ROAD TRANSPORT AND THE ENVIRONMENT RISK ASSESSMENT AND OPTIONS APPRAISAL: FINAL SUMMARY REPORT

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Report 37 June 2000

Title: Road Transport and the Environment Risk Assessment and Options Appraisal: Final Summary Report	Report 37 Version: Final Issue Date: June 2000

Approval	Signature	Date
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Distribution: Environment Agency
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EXECUTIVE SUMMARY

This report summarises the findings of the Agency's risk assessment and options appraisal on road transport and the environment. It follows on from the Agency's initial view of this issue, published as a *Risk Profile* in 1997 (Environment Agency, 1997a). Although the Environment Agency has no formal remit in relation to road transport, many of the associated issues have a bearing on the Agency's ability to regulate and manage the environment effectively.

In undertaking the risk assessment the Agency did not seek to duplicate the efforts of others in addressing the issue of road transport. The Royal Commission on Environmental Pollution, for example, has published two reports on the issue (1994, 1997). Rather, the Agency imposed a risk-based framework on the information available, with the intention of developing consistency across a wide range of issues. Such an approach necessarily involved broad assumptions and understanding how uncertainties in information affected the final outcome. The intention of the methodology was to rank risks relatively, rather than leading to a prescriptive set of quantitative results. The approach was logically structured with an initial screening of a broad range of environmental risks using the technique of preference elicitation. This was followed by a more detailed generic assessment of those issues that were prioritised through this process. The methodology involved the construction of event trees and where appropriate, Monte Carlo simulation to assess the effects of uncertainties. A subsequent stage involved some iteration of the risk assessment and a screening of options.

Key findings of the risk assessment:-

Air quality impacts	HGV's contribute to 41 % of the total vehicle PM_{10} emission but only account for 6 % of total vehicle kilometres. Vehicle PM_{10} could result in 11,000 premature deaths and 14,000 hospital admissions each year.
Global climate change	Vehicular emissions were found to account for 20 % of the total UK contribution to global warming with 93 % of this arising from CO_2.
Water quality impacts during road construction	Under average conditions, the final suspended sediment concentration in a river may be around three times the EQS.

Water quality impacts due to road maintenance	Gully pot cleaning may lead to the exceedance of the EQS for ammonia in very small watercourses. For example, in a small catchment of 50km^2 the critical river flow below that the EQS will not be met is likely to be in range of 0.01 to 0.18 cumecs m^3/s.
Impacts of accidental spillage of motor spirits	A pollution incident in watercourses will result from spillage involving more than 15kg of motor spirits.
Water quality impacts of road runoff	Rivers are particularly vulnerable during periods of low flow to large pollution inputs that may elevate river concentrations of certain heavy metals to above the values of the appropriate EQS. High copper loads represent the greatest risk of heavy metal pollution in surface water.
Potential for flooding due to road construction	Peak discharge may increase by up to 12 %. Greater risk of flooding relates to urban flooding.
Habitat loss from roadstone quarrying	The greatest probability of habitat loss is in East Midlands, Wales and the South West Regions.
Potential for sensitive habitat loss from new road construction	The greatest probability for loss is in the South East. The North West generally has the greatest relative pressure on designated sites.
Impacts of leachate arising from landfill of waste vehicle components	Leachate concentrations are very low and significantly lower than the existing EQSs.

Some of these impacts are specific to urban areas, whilst others are more ubiquitous and affect rural as well as urban roads. Some of the potential implications for the Environment Agency and other organisations were evaluated at the appraisal of options stage and are described in the text of the report. A matrix was drawn up to screen options on various criteria including importance, Agency remit and responsibility. These ranged from improvements in technology, education and economic instruments, to new, or changes to, existing policies.

Summary of results of screening of options:

Sources of Risk	Options Issue	Policy	Programme	Planning	Project	Technology	Education/ Influence	Economic
Road use	Air Quality/ Emissions							
Road use	Climate Change/ Emissions							
Road use	Accidents and Spillages/Water Quality							
Road Construction	New road construction							
Road Construction	Road maintenance/ Water Quality							
Road Construction	Road Runoff/Water Quality							
Road Construction	Flooding							
Road Construction	Habitat loss From quarrying							
Road Construction	New road construction							

The options were categorised in terms of whether the Agency already had a direct impact (shown black), an indirect influence (shown medium grey) or where there was considered potential for further Agency involvement/ improvement (shown red). Even in those areas where the Agency is directly involved there may be opportunities for review and improvement. Recently effort has gone into investigating particular options such as technology (fuel cells). The 'education option' relates primarily to continued education of the Agency's own drivers, although the Agency has undertaken a number of additional initiatives, including the production of a report explaining the problems relating to 'Tyres and the Environment'.

Since 1997 the Environment Agency has been involved in a number of initiatives concerned with transport and several reports have been produced (shown bold in Figure 1.1) or are currently in the final stages of preparation (shown italic). In addition to its own analysis of the risks of road transport, the Agency has been involved in developing initiatives such as the 'Roads Review' and the 'New Approach to Appraisal' for roads, multi-modal transport and airports. As well as influencing policy and programme options for roads, the Agency has also investigated other options, including technology and education, that can be linked to particular risks identified in the risk assessment.

As Government takes measures to tackle the problems surrounding the growth in demand for road transport, the Environment Agency's findings and experience are likely to prove useful. Furthermore as a statutory consultee in the planning process, and as a regulator, the Agency's experience will be valuable in contributing to the development of land use policies at the national, regional and local levels.

LIST OF ACRONYMS

AONB	Area of Outstanding National Beauty
AST	Appraisal Summary Table
BACMI	British Aggregate Construction Materials Industries
BAP	Biodiversity Action Plan
BCR	Benefits Cost Ratio
BRF	British Roads Federation
CEST	Centre for Exploration of Science and Technology
CIRIA	Construction Industry Research and Information Association
CO_2	Carbon Dioxide
CPRE	Council for the Protection of Rural England
DETR	The Department of the Environment, Transport and the Regions
DMRB	Design Manual for Roads and Bridges
DoE	Department of the Environment (now DETR)
EA	Environment Agency
EIA	Environmental Impact Assessment
ELVS	End of Life Vehicles
EQS	Environmental Quality Standard
EU	European Union
GIS	Geographical Information System
GOMMS	Guidance on Multi-Modal Studies
GQA	General Quality Assessment
HA	Highways Agency
HGV's	Heavy Goods Vehicles
LEAPS	Local Environment Agency Plans
LNR	Local Nature Reserve
LPG	Liquid Petroleum Gas
MAF	Mean Annual Flood
MOT	Ministry of Transport Vehicle Test
NATA	New Approach to Appraisal
NCRAOA	National Centre for Risk Analysis and Options Appraisal
NNR	National Nature Reserve
NOx	Oxides of Nitrogen
NPV	Net Present Volume
PAHs	Polyaromatic hydrocarbons
PCB's	Polychlorinated by-Phenyls
PM_{10}	Particle median of less than 10 microns
PVB	Present Value of Benefits
PVC	Present Value of Costs
R&D	Research and Development
RCEP	Royal Commission on Environmental Pollution
RPG	Regional Planning Guidance
SAC	Special Area of Conservation
SAM	Scheduled Ancient Monument (now SM)

SINCS	Site of Importance for Nature Conservation
SSSI	Site of Special Scientific Interest
TRL	Transport Research Laboratory
WMP	Waste Management Paper
WO	Welsh Office

