Environment Policy*, June 1997).
- Reduction of on-road construction works and on-road parking (*Report on the Future of Road Environment Policy*, June 1997).

- Promotion of TDM and ITS: Introduction of various TDM (Traffic Demand Management) measures and advanced road traffic information systems (ITS) including ETC (Electronic Toll Collection) will be expedited to enable more smooth traffic flows and to improve roadside environments.
- Installation of pilot air-cleaning systems which use photo-catalysts or ventilation through soils.
- Introduction of road pricing to reduce traffic volumes in densely-populated areas.

- Increased use of public transportation.
- Promotion of low-sulfur diesel fuel production.

3.3.10. Madagascar

Urban and interurban.

Air

Road, related law contains regulations fixing fume emissions from automobile exhaust gas. These regulations are being applied with the aid of appropriate equipment.

Noise

Regulations exist without being applied due to lack of necessary equipment. Speed limits contribute to noise lessening.

Water
Regulations exist. In order to protect surface water, cleansing networks are fitted with (not very) efficient equipment.

3.3.11. Malaysia

Urban
- Continuous monitoring of air quality including haze due to traffic emissions.

- Conduct medical survey to study the relationship between health and air pollution.
- Incorporate EIA in planning process.

- Incorporate Environmental Management Plan for impacts due to road construction and traffic in urban areas.
- Install silt traps, silt fence and sedimentation or retention ponds to trap pollutants.

Interurban
- Incorporate Environmental Management Plan to projects undertaken in sensitive areas e.g. forests, wetlands, mountainous terrain, near the coasts.

- Incorporate EIA in planning process

3.3.12. Mexico

Urban and interurban
At this time, there are not systems in place for monitoring local pollution along the Federal Road Network; however, the IMT will make periodic measurements within Querétaro state, in order to know the noise behaviour and performance generated by the transport operation (all kind of vehicles).

3.3.13. Nicaragua

Urban
Problems mentioned are controlled in a reactive, not systematic way.

Air
A decontaminating plan is being executed under the authority of the commission of exhaust gasses.

Water
Regulations exist (decreto 33-95), indicating parameters and level of the chemical components that can be dumped in subterranean and soil water.

Interurban
Applications are nonexistent, since all monitoring activity is taking place in Managua.

Air
The problem is settled at national level.

Water
Mentioned regulations (decreto 33-95) are to be applied on the national level, in order to gradually decontaminate industry.

3.3.14. Norway

Urban and interurban
Air
Pollution is monitored in the cities, and the number of persons exposed to different values of PM10 and NO_2 is calculated along the national road network and reported to the Parliament.

Noise
The number of persons very annoyed and persons exposed for different dBA values are calculated along the national road network and reported to Parliament.

3.3.15. Romania

Urban and interurban
An integrated monitoring network is in place.

Road planning laws include regulations concerning environment preservation, site use, traffic security. Regarding to new national roads, environmental authorisation and impact studies are required.

Regarding to road maintenance and repair, an environmental balance can be asked by the environmental authority.

Technical instructions and standards concerning measuring methods and air quality analysis are available.

3.3.16. Saudi Arabia

Urban and Interurban
Vehicles emission monitoring trough vehicle inspection program.

3.3.17. Spain

Urban.
The Law governing the Protection of the Atmosphere, dated December 22nd 1972, and other supplementary legislation on this issue, enable the establishment of partial, and even, in serious cases, total, restrictions, on the circulation of traffic in cities.

The National Network for the Monitoring and Forecasting of Atmospheric Pollution, makes it possible to follow, at all times, the development of the pollution produced by the principal sources of pollution in more than 60 Spanish cities.

In order to combat noise in cities, on some occasions, road surfaces have been covered with a false tunnel, using the surface used for sporting facilities. Also, acoustic screens and land dykes have been installed where the use of same is effective. As a supplementary means, very frequent use has been made of porous paving, which is sound absorbent, and although the reductions in noise levels are not very high, the resulting spectrum of frequencies is less aggressive, since the reduction occurs almost exclusively in the high frequencies, which are the most unpleasant. In Spain, more than 60.000 m^2 of porous paving has been installed. The acoustic soundproofing of buildings has been carried out on occasions, but this method has used principally in the vicinity of airports.

In recent years planning criteria have been adopted in respect of State highways, resulting in reductions in CO_2 emissions, such as:

- Making it more difficult for private vehicles to access the centres of big cities, by means of the installation of toll booths and the introduction of lanes reserved for collective transport, or for those vehicles carrying a numerous of passengers.

- Solving the congestion on the outskirts of cities, and avoiding the access to the city centre for vehicles in transit, by means of the construction of ring roads (beltways).

- Inter-modal transport programmes in large cities with an improvement in local or suburban railroad systems, and the creation of interchanges and parking aimed at dissuading traffic from entering the city.

In so far as concerns the future, three lines of action have been established regarding the transport system, for the reduction in CO_2 emissions, these being:

- An improvement in the energy efficiency of the different means of transport. The principal targets of these improvements are the two means of transport with the highest specific consumption levels: road and aviation.

- Improvement in the energy efficiency of the transport system overall, by means of strengthening those means of transport with lower specific consumption levels.
- Measures aimed at reducing the transport demand.

Interurban
In order to avoid pollutants in the water from reaching public sources, in those situations where the water concerned requires the same, reservoirs will be installed for collection and decanting. Where the areas for the refilling of the subterranean aquiferous system cannot be avoided, protective measures will be adopted in accordance with the requirements of each case.

Noise
In general, with the use of acoustic screens and earth dykes to combat noise, a greater level of efficiency is achieved than in the urban environment.

Planning
The criteria adopted in the planning of public highways aimed at collaboration in the reduction of CO_2 emissions released into the atmosphere are:

- Improvement in the geometric conditions of the routes, which is reflected in a reduced consumption of fuels, particularly in the reduction of ramps and slopes at maximum absolute values of 6%, and normal values of 5%, which has led to the construction of numerous tunnels.
- Increased capacity in congested sections, which, by enabling the more homogenous functioning of the traffic, also reduce CO_2 emissions.
- Plantations in the vicinity of new highways, aimed at improving the landscape, which also reduce CO_2 levels as a result of the carbon sink effect.
- Evaluations of the impact during the alternatives phase of the section, which protect existing expanses of forest which set CO_2, selecting those alternatives which do not have such an impact, despite the fact that they may be more expensive.

3.3.18. The Netherlands

Urban
For air pollution it is possible to calculate the concentrations of the gaseous pollutants.

3.3.19. Turkey

Interurban
Around some local industrial regions or specific project areas some universities perform local air pollution measurements. The Ministry of Environment in coordination with the universities has some local pollution measurement stations where air, water, noise and marine pollution is monitored in such stations.

3.3.20. United Kingdom

Urban
The UK has a large national effort directed at the monitoring of a range of air pollutants . In pursuit of better local air quality management many local authorities now undertake their own monitoring.

Interurban
On the interurban network the Highways Agency in England has for a number of years maintained a monitoring network targeting the principle traffic related air pollutants.

Noise monitoring is not an activity that has been undertaken on a continous basis but is often undertaken in the assessment of new highway proposals.

As part of the research programme into the environmental impacts of highway run-off a number of different sites have been equiped with automatic monitoring equipment to capture first flush effects.

3.3.21. United States of America

a. Answer given by the United States Federal Government

The 1990 Clean Air Act Amendments (CAA) required auto inspection and maintenance (I/M) programs in many areas of the U.S. that do not meet the National Ambient Air Quality Standards (NAAQS). I/M tests use special equipment to measure the pollution in a vehicle's exhaust system. "Basic" I/M tests, which use special equipment to measure the pollution in vehicle exhaust, are required in areas classified as "moderate" for ozone. These tests check that the vehicles key emission controls are installed as designed and then analyse the exhaust to check acceptable control of carbon monoxide and hydrocarbons. "Enhanced" I/M tests, which also check nitrogen oxide emissions are required in areas classified as "serious" or worse for ozone. Standards are set according to the vehicles model year. If the vehicle exceeds those limits, it usually will pass its retest after minor adjustments, maintenance and repairs. Standards are set according to a vehicle's model year. If a vehicle exceeds those limits, it usually will pass its retest after minor adjustments, maintenance and repairs. More than 30 states have inspection and repair programs. By the year 2000, one-third of the nation's cars are scheduled to be included in I/M programs.

As part of the I/M program the U.S. EPA also administers the On-Board Diagnostics (OBD) program, which is a computer-controlled system, which alerts the driver (via a dashboard light) that there is a potential problem with the emissions of their vehicle. OBD is required on all 1994 and newer passenger cars and trucks. OBD systems will be required on heavy-duty trucks beginning in 2005.

b. Answer given by the Washington State Department of Transportation

- *Hazardous Materials*

GIS maps are used to locate known hazardous waste sites that need remediation. Internal applications in the GIS Workbench are used for project scoping and preliminary design related to hazardous materials and other areas. A description of the GIS Workbench can be found at:

http://www.wsdot.wa.gov/eesc/environmental/programs/envinfo/EGWbHome.html.

Statewide geospatial data on contaminated groundwater and wells can be accessed from WSDOT's GIS GeoData Distribution Catalog at:
http://www.wsdot.wa.gov/gis/GeoDataCatalog/

- *Bioremediation of Contaminated Soils*

WSDOT routinely utilized bioremediation methods to decontaminate contaminated soils. Bioremediation utilizes natural processes-most often native soil micro organisms (or "bugs") but occasionally microbial strains developed in laboratories-to breakdown petroleum contaminants into harmless byproducts. A research paper put out by the Minnesota Department of Transportation describes this process in detail, as well as other in-situ and ex-situ methods for remediation of petroleum contaminated soils. The paper, Managing Petroleum Contaminated Soil: Department of Transportation Perspective, is available in the December 2001 "Journal of Environmental Engineering."

- *Use of GIS for Local Pollution*

GIS is on of the greatest innovations for use in areas involving local pollution. GIS is an excellent tool for managing and responding to areas of local pollution. It is also very useful for monitoring actual and possible areas of groundwater pollution. The EAO office of WSDOT utilizes GIS maps and models for all of these uses.

Use of GIS materials can also avoid and minimize potential environmental problems before project construction commences. For example, EAO's GIS Department conducts extensive drainage analysis prior to project construction in order to avoid and minimize stormwater runoff impacts. Also, EAO uses GIS data to identify impaired water bodies in order to further avoid and minimize impacts due to project construction. NPDES permit areas and data on stormwater outfall along state routes can be viewed at the WSDOT GIS GeoData Distribution Catalog site:

http://www.wsdot.wa.gov/gis/GeoDataCatalog/

- *WSDOT Maintenance Manual for Water Quality and Habitat Protection*

This manual, which reviewed maintenance activities for potential impacts to water quality and habitat in order to comply with Endangered Species Act (ESA) provisions, mentions several measures that affect local pollution.

Areas of the plan, as they relate to local pollution are:

- *Integrated Pest Management (IPM):* IPM is used to control noxious weeds growing on the roadside. IPM controls noxious weeds by using biological, cultural, mechanical, and chemical control methods that must consider human health, ecological impacts, feasibility, and cost-effectiveness.

- *Litter Pickup:* This element includes all work necessary to remove litter, debris, and dead animal carcasses from the shoulder and roadside, and haul it to an appropriate disposal site. Litter pickup also includes administration of the Adopt-A-Highway (AAH) Litter Control Program including providing safety hats and vests, signs and litter sacks to the groups and collecting the filled sacks and hauling to an appropriate disposal site.

- *Substantial maintenance to affect aquatic resources*: Major sections of the Manual, each of which have subsections, that affect aquatic resources are Roadway Maintenance and Operations; Drainage Maintenance and Slope Repair; Roadside and Landscape Maintenance (which includes IPM and Litter Pickup); and Bridge and Urban Tunnel Maintenance and Operations.

The Manual develop BMPs for all its elements, and can be viewed at:

http://www.wsdot.wa.gov/TA/Operations/Environmental/MaintMan/WSDOT4dmanual.doc

- *Interagency Streambank Protection Guidelines*

WSDOT, the Washington State Department of Fish and Wildlife, and the Washington State Department of Ecology are cooperatively developing a document entitled "The Integrated Streambank Protection Guidelines" (ISPG) which provides guidance on streambank erosion assessment and remedial action technique selection. The most recent version of the ISPG is currently being used by WSDOT Maintenance in an "evaluative" manner. It is anticipated that the ISPG will become an increasingly-used resource for streambank stabilization permit conditions. Protection of streambanks can prevent bank failure into its associated aquatic ecosystem, thus preventing surface water pollution. See: http://www.wa.gov/wdfw/hab/ahg

- *WSDOT's Watershed-Based Approach to Planning and Mitigation*

In 1997, the Federal Highways Administration (FHWA) funded a WSDOT Environmental Affairs Office (EAO) project called the Snohomish Watershed Demonstration Project,". The project proved to be a catalyst for infusing traditional projects and environmental review functions of WSDOT with a watershed-based perspective, and drew in other state government efforts that sought new ways to coordinated habitat restoration and Endangered Species Act (ESA) compliance with project delivery and mitigation.

The watershed approach brought together disparate programs and functions within the department to reduce transaction costs, increase environmental benefits and obtain a more streamlined consensus on priority mitigation areas within a watershed. Staffing and budgets were aligned to coordinate inter and intra-agency data management and analysis to support the watershed approach. The final report consisted of three phases. Phase One consisted of three notebooks that contained the highlights of EAO's past five years of work, from 1995-2000, of incorporating watershed-based planning and mitigation into its projects. Phase Two provided a synthesis and framework of the WSDOT's watershed-based approach, and Phase Three produced a final report to FHWA for national distribution on the outcome of watershed-based initiatives and it's value-added to transportation development. A more detailed description can be found at:
http://www.wsdot.wa.gov/eesc/environmental/programs/watershed/watershed_sv_final.html

- *WSDOT Environmental Benefit/Cost Initiative*

The WSDOT Environmental Benefit/Cost Initiative effects local pollution by quantifying and defining environmental benefits associated with WSDOT initiatives, so the process of developing regulations and policies can be improved. An overview of WSDOT's Benefit/Cost Initiative, as well as the full text of recently-produced studies from the Initiative, can be found at:
http://www.wsdot.wa.gov/eesc/environmental/programs/watershed/watershed_cost_benefit.htm

There are also a number of planned projects the Initiative plans to implement. These include the development of a quantifiable environmental benefit tracking system for major environmental benefits and the development of models and tools that evaluate the benefit of cost reductions through avoidance/prevention activities and incorporate environmental criteria into MIS/DSS. (Major Investment Study/Decision Support Systems). These and other planned products of the Environmental Benefit/Cost Initiative can be found at:
http://www.wsdot.wa.gov/eesc/environmental/programs/watershed/docs/ECB_Program_Overview.pdf

- *Stormwater Runoff*

During redevelopment projects, WSDOT retrofits highways for stormwater control (both quality and quantity) based on local impacts and a practicability analysis. Stand alone retrofits not associated w/redevelopment are done only for high priority and partnership projects to the extent that the budget allows.

In 2001, the State Department of Ecology's Stormwater Manual was revised to account for updated science and treatment practices. Elements of the Stormwater Manual are being folded into WSDOT's Highway Runoff Manual. Results of a significant amount of WSDOT research on ultra urban best management practices, soil amendments, and treatment trains will also be included in the Manual. WSDOT's Stormwater Management approach, which includes links to the Highway Runoff Manual, can be found at:
http://www.wsdot.wa.gov/eesc/environmental/usertrail/watershed_leginit.htm

- *Roadside Manual*

The Roadside Manual lists and provides instructions for several sediment erosion control practices that, if not implemented, could pollute adjacent aquatic systems. Sediment erosion control measures include preventing sediment erosion by using control grasses, using mulches, and installing silt fences as a temporary sediment control measure.
http://www.wsdot.wa.gov/eesc/cae/design/roadside/RoadsideManual.pdf

c. Answer given by all United States Respondents

- *Wisconsin*

Urban and Interurban
Wisconsin has conducted research into the effects of de-icing salts upon the environment of surface and ground water. Studies have also been conducted on vegetation. Sound studies are conducted to determine the effectiveness of a possible noise barrier in locations where noise is or is projected to be a concern.