1. CONTEXT

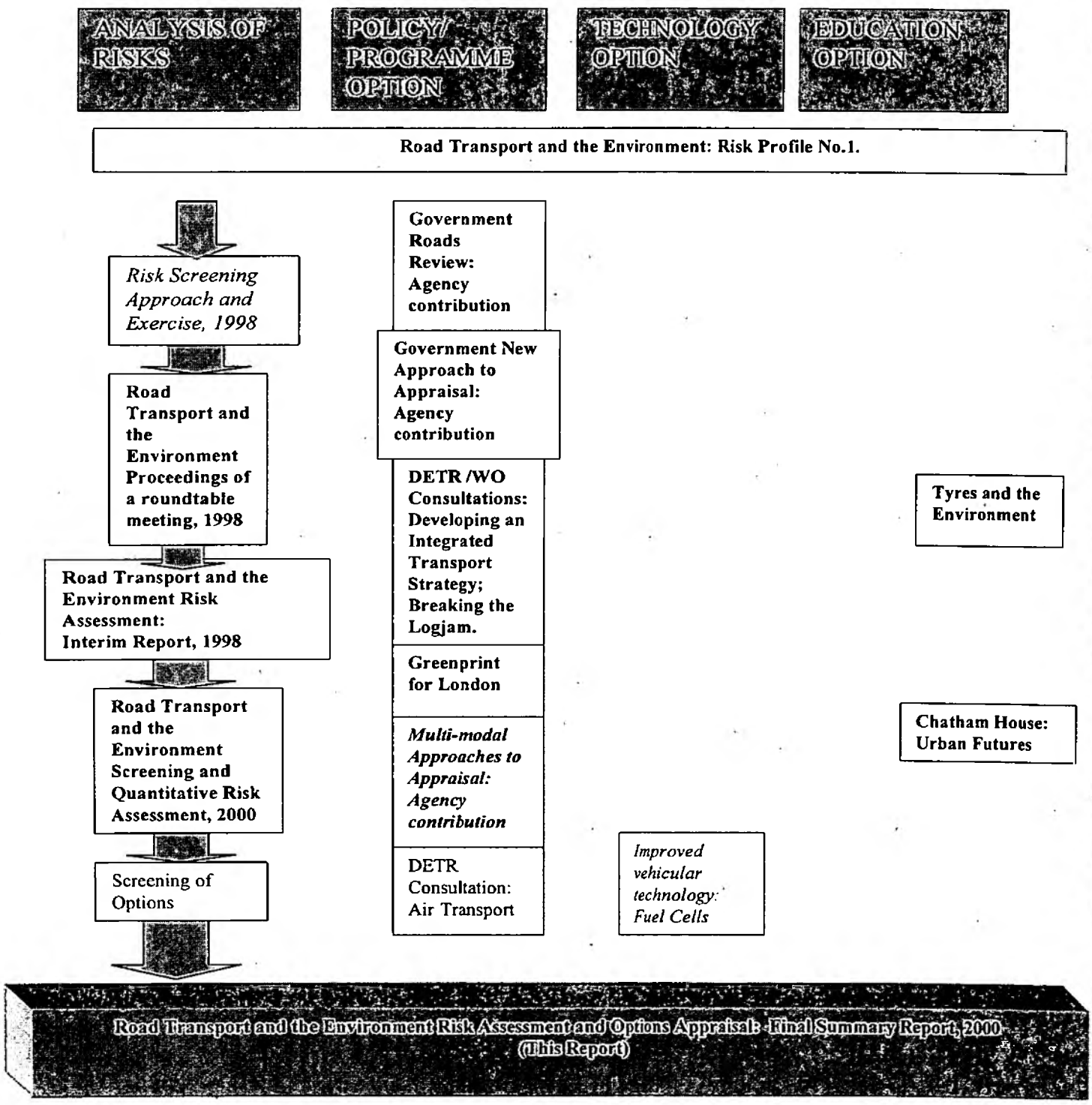
1.1 Purpose Of Report

This overarching report summarises the approach and results of the Environment Agency's risk assessment work and options appraisal concerning road transport and the environment (Environment Agency, 1997a; 1998 a,b,c,d). The principal aim of the report is to analyse some of the key issues/ problems surrounding road transport. It also describes how this work has enabled the Agency to comment on several Government papers concerning transport issues and input directly to the various DETR and Highways Agency methodologies for appraisal of transport schemes (Department of the Environment, Transport and the Regions, 1998 a,b,c,d; 2000). The details of each piece of Environment Agency work are covered in separate reports and the linkages are shown in Figure 1.1 (Environment Agency, 1997c, 1998a,b,c,d,e,f, 1999a,b, 2000a,b,c).

This report also makes a number of overall recommendations on the wider use of the approach and the specific results within the Environment Agency.

Figure 1.1. Some key Environment Agency initiatives on transport (1997-2000)

(bold indicates Environment Agency report or paper currently available; *italic* indicates report or paper in preparation)



1.2 Background To The Environment Agency's Involvement In Road Transport

Many authoritative studies, including the recent report produced by the Royal Commission on Environmental Pollution (RCEP, 1997) have highlighted the severe and widespread environmental impacts of existing and future transport, in particular road transport.

Although the Environment Agency has no formal remit in relation to road transport, the need to take a holistic, long-term view of this issue is at the heart of its principal aim of sustainable development. For example, it is important that in regulating emissions from major industrial processes, the Agency is informed of the relative risks placed upon the environment, both actual and perceived, by road transport. The Agency has a wide range of powers and duties for managing the environment. It is required and guided by Government on how to use these powers and duties. Section 4 of the Environment Act (1995) lays down the principal aim of the Environment Agency 'discharging its functions so to protect or enhance the environment, taken as a whole, as to make the contribution towards achieving the objective of sustainable development ...' The Agency needs therefore to contribute to other aspects of management of the environment even if these are, in the first instance, the responsibility of others. This can only be achieved effectively by working in partnership with and through others to set common goals and to achieve agreed objectives.

Within the Environment Agency, the Environmental Strategy Directorate is responsible for setting the overall direction of the organisation such that it is able to deliver its principal aim. The Environmental Strategy, first published in 1997, is based essentially on the need to take an integrated approach to the management of the whole environment (Environment Agency, 1997b). It also involves forming an overview of the state of the environment at any one time, identifying pressures that affect that state and identifying appropriate responses that need to be made. This simple approach allows the identification of key environmental issues that need to be addressed, either by the Agency itself or in collaboration with others. A more recent document is concerned with progressing this Environment Strategy (Environment Agency, 2000d).

Road transport can be regarded as a subset of one of the 'six stresses and strains' on the environment identified by the Environment Agency (see below). Whilst road transport contributes directly or indirectly to all stresses and strains, it can be regarded as a principal subset of the pressures exerted by Society in terms of population, consumption of energy and lifestyles. It is important that the Agency does not try to solve one problem by creating others elsewhere.

Stresses and Strains	***Examples of environmental impacts concerning roads***
Natural forces	Flooding of roads
Societal	Change to quality of life as a result of road building
Abstractions/ removals	Loss of habitats as a result of winning aggregates for roads
Use/ discharges	Increased pollutants in water bodies/atmosphere
Waste	Disposal of batteries, scrap vehicles, tyres etc
Compliance/ illegal	Vehicles failing emission standards/ fly-tipping

The 'state of the environment' is directly affected by road transport from six different viewpoints set out by the Environment Agency (see below):

Viewpoints	***Effects on state of the environment***
Land use and resources	Road construction
Bio-diversity	Loss of fauna and flora
Environmental Standards and Targets	Air quality
Environmental/ human health	Road deaths/ asthma
Long-term reference sites	?
Aesthetic	Landscape/ noise (areas of tranquillity etc)

It is recognised that there is little point in trying to improve the environment in one way, such as dealing with waste, if it creates other problems, such as noise or smell, or ruins the landscape.

Identifying environmental problems is one thing; solving them is another. One of the reasons for the Agency's existence is to provide a long-term, integrated approach to complex issues. This not only involves looking at the ways in that different risks are managed but also developing a more equitable approach to dealing with such problems in terms of the value that industry and society place on them.

In terms of appropriate responses the Environment Agency outlined a thematic approach to environmental management through its Environmental Strategy, reflecting the broader social context that is essential to sustainable development (see below). It is likely that this 'response' stage for transport will come later, and the Agency has set a number of aims to be achieved by the year 2020 (Environment Agency, 2000d):

- Improving the quality of life
- Enhancing all forms of wildlife
- Greening of industry
- Using natural resources wisely
- Ensuring that the air is clean
- Improving and protecting inland and coastal waters
- Restoring and protecting the land
- Reducing flood risks
- Limiting and adapting to climate change.

1.3 Environment Agency's Approach To Risk Assessment

The National Centre for Risk Analysis and Options Appraisal has been specifically tasked with developing consistent risk assessment techniques that will enable the Environment Agency to determine the factors that contribute to the risk as well as the severity of any impacts (Environment Agency, 1997c). A source document for the development of these tools and techniques is the Governments' guidance on risk assessment, first published by the Department of the Environment (1995a) and most recently (1998-2000) revised and extended with the assistance of the Environment Agency. In its risk assessment work, the National Centre specifically takes account of the perception of risk and the need to communicate risk-related issues effectively. In parallel with forecasting risks to the environment, the Centre is also developing tools and techniques to evaluate options that might be open to the Agency in minimising the risks, and where appropriate, mitigating the effects

The techniques of risk assessment and risk management for environmental protection and sustainable development are still in their relatively early stages of development, although considerable progress has been made (Environment Agency, 2000e). A systematic approach avoids many mistakes, as well as careful recording of each assessment so that lessons can be learned from any mistakes that are made (Department of the Environment, 1995a). Broad assumptions have to be made, not least when working at a strategic policy level, and these need to be clearly recorded for transparency.

1.4 Road Transport and the Environment: Preliminary Work

The National Centre scoped the Environment Agency's initial assessment of the environmental impact of road transport in the summer of 1997 as a 'Risk Profile' (Environment Agency, 1997a). The purpose of this brief document was to identify the key issues surrounding road transport and the environment and was a necessary precursor to the more detailed work. It considered both present impacts and the likely future effects of trends in vehicle use, the impact that these may have on the future state of the environment, and the options, in very general terms, open to the Agency and others in preventing any future environmental damage.