- *Kentucky*

Urban and interurban
Local well and groundwater monitoring at sites.

- *Utah*

Urban
Best management practices have been adopted by Maintenance and Construction. UPDES permit compliance is monitored by state Division of Water Quality.

State Division of Air Quality monitors for standard pollutants, population and industrial growth are tracked, noise surveys are conducted. Stream and wetland monitoring is conducted internally by landscape architects and vegetation managers, as well as by city and county agencies on a regular basis. State and federal agencies spot check roadways. Each of the four largest urban counties operate an emission testing program to monitor mobile source emissions.

Interurban
There is no vehicle emission testing program. Generally coordination with State Div. of Water Quality, Div. of Wildlife Resources, US Fish and Wildlife Service, US Geological Survey, and the Army COE track stream and wetland water quality, bodies of water that frequently lie by roadsides.

NEPA compliance and similar analysis for state-funded projects for both urban and interurban areas.

- *New York*

Urban and interurban
Environmental issues and pollution prevention procedures:
http://www.dot.state.ny.us/eab/oprhbook.html.
Use of recycled materials (concrete, asphalt, glass, tire shreds, etc) into infrastructure and operational activities. Tire shred embankment example at:

http://www.dot.state.ny.us/eab/ftireshr.html.

- *New Hampshire*

Urban and interurban
The Department incorporates temporary and permanent erosion & sedimentation controls and stormwater management measures into the design of its transportation facilities. We deal with all of the vehicle-source pollutants, including petroleum products, heavy metals, air emissions, etc. State and federal water quality laws and regulations require stormwater management and treatment, which are designed into each transportation project. We use empirical data to define the problem and propose solutions and have not engaged in any specific studies or analyses. However, one of our major bridge construction projects incorporated a closed drainage system and that project was included in an NCHRP project (#25-13) to evaluate bridge runoff and appropriate treatment.

Air emissions are modelled to predict exceedances of state and federal air quality standards. As a northern state, we have a statewide deicing program for the maintenance of our highways and bridges during the winter. Salt contamination of private wells is a public health concern and is addressed through a well replacement program. Our Highway Maintenance Office (602-271-2693) can provide more details. Of recent concern in NH is the West Nile Virus, carried by mosquitoes, and whether or not stagnant water in our drainage facilities and wetland mitigation sites contributes to this problem.

- *Florida*

Urban and interurban
Policies on evaluating and addressing local pollution from transportation follow most national practices, on which there is unlimited research and study. Specific to surface and ground water, Florida recently participated in NCHRP project 25-9 that contains some current applications (see results and many other research results on local pollution at:

http://www4.nationalacademies.org/trb/crp.nsf/NCHRP

In general, Florida is beginning to look at some impacts on a larger regional basis or watershed basis, and offsetting individual project impacts on a larger scale rather than addressing in all cases on-site “postage-stamp” mitigation.

- *Connecticut*

Urban and interurban
Project level designs are sensitive to all environmental and socio-economic resources. This is especially true for water resources and historic/archaeological properties.

3.4. Results of studies

3.4.1. Australia

Urban
Several studies of pollutants in road run-off have been undertaken in Australia and Austroads has published a report, titled “Road Runoff & Drainage: Environmental Impacts and Management Options”, summarising some of the available information and documenting various mitigation measures for different roadside environments. The water quality studies have indicated that road run off may contain contaminants above the desirable guideline levels for receiving water quality. Road crashes contribute to gross polluting incidents.

3.4.2. Austria

Urban
Noise
By lack of space, very often noise barriers or protection walls cannot be erected, thus the only (and not very satisfying) solution is in that case the installation of noise isolating windows.

Interurban
Noise
Taking this into account massive efforts are undertaken in Austria to lower the noise nuisance not only for new road sections, but especially on the existing road network too. Many countries in the world have implemented noise limits of 65 dB (A) during daytime and 55 dB (A) during nighttime along their existing roads, Austria has lowered its limits to 60 dB (A) during daytime and 55 dB (A) during nighttime. Together with a reduction of this limit to 55/45 dB (A) in former quiet places at the planning level this meets the reference value for the average outdoor noise level of the WHO in many areas. Furtheron special emphasis should be laid on risk groups and sensitive situations of noise exposure and the research work for the application of measurement methods adequate to human hearing (psychoacustics) should be intensified.

3.4.3. Belgium

Urban and interurban
Brussels possesses a noise and litter plan. An air plan is under construction.

Impact studies are undertaken for every project. Use of pesticides is strictly limited. Construction waste is to be recycled. Studies to limit deicing salt exist.

3.4.4. Canada (Québec)

Urban and interurban
Road noise
Ministère des Transports du Québec, *Le bruit de la circulation routière au Québec – Identification des zones problématiques*, décembre 1995, s. p.

The Québec Ministry of Transport has realised sectorial studies concerning road traffic problems.

Urban
Annual report 2000 on air quality (CUM)
Almost 700.000 light vehicles are registered and approximately 1 billion litres of fuel is sold every year art the Community of Montreal. East Montreal is also the most important bulk distribution centre of petroleum products (local production as well as imported products).
Vehicles are at the origin of important concentrations of nitrogen oxides and volatile organic compounds, forerunners of ozone. It is in the interest of the Community, the Government of Québec and the federal government to control emissions from fuel distribution networks and of badly kept vehicles

Updating data concerning VOC and NOx tendencies in certain metropolitan zones of Canada, 1999
VOC and NOx emissions due to transport in Montreal are available for the period 1980 – 2005 (estimations), as well as the variation level. Concerning VOC, reduction of the emissions due to cars and light trucks between 1980 and 2005 is estimated at 49% (from 37% in 1980 to 22% en 2005).
Concerning NOx, reduction of the emissions due to cars and light vehicles is estimated at 36% between 1980 and 2005 (from 32% in 1980 to 24% in 2005).

Interurban
No studies available. The federal government has published a GG inventory (1997), in which transport is determined (26%), as well as the allocation between the different gasses according the type of vehicle or truck.

3.4.5. Czech Republic

Urban and interurban
http://www.wmap.cz/atlaszp, http://www.atem.cz

3.4.6. Denmark

Urban

Air pollution
On a national scale, the emissions are calculated. On a local scale, some of the major cities and towns have calculated the concentration of at least NO_2 in the most critical streets, but the calculations are as mentioned fairly uncertain.

In a few streets, a monitoring programme is carried out measuring the actual concentration. This includes 3 places in Copenhagen and a few places in 2 more cities in Denmark.

Noise pollution
Reports on the effects of noise reduction pavements show that a definite noise reduction can be achieved.

Water and soil
The investigation mentioned above, the new field studies has demonstrated that road runoff can be toxic to aquatic organisms in laboratory tests. It has not been possible to confirm the expectation that the samples from the area with the highest traffic load would also be the most toxic. Still, it is likely that such a correlation can be demonstrated if a larger programme is carried out. However, the present study has shown that significant exceptions to the general rule should be anticipated.

The results indicate that measures to reduce the amount of suspended matter before discharge of road runoff into water bodies should be considered. Sediments, which are significantly affected by suspended matter in road runoff, can be toxic to aquatic organisms and contain significant amounts of heavy metals and toxic organic substances.

Interurban
Noise
Reports on noise reduction strategies and noise reduction policies on a number of stretches of state highways has made it possible to establish cost effective noise barriers. Reports with examples of specific noise barriers make it possible for relevant road administrations to construct effective noise barriers.

Water and soil
The results of the study show that spreading of pollution from traffic and roads is on a low level. On the other hand, an accumulation of contaminating compounds near the roads can be found to such an extent, that mitigation must be considered. Continuation of measurements must be considered.

As expected, the analyses show for inorganic parameters that there are high concentrations of sodium and chloride in the road water and soil solution close to the road (3 meters) during the winter, when de-icing salts are used. In a way it can be seen that the greatest influence of the soil and water from the road and traffic is due to de-icing salt in winter.

The analyses show that concentrations of heavy metals in water samples from soil solution and groundwater samples are low, but it is seen that the zinc content in the water samples from both stations exceeded the requirement for drinking water in Denmark. The concentrations of the metals examined show a tendency that they are higher during the winter.

The results of the soil samples the motorway at Rud, trafficked for few years are on level with unpolluted soil samples in Denmark. There is no influence from the traffic or the road. The analysis results for soil samples at Vejenbrod, after 25 years of accumulation of low soluble compounds show much higher values - the closer to the road, the higher the values. As example it can be mentioned that the highest concentration of lead from soil samples at the motorway at Vejenbrod is 223 mg/kg, whereas the highest concentration of lead from samples at Rud is at 15 mg/kg.

The content of organic parameters in soil samples (PAH, NVOH and THC) shows the same tendency as for heavy metals. The concentration, which is determined in the soil taken from Vejenbrod, is much higher than that from Rud. For the organic parameters in the run-off there is an increase during the winter, in the same way as for heavy metals. The concentration, which is found in other water samples, has generally been low. However, there is a higher THC content in deposition and soil solution at Vejenbrod.

By choosing the two field sites with such different ages, it is confirmed that there is an increased concentration of heavy metals and organic matter (PAH, NVOH and THC) as a function of the total traffic volume. Various initiatives, such as use of unleaded petrol and the requirement of catalyst in new vehicles, have had a positive effect in the wish to reduce pollution. It must therefore be expected that it will last more than 25 years before she site at Rud will reach the same level of concentration in the soil at Vejenbrod today.

The results of the studies *are further detailed* in the following references: Pihl, K.A. & Raaberg, J. 2000. Examination of pollution in soil and water along roads caused by traffic and the road pavement. Road Directorate, Danish Road Institute, Report 104.

3.4.7. France

Urban and interurban

A very complete panoply of legal texts and regulations is available: Water Act, Noise Act, Air Act, Landscape Act, Litter Act, Archeology Act, Littoral Act, Mountain Act, laws of 1976 and 1995 concerning the protection of nature and environment…, as well as European regulations;

Many awareness documents, methodological and technical guides, case studies and monographs covering the whole of the treated fields. However, while some fields are largely developed (e.g. noise, since 1972), other (air, climate, litter) are just at the primary stage.

Studies have made it possible to quantify noise nuisances and air pollution.

In the field of strategic environmental evaluation, the European guide of the DG VII of 1999 exists; in France, a methodological test study “Corridor Nord” was developed, proposing a strategic evaluation method in order to compare multimode scenarios at a regional scale.

3.4.8. Hungary

Interurban
In general, measured values are under limit values. The level of lead and zinc in the soil and of lead in plants can be important.

In springtime, the concentration of chloride ions in soil and water providing from road surface, can exceed limit values.

3.4.9. Japan

Urban and interurban
Three reports from the Environment Agency are available:

- *Survey of Automotive Traffic Noise.(annually published)*
- *Results of Vehicular Emission Gas Measurement. (annually published)*
- *Results of General Environmental Air Pollution Measurement. (annually published)*

3.4.10. Mexico

Urban and interurban
The IMT has produced several technical papers about the local pollution generated by the road construction and maintenance. All this papers are available at the IMT. For more details please check the internet page: http://www.imt.mx

3.4.11. Nicaragua

Urban
Air - Studies are to be found in UNI - commission for vehicle emissions - and university theses.
Water - Studies are to be found in MARENA, ENACAL, CIRA-UNAN and MINSA.

Interurban
Air - Centralised in Managua
Water - Studies exist, carried out by the local authority in collaboration with the national government.

3.4.12. Saudi Arabia

Urban and Interurban
To be addressed by the Saudi Meteorological and Environmental Protection Agency (MEPA). SIDCEPA.ORG.SA. tel: 00966-2-6517832.

3.4.13. Spain

Interurban
The average costs generated by the construction of highways, due to (direct) environmental protection means, and the choice of environmentally viable alternatives (indirect) are as detailed below:

Average cost of environmental impact study	0.10%
Average indirect cost on choosing route alternatives which are environmentally superior to the multi-criteria method	4%
Average cost of the preventive, corrective and compensatory measures	6%

(The percentages reflect the cost of the work per contract)

3.4.14. The Netherlands

Urban
There are many studies of local situations where air pollution is calculated.

Interurban
There are many studies of situations with different asphalt to measure what is the pollution of the verges and the quality of the run-off.

3.4.15. Turkey

Interurban
The results of these measurements are used in some national and international projects.

The Ministry of Environment has been forming the pollution map of Turkey for some time.

3.4.16. United Kingdom

Urban
The results of urban air quality monitoring can be found at:
www.aeat.co.uk/netcen/airqual/welcome/html

Interurban
The results of the Air Quality monitoring adjacent to major roads can be found at:
www.trl.co.uk/800/mainpage.asp?page=758

Further nformation about the other research monitoring mentioned above can be found through:
http://www.highways.gov.uk/contracts/compendium/index.htm

3.4.17. United States of America

a. Answer given by the United States Federal Government

Once again, transportation agencies in the U.S. do not routinely monitor health effects studies; therefore, we are unable to provide extensive information regarding this question. However, listed below is a description of a recent assessment of the use of oxygenates in gasoline. An MTBE Blue Ribbon Panel was created by a Charter from the Clean Air Act Advisory Committee (CAAAC) to provide independent advice and counsel to EPA on policy issues associated with the use of MTBE and other oxygenates in gasoline. The panel held meetings, analyzed issues, conducted reviews, made recommendations, and performed other activities necessary to meet its responsibilities.

More information on the Panel and its findings can be found at:
http://www.epa.gov/otaq/consumer/fuels/oxypanel/blueribb.htm#Recommendation

b. Answer given by the Washington State Department of Transportation

WSDOT Environmental Procedures Manual (EPM):
The EPM provides guidance for complying with federal, state, and local environmental laws and regulations during the planning, designing, constructing, and maintenance of transportation facilities in Washington State. It applies to facilities that are owned and operated by WSDOT. Relevant to local pollution, the EPM addresses two areas: water quality/surface water (information and requirements for water quality, surface water, stormwater runoff, fill material in wetlands, and construction erosion control and runoff); and, hazardous materials (policies and procedures for dealing with hazardous materials or problem materials encountered in property WSDOT owns, manages, plans to sell, or plans to purchase).

The EPM is available at:
http://www.wsdot.wa.gov/eesc/environmental/programs/regcomp/ProceduresManual/start.pdf

c. Answer given by all United States Respondents

Wisconsin

Urban and interurban
Deicing salt studies have resulted in more precise equipment for spreading de-icing materials and the gathering of more accurate and timely information about road conditions. Salt storage facilities have also been constructed to eliminate the leaching of de-icing salts into the environment. Noise barriers have been constructed where they are most effective and agreeable to the affected population.

Kentucky

Urban and interurban
Soil contamination at some sites areas cleaned up. No long-term impacts on health or water contamination.

Utah

Urban
Metropolitan Planning Organizations and the siting of air monitoring centers in urban areas of the state has prompted traffic congestion, flow studies, noise studies, and CO hot spot analyses. Emission controls are stricter, traffic signals are being synchronized, noise walls constructed, and settling ponds or vaults/detention basins are being constructed to remove sediment and hydrocarbons.

Interurban
Little detection of air pollutants in rural areas, except where local industry is large (emission controls are mandated for large industry).
Pilot project in partnership with EPA to facilitate education and adoption by local communities of sustainable development/smart growth in parallel with the EIS for a proposed new transportation corridor.

New York

Urban and interurban
Storm Water Management Practices
Open and Closed Systems Effectiveness Research Studies Research projects to evaluate the effectiveness of:

(1) Selected biofiltration systems, such as wetlands, retention basins, swales and filter strips in treating the quality of highway storm water runoff; and

(2) Selected pre-manufactured devices, such as water quality inlets, catch basin inserts, passive skimmers and cartridge filters in treating the quality of highway storm water runoff in urban areas where above ground treatment through biofiltration is not an option with work to begin fall 2001

NYS Green Building Initiative
For promoting the construction/reconstruction of commercial and residential buildings through the creation of a "green building" tax credit.

NYSDOT accessing energy reduction features in operations support buildings (i.e., new Equipment Management Facility in R9)

http://www.dec.state.ny.us/website/dar/ood/grnbldg
http://www.nyserda.org/green.html

Connecticut

Urban and interurban
CT-Environmental Permitting programs and environmentally sensitive design parameters. National Environmental Policy Act and Connecticut Environmental Policy Act compliance.

4. BIODIVERSITY

4.1. Preface

The following countries responded to the topic: Australia, Austria, Belgium, Canada-Quebec, Czech Republic, Denmark, Finland, France, Hungary, Japan, Madagascar, Malaysia, Moroco, Mexico, the Netherlands, Nicaragua, Norway, Romania, Saudi Arabia, Spain, Turkey, United Kingdom and the United States of America.

Most of the countries pointed out in their answers that the effects of road networks and transport policies on biodiversity are mainly seen as a matter of interurban areas. The loss, fragmentation, disturbance and pollution of habitats were reported as the major impacts, various measures and studies were undertaken to identify the most critical road and network sections and to improve the current situation by means of underpasses, overpasses and ecological compensation measures. At the planning stage a re-routing of particular road sections might solve the problem in less populated areas. Only a few countries took into account the positive effects roads and the road network could have on biodiversity. For example in areas with intensive agricultural use or in heavily built-over areas, road verges and road greenery can offer some species a habitat and a migration route.

4.2. Effects of road networks and transport policies on biodiversity

4.2.1. Australia

Interurban
The general approach taken in Australia is to avoid, minimise and mitigate.

The effects of road networks on biodiversity include:

- Loss of habitat due to clearing for road construction/expansion

- "Edge effects" due to road clearing allowing increased light, noise, weeds and dust to penetrate into nearby vegetation.
- Fragmentation of habitat areas leading to "islands" which prevent movement of animals and therefore a loss of genetic diversity over time.

- Pollution of habitat with noise and chemicals
- Waterway crossings can impede fish passage.
- Increasing road kills
- Change in hydrological patterns can change the vegetation of an area

These effects must not only be negative. Road reserves and road sides, for example, can preserve remnant vegetation in areas cleared for other uses such as agriculture. In Australian, significant remnant vegetation occurs along many roadsides and these are identified for particular management.

Also transport policies, careful planning and design can reduce negative effects and increase positives, for example, by:

- Provision of fauna under/overpasses.
- Avoidance of significant habitats
- Promotion of better use of existing infrastructure to avoid the need for new roads.

- Management of significant habitat along roadsides to promote preservation.

4.2.2. Austria

Interurban
Landscape and habitat fragmentation, due to various kinds of human infrastructure, presents an increasing problem in Austria. In interaction with other anthropogenic infrastructures the network of fenced motorways in Austria is reducing the possibilities of migration and genetic interchange for wildlife species. Additionally, landscapes of intense agricultural use reduce migration. The network of motorways in Austria is almost complete and no information was available so far whether this network of barriers (2000 kilometres) offers enough permeability for wildlife especially for big game species and where suitable passageways were situated.

4.2.3. Belgium

Interurban
The major impacts on biodiversity are indicated as:

- Loss of habitats
- Habitat fragmentation
- Disturbance of habitats
- Possible extinction of particular species

The policy of the government is a compelling legal regulation for an ecological management and maintenance of the verges for an improvement of the natural relations.

4.2.4. Canada - Quebec

Interurban
Road planning and the development and operation of the transport system may generate negative impacts on the environment. In consequence the most important symptoms for biodiversity are:

- The transport network for goods and people can influence the loss or fragmentation of habitats by road infrastructure buildings

- The increasing urbanisation caused by the growth of cities and villages is furthermore leading to a reduction of the agricultural areas and the size of habitats with the effect of a deplacement of some populations.

- The operation of the different transport systems generates pressure on the environment too, by pollutants (on air, water and soil), consumption of non-renewable resources and changes to the natural environment.

Urban
The increasing urbanisation caused by the growth of cities and villages is furthermore leading to a reduction of the agricultural areas and the size of habitats with the effect of a displacement of some populations.

4.2.5. Czech Republic

Urban and Interurban
From the Czech Republic, the following were stated as the main effects of road networks and transport policies on biodiversity:

- Fragmentation of fauna habitats
- Local problems on species migration and
- Local rare contamination of wetlands

4.2.6. Denmark

Interurban
Transport infrastructure forms massive barriers in the landscape and decreases the habitat areas as well as the possibilities for dispersal of many species. In the worst cases the barrier effect can result in total isolation and extinction of a population. Amphibians, hare, badger and otter are found to be the most sensitive species.

Animal populations have during a long period adapted to environmental changes in the mosaic landscape. However, fragmentation is today one of the more serious threats to the Danish native fauna.

The major effects are:

- Fragmentation of natural and semi-natural habitats
- Decrease of habitat areas, such as felling of forests, drainage of wetlands etc.

- Fauna casualties
- Barriers to dispersal of species
- Isolation of populations
- Pollution from contaminated road surface water, pesticides, de-icing salt etc.

- Changes in habitats due to increased disturbance, eutrophication and pollution.

Urban
The effects on biodiversity in urban areas are roughly the same as mentioned for interurban areas, but a much lesser extent.

In a very intensively exploited urban landscape the traffic infrastructure including verges, embankments, interchanges, etc., may function as dispersal corridors, habitats and refuges for wild species

4.2.7. Finland

Interurban
In rural areas, the main impact is caused by fragmentation by the main roads, dividing and reducing animal and vegetation habitats, and traffic kills. Some positive impacts can be provided by road verges, especially for insects, birds and small mammals endangered by intensive agricultural techniques or, conversely, by abandoned fields turning into shrubbery and forest.

Road verge maintenance has an impact on vegetation, which can be positive as well as negative.

Urban
In urban areas, road network impacts on biodiversity are part of overall urban land use impacts: land is built over, natural areas taken into other use or fragmented by all kinds of infrastructure. On the other hand, in heavily built-over areas, road verges and road greenery can offer some species a habitat and a migration route, though the utility of this is open for discussion - it may have a psychological value for urban citizens rather than a biological one for any endangered or other species.

4.2.8. France

Interurban
Major effects of road network and transport system on biodiversity:

- Disturbance of fauna
- Destruction of habitats
- Injuring effects on the natural environment
- Pushing aside biodiversity into very exposed areas

Different approach to the subject is possible :

a. Function of the type of species:
   - big mammals
   - small mammals
   - avifauna
   - water fauna
   - flora and ecosystems

b. Type of the concerned natural environment:
   - terrestrial area
   - humid zones
   - rivers and lakes
   - coastal regions

c. systematic function
   - habitats
   - biological corridors

d. level of protection
   - protected plants or animals
   - protected habitats

4.2.9. Hungary

Interurban
The report of Hungary is indicating the following as the main problems occuring for biodiversity by the road network and transport system :

- the transformation of habitats (loss of a balanced ecological system)
- the restriction of species in their movement
- the seperation of habitats and
- the death of animals by road traffic (esp. amphibians)

4.2.10. Japan

Interurban
Japan is endowed with the diversity of natural environment with clear seasonal variations.

Natural environment is the foundation that nurtures and sustains the biodiversity, including humans. People are intensely aware of the necessity of conserving the natural environment.

Conservation of natural environment and biodiversity is now considered as one of the social imperatives. Conservation efforts should cover not merely endangered and rare species but ordinary species, ordinary genetic resources, and ordinary ecosystems. Along with the extensive development of highways, wildlife road casualties have been increasing gradually. Wild animals killed by road accidents on national expressways numbered roughly 33,000 in 2001.

Construction of roads has caused fragmentation of natural habitats of wildlife, and reduced, or destroyed natural habitats for a variety of wildlife species.

4.2.11. Madagascar

Interurban
Fauna
Certain tribes of animals need corridors and places for retreat. The existing road network is of negative impact on these migration activities as well as for animal resting

areas. The collision of animals with vehicles and the disturbance of near to the road located habitats are the main problems to be solved.

Flora
The construction of new roads is of great influence on the green areas (biotopes) which are the refuge of rare or protected species. A loss of species and the change into an artificial landscape is very often the result of such infrastructure projects.

4.2.12. Malaysia

Interurban
Temporary removal of terrestrial vegetation and terrestial habitat(s) during construction and Permanent removal of vegetation and loss of terrestrial habitat(s) are named as the main effects of the road network in Malaysia.

4.2.13. Mexico

Interurban
In Mexico, the National Ecology Institute (INE) depending to the Environment and Natural Resources Ministry (SEMARNAT) has defined several natural protect zones, than its features and ecologic value should be preserved and improved. For those cases, the regulation is very strict and the environmental studies are detailed in order to prevent and mitigate adverse impacts at the environment.

The environmental criteria for roads project designs, it's been incorporated at the SCT strategies, with special careful on natural protect zones and total respect to the economic and cultural life of the communities. The furtive hunter and the forest explotation are the main problems and they are induced in a way for rural roads.

4.2.14. Morocco

Interurban
To avoid or minimize fragmentation caused by the construction of new roads an alignment along existing routes is favored in Morocco. Specific studies were carried out to minimize the effects on biodiversity prior to the road construction.

4.2.15. Nicaragua

Interurban
As the main effect of the road network and transport policies on biodiversity the rapid expansion of the number of passenger cars is reported in Nicaragua. Due to this expansion more and more people reach unique and sensitive areas with the consequence of a negative impact to natural habitats. The disturbance for big mammals is much more severe than for small species.

4.2.16. Norway

Interurban
There is a loss of area in national parks, special protected landscape areas, national reserves, intact natural areas, riparian habitats and shore zones due to road building.

4.2.17. Romania

Urban
Traffic accidents are caused by collision between vehicles and large animals crossing urban roads.

Interurban
The following effects of the road network on biodiversity were indicated:

- Reduction of biotopes (number and size)
- Modification of species
- Isolation of biotopes and biotop population (by interruption of migration)
- Menace of protected animals and sensitive areas
- Barrier effects (obstacle for small animals, thermic effects: dehydration of amphibies)
- Danger of collision with (big) animals
- Depreciation of the botanic potential
- Contamination of plants (feed-chain)
- Disturbance of protected zones, natural monuments and national parks.

4.2.18. Saudi Arabia

Interurban
The major impact of road construction is the destruction of both plant and animal habitats. Plant habitats are especially impacted in hilly or mountainous areas where deep cuts lead to erosion. Much greater damage, however, is done to animal habitats, as road traffic extends habitat disturbance for considerable distances on both sides of the road. Death of many animals is also a result of road construction and ensuring traffic. It has been suggested by scientists of the Meteorology and Environmental Protection Administration (MEPA) that road kill of snakes and lizards and frightening away of owls has disrupted the ecosystem balance between carnivores and small seed-eating mammals to such an extent that primary production of rangelands may be appreciably lowered by the increase in seed consumption.

On the other hands, the fencing along main roads together with increased moisture from roads run-off to the depressions besides the roads have created a narrow band of protection for the growth of plants. Some such ungrazed and favored areas are veritable gene banks of grasses and small forbs. Possible imbalance in the ecosytem was suggested as leading to decrease of rangeland plant production of meat and milk.

4.2.19. Spain

Interurban

The Spanish territory has the most rich flora in Western Europe including more than 7.000 species of vascular flora and more than 20.000 subspecies. Talking about fauna, there are more than 600 species of vertebrates (400 birds, 100 mammals, more than 70 amphibious and reptiles and 50 different species of fishes) and a great variety of invertebrates. These reasons give Spain a role as the more important genetic reserve in Western Europe.

The different effects of road construction and exploitation on areas with a singular ecological value are, among others, habitat loss and fragmentation, barrier and corridor effect, population decrease, generation of biological islands (isolated areas) and in consequence a decrease of the natural biodiversity. In some extreme cases, these effects might cause a local or regional extinction of certain flora and fauna species.

4.2.20. The Netherlands

Urban and interurban

The ecological value of national highway verges: how to maintain and increase the value of roadside verges as habitat for plants and animals.

The effect of habitat fragmentation: how the fragmentation can reduce the negative effects of highways for passage of animals.

4.2.21. Turkey

Interurban

The concrete structures (boxes etc.) of existing road network which are built to protect roads from run-off water are not enough to protect the habitats and ecological balance of the flora and fauna species. The new transport (Highway) policy incudes the preparation of EIA-Reports for new road projects. So that road environment, especially biologically sensitive areas where route passes around could be protcted with appropriate designs. On the other hand Ramsar Regions (wetlands), forest areas, national parks, wildlife protection areas, endemic species and monumental trees are under protection. It is not possible to pass the route from these areas. Also biological wealth areas, 1st and 2nd degree farm areas and animal pasturage lands could not be used in any other purposes.

4.2.22. United Kingdom

Urban

Urban transport networks can have benefits for wildlife through the provision of linear habitats that have both a corridor effect and can act as a refuge for fauna and flora. Policies to limit the growth and use of vehicles in town and city centres can only benefit biodiversity. Moving the balance of investment towards rail and light rail will provide opportunities to protect and enhance biodiversity on railway land which has been demonstrated to have significant biodiversity value. In London for example, the London Underground Network's above ground estate is teeming with protected species as

confirmed by the London Ecology Unit's surveys in year 2000. 350 plant species have been found by the lineside and some areas have been designated as Sites for Importance for Nature Conservation.

Interurban

The principal roads in the countryside can have both beneficial and deletereous effects on biodiversity. The most significant damage is through direct loss of habitats and the fragmentation effects of the infrastructure. Road deaths for some species are a significant cause of overall mortality as is the case for Barn Owls, Otters, Badgers and amphibians. Benefits can be achieved through maintaining connectivity with viaducts, under and overpasses adapted to make these features attractive to wildlife. The highway estate can be designed to replicate habitats mostly grasslands, scrub and woodland edge with an element of water through the ditch and balancing pond network.The extensive planting of native trees and shrubs combined with wildflowers and companion grasses provides a prime habitat for small mammals, reptiles, amphibians and invertebrates that form such an important part in the UK Biodiversity Action Plan. The publication of the Highways Agency's Biodiversity Action Plan in March 2002 establishes a programme of measures to protect and enhance 20 priority species and 5 priority habitats throughout the English Trunk Road Network over the next ten years. http://www.highways.gov.uk/

4.2.23. United States of America

Interurban

In considering the effects of highway traffic noise on areas adjacent to highways, analysts normally give primary consideration to exterior areas of frequent human use. Research on the effects of highway traffic noise on wildlife has been very limited. Additional research is needed to properly assess potential traffic noise impacts to wildlife populations. This may include physiological responses, such as changes in heart rate, metabolism, and hormone balance or stimulation to the nervous system and chronic stress. This may also include behavioral responses, such as minor responses of head-raising or body-shifting or major responses of panic and escape. Information is needed on both the short-term and the long-term effects of highway traffic noise disturbance.

4.3. Systems in place for monitoring the effects

4.3.1. Australia

Interurban
For monitoring the effects biological surveys in relation to road project areas and management plans for road construction projects are carried out. Vegetation clearing statistics are kept in many areas and road side monitoring and vegetation/habitat management programs form part of normal road maintenance in most States of Australia. In some areas, GIS databases are used to monitor extent and quality of roadside and other vegetation.

A study is currently being undertaken in Victoria into means of identifying and quantifying biodiversity values and developing standard means of assessing impacts and determining appropriate amelioration measures. Examples of the information available are: Guidelines for the conduct of Biological Surveys and Roadside Management Guidelines

4.3.2. Austria

Interurban
Due to this lack of information the Ministry of Transport ordered a study with the main purpose to find out the permeability of the existing network of motorways, and requirements for greenbridges or other crossing possibilities for larger game species in Austria. Existing passageways, bridges and tunnels primarily built for human use, had to be documented and recorded with regard to their suitability for game species (Völk et al. 1999, 2000 and 2001).

For the assessment of migration corridors for genetic interchange of game a survey, focused on forest favouring species, which are most sensitive regarding size of home range and size of passageways, was worked out. As indicator species we selected rare big game species (brown bear, lynx, wolf, moose) and widespread ungulates (red deer, additionally chamois and wild boar, supplementary also roe deer).