1.5 Environment Agency's Responses To Government Consultation Papers

In parallel with the risk assessment and appraisal of options work, the Agency was involved over a period of three years with a number of Government consultations on transport and the development of new approaches to appraisal.

1.5.1 Environment Agency's Response To 'Developing An Integrated Transport Policy'

The preliminary work outlined in 1.4, together with early results from the more detailed risk assessment, enabled the Environment Agency to be informed, in the context of sustainable development, of some of the road transport options available. In November 1997, the Agency responded to the Government's Consultation Paper 'Developing An Integrated Transport Policy'. The Agency addressed the issues set out in the consultation paper and, although they were all regarded as pertinent it restricted its response to those areas where it was able to make constructive recommendations. The Agency's comments are summarised in Appendix 1.

1.5.2 Environment Agency input to the Roads Review, the Development of A New Appraisal Framework, And Multi-Modal Transport

Towards the end of 1997 the Environment Agency, together with the other statutory bodies, were contacted by the Department of the Environment, Transport and the Regions (DETR) to provide an input to a forthcoming comprehensive transport review (Environment Agency, 1998d 1999a,. Specifically, to assist in the appraisal of the trunk road programme inherited from the previous government. Although the first part of this work was undertaken in parallel with the early risk screening exercise, it is summarised in detail in Chapter 4 (Section 4.4), that considers options appraisal.

1.5.3 Other Work On Transport Issues

The National Centre provided comments on behalf of the Agency on several DETR consultation papers. These included the consultation on the revised Statutory Instrument on the Environmental Impact Assessment of Trunk Road Projects (January 1999) required to implement the revised EC Directive on EIA (97/11/EC). The Centre also commented on the DETR's Breaking the Logjam (DETR, 1998d) consultation paper that set out proposals for road user and parking charging.

In early 2000 comments were also made on DETR's Appraisal Framework for Airports in the South East and Eastern Regions of England consultation paper (DETR, 2000a). This concerned the development of an appraisal framework to be applied to the alternative ways of dealing with demand for more airport capacity.

2. ROAD TRANSPORT AND THE ENVIRONMENT RISK ASSESSMENT

2.1 Introduction

This work built upon the preliminary collection of information and appraisal made for the Risk Profile. It was intended to be a more-in-depth look at the problems/issues surrounding road transport. It concerned risks that are a direct responsibility of the Agency, those that are a joint responsibility with other organisations, and those for that the Agency has no responsibility but may impact on the Agency's ability to deliver sustainable development. The overall objective of the work was:

To undertake a risk assessment of road transport and to provide a suite of risk management options to support the Agency in discussions with Government and other organisations.

This objective was kept in mind during subsequent internal and external workshops held at various stages of the project. The consensus view at these meetings was that the principal aim should be to convey the true impacts of roads rather than become too involved in prescribing exactly what the Government should do about the problem (e.g. change of fiscal system, changes in vehicle technology, persuading people not to drive, integrating travel with planning and the environment etc.).

This chapter has concentrated on the background to the Environment Agency's involvement in transport issues and has summarised several examples of where the risk-based work/approach had an impact in discussions with Government. This final summary report, published in July 2000, is intended to summarise the results of a risk screening exercise (Chapter 2) and generic stages of the risk assessment (Chapter 3) in a form that conveys some of the key impacts of roads. A more detailed report specially aimed at those interested in learning about the risk assessment methodology, including limitations and assumptions, is also available (Environment Agency, 2000a). The results of the screening exercise at the appraisal of options stage is also included (Chapter 4), together with a summary of some of the more detailed work undertaken by the Agency on a number of options. The report combines the technical input of key Environment Agency staff and external specialists. The approach to risk ranking was assisted and facilitated by The Warwick Risk Initiative of the University of Warwick. The generic risk assessment (results in Chapter 3) was undertaken by WS Atkins Environment, and further technical assistance was provided by Mr Ric Eales, independent consultant, particularly in relation to the Roads Review, the New Appraisal Framework and various Government consultations.

2.2 Risk Screening

2.2.1 Background

Methods for screening or ranking enable the most important risks to be assessed in more detail through more complex techniques later. This helps prioritise effort and resources. Ball and Golob (1997) summarised some of the pertinent challenges and opportunities involved in the development and use of risk screening methods:-

- Risk screening is about identifying goals and setting priorities.
- Subtle differences in goals and purposes can make big differences in the type of screening methodology that is appropriate.
- Risk screening is carried out differently by engineers, natural scientists, psychologists, sociologists, lawyers, economists and decision-makers.
- All methods have benefits and limitations and there is a need to clearly convey these.
- Above all, risk screening enables more consistency and transparency than might otherwise be achieved.

A key purpose of screening road transport issues has been for the Environment Agency to determine where it can most effectively invest its resources to further the understanding of risks and associated management and mitigation techniques.

2.2.2 Determination Of What Should Be Screened

It was felt that for consistency of approach, the sources of risk and environmental impacts scoped in the Risk Profile (Environment Agency, 1997a) should be initially adopted for the risk screening exercise. As a precursor to the risk screening exercise, the Environment Agency facilitated a roundtable meeting on 25 November 1998 to inform key organisations outside of the Agency's interest in road transport but also to obtain the views of others to help focus the project.

Table 2.1 lists those government departments, agencies, business groups and non-governmental organisations who contributed either as speakers and/or in discussion.

Table 2.1 Organisations attending the Environment Agency's round table meeting held on 25 November 1998

Environment Agency
WS Atkins Environment
Royal Society for the Prevention of Accidents
National Society for Clean Air
Royal Society for the Protection of Birds
Imperial College (London)
Institute of Highways and Transportation
Alarm UK
Local Government Association
Council for the Protection of Rural England
British Road Federation
Guildford Borough Council
DETR
Highways Agency
Countryside Commission *(invited)*
Road Haulage Association *(invited)*

The basis for the risk screening work was a meeting assisted and facilitated by 'The Warwick Risk Initiative', involving about 12 specialists on issues relating to air, land and water aspects of road transport carefully drawn from the across the entire organisation. This meeting was held on 26 January 1998 (Environment Agency, 1998b). The initial categories scoped in the Risk Profile were critically reviewed by those present at the meeting as an early step in the ranking process.

Within the context of the Agency's Environmental Strategy (see Section 1.2) a more prescriptive classification of risks and environmental impacts of road transport was developed. Risks to the environment of greatest concern to the Environment Agency in relation to roads arise from the following sources:

- raw materials
- road construction
- road maintenance
- road run-off
- accidents and spillages
- exhaust emissions
- waste disposal and tyre disposal

Relevant environmental impacts from these sources include:

- climatic change
- air quality
- soil quality

TABLE 2.2: Overall Results Of The Risk Screening Process

	SOURCE OF RISK						
	ROAD CONSTRUCTION			**ROAD USE**			
IMPACT	Raw Materials	Road Building	Road Maintenance	Road Run off	Accidents and Spillages	Emissions	Waste Disposal
Climate Change							
Air Quality							
Soil Quality							
Water Quality							
Flooding & Water Resources							
Ecological Quality and/or Habitat Loss							
Landscape							
Property							
Noise							
Human Health							

- water quality
- flooding and water resources
- ecological quality
- landscape
- property
- human health
- quality of life

The sources of risk were further divided into two broad categories, namely road construction and road use. The full list of subcategories is:-

Road Construction

- raw materials
- road building
- road maintenance

Road Use

- road runoff
- accidents and spillages
- emissions
- waste disposal

This was felt to be an improved classification of areas of activity (and therefore potentially for investment of resources).

2.2.3 Approach To Screening

Discussion led to calls for a systematic and transparent approach for comparing and appraising the options and setting out explicitly the reasons behind the assessment of each option.

After considerable debate, the solution eventually accepted was to look at each impact in terms of three categories considered to be of equal importance:-

A.	Policy remit	:	whether the Environment Agency has a policy or formal remit in the area.
B.	Potential for mitigation	:	whether there is capacity (e.g. via negotiation to influence policy) to mitigate impacts.
C.	Significance/importance	:	whether there is an irreversible or large impact.

A, B and C were considered as attributes in the analysis, each impact being awarded a number of ticks (✔ or ✔ ✔ or ✔ ✔ ✔). to indicate necessary significance. Each impact was given full discussion before reaching a scoring on consensual grounds. The principal benefit of this approach was not the scores, per se, but setting out explicitly the reasons behind the scoring. This approach to preference elicitation, is are outlined in a separate report to this final summary

(Environment Agency 2000a).

2.2.4 Results

A summary matrix has been produced to show the overall results of the risk screening process (Table 2.2). The prioritised risks are shaded. The following discussion provides a brief outline of why particular issues were chosen and their importance. This is not intended to play down the significance of some of the other issues. There was also protracted discussion on several impacts, such as landscape, that were ranked fairly low by the process, but that people considered an error to omit.

Certain issues were considered as important but too far outside the Environment Agency's remit. Equally, there are several issues related to those that were prioritised, that have been considered for inclusion in the generic risk assessment. For example, human health is a key issue that logically links with air quality/emissions. Human health (as a result of poor air quality), however, is not something that the Environment Agency has a regulatory remit over and was not therefore given prominence in this study. There was also some debate over whether certain issues fell readily into the 'Road construction' 'or Road Use' categories.

For some of the issues (eg. increased flooding as a result of structures crossing the channel and/or floodplain and discharges) the Agency has certain statutory powers to enforce appropriate mitigation. However, for many of the prioritised issues the Agency does not have direct responsibility for the control of the environmental implications. Nevertheless because of the Agency's concern over other issues there may already have been instances where the Agency has worked in partnership with others (eg the Highways Agency) to develop appropriate policy and to negotiate in particular circumstances. For some of the prioritised issues the Agency may yet need to develop/strengthen partnerships/negotiations.

Road Construction

- Raw materials and ecological quality

  Raw materials present a risk to the environment as a consequence of their extraction, transport, and usage. Road construction materials (e.g. roadstone, cement and gravel), car construction materials (e.g. steel and rubber) and petroleum products are all sources of risk to the environment. All of these have the potential to increase over the next 20 years or so in relation to the length of new roads built and the amount of kilometres travelled. The impact of raw materials on ecological quality was therefore seen as a key issue for consideration by the Environment Agency.

- Road building and water quality

  The construction phase of roads can have a very major impact on water quality. Experience from Environment Agency officers around England and Wales suggests that construction sediments are potentially one of the most significant and enduring impacts of road building, affecting downstream interests such as fisheries. Sediment sources include the movement of earth and the creation of bare surfaces as a consequence of the removal of vegetation. In addition there are potential risks of spillages of substances such as oil from site contractor's compounds and vehicles. The impact of road building on ecological quality and/or habitat loss was considered to be an associated issue.

- Road building and flooding/water resources

  Without adequate mitigation measures, the building of roads in the floodplain can affect flooding regimes, potentially increasing the flood risk to land and property, resulting in financial loss and trauma. Road building can also create temporary (eg. as a result of coffer dams) and more permanent impacts on groundwater flow. Road runoff can also affect the quality, and hence the quantity, of water available for abstraction downstream for purposes such as drinking water and irrigation of agricultural land. Experience throughout the Environment Agency has shown there to be significant concerns in relation to this impact. There was some debate as to whether this issue best fitted under the road construction arm as opposed to road use.

- Road building and ecological quality and/or habitat loss

  The loss of habitat as a direct result of new road building was seen as a key issue, prioritised for detailed investigation. Experience suggests that this has, in the past at least, affected many sensitive ecological habitats, not least those on floodplains. Impacts on habitats may also extend into the road use phase, with roads acting as a barrier to species movement, and the recovery of restored ecosystems being adversely affected by road runoff and air pollution.

- Road maintenance and water quality

  Reports from some Regional offices of the Environment Agency indicated that the cleaning of gully pots may result in pollution of adjacent watercourses. Road maintenance in terms of operations to keep roads free from ice and snow were also seen as potentially significant.

- Road Use

  - Road runoff and water quality

    Water pollution from road runoff is a major concern for the Environment Agency. As water runs off a road it takes with it many pollutants including oil and tyre residues. The flush of these substances together with their inherent ability to pollute, poses a significant risk to the environment. There are a number of actions that can be taken at a project level for mitigation of these impacts, including the use of oil interceptors and wetland basins and root zone treatment and the attenuation of runoff. The impact of road runoff on ecological quality and/or habitat loss was considered to be an associated issue, as was the impact of road runoff on human health.

  - Accidents and spillages and water quality

    Road accidents result in spillages of substances that pollute the environment. In 1996 there were 1915 water pollution incidents in surface waters arising from transport. Of these, 73 % were due to road transport, and road traffic accidents in particular. Such substances can range from noxious liquids and toxic chemicals to ordinary liquids such as beer and milk. All have the potential to cause environmental damage, and the risk is increasing. The statistics show an increasing trend with the 1996 figures representing a 28 % increase on those for 1993. This places road transport on a par with agriculture as one of the principal sources of diffuse pollution. One solution for minimising the effect of road transport related incidents on water quality is improved liaison with the fire services.

  - Emissions and climate change

    Carbon dioxide is one of the principal greenhouse gases contributing to global warming. Road transport comprises around 20% of national CO_2 emissions resulting in 16 % of the total global warming potential of UK emissions. There is an increasing trend with emissions in 1993 over 60 % greater than those in 1970.

  - Emissions and air quality

    Road transport is a major contributor to poor urban air quality. Vehicles account for over 50 % of NOx emissions and, as these are released close to the ground,

they have a disproportionate effect on urban air quality, particularly close to busy roads. Advances in technology could lead to the manufacture and sale of more fuel-efficient vehicles leading to reduced emissions. It was also felt that air pollutant impacts on human health should be considered in relation to this category. Some pollutants emitted from vehicles may have an impact on human health.

- Waste disposal and soil quality

  Although the disposal of tyres, scrap cars, old road surfaces, spent oils and petroleum appears to be decreasing as more recycling and re-use schemes are implemented, there are still significant risks to soil quality. Such risks should be considered alongside changes in the soil quality arising directly from emissions, and their impact on ecological quality and/or habitat loss

3. GENERIC RISK ANALYSIS

3.1 Background

Quantitative and qualitative techniques such as mathematical models, decision trees and fault charts can be used to determine the probability and magnitude of environmental damage that may result from particular activities. There are considerable difficulties in assessing the potential consequences of environmental risks, although even describing an intention and identifying the hazards can have considerable value.

There are a number of advantages in following a structured approach (Department of the Environment, 1995a):-

- By breaking down a problem of judgement into smaller parts, the resulting more detailed analyses may facilitate a judgement and allow a more qualified judgement to be made.
- By highlighting those matters on that it is not possible to make a judgement, analysis may indicate gaps in information that may need to be subsequently plugged.
- Areas of uncertainty may be identified. If this uncertainty is associated with significant potential damage, then there may be a need to invoke the precautionary principle.
- Analysis may indicate where regulatory resources are needed.

3.2 Approach Followed

The methodology and results are detailed in a compendium report that accompanies this final summary report (Environment Agency, 2000a). Using the ten issues identified at the risk screening stage, event trees were constructed. Examples are given in Appendix 2 (pages 2-1 to 2-12). These event trees were designed to enable risks from diverse sources to be compared and ranked, and to eventually allow the effects of management options to be evaluated. Event trees also introduced consistency and transparency. The event trees addressed environmental pressures but have included links with some measure of environmental impact. The data used for constructing each event tree were highly dependent on the available data relating to the scenario.

Where appropriate, the effects of uncertainties associated with the values of key input variables on selected event tree risk estimates were assessed using Monte Carlo simulation modelling. Crystal Ball version 4.0 was used. The modelling entailed the definition of probability distributions for input variables. This method of statistical modelling facilitated calculation of the combined impact of uncertainties inherent in the risk analysis and resulted in the production of a probability distribution for the selected event tree estimates.

Sensitivity analysis was conducted using rank order correlation, a non-parametric technique for quantifying the relationship between two variables. The rank correlation coefficients for input variables represented the degree of correlation, either positive or negative, between the event tree input variables and risk estimates. Sensitivity analysis enabled the identification of input variables that had the most significant effect upon the estimates and therefore provided a valuable means by which to prioritise and optimise further resource investment. It also assisted in targeting options.

Section 2.3 - 2.12 detail the scenarios, starting with those that fall under the broad category of Road Construction (those relating to raw materials, road building and road maintenance) and then examining specific scenarios related to Road Use (runoff, accidents and spillages, emissions and waste disposal).

3.3 The Potential For Habitat Loss From Roadstone Quarrying Activities

Scenario Modelled

The construction and maintenance of any road network requires raw materials, principally a significant quantity of aggregates in the form of roadstone, sand and gravel. Aggregates used for roadstone comprise around one third of the total amount of material quarried annually (CPRE, 1993). This results in considerable loss of land surface and ecological habitats. In 1988 about 114,000ha of land were affected by permissions for mineral working or mineral waste disposal (Department of the Environment, 1991). The two examples described here are event trees constructed for the loss of the land surface in different regions of England and Wales and for the different uses of the land surface taken for quarrying prior to its loss. These are based on:-

- the ratio of landtake to quantity of aggregate extraction;
- the ratio of road spending to roadstone consumption; and
- the fractions of the road budget spent on construction and on maintenance.