4.3.3. Belgium

Interurban
Several studies were undertaken for monitoring the situation:
One study was done to monitor the flora inventory along 7 motorways in order to provide an ecologically management of those areas nearby the motorways. Another study has investigated the possibilities of restoring the natural relations between the habitats and another field of studies are the protected areas. A map of the unprotected ecotypes was carried out.

4.3.4. Canada

Interurban
In Quebec the Ministry of Transport is taking into account environmental matters on the transport sector since 30 years. The current and future policy is to converge the transport sector to the principles of sustainable development and conservation of the biological divesity. An environmental evaluation is carried out for every road and infrastructure project and general studies with the vision to implement a system for the conservation of the environment are undertaken. Furthermore an inter-ministral committee for sustainable development has been established.

4.3.5. Czech Republic

Urban and Interurban
Local monitoring of big mammals migration (deer, wolf, lynx, otter, bear, elk) is provided by the Nature conservation agency (AOPK). Monitoring via telemetric watching and GIS presentation is used.

4.3.6. Denmark

Interurban
Various studies in place for monitoring the effects have been carried out to get an approach to the problem.

- In 1996-97 the existing fragmentation of nature areas due to traffic barriers in Vejle County was mapped and described, and mitigation measures were assessed for a number of conflict areas in the county (Salvig et al. 1997). The Road Directorate has initiated a major survey of the barrier effects for wildlife of the Danish State road network (Fauna Statsvej). Copenhagen County has carried out an initial screening and mapping of possible points of conflicts between major traffic infrastructure facilities and regional dispersal corridors for flora and fauna.

- So-called biological road maps have been prepared for a number of state roads. These maps show localities of specific biological (Botanical) values, and describe how these localities should be managed to maintain and increase biodiversity.

- The animal's use of a number of established faunapassages are monitored by infrared camera surveillance. The survey is conducted by the National Environmental research Institute (NERI).

A comprehensive book of general guidelines for fauna- and recreational passages based on several Danish and European experiments has been collected and published by the Danish Road Directorate. The guidelines for mitigation measures, such as fauna passages, compensation habitats, landscape adaptations will be followed in projects for construction of new state roads.

Urban
The Road Directorate, the counties and the municipalities undertake registration on the annual use of pesticides for the maintenance of roads, railways and paved surfaces.

The Road Directorate records the use of de-icing salt. In 1996 a study of the possible effects of de-icing salt on trees and bushes were undertaken.

4.3.7. Finland

Interurban
Finnra monitors impacts on flora,insects, birds and large animals in one study, on flora in another, and has made several studies of impacts on birds. Recent studies take up traffic kills, at this stage mainly to define their extent more closely, as earlier studies have only dealt with individual road stretches.

4.3.8 France

Interurban
For limiting and monitoring the effects on biodiversity four types of measures are proposed in principle:

- to respect the sites, reserved zones, natural parks, protected habitats and protected species
- avoid the touch of sensitive zones
- conservation and reconstruction of biological corridors
- specific installations (openings for the big species, passages for small animals, fish stairs, reconstitution of biological corridors, minimizing the collision risk for avifauna, compensatory measures, etc.)

4.3.9. Hungary

Interurban
A monitoring of the passages for protected animals is done in order to examine the effectiveness of the measures. The current result of the examination shows a great variaty in the effectiveness of animal passages, but it is reported that the knowledge of the behaviour and movement tracks of the animals is very important for a successful installation of such devices.

4.3.10. Japan

Interurban
Approach to the problem is a National Strategy on Biological Diversity. Preparation and design of road projects must be changed to emphasize environmental conservation and improvement. Principally, projects should try to avoid those locations where valuable natural habitats are found. If unavoidable, projects must be so prepared and designed as to minimize their adverse environmental impacts and to prepare appropriate mitigation measures to offset the impacts.

Projects will be prepared in accordance with the stipulations of the Environmental Impact Assessment Law. In this regard, it is essential to strengthen the method of evaluating the project impact on local ecosystems. Side-slopes of roads will be greened by efficient planting and seeding, including those side-slopes of the existing roads that have not been greened yet. By utilizing spaces available along roads, local parks and rivers will be connected to establish ecological networks.

Those roads that were closed down because of the construction of by-passes will be revived by planting and seeding to be used as nature trails (trails to enable people to contact with nature and to visit historic remnants).

4.3.11. Madagascar

Interurban
Fauna:
For a reduction of the number of collisions between animals and vehicles the following measures are proposed:

- a reduction of the speed of the vehicles by means of speed limits
- the elimination of trees on the border of the road in order to improve the visibility

To point out the most confident measures some experience is necessary, by limited amout of available money it is supposed to identify the most severe conflict points.

4.3.12. Malaysia

Interurban
As an approach to the problem it is suggested

- to conduct floral and faunal survey immediately before construction, during construction and during operation and
- to prepare rescue and mobilisation plan for animals and salvage endemic, rare or endangered plant or tree species to aboretum, etc.

4.3.13. Mexico

Interurban
The INE has produced studies for monitoring the behaviour of the nature protected zones and other zones that may be designed as nature zones. Also, the INE work cover Land Use at national level, biodiversity catalogue and ecologic regulations. Furthermore, exist the Comisión Nacional de la Biodiversidad (CONABIO) (National Biodiversity Comission). That agency has several species catalogues and has developed researchs and monitorings works.

For biodiversity monitoring, the SCT and IMT do not have any systems in place.

4.3.14. Morocco

Interurban
Studies of the effects on biodiversity are carried out only for motorways. The studies were entrusted to private consultants.

4.3.15. Nicaragua

Interurban
After the construction of the north section of the Panamericana motorway on specific animal crossings a comparison study was carried out to investigate the influence of traffic signs on the number and depth of animal accidents and mortalities.

For the mapping of the fauna in specific zones GPS is used.

4.3.16. Norway

Urban and interurban
The loss and disturbance of the different types of areas named over are reported to Parliament.

4.3.17. Romania

Interurban
Legislation in Romania is providing regulations for biodiversity preservation to avoid negative impacts on habitats for road infrastructure as well as at the project level. The quality of the environment is taken into consideration by means of indicators (flora, fauna, air and water) for habitat preservation.

4.3.18. Saudi Arabia

Interurban
The National Commission for Wildlife Conservation and Development (NCWCD) is especially concerned with "protected areas" for the conservation of wildlife. The NCWCD also publishes the FAUNA of Arabia and an international scientific journal

4.3.19. Spain

Interurban

There is an extensive collection of regulatory laws concerning species protection and its habitats in Spain, coming, almost all of them, from the European Union legislation. As a result of this legislation different valuable zones, from the point of view of their natural resources, have been protected, and in the future will be included in the Natura 2000 Network.

Spain is the European Union country has the most area proposed to be included in the Nature Network 2000. In this way, more than 34,876 km^2 have been declared as Special Protection Areas for bird protection (179 areas) and 867 areas, 88,076 km^2 in total, as Special Areas of Conservation.

The purpose to cross any of these areas with any kind of road, has to be accompanied with the necessary demonstration that the construction of the infrastructure is absolutely necessary for a public interest reason, and that any other alternative can be considered. At the same time compensatory measures must be applied in order to compensate the environmental damages that have been caused.

Also, the construction of a new road must be subject to the environmental assessment impact process, where minimising, correction and protection measures must be improved. Among these measures, barrier effect minimising must be highlighted, by mean of biotunnels, biobridges, culverts and other structures adaptation. In highways, where the barrier effect is increased because fences close them, escape mechanisms are set up to provide the way out to animals that may come into the highway.

4.3.20. The Netherlands

Interurban

Measures for ecological construction, lay-out and management (special mowing regimes) of roadside verges will increase the ecological values not only for plants but also for smaller mammals, amphibians and insects. Ecological verge management, bases on one or two annual mowing sessions (whereby the cuttings are removed), contributes to the growth of verges rich in wild plans and animals.

Road verges contain more than 800 flowering plant species, more than half of all Dutch plant species. The National Transport and Transportation Plan (2000) says that by the year 2010 ninety percent of the exiting conflict situations between highways and the natural environment should be solved. Progress reports are submitted on an annual basis and so far the programme is running to scedule. Measures which are taken include : badger tunnels, ecoducts, fauna adjustments to existing bridges and viaducts. We are also gaining practical experience with nature compensation if de-fragmentation measures are not enough to reach no net loss for natural values. In the COST Action 341 (Habitat Fragmentation due to infrastructure) and the IENE (Infra Eco Network Europe) some 30 experts representing 14 European countries are working together in the field of exchanging experience and stimulating research. In May 2002 discussions will take place how to work together with similar organisational structure in the USA.

4.3.21. Turkey

Interurban

Universities, NGO´s and some governmental organisations have been monitoring biodiversity not only for the purpose of detecting the effect of highways but with general purposes. Some specific examples are:

The Underwater Research Foundation and Mediterranean Seal Research Group (SAD-AFAG) is performing researches for the protection of Mediterranean seals in Foca and Mersin.

Many NGO´s (f.ex. Foundation for the Protection of Natural Life, Foundation of Turkish Nature Protection) and governmental organizations (Ministry of Environment and Special Environment Protection Organisation) has been working on specific projects such as preservation of water birds in Ramsar Regions and Marine Turtles etc. .

4.3.22. United Kingdom

Urban

Highway authorities utilise the resources of the voluntary sector as well as ecological consultants to monitor some parts of their networks where important habitats or species are present and specific maintenance should be carried out to protect these valuable locations. Local authorities such as Nottingham, Tyne and Wear and Milton Keynes have in place nature conservation plans and strategies to maintain wildlife corridors to provide the essential connectivity with the countryside and between urban wildlife areas.

Interurban

The Highways Agency in England has assembled an environmental database for its estate which linked with the Agency's Biodiversity Action Plan (HABAP) will provide the basis for monitoring progress in the implementation of the habitats and species action plans as well as more routine nature conservation practice that will benefit less threatened species and habitats. Post Opening Project Evaluation and scheme specific monitoring projects will provide an insight into the effectiveness of mitigation and enhancement measures for biodiversity that are installed as part of major road improvements.

4.3.23. United States of America

Interurban

In Florida, the State DOT has installed 23 wildlife crossings, 13 bridge extensions of 40 feet each, and right-of-way fencing along 40 miles of highway during a recent upgrade and reconstruction of U. S. Highway 75 in south Florida. These efforts were implemented to overcome the range restriction barrier presented by the highway in the south Florida ecosystem. The measures were used also to protect and provide passage for the Florida panther and black bear, both of which are endangered species in that area. The structures cost approximately $13 million state highway funds, plus $2 million federal-aid funds. Right-of-way fencing was paid for with a combination of state highway and federal aid highway funds. The 120-foot long "wildlife underpasses" were designed in consultation with the U. S. Fish and Wildlife Service, and monitored photographically after construction. Both Florida panther and black bear have been documented using the structures. Other species using the structures include alligators, deer, raccoons, bobcats, turkeys, and opossum. Fencing has been highly effective in keeping wildlife off the roadway, and has reduced wildlife mortality significantly.

Similar structures have been used to provide connections between essential migration habitats for wildlife. In California, Wyoming, and Colorado, deer underpasses were constructed to allow major deer migrations to move between critical summer and winter ranges along several State routes and Interstate highways. Deer-proof fencing and one-way gates were installed on rights-of-way adjacent to major deer movement corridors to keep deer off the highway and to channel them to crossing structures. In Southern California, culverts and right-of-way fencing have been used to provide corridors for movement of the endangered desert tortoise in its desert environment. Other states have also used culverts and other structures to provide wildlife passage.

Advanced planning and management activities are another way to address barriers to wildlife movement, habitat fragmentation, and habitat loss. FHWA supports State transportation agency efforts to incorporate advance data collection, thorough coordination, and shared objectives and information into the transportation planning process. For example, the Headquarters office of FHWA and Montana DOT are working with the FWS to develop and fund a proposal to use digital data and Geographical Information Systems (GIS) technology to analyze the location of important "linkage zones" used by wildlife to move between different ecosystems and habitats. One aspect of the project will try to determine some of the effects of highways on these linkage zones, and evaluate different strategies for maintaining wildlife movements. The proposed study uses GIS analysis techniques developed by the FWS Grizzly Bear Recovery Team to analyze bear movements in the Northern Rocky Mountains and Flathead River Ecosystem. The project is the result of an interagency workshop on the impacts of highways on large carnivores in the Northwest, held in Missoula, Montana, May 1995. Initiated as a cooperative effort by FHWA and FWS, the workshop was attended by highway and resource agency managers and biologists from Montana, Idaho, Washington, Wyoming, and Colorado.

In Utah a bisection of habitat and disruption of migration routes was monitored. This occurs more frequently where high fences and retaining walls are insurmountable.
Big game casualties are collected over many state/federal roads, but data collection is not uniform. A wetland hydraulics study was conducted for the new roadway to determine if the road bed will alter ground water flow to wetlands on downhill side.

Florida is reporting that a reduction of habitat type and amount leading to secondary impacts to biodiversity. Created/enhanced wetlands are monitored over years for viability and success in replacing lost biodiversity, etc. and/or improving habitat diversity. Biodiversity impacts can be lessened or mitigated to some degree by properly implemented mitigation measures.

4.4. Results of studies

4.4.1. Australia

Interurban
Many results of the studies are project specific – impact assessment indicates ecological resources requiring protection. Noxious plants have been found in road, spread of plant disease is a major problem. Increased access to areas via the road network increases these problems.

There is a continuing program of monitoring of fauna underpasses in NSW and similar work has been done in other States. The results are used to improve the design of underpasses and results show that many animals, including some endangered species, use the underpasses.

Research has been done on providing overhead structures such as rope bridges and overhead tubes to provide safe passage for treeliving animals to major cross roads. These have not all been successful but rope bridges appear to have some use.

There is a 6 year study of the effects of road construction on koala populations being undertaking. The study includes radio-tracking of koala in two distinct populations. Further research into the effectiveness of wildlife reflectors for Australian animals has recently commenced again, after earlier research was inconclusive.

4.4.2. Austria

Interurban
As a result of these studies the standards for existing motorways were defined:

Passages Type A (for international habitat defragmentation)
Each crossing of wildlife corridor with international relevancy and motorway requires a passageway for wildlife with a minimum width of 80 m. (Recommended width 80-100 m)

Passages Type B (for regional and national habitat defragmentation)
To ensure a minimum permeability and minimum habitat defragmentation for the sensitive indicator species at least 5 passageways for wildlife with a minimum width of 30 m are necessary along one motorway segment. Their locations should be away from human settlements and the maximum distance between neighbouring passageways of type A or B must not exceed 20 km. If the motorway segment is longer than 75 km, the number of necessary passageways increases for every started 20 km by 1. (Recommended width 30-80 m)

Passages Type C (for local habitat defragmentation)
For local habitat defragmentation away from far ranging wildlife corridors 5 passageways with a minimum width of 15 m along one motorway segment are necessary. The average distance between passages of the type A + B + C should not exceed 10 km. (Recommended width 15-30 m)
For very short motorway segments (<5 km , <25km) exceptions are provided.

4.4.3. Belgium

Interurban
The result of one study is showing the elements of fauna within the road verges, another is presenting the possibilities for the recovery of natural relations. A monitoring study was done for an ecotunnel at the E 314 near Houthalen.

4.4.4. Canada-Quebec

Urban and Interurban
The Quebec Ministry of Transport has contributed to the general strategy of the Ministry of Environment for biodiversity and the corresponding action plan 1996-2002. Every single action was monitored and evaluated, at the present stage a new plan for 2002-2007 is under elaboration. The respective documents are available at the following e-mail address: http://www.menv.gouv.qc.ca/biodiversite/index.htm .

4.4.5. Czech Republic

Urban and Interurban
All the results have been collected in materials for a methodology for migration of big mammals crossing roads.

4.4.6. Denmark

Interurban

Result of studies and current policy :

Efficiency studies show that the location of fauna passages is more important to the use, than the design and dimensions of the passages. The effectiveness of passages is mainly associated with the position of the passage in relation to animal dispersal routes.

It is not possible to consider all native species by the establishment of compensation habitats. Danish experience shows, that especially the survival of amphibians can be secured by the digging of new waterholes. Some habitat types are impossible to recreate, and further research in the field of nature restoration and establishment of compensation habitats is needed.

As the valleys are important habitats and dispersal routes for wild flora and fauna the general policy in Denmark is to build landscape bridges as large as possible when crossing of a river valley is unavoidable. It is generally much more expensive to construct bridges and other type of passages through existing infrastructure than it is to build in passages for recreation and wildlife in the design of new roads.

The compensation measures currently applied in Denmark comprise establishment of compensation habitats, for instance: Digging of new water holes and ponds, planting of new forest to substitute cleared areas, planting of shrubbery with fruits and berries to replace the wood edges.

Today all major infrastructure projects are subject to EIA. The best results for biodiversity are obtained when the EIA is an iterative process, where roadengineers, planners and biologists participate cooperate on the design and alignment of new roads.

4.4.7. Finland

Interurban

The studies of impacts on birds have given some conflicting results, but in the main, they show that bird population are reduced in the vicinity of larger roads and nesting failure increases. One study concluded that main road noise disturb birds, but another one concluded that it did not. Other biological studies results are not yet available. The many elk accidents and their often severe consequences underline the importance of elk migration studies and ecoduct development. In addition to man made infrastructure there exists an "invisible" ecological network for animals. The core areas and the ecological corridors that establish the ecological network are important for the functioning of nature and for the ecology of animal populations. One aim of the study was to find means to prevent nature fragmentation and take the ecological network in consideration in land-use planning and road building.

The other aim of the study was to improve traffic safety and to reduce the high rate of moose accidents in Finland. The moose was an indicator and follow-up species of the study. The inquiry was made to moose hunters to sketch the moose routes. These and future land use were digitised to the digital map and they were studied with overlay analysis. After the opening of the road the follow-up program for animals was started. Animals have actively searched for under passages and they have learned to use them. The species which have been observed are the moose, the white-tailed deer, the lynx, the mountain hare and the brown hare, the red fox, the racoon dog, the stoat, the red squirrel, the pine marten and the badger.

4.4.8. France

Interurban
As available information the zones Natura 2000, national parcs, European directives on birds and habitats, the Ramsar-convention, the French report to COST 341 project, the work of IENE (Infra Eco Network Europe) and various French guidelines and regulations were stated.

4.4.9. Japan

Interurban
Available information is given in the National Strategy on Biological Diversity, the Environmental Policy Principles of the Ministry of Construction Jan. 1994 and The Future of Road Environment Policy of the Road council June. 1997

4.4.10. Madagascar

Interurban
Monitoring reports for for flora and fauna for respective projects are available.

4.4.11. Mexico

Interurban
Mexico does not have specific studies for the effects of road networks and transport policies on biodiversity analysis; however, the natural protected zones, some analysis are available in the following internet address: http://www.ine.gob.mx and http://www.conabio.gob.mx .

4.4.12. Morocco

Interurban
For example the motorway between Rabat and Larache was re-routed in order to preserve the lake Merja-Zerga, which is an outstanding site of biological interest (with world wide known rare species such as the flamingo colored roses. Furthermore after the road construction work additional protection measures were realized, such as under passages for amphibious animals and oil filter devices to avoid harmful impact for lake Merja-Zerga by broken cars or traffic accidents.

4.4.13. Nicaragua

Interurban
For protected areas and some additional local places information about biodiversity is available. An overall information does not exist for the interurban network.

4.4.14. Norway

Urban and interurban
A white paper on biodiversity, number 42 (2000-2001), has been published.

4.4.15. Romania

Interurban
At an existing motorway section between Bucarest and Pitesti an observation of the dividing effects on habitats was done after 135 amphibian animals were killed in 1993. Together with the rehabilitation of the motorway a few years later underground animal passages were got installed.

4.4.16. Saudi Arabia

Interurban
There is clear evidence that the rapid expansion of the road network in the Kingdom of Saudi Arabia, which allows people to reach unique and fragile areas has caused degradation of forest areas in recent times. These includes overgrazing, continual tree cutting for timber and fuel, accidental fires, disease, insect damage and clearing for agricultural expansion. The spots from which forests have been removed are clearly observable everywhere due to the construction of the road network: on the slopes of mountains, on semi-flat plateau land and floors of valleys. This has contributed to disfigurement of the beauty of nature in several localities.

4.4.17. Spain

Interurban
Spain is a member of the Cost Action nº 341 (habitat fragmentation caused by transport infrastructure) of which the two principal aims are firstly, the exchange of technical and scientific knowledge and experiences to improve an European Transport network safe and sustainable. Secondly, different measures will be recommended as a final result of the action, such as planning proceedings of roads in order to conserve the biodiversity and reduce the accidents caused by collision with animals.

4.4.18. The Netherlands

Interurban
The effects of maintenance of road side verges are regularly monitored and the results are compaired with the specific goals which have been formulated beforehand.
Also for the de-fragmentation measures an inventory system has been set up. Up till now 4 ecoducts, (several other are underway), 200 faunatunnels and 100 other facilities for fauna have been built.

4.4.19. Turkey

Interurban
These studies are continuous and aim to protect the biological nature of that specific environment. But it could be observed that recently public awareness about the preservation of natural life has been becoming very high in Turkey.

4.4.20. United Kingdom

Urban
See the above mentioned London Ecology Unit study for London Underground Limited. On the trunk road network in England, the 14 managing agents have done preliminary surveys and some minor studies to support the development of their Estate Management Plans. Some urban lengths of the network have been studied in this work.

Interurban
Studies have been undertaken in the South West of England to examine the ecological value of the trunk road network estate: on the A30, A303 and M5.Studies have examined the value of highway land for butterflies. The habitat creation and translocation at Twyford Down on the M3 Bar End- Compton scheme is the subject of a 10 year post construction monitoring project.

4.4.21. United States of America

Interurban
The Federal Highway Administration and State Highway Agencies have broad responsibility for ensuring the planning, construction and operation of an environmentally sound, effective, and safe national transportation system. These responsibilities encompass almost all ecosystems where any human development has occurred. Transportation projects often have important direct and indirect impacts on natural ecosystems, and connect adjacent or distant ecosystems through travel corridors and right-of-way management practices.

Research suggests that road networks contribute to a decline in biodiversity over time due to a number of factors including increased direct mortality, restricted movement of species between local populations and between different types of habitat, habitat loss, habitat fragmentation, dispersal of exotic species along roadways, and increased human access to wildlife habitat. The fate of isolated habitat fragments has been one of the most active research areas in the field of conservation biology. Based on hundreds of studies -- isolated remnants suffer predictable, cumulative losses of species over time. As natural habitat is cleared for road construction or other development, edges are created, and many resource values associated with interior habitat are changed. Some species benefit from this “edge-effect,” and the total number of species can be high in these areas.

However, as habitat fragments become smaller, interior-dependent species can be impacted by increased predation, competition, and parasitism, thus leading to a decline in biodiversity at the landscape level. It is important to note that although direct impact from roads can be determined in many cases (i.e. direct mortality), it is often difficult to separate the ecological effects of roads from those of other land-use activities. Road density or vehicle miles traveled (VMT) are used as proxy indicators of cumulative effects associated with development and other human activities.

Federal transportation legislation, most recently the Transportation Equity Act for the 21st Century (TEA-21) enacted in 1998, establishes the eligibility for funding participation of all activities carried out in during the planning and construction of federally funded highway projects, including mitigation and research. The Federal Highway Administration, under the authority of the Federal transportation legislation, is responsible for ensuring compliance with Federal, State, and local environmental laws and regulations, such as the Endangered Species Act, Clean Water Act, and NEPA during the planning and construction of federally funded highways.

In support of TEA-21 and other Federal laws, FHWA has passed regulations and established policy, guidance, and goals relative to use of Federal aid funds to mitigate impacts to wetlands, wildlife habitat, streams, and wildlife mortality on highways. Transportation public laws and regulations relating to highways are found under title 23 United States Code (USC) and Code of Federal Regulations (CFR). Associated FHWA environmental policy and guidance can be viewed online at (http://www.fhwa.dot.gov/environment/guidebook/index.htm). Specific FHWA regulations address NEPA Compliance (23 CFR Parts 771) and mitigation of impacts to wetlands and natural habitat (23 CFR 777).

Under TEA-21, Federal Highway Administration funding support is available to address many of the ecological concerns related to the impact of transportation projects on biodiversity. For example, the issue of habitat loss is addressed through the use of Federal-aid highway funds for mitigation of impacts to wetlands and other natural habitat due to federally funded highway projects (23 CFR 777). The current regulation recognizes new needs, requirements, and methods to successfully implement compensatory mitigation, and allows for restoration or mitigation of impacts that were not addressed when the projects were initially built.

Costs related to mitigating impacts to natural resources are eligible for Federal-aid participation under TEA-21. Costs eligible for Federal-aid funding include measures necessary to establish mitigation, such as revegetation, site preparation, fencing, irrigation or water control structures, access control, and mitigation performance monitoring. Monitoring programs are generally developed on a “project by project” basis and are based on the unique characteristics of a given site.

Wetlands are a high priority area for FHWA, with a cost of mitigating wetlands impacts estimated at 40-80 million dollars per year. FWHA established a specific goal for the Clean Water Action Plan in the Federal aid highway program of providing a 1.5:1 mitigation ratio for wetlands impacted by Federal aid highway projects. So far, the mitigation ratio reported for individual permits has exceeded the target ratio substantially for data collected since 1996.

Another example of the impacts of highways on an ecosystem is the formation of barriers between existing ecological communities. Mitigation of these impacts can involve the use of structures to provide travel corridors, fencing to control animal movements, or alternative alignments to eliminate or minimize the interaction between wildlife and the highway.

In Wisconsin studies are conducted on an as needed basis to determine whether endangered species or their habitat will be affected by a transportation facility's development. WisDOT also uses GIS information to identify known or likely habitats for endangered species. Wetland studies are conducted to assist in determining the most practicable solution to replace lost wetland functions and values.

The Kentucky Department of Fish and Wildlife has reintroduced elk into Western and Eastern Kentucky without consultation with KYTC. Elk has not been native to Kentucky for a century. KYTC is concerned about state government liability issues regarding vehicle crashes and fatalities from collisions with elk.

In the state of New York a Wildlife Viewing Guide has been installed to promote places to see every type of wildlife, both rare and common, in New York. NYSDOT's role in producing and installing directional signs contributed to the state effort in providing increased access and encouraging people to access and enjoy the state's historic and natural features. See:

http://www.dec.state.ny.us/website/press/pressrel/98-55.html

New Hampshire addresses biodiversity tangentially through discussion and study of habitat fragmentation/loss and wildlife movement. No particular methodologies are employed, instead working with the state and federal wildlife and land resource agencies and consultant specialists to address these issues on a project-by-project basis has taken place. Transportation projects can eliminate or reduce the value of wildlife and plant habitat by the physical taking of property or the introduction of elements out of character with that habitat. Transportation facilities can also serve as major barriers to wildlife movement. We are in the midst of planning a wildlife movement research project to study the use of wildlife crossings installed on a major highway system in the southeast part of the state. It is hoped this will provide some real evidence of the success of such crossing facilities. The New Hampshire Natural Heritage Inventory (NHNHI) maintains records of threatened and endangered, state and federal, wildlife and plant species, as well as exemplary natural communities. They routinely request info from the NHNHI regarding the presence of such resources within our project areas. The NHNHI is working with the NH Fish & Game Department to develop a GIS layer of this information for use by other state agencies.

Research on ecological impacts of highways is carried out in several ways. Research is carried out independently by State highway agencies using Federal aid highway funds. These funds may be earmarked research funds or they may be construction funds in the case of special situations unique to the highway project involved. For example, research might be conducted as mitigation for project impacts, or initiated in response to a state wide or regional issue. In some cases State highway agencies contribute Federal highway funds to interagency research projects.

Many environmental concerns are regional or national in nature, transcending state boundaries. In those cases, several State highway departments may pool their research funds in a pooled funds study. These studies are usually managed under the National Cooperative Highway Research Program, or NCHRP. One such study involved movement of salmonids through culverts. It is programmed to start in 2001. The NCHRP program is carried out the Transportation Research Board of the National Academies of Science in Washington DC.

Their website explains more about the NCHRP and the different projects that have been carried out. FHWA also contributes to and carries out independent research through, the Transportation Research Board (TRB). An example of a pooled funds study result is NCHRP Report 379, titled Guidelines for the Development of Wetlands Replacement Areas. This report is available from the Transportation Research Board, Constitution Avenue, Washington DC.

The Office of Environment and Planning, Headquarters, FHWA also carries out research independently. A summary of these projects is provided in the recent publication Environmental Research: A Decade of Accomplishments 1990-2000 (www.fhwa.dot.gov/environment/accomp/titlepg.htm).

The following are some examples of ongoing research projects:

- Deer underpass research on migratory mule deer in Wyoming using an adjustable opening to determine deer responses to different size underpass openings and approach treatments. Investigator: Kelly Gordon , University of Wyoming Cooperative Research Unit.

- Grizzly responses to highway activity and rights of way. Investigator: Chris Servheen, University of Montana, USFWS Grizzly Bear Recovery Team.

- Development and Application of an Ecological Linkage Zone Model as a Method to Identify Highway Design and Mitigation Opportunities for Wildlife. Investigator: University of Montana.

In addition, several State Highway Departments have ongoing research activities related to wildlife crossings including:

- Washington State - salmon passage in culverts.
- Oregon - culvert restoration to enhance fish spawning and habitat availability.

- Arizona - deer and elk crossing behaviour.
- Utah - deer crossing behavior at a simulated crosswalk.
- Minnesota - deer responses to different vehicle avoidance systems.

Many recent publications on wildlife issues with respect to highways are summarized in the Proceedings of the International Conference on Wildlife Ecology and Transportation, Vol. I-III. Vol. I and II are available from the Federal Highway Administration (FHWA, 1996, 1999); vol. III is on line at the Florida Department of Transportation website, linked to the FHWA website (www.FHWA.dot.gov).

5. LANDSCAPE

5.1. Preface

The topic Landscapes deals with the interaction between the road and the landscape. It presents the “state of the art” of all kind of problems encountered in this field and their possible solutions, given by in total 20 countries, which kindly answered our questionnaire.

Many countries mention similar problems regarding the impact of the road in the landscape. They all deal with the increasing interest in the appreciation of the natural landscape, the archaeological and historical heritage, scenic values and the fear to lose these values due to new road construction.

Specific problems mentioned are the fragmentation of habitat and flora, the influence of public services and billboards on the landscape, the long term effects and the economic aspects. During the construction of the road there soil erosion and loss of vegetation may occur. Also the remaining excavation areas and quarries for building materials of the road may influence the landscape.

Specifically in urban areas, aesthetics of noise barriers in urban areas are mentioned and the effects of “concrete jungles” which obscure the horizon. Also the maintenance of flora alongside the road in urban areas, where space is limited, is a problem.

The questionnaire presents quite a lot of possible solutions to the these problems. They can be subdivided into proposals to improve the methodology, the monitoring and global or more specific measures.

Fortunately, not only problems were mentioned. At the same time, the road is an important observation point of the territory, so new views will be generated as a result of the road presence in the territory. So, new roads also allow human beings to enjoy nature and the landscape!

5.2. Effects of Road Networks and transport Policies on landscape

5.2.1. Australia

Urban

Visual intrusion of new road construction eg. Overpass resulting in loss of visual amenity & loss of privacy (overlooking). There is a need to not only consider the visual effect on the landscape but also the function of the urban area in relation to the built form and access to services, entertainment and the general social movement of people. Functional urban design is a major consideration in the planning of roads in parts of Australia.

Interurban
Loss of scenic values & visual amenity. (Incl. landholders) resulting from new construction in scenic landscapes. eg. view of road corridor from look-out in national Park.

Maintenance of access across major highways is a concern in interurban areas.

Can provide connectivity of habitat and flora. Can allow the re-establishment of indigenous stands of flora.