Specific Assumptions Made

- Land reclamation is not considered in the assessment, principally because the vast majority of aggregates for road construction are sourced from rock quarries where reclamation to original use is less likely to be pursued.
- The ratio of hypothetical landtake to aggregate quality is assumed to be the same for secondary aggregate as for primary aggregate.
- The total area of land changing to the mineral extraction use category, together with an indication of previous uses of land, have been taken from the DETR Land Use Change Statistics Database (Department of the Environment, Transport and Regions, 1998e). There is significant uncertainty connected with this data.
- Assumed that landtake to aggregate quantity ratio will be representative with some quarries taking new land and others exploiting that previously taken.
- The average area of land required per tonne of aggregate has been estimated to be $0.057 m^2 t^{-1}$.
- Assumed volume of secondary aggregate used is 11 % of the figures given by BACMI, (1996) for the annual production of roadstone in different regions of England and Wales.
- The ratio of road spending to primary aggregate demand has been determined to be $13.9 kt£M^{-1}$.
- The ratio of road spending to secondary aggregate has been determined to be $1.53 kt£M^{-1}$.
- The hypothetical landtakes for primary and secondary aggregates has been assigned in the same proportions.
- 11 % of total budget, on average, is used for aggregate purchase on new road schemes; 50 % on maintenance schemes (Highways Agency, 1998).

Results

Sand and gravel quarries have relative short life spans and are suitable for reclaiming for agricultural and amenity uses. However the vast majority of aggregates for road construction are sourced from rock quarries, that are usually much larger operations involving a significantly longer period of active quarrying and a greater depth of extraction. Such rock quarrying is likely to lead to irreversible damage. It is estimated that 799m^2 of land are lost annually through primary aggregate extraction for each £M spent on road construction and maintenance, the majority being for road maintenance schemes. 88 % of the land taken is agricultural and 3 % is natural or semi-natural land. The primary roadstone production in England and Wales per £M spent on road building and structural maintenance in both 1991 and 1995 has been determined to be particularly high for East Midlands, South West and Welsh Regions. For 1995, these are 26 %, 22 % and 15 % respectively of the total for England and Wales.

Some Implications

One possible implication of these findings is in terms of Regional Planning Guidance. These Regions where there is a high landtake required to supply primary roadstone per £M spending on construction and maintenance (e.g. may be South West, Wales and East Midlands) could be targeted for aggregate reduction measures. If necessary the use of secondary aggregate for both construction and maintenance will result in a decreasing amount of landtake by primary aggregate extraction. The loss of sensitive areas needs to be further assessed. Although only 3 % of total estimated landtake, these areas may be vulnerable by nature of their inherent sensitivity, the size of habitat patches and the number of similar habitats.

3.4 Water Quality Impacts During Road Construction

Scenario Modelled

Discharges with high suspended sediment concentrations are an important environmental risk during road construction. Suspended sediment concentrations 100 to 300 times background levels have been recorded downstream of building construction sites. High concentrations of suspended sediments in rivers discourage fish migration and spawning and destroy habitats for aquatic macrophytes. The branch probabilities of the event tree (see Appendix 2-1) describe the pathways of sediment transfer from the construction site into the surface water.

Specific Assumptions Made

Several assumptions were made, including:-

- various simplifications arising from the soil erosion model have been used.
- expert opinions have been used to determine the amounts of sediment derived from bank disturbance, wind erosion and from site vehicles.
- the average sediment trapping efficiency of control structures has been set at 75 % (with a range of 50 % to 100 %).
- an assumption has been made that the mean daily flow dilutes the eroded sediment.

Results

Appendix 2-1 details the sediment event tree. Most sediment (88 %) is incorporated into the ground works of the road but suspended sediment discharges can impact considerably on surface water quality, in particular when intense storms coincide with periods of lower summer flow. Sediment enters surface waters due to high runoff during high intensity rainfall events, wind erosion mostly during dry periods, disturbance of the stream banks during the construction of culverts and bridges and through the drainage system of off-site roads. Under average conditions the final suspended sediment concentration in the river may be three times the EQS. Road construction discharges may be fourteen times the EQS for suspended sediment concentrations in drinking water.

Implications

There are reported experiences from around the Environment Agency of construction sediments from roads impacting the downstream channel, sometimes from considerable distances. The risk assessment confirms these observations. Depending on the timing of these releases, there can be several impacts on downstream ecology, including fisheries interests. In terms of management options, this may mean that more consideration be given to mitigating or managing sediment runoff from construction sites and that the timing of particular construction activities be prescribed.

3.5 The Potential For Flooding Due To Road Construction

Scenario Modelled

Water runs off impermeable surfaces such as roads far faster than from areas such as grassland. Consequently the hydraulic characteristics of the floodplain are altered, posing a potentially greater flood risk to areas both upstream and downstream. This can result in financial loss and trauma. In addition road construction can increase sediment deposition, with a temporary loss of channel storage. The scenario considered here is for increased flooding and the effects of channel erosion.

Specific Assumptions Made

Several assumptions were made, including:-

- the threshold for erosion has been assumed to be equal to the average standardised Q_{10} discharge.
- the bankfull discharge has been assumed to be equal to the average standardised Mean Annual Flood (MAF) from the rivers database.
- it has been assumed that the thresholds remain the same immediately following a road development.
- an assumption that road building will increase runoff volumes and river discharge, and reduce the time of concentration, has been made.
- a low probability (of 0.05) has been selected for the use of floodplain storage.
- most stored water on the floodplain has been assumed to discharge back into the river channel at a safe velocity.
- the relative costs of flooding on different land use types have been estimated by applying damage scores and examining the costs of flooding for a range of flows using a flow frequency distribution.

Results

The event tree included in Appendix 2-2 depicts the risks of flooding due to road construction. In urban areas an increased road area may significantly increase both the magnitude and frequency of flooding. For specific cases there may be a lesser or greater risk of flooding depending on the detailed engineering design. Following urban flooding, in decreasing order of significance, are scouring and erosion, flooding of high quality agricultural land, flooding of other land uses, and failure of storm storage structures. New road building in any area is unlikely to result in an increase in road area by more than 0.5 to 1 % for any catchment but the peak discharge may increase by up to 12 %.

Implications

Environment Agency staff concerned with flood defence have been aware of the potential impacts of existing and new roads on peak discharges, particularly significant in urban areas. This risk assessment supports that experience. Any new roads proposed for urban areas may have to be critically appraised in the future. Ironically in most urban areas there is limited space available at a site on that to build flow attenuation devices. One possible option is the continued need for catchment hydraulic modelling, and the possible contribution by road developers to attenuation in the upstream catchment where appropriate.

3.6 The Potential For Sensitive Habitat Loss From New Road Construction

Scenario Modelled

Whenever a new road is built, or an existing road widened, land is removed from its previous use and converted to a man-made form that cannot sustain any significant biodiversity and usually has a negative effect on the biodiversity of the adjoining habitats. The assessment made use of road schemes being considered by the DETR for construction over the next few years. Wales is excluded from the analysis because the data collected covered only England. The scenario modelled is specifically for the potential for sensitive habitat loss.

Specific Assumptions Made

- predictions of the future extent of habitat loss were uncertain: the approach has been based on an estimate of the area of green and brown field landtake that may arise in the next year in different regions of England, and to compare this to the total area of landtake of this type arising from other development activities.
- the level of impact on designated conservation sites was obtained by correlating the density of the designated sites within each region to the level of road development within the region. This provided a good indication of the relative pressure to that the designated sites in each region are exposed due to road construction.
- in the absence of specific regional data listed buildings and archaeological sites were assumed to be relatively evenly distributed throughout the country.

Results

The example given in Appendix 2-3 to 2-7 is for the impact of habitat loss on designated sites. If 100 % of the schemes reviewed by DETR were to proceed then landtake would be greatest in the South East (801ha), Yorkshire and Humberside (559ha) and North West (480ha). There is considerable variation in the area (and number) of designated conservation sites (Ramsar, SAC, NNR, SSSI, National Parks, AONB, World Heritage Sites, SAM, Grade II Listed Buildings and Sites of Archaeological significance) in different regions.

Implications

The methodology provides a framework for assessing the cumulative impact for any specific combination of road schemes so that where the combination of schemes is well defined their impact in terms of landtake and development pressure can be determined. It may provide a useful tool for input to Regional Planning Guidance and the Environment Agency's own Regional Sustainability Plans

3.7 Water Quality Impacts Of Road Maintenance

Scenarios Modelled

Road maintenance covers a broad number of activities, ranging from repair of carriageways to winter operations intended to keep roads free from snow and ice. The clearing of gully pots has been selected as the procedure to be considered in the analysis, principally because it is cited as causing local pollution events. The event trees (see Appendix 2-8 to 2-9) are based on:-

- the quantities of ammonia discharged through gully pot outlets per hectare during a four hour period;
- the presence of filters/treatment processes or infiltration ducts/soakaways in the drainage system; and
- dilution in the receiving river.

Specific Assumptions Made

- Assumed 80 to 140 gullies cleaned per day (Osborne et al, 1998).
- Assumed that the area of road served by a gully is $200m^2$ (Luker and Montague, 1994).
- The capacity of a vacuum tankers has been taken to be 4,000 to 8,000 litres (Osborne et al, 1998).
- A value of 1:2 has been taken to be the ratio of vacuum tanker capacity between clean water and black water (Osborne et al, 1998).
- 10 litres of water has been assumed to be discharged during backwashing of gully pots with black water when discharge occurs (Osborne et al, 1998).
- $16mgl^{-1}$ ammonia (as nitrogen) concentration has been assumed to be in discharge from gully pot during backwashing with black water (Osborne et al, 1998).
- Volume of water discharged during backwashing of gully pot when airbag or jetter employed has been assumed to be zero (Osborne et al, 1998).
- 45 litres of water has been assumed to be discharged from gully pot during refilling (Osborne et al, 1998).
- $3mgl^{-1}$ ammonia (as nitrogen) concentration has been assumed to be in discharge from gully pot during backwashing with clean water (Osborne et al, 1998).
- 50 to 100 litres of water and sediment has been assumed to be present in each gully pot (Osborne et al, 1998).
- 0.5 taken of the total capacity of a gully pot by sediment (pers.com., 1998).
- 1,880 litres of black water has been assumed to be in full tanker when clean water used to refill gully pots (expert opinion).
- 200 litres black water has been assumed to be in full tanker when clean water used to refill gully pots (expert opinion).
- $16mgl^{-1}$ concentration of ammonia (as nitrogen) has been assumed to be in black water from tanker (Osborne et al, 1998).
- 24 % ammonia removal has been assumed during filter or treatment process (Nuttall et al, 1997).
- 20 % water removal has been assumed during filter or treatment process (Nuttall et al, 1997).

- 15 % ammonia has been assumed to be removed during infiltration or soakaway process (expert opinion).
- 10% water removal during infiltration or soakaway process (Nuttall et al, 1997).

Several assumptions were also made about the mixing of the discharge into surface water and river discharge:-

- the load of ammonia per hectare entered the river over a four hour period; and
- the area of the road surface was equal to 1.78 % of the catchment area (an average for England and Wales, based on British Road Federation, 1990).

Results

The event tree (see Appendix 2-8 to 2-9) traces the volume of water and mass of ammonia until they are discharged into surface water or groundwater, or removed from the system. The results indicate that the volumes of water discharged during refilling of a gully pot and during backwashing with black water are the most important parameters in determining the concentration of ammonia in the discharge. For the flow required to meet the EQS by far the most important parameters are the four hourly discharge in the receiving water and the background river concentration. The study concluded that the probability of the concentration of ammonia in the river meeting the EQS was just under 0.9, demonstrating that it is unlikely that the EQS will be exceeded except for very small watercourses.

Some Implications

Whilst it is unlikely that for ammonia concentrations the EQS will be exceeded in the majority of cases, it is almost certain that in those places where it will be exceeded (e.g. small streams and ditches) traditional thinking will have meant that interceptors will not have been installed at these points of discharge. On some roads, for example in upland England and Wales, where the drainage density is high, then there may be tens if not hundreds of crossings of smaller watercourses by a specific road. The precise impact will depend on the catchment size and the threshold for the critical flow will vary accordingly. For example, in a small catchment of 50 km^2 the critical river flow below that the EQS will not be met is likely to be in the range 0.01 to 0.18 cumecs. It may be necessary to consider the installation of interceptors at points of discharge to these smaller watercourses. Streams high up in the headwaters of a catchment are those that contain a stock of flora and fauna for colonisation downstream. This approach could also be used to derive critical rivers flows for other substances.

3.8 Water Quality Impacts Of Road Runoff

Scenario Modelled

As water runs off roads it takes with it many pollutants including oil and tyre residues and heavy metals. The scenarios modelled have been for three heavy metals: copper, zinc and lead. Copper and zinc are widely used in the car industry, for car bodies and parts such as brake linings and tyres. At low concentrations copper is highly toxic and zinc is the most important heavy metal in terms of its contribution to total load. Lead levels are less than in the 1970's and 1980's due

to the uptake of lead free petrol and consequent reduction in lead deposits on road surfaces. Appendix 2-10 contains an example event tree for zinc metal loads.

Specific Assumptions Made

Significant assumptions and uncertainties in the method include:-

- a general model of the water balance for roads in England and Wales has been adopted. The worst case, in terms of concentration of any pollutant, has been included in the analysis.
- the mean annual precipitation has been considered to be normally distributed with a standard deviation of 88 mm to account for the large regional variations.
- detailed data on the total numbers of different drainage structures in roads in England and Wales were not available.
- it has been assumed that the pollutant load had a log normal distribution.
- it has been assumed that pollution loads increased linearly with traffic volume.
- it has been assumed that routine maintenance of gully pots and drains only removed 90 % of sediment, with the remaining 10 % being washed into the drainage system.
- an estimate that gully pots are used on 70 % of roads in England and Wales has been used (ie. giving a probability of 0.7).
- it has been estimated that filter drains or French drains are used on only 20% of roads in England and Wales.
- % of the existing road network has been assumed to have surface water channels (ie a probability of 0.2).
- 20 % of roads have been assumed to have soakaways.
- in calculating final river concentrations several assumptions were made

Results

The results of the event trees represent a generalised description of heavy metal pollution arising from road runoff in England and Wales. For each heavy metal about 43 % of the deposited heavy metal load is discharged to surface water, 5 % is discharged to groundwater, 27 % is removed from the drainage system and the remaining 25 % is deposited on the land adjacent to the road surface. The dominant pathway for heavy metal pollution is road runoff through gully pots directly into surface waters. The metal concentrations discharged via this pathway will normally exceed the EQS for both drinking water (EEC, 1975) and freshwater fisheries. In particular cases the road runoff concentrations may be higher or lower than the range of values predicted by the event trees. The final river concentration is most sensitive to river discharge, highlighting the vulnerability of rivers during low flow conditions. This period is likely to coincide with the highest loadings in the summer when intense rainfall events transport large pollutant loads that have accumulated during antecedent dry periods. High copper loads represent the greatest risk of heavy metal pollution in surface waters.

Implications

These findings potentially have substantial implications for the Environment Agency throughout England and Wales. Options that might be explored in the next phase of the risk assessment include furthering the work on establishing the effectiveness of wetland basins for attenuation of runoff and root zone techniques. Although these are not considered directly in the event trees they will behave in a similar manner to soakaways and grass swales/ditches. Although the technology is in its infancy a few wetland basins have already been installed along new road developments at the behest of the Environment Agency as a matter of precaution. It is clear that in each case a substantial; parcel of land adjoining the new road has had to be earmarked for the wetland basins. Experience has demonstrated, at least partially, the effectiveness of such structures in removing heavy metals. Up to 94 % suspended sediment can be filtered under regulated flow conditions.

3.9 Water Quality Impacts Of Accidental Spillages

Scenario Modelled

Accidental spillages of substances can range from industrial products such as motor spirits, chlorine and ammonia, to foodstuffs such as milk or beer. All have the potential to cause environmental damage. Modern motorways, trunk roads and principal roads are designed with safety valves that can be operated to prevent pollution incidents arising from such accidental spillages.

The example given is for an event tree constructed for motor spirits carried in road tankers and is based on:

- the likelihood of an accidental spillage occurring;
- the probability of a rain day; and
- the likelihood of the existence of pollution control structures such as control valves and storage ponds.

Specific Assumptions Made

- An incident frequency per tanker km for motor spirits tankers of 2.1×10^{-8} (Health and Safety Commission, 1991) has been employed in conjunction with the loaded tanker distance for 1994 of 1.29×10^{8}km (Health and Safety Executive, 1994) to obtain an incident frequency per year of 2.71.
- The probability of containment of the pollutant has been estimated as one minus the probability of a rain day, that is 0.55. For Monte Carlo analysis, a range of 0.4 to 0.5 with a normal distribution has been assumed for the probability of a rain day. Assumptions have also been made for atmospheric and infiltration losses of motor spirits.
- Since there is no available data on the effectiveness of drainage structures in accident situations, it has been assumed that runoff either enters a soakaway or surface water. Soakaways are estimated to be present on 20 % of roads in England and Wales and a probability of 0.2 has been employed (Luker and Montague, 1994).

- Only a portion of major roads have pollution control measures such as stop valves and oil filters. For the purpose of analysis, a probability of 0.15 has been assumed. For Monte Carlo analysis, a range of 0.05 to 0.25 with a normal distribution has been assumed for the probability of a safety valve being operated.
- A probability of 0.1 has been assumed for the presence of an oil trap. It has been assumed that 50 % of oil entering a filter is removed from the drainage system. A range of 0.4 to 0.6 for the removal of oil has been assumed for Monte Carlo analysis. An estimated probability of 0.1 has been assumed for diversion of pollutants to a storage pond.

The event tree for spillages is shown as Appendix 2-11.