5.2.2. Austria

The main problem is the evaluation of visual impacts and other impacts which cannot be calculated.

5.2.3. Belgium

Construction and reconstruction of a road changes the landscape.
Vegetation and maintenance of roadside verges also determines the appearance of the landscape.

5.2.4. Canada (Quebec)

Urban
In terms of landscape, road networks in urban areas often cause integration problems because of their scale and their proximity to built-up areas. Management of roadside verges cannot always compensate for these effects with appropriate landscape management because of space, budgetary and maintenance restrictions. There are also associated effects linked in particular to location of public services and advertising boardings along road corridors.

Interurban
In rural and peripheral urban areas, conditions are different to those in urban areas. The scantiness of space available for siting roads presents itself increasingly as one of the landscape issues, especially in terms of relations between the latter, and as a point of departure for observing the landscape. At the same time, the identity of the routes, their diversity, are new challenges to be highlighted, in particular in transitional sections formed by entrances to countries, to regions and to conurbations. Maintenance of vast green dependencies also raises certain questions.

5.2.5. Czech Republic

Landscape fragmentation, culture and heritage impacts. Archeological survey.

5.2.6. Denmark

Urban
The road networks in urban areas means concentration of for instance noise in already disturbed areas where many people are living.

Interurban
The interurban road networks mean fragmentation of coherent landscapes, physical and visual barriers, for instance in natural and cultural landscapes of scenic value or ecological importance, besides alterations of areas by drainage, spreading of industries along roads, and noise. The road networks in interurban areas do also mean access to landscape and nature.

5.2.7. Finland

Urban
The urban landscape, i.e. the townscape, is integrally linked to the street and its geometrical and spatial properties: streets make a town. However, the present scale of transport and especially road transport creates structures that are difficult to integrate into the townscape and have little or no relation to the concept of the street. This causes very large problems both if transport infrastructures are extended in historical town areas but also in the intermediate, often also otherwise environmentally deficient areas surrounding towns. Transport infrastructure land take (including parking) can endanger cultural heritage and social townscape characteristics.

Interurban
In sensitive environments, large road structures can be a landscape disaster, but in principle, roads can be designed to fit into a wide range of landscapes. Problems arise mainly in the nodes linking the spatial structures of the landscape, because these are often also bottlenecks roads need to pass through: land use, landscape (and often also archaeological and historical heritage) compete for use of the same node, often ending in a less than happy compromise.

5.2.8. France

Greatly on the increase:

Underscoring the high stakes in the landscape, structured tracts of landscape determining the route and significant choices in terms of project integration.

- Visibility and co-visibility
- Formal treatment and inclusion in the site
- Scenography
- Visual and architectural quality
- Plantings, green dependencies, landscaping
- Treatment of embankments, etc.

These impacts are understood to be : On the one hand, and firstly, from the roadside dweller's point of view: how the road is seen in the landscape, what is the new scenery being offered long term to the inhabitants; On the other hand, from the road user's point of view: how does one discover the landscape and the area.

The economic stakes associated with tourist activities and the symbolic image of the sites in question cannot, in general, be separated from impact on the landscape.

5.2.9. Hungary

When a road is widened, the road may get too close to trees. - Illegal advertising along the edge of roads is important.
When a new route is being built, landscape management, the relationship between scenic features, may be changed considerably.

5.2.10. Japan

Urban
The percentage of greening regarding urban roads is approximately 40%.

The percentage of underground electricity cables is extremely low in comparison with major Western cities, as shown below. 100% - Paris and London, (1977) - 99.2% - Berlin, (1977), 72.1% - New York, (1977) and 3.1% - 23 wards of Tokyo (1998)

Interurban
Rapid urbanization and concomitant changes in life style encroached on local natural environments and those spaces that used to be rich in local historical and cultural heritage.

Growing numbers of people now seek not merely material but also spiritual affluence in their life. Their living environment will be made more visibly appealing and comfortably livable, by nurturing local natural environments and incorporating the characteristics of local historical and cultural heritages.

5.2.11. Malaysia

Urban
Places of historical interest or archaeological sites may be affected.
Aesthetics of noise barriers in urban areas e.g. stark appearance and obtrusiveness (indirect).

Interurban
Fragmentation of natural landscape especially in the forests and mountains.
Affect natural waterfalls, hot springs, etc.

5.2.12. Morocco

Interurban
For rural routes, the same answer as for effects on bio-diversity.
With regard to motorways, lancscape treatments are carried out after roadworks to integrate the work into the surrounding landscape.

5.2.13. Mexico

Cuts, embankments and borrow pit materials used in road construction, are the main impacts on the landscape; at this time there are not any regulation or policies for procedures to harmonize this kind of works with the landscape. However, when federal road construction is done, cuts and embankments are usually covered with vegetation or sown ground to avoid erosion, more than aesthetic reasons.

5.2.14. Nicaragua

Urban

In the urban area, the road infrastructure is the responsibility of the municipalities, whose objective is to provide road maintenance or construction of new roads or quick exits from the city. In order to change the road infrastructure, reserved or vulnerable areas are used.

Another thing that is changing the look of the urban landscape is the growth of Concrete Jungles in the cities, which totally obscures the horizon.

Interurban

As a population grows, the landscape is modified in some way. In some cases this leads to a disappearance of open spaces that allowed us to see the landscape. In tandem with the construction of motorways is the development of commercial advertising, such as billboards, eliminating vegetation and leading to a total or partial loss of the landscape. In some cases, the motorway embankments modify the landscape or the position of a natural lookout point.

5.2.15. Norway

There is a loss of cultural monuments, areas of cultural environments and cultural landscapes with national importance as a result of road building.

5.2.16. Romania

Urban

Certain road constructions (sound-absorbing panels). [sound-proofing detract from integration into the landscape.

Interurban

- The barrier effect
- Constructions specific to roads hamper integration into the landscape
- Modification of the micro-climate by changes in climatic features (wind, vibration)
- During construction of a new road: distancing of vegetation, diversion of watercourses, soil erosion
- Disruption to protected areas that have been declared areas of outstanding natural beauty because of the landscape

5.2.17. Saudi Arabia

Urban
The Moc has a budget item that deals with the beautification program (trees & shrubberies) planting along the highways.

Interurban
As for Interurban, according tot the geographic and climatic conditions (desert environment) not relevant in this case, except the usage of trees for sand stabilization in some areas.

5.2.18. Spain

Interurban
The construction of any road will generate a landscape impact, because it introduces the presence of straight lines differing from the natural landscape. It also generates a chromatic contrast caused by the colour of the road as well as the removal of vegetation. At the same time, the road is an important observation point of the territory, so new views will be generated as a result of the road presence in the territory.

The importance of these effects depends on the “visual absorption capacity”, that is to say, the territory capacity to integrate the road without altering the visual issues.

5.2.19. The Netherlands

The question is how roads can fit into the landscape in order to fulfil as many functions as possible.

5.2.20. Turkey

Road is a line construction and because of this construction it divides the topography. Either cuts and fills or the excavation works in the quarry areas change the topography. In some places big holes occur on the topography. Besides some roads change the coastline. Settlements and industrial buildings are established near the road. Also road networks divide agricultural, forest and wild life areas. That´s why in some regions, agricultural areas are used for out of its real purpose. Besides exhaust gas has negative effects on flora and soil quality along the road. Erosion might be severe at side slopes.

5.2.21. United Kingdom

Urban
Urban trunk roads are predominantly dual carriageways (D2/D3 and D4) and as such are high capacity roads with significant intrusive effects on urban landscapes and townscapes. Mitigation for traffic noise and visual intrusion usually takes the form of environmental barriers. These can be detrimental to the driver/road user experience denying views out from the road and require the use of visually pleasing design elements and the planting of trees and shrubs of varies form and colour.

Interurban

The Highways Agency has in place robust design advice in Volume 10 of the Design Manual for Roads and Bridges for the landscape integration of interurban highways. The visually disruptive effect of the infrastructure combined with the severance of natural and cultural links and entities must be overcome through careful choice of route, detailed alignment and subtle mitigation using earthworks and planting to achieve integration with the surrounding landscape as well as the appropriate degree of visual screening for the route.

5.2.22. United States of America

The Federal Highway Administration and State Highway Agencies have broad responsibility for ensuring the planning, construction and operation of an environmentally sound, effective, and safe national transportation system. These responsibilities encompass almost all ecosystems where any human development has occurred. Transportation projects often have important direct and indirect impacts on natural ecosystems, and connect adjacent or distant ecosystems through travel corridors and right-of-way management practices. Highways affect ecosystems by altering and replacing existing biological communities, by creating barriers between different habitats, by introducing new species and activities, by providing new access for socio-economic development and construction, by altering drainage patterns, and by changing the basic geochemistry of a region (for example, water and air quality). Many of these impacts are long-term, even those which we often consider to be temporary. An example is erosion and sedimentation. While the source of erosion might be temporary, the effects of the sediment are long lasting once it has entered the aquatic system. Other impacts, such as those generated by access, can be both long term and progressive, depending on local land use and development planning.

5.3. Systems in place for monitoring the effects

5.3.1. Australia

Urban
Visual impact assessment forms part of project environmental investigations for new Road works. A guideline “Beyond the Pavement” has been published and is available from the Austroads C14 representative as a “good practice” guide to urban design considerations in road development.

Interurban
Visual impact assessment of route selection options forms part of road planning studies. “Beyond the Pavement” incorporates guidelines for regional design.

5.3.2. Austria

Many ideas are used and implemented in this field in Austria, but which of them will be the best practice for the future is under current discussion.

Examinations on landscape mainly are done outside of cities. This problem however is a important one also for cities. We have to distinguish problems of dimensions inside existing streets and the effects of new streets on the development new enlargement areas, suburbs and the hinterland of cities. The problem of waste of space by new streets is already treated (see below), but there are no studies about new streets and their impulse to new building areas.

5.3.3. Belgium

An analysis of the landscape is carried out when the plans for ecological management of motorway verges are drawn up.

5.3.4. Canada (Quebec)

Urban
At the Ministry of Transport in Quebec, accounting for the landscape forms an integral part of current operations by the regional administrations responsible for road infrastructure. The road management and re-organisation projects consider a landscape section. Guides are used to inventory the nature of the landscape, diagnose the situation, define abatement and integration measures and to draw up landscape intervention plans.

Interurban
Accounting for the landscape forms an integral part of current operations by the regional administrations responsible for road infrastructure. The road management and re-organisation projects comprise a landscape section. Guides are used to inventory the nature of the landscape, diagnose the situation, define abatement and integration measures and to draw up landscape intervention plans. From 2000, by way of experiment, a visual monitoring system run by the Landscape and Environment Chair of the University of Montreal has been used on three sections that are subject to ecological management.

5.3.5. Czech Republic

Only expert studies without strict methodology.

5.3.6. Denmark

Urban
The Road Directorate's 'Strategy for Beautiful Roads' steering committee was set up in 1994. The work concerns the visual appearance, aesthetic of the roads, as regards road trees, signs, signals etc.

Road trees have been evaluated based on aesthetic, health and safety aspects.

Valuable buildings and urban structures are recorded using SAVE-registration system. SAVE (Survey of Architectural Values in the Environment) is a quick and simple method for mapping of architectural quality and buildings worth preserving. In urban areas valuable buildings and parts of towns worth preserving have been pointed out.

Interurban
A methodology to estimate large undisturbed landscapes on regional and national level has been developed.

The barrier-effect of larger traffic constructions on recreational accessibility has been modelled using Geographical Information System (GIS). The barrier-effect study has pointed out how crossing points best can be designed to meet recreational needs. Silent landscapes have been modelled.

On regional level valuable or undisturbed landscapes are designated. In general these landscapes should be kept free of constructions, and in cases where locations within these areas are necessary due to important social considerations, special considerations should be given to adaptations to the landscapes.

The Danish Forest and Nature Agency have developed a method for evaluation of cultural heritage environments: CHIP cultural Heritage in planning.

A guideline for how to predict the effects on the landscape has also been set up by the National Forest and Nature Agency :

- Infrastructure should be kept in transport corridors
- No new infrastructure in major undisturbed areas

- No new infrastructure in the coast protection zone (i.e. within 3 km from the coastline)
- No transport infrastructure alongside watercourses

- Landscape bridges should be constructed when crossing river valleys
- New transport infrastructure must be adapted to the landscape; for instance, all crossing of river valleys should be perpendicular.

5.3.7. Finland

Landscape and townscape development is monitored as part of overall land use planning, by local and regional authorities. The road administration periodically surveys the impacts of its own activities on landscape and land use, but does not have any separate monitoring system. Co-operative research programs (Traffic and Land Use 1991-1996, The LYYLI programme for “An Environmentally Friendly Urban Form and Transport System” 1995-2001) also take up the landscape impacts of transport.

5.3.8. France

Much more attention is being paid to strategies for avoidance of sensitive landscapes, otherwise there is a choice between an "insertion" strategy or a "scenographic" strategy; Detailed study of routes, insertion techniques, landscaping to minimise the impact and cover up traces of the passage of infrastructure; Quality of detailed treatment and planting; Implementation of accompanying policies or compensatory measures, for example the policy of “1% landscape and development” relating to activities beyond the reach of the project to deal with the issues of co-visibility and to benefit economic development (discovery trails, village stop-offs, etc.). Campaigns for landscape and cultural activities/events.

5.3.9. Japan

Urban/Interurban

Road projects must be prepared in accordance with the Environmental Impact Assessment Law, and/or the respective prefectural ordinances pertaining to such impact assessment (e.g., impact assessment vis-à-vis local natural landscape). In this respect, it is necessary to strengthen the method of assessing the project impact on local landscape.

In order to ensure landscape-conscious project preparation, landscape experts should be involved in the early stage of project identification and design, and some form of proposal competition introduced.

Urban

Increased ratio of roadway greening within cities (in terms of the percentage per aggregated kilometers of four-lane national highways and prefectural and municipal roads within the DID (Densely Inhabited District)

Achievement rate (1997): 44% Target for 2002: 51%. Long-term target: 75%. Increased ratio of common underground conduits for electricity cables (the percentage in major built-up areas within cities). Achievement rate (1997): 20% (3,010km); Target for 2002: 40% (6,010km); Long-term target: 100% (15,000km)

Measures:

- Improvement of the roadside landscape by greening in available road spaces

- Underground installation of electricity cables
- In order to maintain and improve local roadside landscapes, road projects will be designed and implemented as part of the townscape planning as stipulated in the respective municipal ordinances, including sidewalks, street alignments and roadside scenery. The improvement of arterial roads passing the built-up areas will be designed to upgrade their visual appeal by providing high-quality greenery.

- Regarding major access roads to railway stations and main streets within cities, roadway landscape planning will be undertaken in coordination with landscaping efforts on the surrounding buildings and structures so that their surface spaces will be used as venues for festivals and other public events and thereby serve as symbolic centers of the respective cities.

Interurban

Planning and designing of road projects in harmony with local natural landscapes should be carried out considering the Natural Environmental Conservation Law and the Natural Park Law.

5.3.10. Malaysia

Urban

Conduct social survey to those residents affected and allow public participation in the development of a noise barrier in order for its acceptability both socially and physically.

5.3.11. Morocco

Interurban

Concerned in particular with treatments for embankments or very high soft verges by means of either plantings or other landscaping treatments that improve their appearance and allow them to be integrated into the landscape.

5.3.12. Mexico

We do not have systems in place for monitoring the effects on landscapes; observations along the time, establish the action effectiveness.

5.3.13. Nicaragua

Urban

There are municipal ordinances for the regulation and installation of signs. The Tourism Institute is attempting to co-ordinate action with the municipalities to avoid the visual and noise pollution of the landscape, through the reclassification acceptable land use.

Interurban

The Tourism Institute instructs the placement of signs with positive messages. The MARENA has implemented requirements for environmental reform of quarries operating outdoors and the extraction of materials in rivers.

5.3.14. Norway

Loss and disturbance of the different types of designated areas/monuments named over are reported to Parliament.