Results

The event tree demonstrates that by far the most important parameters determining the mass of motor spirits entering a watercourse are the probability of a rain day and the presence of a safety valve. Under existing conditions an accidental spillage of motor spirits of greater than 15kg will always lead to a pollution incident in the receiving watercourse.

Some Implications

There are obvious management implications of these findings, not least the fact that only a relatively small proportion of roads have pollution control measures such as stop valves and oil filters. As part of the ongoing liaison with the fire brigade, a threshold of 15kg may be an appropriate trigger for the accident services to contact the Agency. The precise options for helping to minimise the effect of road transport-related incidents on water quality will be determined during the next phase of the project and could range from recommendations for improvements along specific roads throughout England and Wales, to changes in future policy.

3.10 Global Climatic Change Impacts Of Road Traffic In The UK

Scenario Modelled

Carbon dioxide is one of the principal greenhouse gases contributing to global warming. The scenario modelled concentrates principally on carbon dioxide (CO_2). Other greenhouse gases emitted from vehicles, such as nitrous oxide are also included, but in less detail.

Specific Assumptions Made

- Key assumptions have been made, including the emissions factors for petrol cars and kilometerage.

Results

Vehicular emissions account for about 20 % of the total UK contribution to global warming, of that 93 % arise from carbon dioxide. The estimate of total vehicular emissions is between 34.5 and 36.3 Mt. Breaking down the vehicular contribution of CO_2 it can be seen that about 20 % arises through motorway driving, 46 % due to urban driving and 34 % non-urban driving. Petrol cars are by far the most important source of vehicular greenhouse gas emissions, accounting for over 50 %. Petrol cars emit more CO_2 per km than diesel. In total, cars account for about 62 % of vehicular greenhouse gas emissions, goods vehicles about 34 % and coaches 4 %.

Implications

The potential for global warming as a direct result of CO_2 emissions from road vehicles is increasing. It is important to note the significance of vehicular greenhouse gas emissions compared to non-vehicular. This could have a key implication when considering integrated transport policy. Technological advances, for example, the manufacture and use of cars driven by fuel cells, could potentially reduce CO_2 emissions.

3.11 Air Quality Impacts Of Road Traffic

Scenario Modelled

Road transport is widely regarded as a major contributor to poor urban air quality. It is a significant source of a number of air pollutants including oxides of nitrogen (NO_x), volatile organic compounds, carbon dioxide (CO_2), carbon monoxide, particles with a diameter of less than 10 micrometres (PM_{10}), and lead. These pollutants have a range of impacts acting both singularly and synergistically on human health, soils, vegetation, buildings and freshwater. The effects may result from direct exposure or through wet and dry deposition of primary and secondary pollutants. The particular focus of this study is the human health effects arising from PM_{10}. Specifically, the event trees address the environmental pressures created by road transport by evaluating emissions of PM_{10} from different traffic sources. Detailed evaluation of the contribution of road traffic emissions to exposure and subsequent impacts requires complex exposure modelling involving examination of the concentration and time to that individuals are exposed to a pollutant in different micro-environments and the proportion of emissions arising

from each source. This is a complex procedure that, given the uncertainties in available data, has not been applied in conjunction with the event tree approach prescribed for this project.

Specific Assumptions Made

Several assumptions are made, including those concerning the reliability of data. Key points are:-

- it has been assumed that exposure to, and therefore the impact of, PM_{10} is directly proportional to the annual average UK emissions. In practice the extent to that traffic related PM_{10} emissions are responsible for health outcomes is variable. For example, in London traffic accounts for up to 77% of PM_{10} emissions.
- there is considerable uncertainty in non-vehicular PM_{10} emissions since there are few measurements of emissions from processes.
- it has not been possible to determine reliably the overall uncertainty in, for example, cold start emissions, emissions from tyres and emissions from road dust re-suspension, and therefore expert judgement has been employed.
- Analysis is done in terms of mass of PM_{10}, this is the Government measure but has potential to be misleading:-

➢ The three identified sources of PM_{10} will have very different chemical properties. Those from an exhaust emission origin will contain Polyaromatic hydrocarbons (PAHs) and other products of the combustion process. Those from tyres will effectively be micronised tyre crumb, chemically vulcanised rubber and tyre compound fillers. Those from brake dust will contain amongst other things metals such as iron and copper. Such materials with very different chemical make-ups will almost certainly cause different health problems.

➢ No account is taken of particle size and shape. Health effects may be more dependent on numbers of particles and their potency will be influenced by shape (needle shaped particles will travel and lodge themselves in the air ways of the lung in different places to spheres).

Results

Appendix 2-12 presents an outline event tree for the air quality impacts of PM_{10} on human health. The first branch of the event tree distinguishes vehicular from non-vehicular PM_{10} sources in the UK. Primary vehicular emissions are from exhausts, brakes and tyres, whilst secondary vehicular emissions include road surface dust re-suspension and secondary PM_{10} formation. The methodology has been found to be of particular value in the assessment of emissions of PM_{10} and the uncertainties associated with these estimates. However there were considerable difficulties in linking these emissions to impacts since the effects of air pollution are dependent on the concentration and duration of exposure, and not directly to the amount of PM_{10} released to air. As far as emissions of PM_{10} are concerned:-

- HGV's contribute 41 % of total vehicular PM_{10} emissions but only account for 6 % of total kilometerage.
- petrol cars are responsible for 22 % of total primary emissions that is more than diesel cars (15 %). NB: 82 % of the vehicle kms driven are by petrol cars.
- buses and coaches account for 10 % of vehicular emissions, but emissions per passenger are considerably lower than for cars.
- knowledge of vehicular emissions from stationary sources is very poor.
- improved knowledge of dust re-suspension from the road surface will provide an improvement in knowledge of vehicular emissions of PM_{10} followed by HGV emission factors.
- the vehicular contribution to secondary particulate nitrate may be very significant.
- the proportion of non-vehicular PM_{10} emissions is a skewed distribution likely to be in the range 16 to 59 %, for that the most likely estimate is 30 %.
- overall the UK emissions of PM_{10} are between about 100 and 350 kt of that vehicular emissions are between about 50 to 70 kt.
- PM_{10} is likely to result in about 11,000 premature deaths and 14,000 hospital admissions in the UK, with the vehicle contribution to these being highly uncertain (cf. Department of Health, 1998).

Implications

It should be possible to determine how different management strategies will affect the level of emissions. The fact that PM_{10} emissions from traffic vary geographically, and that secondary PM_{10} can be significant in episodes of poor air quality, may also have an important bearing on the precise way in that the Environment Agency approaches regulation of sources of non-vehicular PM_{10} emissions.

Particle size, shape and chemical make-up was not considered in the analysis, primarily because it was not practical to do so. Clearly this type of study should be done subsequently: particle size is of sufficient concern to warrant more work.

3.12 Water Quality Impacts Of Leachate Arising From Landfill Waste Vehicle Components

Scenario Modelled

The majority of end of life vehicles (ELV's) can be recycled to some extent. It is the remnant material that is shredded to pieces typically less than 100mm in size. Extraction systems are used to separate the shredded material into three products: ferrous metal, a non-ferrous metal heavy fraction (predominantly non-ferrous metals and rubber) and a light reject fraction (foam, wood, plastic, glass, stones and fine dirt). The majority of the metal is recycled and it is only the residue that is disposed of to landfill. There is the potential for concentrations of pollutants from the landfill disposal of shredder residue to be discharged as liquid to groundwater. The scenario modelled looks at iron, cadmium, mercury and PCB's.

Specific Assumptions

Several assumptions have been made in order to calculate the concentrations of each component of the shredder residue from vehicles within the event tree:-

- best practice landfilling was assumed, as detailed in Waste Management Paper (WMP) 26B (Department of the Environment, 1995) that relates to capping and liner quality and hence influx and efflux of water and leachate;
- a worst case scenario has been assumed in calculating an initial concentration in the leachate: it is implied that all the components in the waste is entirely soluble in forming the leachate;
- it was assumed that the volume of rain infiltration into the site over a 100 year period would solubilise all the components, with the consequent volume of leachate used in calculating the initial concentration of the component in the leachate; and
- information on the mass of vehicles disposed of to landfill is scant and a range on the data has been calculated from the range of total shredder residue to landfill and the likely range of percentage of vehicle residue in that material.

Results

The event tree indicates that the concentrations of iron, cadmium, mercury and PCB's arising from the landfill disposal of shredder residue of ELV's are expected to be very low and significantly lower than the appropriate EQS's or other guidance. This is even before dilution in the environment is taken into account. In practice the other (majority) component of waste in the landfill will add significantly to the concentrations derived in these event trees.

Impiications

The low potential risks arising from shredder waste depend on effective risk management, based on best practice for landfilling. The move towards further recycling and reuse are welcomed. There are areas where waste disposal causes concern to the Environment Agency, such as breakers yards and the disposal of tyres. However, these were not considered as part of this study.