5.3.15. Spain

Interurban
The preventive action is made considering urban planning issues and the geometric adaptation of the road design to the natural landscape features.
Intervisibility analysis of the territory must be done in order to assess the potential view of the road from the adjacent territory.
Finally, as a restoration measure, plantating of trees and shrubs and herbaceous sowing.

5.3.16. The Netherlands

A Handbook is available showing how all the relevant aspect of roads and the landscape can be effectively dealt.

In the Architectural Policy Document the A12 between The Hague and the German border has been selected as a case study and show case, one of the Grand Design Projects, how the design and implement an integral landscape approach.

A new vision has been developed:

- Continuity, more uniform and generous sizes form the basis of the plan.

- The design will be geared to the function.
- The green elements will need efficient management, whilst the added value for nature is of prime importance.
- The culture-historic quality of the surroundings must be made visible to the road user.
- Bringing unity into the constructions and engineering structures.
- Giving a place a look of its own will be promoted, which should give powerful and business-like results.

Results

On the basis of the new vision some new landscape plans has been made.
Due to the policy document, a wide discussion with all relevant parties has been organised, exhibitions about the Grand Design Projects stimulate the spreading of the new message of landscape design of highways.

5.3.17. Turkey

There is no specific monitoring project about especially for transport. But some NGO´s such as TEMA (Turkish Erosion Protection and forestation) Foundation and some of the Universities has some specific and narrow research studies about this subject.

5.3.18. United Kingdom

Landscape management plans are written for all new and existing trunk roads to guide the maintenance of the soft landscape mitigation to ensure that all the elements perform their design function as they mature. The management of planted areas is increasingly related to the analysis of the road corridor landscape and considerations of ensuring that land use changes are taken into account in maintaining the integration function of the planting whilst providing screening for properties and communities affected by the road and its traffic.

5.3.19. United States of America

Costs related to mitigating impacts to natural resources are eligible for Federal-aid participation under TEA-21. Costs eligible for Federal-aid funding include measures necessary to establish mitigation, such as revegetation, site preparation, fencing, irrigation or water control structures, access control, and mitigation performance monitoring. Monitoring programs are generally developed on a “project by project” basis and are based on the unique characteristics of a given site.

Wetlands are a high priority area for FHWA, with a cost of mitigating wetlands impacts estimated at 40-80 million dollars per year. FWHA established a specific goal for the Clean Water Action Plan in the Federal aid highway program of providing a 1.5:1 mitigation ratio for wetlands impacted by Federal aid highway projects. The Wetlands No Net Loss Database was developed to provide an interactive tool that can be used by State Departments of Transportation to collect, analyze, organize, and periodically update wetland mitigation information as needed for data reporting and management decisions. This information will allow the States and FHWA to determine if stated no-net-loss and net gain wetland goals and policies are being met. So far, the mitigation ratio reported for individual permits has exceeded the target ratio substantially for data collected since 1996.

Specific projects to be mentioned are:

- Aerial photography: Aerial photography can assist with landscape planning, as well as a number of other areas, by defining a project area with minute detail in a single scene regardless of the project area size.

- GIS modeling: Use of GIS modeling is helping to push environmental issues earlier in the 20-year system plan of the WTP. GIS will develop a model of current and projected land use and land cover of environmental features in order to help predict environmental impacts.

- Land sat Imagery: The land sat research project will gather data in order to understand total impervious surface in the project area and assess the importance of transportation in adding to improving both the new road surfaces in the I-405 project area, and subsequent development in the project area.

- Digital Images: Developed in 1996, SRview allows users to view digital images of the entire state highway system on their computer. The view displayed is what the "driver" would typically see as they proceed along the road, which includes not only the road itself but the road in the landscape.

- WSDOT Heritage Corridor Program: The purpose of the Heritage Corridor Program is to preserve the unique scenic character along Washington's transportation corridors, and to provide travelers with a continuing opportunity to appreciate and obtain information regarding unique natural, cultural, and historic features that are near to or accessible by transportation routes**.**

- Growth Management Laws: The main point of the legislation was to enact growth boundaries within the state of Washington in order to control sprawl.

- Recovery of Endangered Salmon is necessitating more innovations in early environmental analysis of transportation system plans.

5.4. Results of studies

5.4.1. Australia

Urban
In locations of high relative impacts, measures to minimise adverse effects taken at design stage. eg location and height of built visual screens.

Case studies are included in the guideline “Beyond the Pavement”.

Interurban
In locations where impacts are likely measures to minimise extent and duration of cut and fill design, and other earthworks locations when key views are to be retained or enhanced as part of vegetation.

5.4.2. Austria

Deuring, Andreas: „Flächenverbrauch der Strassenverkehrserschließung“; Insitut für Verkehrssystemplanung, IVS-Schriften, Band 12, Österreichischer Kunst- und Kulturverlag, 2001.
Winkler, M., „Innenentwicklung durch Nutzungsentwicklung von Wohngebieten“; Diplomarbeit am Institut für Verkehrsplanung und Verkehrstechnik der Technischen Universität Wien, 1995.
Pernsteiner, H.J.P.; Literaturstudie der Flächenbeanspruchungs- und Flächennutzungsveränderungen unter verkehrspolitischen Gesichtspunkten“; Diplomarbeit am Institut für Verkehrsplanung und Verkehrstechnik der Technischen Universität Wien, 1997.
Sammer, Querschnittsrichtlinie (Dimensionierungen), Forschungsgemeinschaft Strasse und Verkehr, 2001

5.4.3. Canada (Quebec)

Urban
Various studies have been carried out in the past, some are in progress, others will take place. The QMT (the Quebec Ministry of Transport), in particular with the involvement of the Landscape and Environment Chair of the University of Montreal, and other partners, has examined in greater details subjects such as management of road corridors, routes across built-up areas (1997, 2000), entries to the national capital (1998, in progress) and conurbation (2001), advertising hoardings, visual analysis of integration of transport infrastructures (1986), a landscaping study concerning soundproofing panel projects (1989), etc.

Interurban
Various studies have been carried out in the past, some are in progress, others will take place. The QMT, in particular with the involvement of the Landscape and Environment Chair of the University of Montreal, and other partners, has examined in greater details subjects such as management of road corridors, landscape management (Laurentides case, 1999), visual analysis of integration of transport infrastructures (1986), management of routes into the country (1998, 2000), entries to the national capital (1998, in progress) and conurbation (2001), ecological management of green dependencies and visual monitoring thereof (in progress), installation of windbreaks, the visual impact of a motorway being crossed by an electricity supply line (2000), etc.

5.4.4. Denmark

Interurban
Kaae, Berit C.; Skov-Petersen, Hans; Larsen, Kim Spiegelberg (1998): Large traffic constructions as barriers for recreational use of the landscape. Park- og Landskabsserien, nr. 17-1998. Forskningscentret for Skov & Landskab (only in Danish).
Danish Forest and Nature Agency 2001. CHIP Cultural Heritage in Planning. Identifying valuable cultural environments through planning.
Skov og Naturstyrelsen: Visualiseringer og VVM - behov, metoder, teknikker, eksempler.
Vejdirektoratet 2000. Vejregler for beplantning i det åbne land. Vejregelforslag. Vejdirektoratets Vejregelafdeling.
Planning documents form the 14 Danish counties are available from the County home pages on the Internet.

Urban
Vejdirektoratet 1995. Strategi for Smukke veje - 1995.
Skov- og Naturstyrelsen, 1997. SAVE - Et samarbejde mellem Skov- og Naturstyrelsen og kommuner om kortlægning og registrering af bevaringsværdier i byer og bygninger.

5.4.5. France

Regulatory documents:
"Landscape" law;
Circulars on "1% landscape and development";

Technical and methodological guides:
On landscape surveys and dealing with the impact on the landscape;
On visualisation techniques;

Other reference documents:
Qualitative and quantitative consequences of the "1% landscape and development" policy on the A20 and A75 motorways; Studies and surveys (acceptability of a motorway in mountain scenery, A 430 in the Maurienne valley); Landscape circulation studies.

5.4.6. Japan

Ministry of Construction, *Green Policy Principles*, July 1994.
Ministry of Construction*, Green Plan 2000*, Dec. 1996.

5.4.7. Malaysia

Urban
Dr. Roslan Md-Taha's thesis on Public Perception of Road Traffic Noise Barrier, University of Wales, 1999.

Interurban
Aesthetics of noise barriers - barrier to blend with surrounding environment and may become distinctive feature of a particular town or village.

5.4.8. Morocco

Interurban
On the very high earthworks on the Rabat-Salé bypass, the embankments composed of crumbly rock have been treated with sprayed concrete dyed the same colour as the rock to integrate the works into the landscape

5.4.9. Nicaragua

Urban
The little information that exists is centralised in the City governments, the Tourism Institute and some universities or architecture schools.
In the interurban area, there is non-systematised information on Thesis projects completed as part of the university degree in architecture.

Interurban
The Land Studies Institute (Ínter) has conducted studies and diagnoses on the ordering of land in order to soundly plan the economics, culture, tourism, etc. of different departments.
Some environmental NGOs and Universities are working on the issue of tourist areas, according to their ecosystems and landscapes.

5.4.10. Norway

Public road administration's own cultural heritage is documented in a new report coming in 2002.
"Roads and nature" handbook 192 Public road administration
"Roads and the cultural environment" handbook 208 Public road administration

5.4.11. The Netherlands

- Naar een stelsel van duurzaamheids indicatoren van infrastructuur
- Brochure Duurzaamheidsindicatoren
- Landschapsplan A12
- Handreiking "Ontwerpen en milieu"
- Beleid vertaald

5.4.12. Turkey

TEMA has a large scale Campaign for prevention of erosion by plantation of 10,000,000,000 Valonia Oak all over Turkey. This Campaign is not yet complete.

5.4.13 United Kingdom

Interurban
A national Countryside Survey 2000 has provided some background information to the impact of road infrastructure in the English countryside and has been complimented by the Guide to Management Plans for Areas of Outstanding Natural Beauty (AONB) wherein the routes of many trunk roads pass.

5.4.14. United States of America

Research on ecological impacts of highways is carried out in several ways. Research is carried out independently by State highway agencies using Federal aid highway funds. These funds may be earmarked research funds or they may be construction funds in the case of special situations unique to the highway project involved. For example, research might be conducted as mitigation for project impacts, or initiated in response to a state wide or regional issue. In some cases State highway agencies contribute Federal highway funds to interagency research projects.

The following are some examples of completed and ongoing projects:

- An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Reference Wetlands, and Functional Indices. Report numberWRP-DE-9. (Completed 1995) Performer(s): U.S. Army Corps of Engineers (COE).

- Noxious Weed Database. (Completed 1997) Performer(s): U.S. Army Corps of Engineers (COE), Waterways Experiment Station. Sponsor(s): FHWA

- Development and Application of an Ecological Linkage Zone Model as a Method to Identify Highway Design and Mitigation Opportunities for Wildlife. Performer(s): Washington State DOT Demonstration

- Project to Integrate and Enhance Environmental and Transportation Decisionmaking. Performer(s): Washington State Dept. of Transportation (WSDOT).

6. VEHICLE REGULATION AND PROMOTION OF LESS POLLUTING VEHICLES

6.1. Preface

This report summarizes the responses from 20 countries for Topic 5 -Vehicle Regulation and Topic 6 -Promotion of Less Pollution Vehicles. Each topic has three questions, which focus on the effects that government policies have on vehicle regulations and on identifying systems that each country has in place, or is in the process of developing, to reduce vehicular emissions and improve air quality. The questions are listed below.

Topic 5: Vehicle regulation

1. Please explain the effects of Road Networks and Transport Policies on vehicle regulation. (regulation on vehicle emissions through standards, fuel quality, maintenance and fleet composition) (problem definition)

2. Please explain any systems in place for monitoring the effects on vehicle regulation. (approach to the problem)

3. Please explain the results of studies in this field. (available information)

Topic 6: promotion of less pollution vehicles

1. Please explain the effects of Road Networks and Transport Policies on promotion of less polluting vehicles. (less polluting and alternative fuels including recycling, noise, etc.) (problem definition)

2. Please explain any systems in place for monitoring the effects on promotion of less polluting vehicles. (approach to the problem)

3. Please explain the results of studies in this field. (available information)

6.2. Effects of Road Networks and Transport Policies on Vehicle Regulation and Promotion of Less Polluting Vehicles, Systems in Place for Monitoring the Effects and Results of Studies

6.2.1. Australia

Topic 5: Vehicle Regulation
New fuel standards under the Fuel Quality Standards Act 2000. Issues addressed :

- Mass and length of freight vehicles
- Speed and noise produced by engine compression brakes
- Older vehicles meeting regulations
- Regulation of commercial drivers' hours
- Regulation of speeds

- Systems in place for monitoring effects on vehicle regulation An emissions-testing program for buses and trucks in Sydney: Emissions reductions are predicted to be 30-75% between 2003 and 2020. These predictions do not include changes due to alternative fuels or fuel cell vehicles.
- Fuel cell powered buses tested in Perth, Western Australia.

Topic 6: Promotion of Less Pollution Vehicles

Focus is on policies and programs to promote alternative fuels to reduce greenhouse and urban air-quality impacts. The government is exploring strategies to support increased use of low-emission vehicles in the Australian market. Current programs include:

1) Compressed Natural Gas (CNG) Infrastructure Program – CNG refueling stations for heavy vehicles, and
2) Alternative Fuel Conversion of heavy vehicles to CNG.

For details: www.greenhouse.gov.au

6.2.2. Austria

Topic 5: Vehicle Regulation (Topic 6: Promotion of Less Pollution – Not addressed)
Austrian traffic policy guidelines identify the following objectives :

- Avoiding unnecessary traffic
- Fair transport pricing
- Intermodal co-operation
- State of the art technology

The Austrian Government promotes five principles for a sustainable traffic system:

1. Minimizing the ecological risks and health hazards
2. Minimizing danger potential and accident risk
3. Precedence of prevention over remedial action
4. Ensuring equal mobility opportunities for all
5. Promoting traffic modes that best comply with the said principles.

Systems in place for monitoring effects on vehicle regulation:

- Establishing of "Sensitive regions" to reduce traffic volumes and health "side effects"
- Implementing the Transit Traffic Agreement of 1991
- Limiting the number of foreign trucks through Austria by using environmental standards Study

Results show a 13% reduction of NOx between 1991 and 1996 along the main transit traffic artery, the Inntal in the Tyrol. Study results available at: **www.nepc.gov.au**.

6.2.3. Belgium

Topic 5: Vehicle Regulation – Not addressed
Topic 6: Promotion of Less Pollution Vehicles
Systems in place include: bonuses are paid by the Belgian Government as an incentives for purchasing Liquid Petroleum Gas (LPG) equipment; adapting tax systems; and lowering taxes for less-polluting vehicles.

Demonstration Projects:
Purchase of less-polluting vehicles for public institutions (including mass transit agencies)
A Website with the latest developments in the vehicle market and emission controls www.emis.vito.be/mobiliteit
Study: "Evaluation of Pollution Reduction Potential of Measures relating to less-polluting vehicles and fuels."

6.2.4. Canada-Quebec[1]

Topics 5 & 6: Vehicle Regulations and Promotion of Less Pollution Vehicles

The Quebec Action Plan 2000-2002 for climatic changes intends to reduce the emissions of light and heavy road vehicles. This plan establishes a mandatory program for vehicle inspection and maintenance, which will: decrease greenhouse gas emissions of road vehicles in Quebec; achieve a higher quality of life in all urban centers; and reduce smog, particularly in the Montreal region. The Vehicle Inspection and Maintenance Program, which will be phased in as of 2002, will be aimed at both heavy and light vehicles and will

1 Information from: *Ministère des Transports du Québec*, 18 September 2001

be based on government regulations. For preliminary results visit: www.menv.gouv.qc.ca/air/inspection/index.htm [2]

The Quebec Action Plan for 2000-2002 on climatic changes seeks to promote the use of more energy-efficient and environmentally-sound vehicles. To this end, the Government of Quebec (GOQ) has helped finance several projects to promote and develop alternative-fuel vehicles.

Systems/Projects Include:

The Electric Vehicle Project - Montreal 2000: This project documents the advantages of electric vehicles (EV) and demonstrates that their use provides an alternative to fossil fuel. (Greater Montreal Region)

The Environmentally-Friendly Bus Project: This project experiments with and evaluates buses powered by new technologies that are less polluting and more energy efficient. (Quebec Urban Community Transportation Corporation/Quebec's historic district)

The Low Speed Vehicle Pilot Project: This project seeks to evaluate the integration of vehicles which run at less than 40 km/h into the urban traffic flow. (Quebec Center, city of Saint-Jérôme)

The Electric Bicycle Project 2000: The project documents electric bicycle use under new regulations allowing their sale on the Quebec and Canadian market. (Montréal, Québec, Saint-Jérôme and Toronto)

The impacts of these pilot projects have not been evaluated[3].

6.2.5. Czech Republic

Topics 5 & 6: Vehicle Regulation and Promotion of Less Pollution Vehicles

There has been a rapid car fleet change. Over 70% of cars are equipped with technological improvements (TWC). Most buses have EURO 1 or EURO 2 emission limits. Systems in place to monitor traffic and air-quality include: local traffic surveys, the Dynamic Fleet Composition Survey provided by RSD Czech Republic. Study results are yet to be published.

Tax reduction incentives are in place for cars equipped with technological improvements (EURO2, EURO3, EURO4).

Air-pollution dispersion studies are being conducted, which take into account the changing car fleet parameters. There are obvious impacts on total concentration

monitoring. Study results can be viewed at: http://www.wmap.cz/atlaszp and http://www.atem.cz

6.2.6. Denmark

No Information provided for these topics.

6.2.7. Finland

No specific information provided for these topics.
In general, Finland follows EU directives and practices for vehicles. Finish car production is very minor (Porsche Boxter convertibles, some buses and trucks).

6.2.8. France

Topic 5. Vehicle Regulation

URBAN	INTERURBAN
Effects of Road Networks & Trans. Policy Given regular saturation on certain arteries: - Control of entry on express lanes - Modulation by means of tolls - Fuel taxation - Traffic management system	**Effects of Road Networks & Trans. Policy** Given seasonal saturation on certain arteries: - Modulation by means of tolls - Fuel taxation - Traffic management system
Systems Research on the concept of Intelligent Road/Vehicle	**Systems** Research on the concept of Intelligent Road/Vehicle

Topic 6. Promotion of Less Pollution Vehicles

URBAN	INTERURBAN
Effects of Road Networks & Trans. Policy In response to air and noise pollution: - Electric, mixed vehicles - Quieter road surfacing - Promotion of mass transit, bicycles, walking - New fuels (alt. Agricultural fuels, etc.) - Assisted or semi-motorized transport	**Effects of Road Networks & Trans. Policy** In response to noise: - Mixed vehicles - Quieter road surfacing - Quieter engines and tires - New fuels (alternative agricultural fuels, etc.) **Systems** Blueprint for Bicycle Paths and Green Ways

6.2.9. Hungary

Topic 5: Vehicle Regulation (Topic 6: Promotion of Less Pollution – Not addressed)

The use of lead-free gasoline has decreased environmental pollution. In most areas, lead content has decreased to below the limit value (in the soil and in vegetation).

6.2.10. Japan

Topic 5: Vehicle Regulation

Japan has put in place gasoline and diesel gas emission regurations on passenger cars, trucks and buses in accordance with the Air Pollution Control Law, the Noise Regulation Law and the Law Concerning the Rational Use of Energy. Lower standards will be phased in through 2005. Pollutants of concern: NOx, PM, HC and CO.

Monitoring: Air and Noise Pollution:

NO_2 -	68.1% of roadside monitoring stations achieved the standard (in 2001)
SPM (PM10) -	35.7% of roadside monitoring stations achieved the standard (in 2001)
Noise	regulations range from 83dB for large-size vehicles to 72dB for passenger cars 38.2% of nationwide monitors achieved the environmental quality standard 36.1% of large cities achieved the standard

Study Results: Central Environment Council of Environment Agency, *Future Policy for Motor Vehicle Exhaust Emission Reduction;* Environment Agency, *Quality of the Environment in Japan*, FY2000; Environment Agency, *The Report on the Survey of Automotive Traffic Noise*

Topic 6: Promotion of Less Pollution Vehicles

In addition to controls, Japan is developing more less-polluting vehicles. Lower taxes are an incentive for the production of less-polluting vehicles, while increased taxes are placed on polluting and fuel-inefficient vehicles.

Other measures being implemented include:

- Subsidizing the purchase of less-polluting vehicles
- Reduction of property tax for the stations supplying alternative fuels

Less-polluting vehicles in use (at the end of 2001):

- Electric vehicles: ~ 4,700
- LNG vehicles: ~ 12,012
- Methanol vehicles: ~ 135
- Hybrid vehicles: ~ 74,600

Fuel Cell Electric Vehicles began to be sold in December 2002.

Study Results:
Environment Agency, Ministry of International Trade and Industry and Ministry of Transport, A *Guidebook on Less-Polluting Vehicles*

6.2.11. Madagascar

Topics 5 & 6: Vehicle Regulation and Promotion of Less Pollution Vehicles

In general, the vehicle fleet is rather antiquated: over 40% of imported vehicles (greater than 3.5 tons) during the year 2000 are over 20 years old and most have diesel engines. It is not known whether or not most vehicles meet the emission standards. Many repair shops that do vehicle repairs and maintenance do not have adequate equipment.

Renewal of automotive fleet: Operators are encouraged to import vehicles (for both passenger and freight transportation) that are less than 10 years of age. In 2000, only 9% of large trucks were less than 10 years of age.

6.2.12. Malaysia

Topics 5 & 6: Vehicle Regulation and Promotion of Less Pollution Vehicles

Malaysia's priority traffic concerns are congestion, drivers' stress and long peak-hour delays. To address these the government is promoting: 1) the use of High Occupancy Vehicle (HOV); 2) the use of unleaded gasoline by imposing higher rates and taxes for leaded gasoline; 3) car pooling and higher toll to SOVs; and 4) Enforcement of the use of catalytic converters.

6.2.13. Morocco

Topics 5 & 6: Vehicle Regulation and Promotion of Less Pollution Vehicles

Effects of Road Networks and Transportation Policies include :

- Establishment of emission standards
- Privatization of refineries to improve production capacity (decrease lead, sulfur, etc.)

- Marketing of lead-free gasoline
- Research initiated by the Moroccan Automobile Association on fuel quality

- Increased maintenance and stricter vehicle inspections
- Incentives for the purchase of new vehicles (rejuvenation of fleet)
- Imports of vehicles outfitted with higher performance and less-polluting engines (improved combustion, catalytic converter, etc.)
- Trial marketing of battery-operated electric vehicles.

Study Results and Monitoring :
Current systems include vehicle registration statistics, which highlight the rate of new registered vehicles compared with the overall number of registrations. Future systems include a decree on the maximum admissible values for vehicle exhaust gases.

The Government has set a 12%-reduction target in carbon dioxide emissions over a 3-year by more efficient vehicle use and procuring cleaner, more efficient vehicles.

PowerShift Program: Grants to develop a sustainable market for LPG, natural gas and electric vehicles.

CleanUp: Grants to support retrofit pollution-reduction equipment such as catalytic converters and particulate traps, in particular to heavy diesel vehicles.

Tax-based Measures: Fuel duty differentials for cleaner fuels such as compressed natural gas (CNG) and liquefied petroleum gas (LPG); Graduated excise tax, for private automobiles, buses and lorries, according to carbon dioxide emission levels; CO2-based tax structure for company cars- to incentivise the purchase of more efficient vehicles

The Energy Efficiency Best Practice Programme helps organizations improve environmental performance and cost effectiveness of transport operations. Key areas:

- Travel plans - measures to reduce single-occupancy travel
- Car and Van Fleets – improving fuel-efficiency and minimising vehicle use
- Road Haulage – fuel management and improved logistics.

More information is available at: http://www.transportenergy.org.uk/

6.2.22. United States

Topics 5 & 6: Vehicle Regulation and Promotion of Less Pollution Vehicles

Federal Government:
The U.S. Congress adopted the first major Clean Air Act in 1970 and the Clean Air Act Amendments in 1990, which called for reductions in polluting sources: CO, transportation hydrocarbons (HC), NOx and PM10.

Programs are carried out by various Federal Agencies include:

- *Transportation programs* – Congestion Mitigation and Air Quality (CMAQ) Improvement Program and Section 3 Discretionary and Formula Capital Program.
- *Fuel Programs* – Federal Transit Administration/Clean Fuels Formula Grant Program, which supports emerging technologies and markets for new clean fuel technologies for transit; Environmental Protection Agency (USEPA) Clean Fuel Fleet Program (CFFP), National Low Emission Vehicle (NLEV) Program.

- *Emissions Programs* – USEPA Air Pollution Control Program, Pollution Prevention Grants Program, Light-Duty Vehicles: Tier II standards – Tailpipe standards for NOx, Heavy-Duty Vehicles: Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Requirements, New Vehicle Certification Program, and Emission Recall Program.

- *Corporate average fuel economy* (CAFE) (USDOT) – Enacted in 1975 in response to the energy crisis caused by the 1973-1974 oil embargo – sets motor vehicle fuel economy standards. The CAFE standard for passenger cars is 27.5 miles.

Study Results :

- National Academy of Sciences (July 2001) – CAFE contributed to increased fuel economy, but also additional traffic fatalities. The National Highway Traffic Safety Administration (NHTSA) plans more current analysis.

- The consumption of alternative fuels increased since the early 1990s, but its relative share in total motor fuel consumption remains small.

State DOT Respondents (WI, KY, UT, NY, NH, FL, CT, WA)

Effects of Road Networks and Transportation Policies include :

- Increased emissions testing, particularly in heavily polluted areas

- Usage of alternative fuels: natural gas, propane, ethanol, enhanced fuel

- Influence travel behavior (e.g. modal and vehicle choices, non-peak travel, reduced trips) Proactive planning to reduce sprawl and promote transit and rail alternatives

- Intelligent transportation systems: electronic toll collection system, freeway cameras, etc.

Systems/Programs :

- Natural gas, hybrid and alternative fuel vehicles tax incentives

- Information sharing, motorist education and outreach efforts
- HOV lanes, ride sharing, alternate commuting schedules, alternate transportation modes including bus, pedestrian, and bicycle

- Tax incentives for employers, subsidies for bus passes, van/carpooling & telecommuting

Many State DOTs keep statistics on commute trip reduction and non-motorized transportation and surveys identify obstacles and opportunities to improve the effectiveness of the program.

7. GENERAL RECOMMENDATIONS

7.1. Health

Based upon the analysis of the inquiry, for capital city regions, for other cities, for urban areas and main roads, we can see that most health effects of road networks are due to accidents (fatalities and injuries), indirect impacts follow from air pollution (with especially respiratory disease); in a longer perspective, also from greenhouse gas emissions; from noise (with annoyance, sleep disturbance, possible cardiac and other disease). There are also possible links from road maintenance chemicals use impacts on groundwater and soil to human health.

In the developing countries road networks can still have a positive effect on health - direct access to hospitals- dust and noise reduction by surrounding a village etc.

In any case close collaboration with nature and environmental specialist is a important step to make up a healthy transport system for all of us. Engineers of the department of Road and Highways, and their collegues of the department of environment have to provide advice in matters of environmental management.

7.2. Local Pollution

The problem of local pollution has been an object of concern of many countries; 23 amongst them have responded to the questionnaire.

In urban environments, noise, vibration and air pollution are taken into account with priority. Out of the cities, local impact concerns mostly the pollution level of soil and water. Along roads, urban as well as interurban, tidiness is a perpetual concern. Countries facing heavy winters, are of course interested in the effects of deicing salt. Some countries highlighted problems involving road construction technology, and associated road traffic accidents.

The importance of pollutions varies with the country. The same goes for the means, elaborated to limit impact. Some countries establish the problems, unfortunately without possessing the means to deal with it.

Generally speaking, performed studies mostly concern the establishment and the deployment of measuring networks. Adapted methodologies, specific to road impact, are developed in particular for noise and atmospheric pollution.

It must be a clear aim for the road engineers to find solutions which deal with the environmental demands in a balanced way.The main problems faced in most of the countries are related to an explicit need to attend to the ecological and biological values of the environment, to the protection of the landscape. In pratice, an "environmental consultant" who takes part in the discussion during the road construction seems to be a possibillity to reduce the impact on the environment.

7.3. Biodiversity

Most of the countries pointed out in their answers that the effects of road networks and transport policies on biodiversity are mainly seen as a matter of interurban areas. The loss, fragmentation, disturbance and pollution of habitats were reported as the major impacts, various measures and studies were undertaken to identify the most critical road and network sections and to improve the current situation by means of underpasses, overpasses and ecological compensation measures. At the planning stage a re-routing of particular road sections might solve the problem in less populated areas. Only a few countries took into account the positive effects a roads and the road network could have on biodiversity. For example in areas with intensive agricultural use or in heavily built-over areas, road verges and road greenery can offer some species a habitat and a migration route.

7.4. Landscapes

Regarding the methodology, visual impact assessment studies may form part of project environmental investigations for new road works. Also a methodology to estimate large undisturbed landscapes on regional and national level may be applied.

As for monitoring, valuable buildings and urban structures are recorded using a registration system, which is a quick and simple method for mapping of architectural quality and buildings worth preserving. Specific monitoring techniques may be used such as aerial photography, GIS modeling and Land sat Imagery of a project area or Digital Images, where the "driver" would typically see as they proceed along the road.

The measures proposed are sometimes very global, sometimes very specific and are difficult to combine in one major “rule”. A combination of measures seems to be the best approach. One way to deal with landscape is to implement compensatory or mitigation measures, such as revegetation, site preparation, fencing, irrigation or water control structures, access control, and mitigation performance monitoring and de-fragmentation of natural landscape, habitat and flora, especially in the forests and mountains.

Public participation is important to promote the landscape by e.g. campaigns for landscape and cultural activities and events and by visualising the culture-historic quality of the surroundings to the road user. Especially in urban areas, a social survey may be conducted to those residents affected.

Some other proposals deal with the initiation of regulations, procedures and guides to harmonise road construction with the landscape. At last, some recommendations mentioned are to keep infrastructure in transport corridors and to involve landscape experts in the early stage of project identification and design.

7.5. Vehicle Regulation and Promotion of Less Pollution Vehicles

Transportation systems vary considerably from one country to another. However, we do not live in a vacuum. We share one common earth, which is greatly affected by the millions of vehicles we employ. Techniques to reduce the harmful effects of motor vehicles are being deployed worldwide. A detailed scan and documentation process of effective practices can serve as an intellectual platform toward continued technological progress in a sustainable manner.

Listed below are action items we can consider as we collectively move, in time and space, into a productive and sustainable 21st century. Actions focus on knowledge assessment and knowledge transfer.

Proposed Action Items “Draft” :

1. Examination of standards and controls, based on existing statutes and regulations, which promote the use of less-polluting vehicles. Gather and showcase effective examples that further promote less-polluting vehicles.

2. A detailed scan of country-specific controls that seek to minimize emissions and local/regional pollution. This information can be shared and technology transferred.

3. Survey of fuel standards, control systems, and testing programs currently used and their applicability and/or challenges in applicability across borders.

4. A scan of effective air and noise monitoring practices and measures that have been used to reduce roadside air and noise pollution.

5. A survey of equipment-upgrades success stories in efforts to increase ‘clean-air’ vehicle fleets. Success stories and the impact of these efforts on country and/or regional systems can help other countries/regions with antiquated vehicle fleets.

6. Identification of transportation policies that have successfully influenced behavioral change and subsequently helped reduce pollution: i.e.: fleet upgrade, change of fuel-type usage, alternate vehicle usage and/or programs that affect travel patterns.

7. A comparison of grant programs/incentive programs (Incentives/”Carrots”), legal measures/policies (Penalties/”Sticks”) and education programs (Behavior Modification) that have increased the use of less-polluting vehicles.