4. OPTIONS APPRAISAL

In addition to the Government publications detailed earlier in this report, there has been a considerable amount of literature published on the subject of transport in the last two to three years, including books, journal articles and newspaper reports. Most relevant professional bodies have published their own views on the problem and many have voiced opinions on what should be done about it. For example, the Institute of Highways and Transportation is about to publish in the year 2000 a book describing environmental impacts. There has also been much discussion in *'Planning'* about the design and management of town centres. Many of the options are within the Government's remit, such as road user and workplace parking charges, and have societal as well as political implications.

4.1. Approach To Options Appraisal

At a detailed level options appraisal entails understanding the relative merits, costs and implications of the options available for environmental management, enabling the Agency to make better and informed decisions. It is also important for the Agency to assess emerging technology and techniques as they may affect the way in which future policies and practices are framed. The Agency also has a duty to consider the costs and benefits of the decisions it takes.

The process itself should start with the identification and screening of options and then (if appropriate) subsequently involve identification, prediction and assessment of environmental, economic, social and technical implications of options. After this stage a trade-off analysis of the options may be undertaken, involving techniques such as analysis of costs and benefits, multi-criteria analysis, multiple attribute techniques and sustainability appraisal (Environment Agency, 1998g). The process of options appraisal is inevitably iterative from start to finish and should involve an appropriate level of participation and dialogue. It is also important that the options appraisal is fit for the purpose in hand and proportionate to the scale of the problem under investigation.

4.2 Agency Approach To Road Transport Issues

As well as providing a useful platform from which to consider options, the risk assessment described in this report was relatively pioneering and inevitably developmental in its approach. It was decided in 1998 within the Agency that to run through the full options appraisal process (described in the previous section) for road transport issues, solely for purposes of developing appraisal tools and techniques, would be inappropriate and the funding initially set aside was withdrawn. The reasoning for this was threefold. The majority of options for road transport are obviously not directly within the Agency's remit; many options have been or are currently being developed/ evolved by a large number of Government, non-government organisations, academic and other institutions; and the conceptual challenges for trading-off options for road transport are enormous.

It was originally planned that the event trees (Chapter 3, Appendix 2) should be refined and then employed in the assessment of risk management options. Whilst appreciating the importance of iterating the process (eg. Department of the Environment, 1995), as explained previously this was

not possible due to Agency constraints. Furthermore it is often difficult to obtain information on costs (for technology options, for example) because the information is often 'commercial in confidence'. The work undertaken and reported in Chapter 3 therefore represents only a first iteration of the quantitative risk assessment. The impacts of particular risk reductions measures were therefore not modelled. Nevertheless the results provided a number of valuable pointers for further investigation and these were carried through to the options appraisal stage. Each branch of a tree provided an opportunity.

In view of these limitations and assumptions the approach taken to the appraisal of options concentrated on screening. In particular an Agency brainstorming was undertaken in 1998 and a matrix drawn up to screen options on various criteria. The matrix was based on the same issues identified as part of the original 'Risk Profile' in 1997. The options ranged from improvements in technology, education and economic instruments, to new, or changes to existing policies. The options covered the span of decision-making from project to policy levels. Tables 4.1 and 4.2 summarise the results of the brainstorming exercise.

The criteria used for narrowing down the range of options (screening) included the relative importance of the issue to Society, formal Agency remit (as opposed to non-formal) and potential for prevention/ mitigation. It was felt particularly important to concentrate on the Agency remit to avoid duplicating the substantial work on options being investigated by other organisations. This was a qualitative process and the results are summarised in Table 4.2. The issues/options are categorised in terms of whether the Agency already has a direct impact on decision-making (shown black), an indirect influence (shown medium grey) or where there is potential for further Agency involvement/ improvement (shown red). Even in those areas where the Agency is directly involved it was felt that there may be opportunities for review and improvement. Table 4.3 provides some comments/observations on key options discussed as part of the brainstorming. Building on the screening exercise, since 1998 the Environment Agency has been involved in several initiatives concerned with transport and a number of reports has been produced (shown bold in Figure 1.1) or are currently in the final stages of preparation (shown italic).

4.3. Policy Options

In terms of policy options many of these are the direct responsibility of central Government, including the need to switch fuel types, tighter emissions and the potential shift from private to public transport. In parallel with Highways Agency policy on road construction and road runoff, the Environment Agency has developed approaches intended to minimise environmental impacts at sites. It also has specific guidance on source control related to flooding. The risk assessment provided pointers to where further collaboration on policy issues could be undertaken by the Environment Agency. For accidental spillages there could be specific liaison with the fire service to raise awareness of the environmental risks identified in this report, and with the Highways Agency in constructing adequate mitigation devices. With regard to the findings related to road maintenance risks there could be greater dialogue between the Environment Agency and the Highways Agency/ local authorities. The Agency has also contributed to work on scenario building, such as that carried out by the Cities and Transport Group of the Chatham House Forum (1999-2000).

Table 4.1. Road transport and the environment: preliminary screening of options

Sources of Risk	Options Issue	Policy	Programme	Planning	Project	Technology	Education/ Influence	Economic
Road use	Air Quality/ Emissions							
Road use	Climate Change/ Emissions							
Road use	Accidents and Spillages/Water Quality							
Road Construction	New road construction							
Road Construction	Road maintenance/ Water Quality							
Road Construction	Road Runoff/Water Quality							
Road Construction	Flooding							
Road Construction	Habitat loss From quarrying							
Road Construction	New road construction							

4.4 Programme Options

The Agency was involved in partnership with other Statutory bodies in developing key Government initiatives for roads, multi-modal transport and airports. Through this work, the Agency had an indirect influence on, for example, the number of roads built in the short term. Obviously the decision on the numbers of roads built was ultimately a Government one, dependent on a wide range issues.

4.4.1 Roads Review and New Approach to Appraisal (NATA)

The Government's key objective in undertaking the 'Roads Review' was to develop a clear and open framework to appraise and inform the prioritisation of trunk road investment proposals. To achieve this objective a 'New Approach to Appraisal' (NATA) was developed. This was designed to be broadly based and provide assessment information to decision-takers on five criteria: accessibility, safety, economy, environment and integration.

An important element of the new approach was the inclusion of an 'Appraisal Summary Table' (AST). This is a one page tabular summary of the main economic, environmental and social impacts of the scheme (Figure 1.2). This simple and concise summary does not make judgements about the relative values put on the criteria, but summarised the main effects on each area so decision takers have a clearer and more transparent basis on that to make those judgements.

The five main criteria used in NATA were divided into several sub-criteria. The environmental sub-criteria include: noise; air quality; landscape; biodiversity; cultural heritage, and water. The four statutory bodies (Countryside Agency, English Nature, English Heritage and the Environment Agency) were responsible for preparing guidance on the last four of these sub-criteria, respectively.

Figure 4.2. Appraisal Summary Table (AST)

Proposal name		**Option description**		
PROBLEMS		*Statement of problems*		
OTHER OPTIONS		*List of other options that have been, or could be, tested.*		
OBJECTIVES		**QUALITATIVE IMPACTS**	**QUANTITATIVE MEASURE**	**ASSESSMENT**
ENVIRONMENT	**Noise**		No properties experiencing: - Increase in noise xxx - Decrease in noise xxx	Net xxx properties experience *higher* noise levels
CO_2: **xxxx tonnes added or removed**	**Local air quality**		No, properties experiencing: - better air quality xxx - water air quality xxx	+/-xxxPM_{10} +/-xxxNO_2
	Landscape		Not applicable	*Moderate adverse*
	Biodiversity		Not applicable	*Neutral*
	Heritage		Not applicable	*Moderate beneficial*
	Water		Not applicable	*Large adverse*
SAFETY			Accidents Deaths Serious slight xxx xxx xxx xxx	PVB £xxm xx% of PVC
ECONOMY	**Journey times & Veh. Op. costs**		Trunk road journey time savings: peak xxx mins; inter-peak xxx mins	PVB £xxm xxx% of PVC
	Cost		Not applicable	PVC £xxm
	Journey time reliability		Stress on key trunk road link: Before xx%; After xx%	*Moderate beneficial* *Small rel.* to PVC
	Regeneration		Serves regeneration priority area? Development depends on scheme?	*Yes* *No*
ACCESSIBILITY	**Pedestrians and others**		Not applicable	*Slight beneficial*
	Access to public transport		Not applicable	*Moderate beneficial*
	Community severance		Not applicable	*Large adverse*
INTEGRATION			Not applicable	*Positive*
Version of date		**Cost benefit analysis:**	PVB £xxm PVC £xxm NPV £xxm BCR xx	

The Agency's remit was subsequently to appraise the impacts on the water environment from the 74 schemes in the trunk road programme. The National Centre, in consultation with Regional and Area offices, reviewed the potential severity of the impacts of these schemes and produced a methodology to carry out a consistent appraisal and complete the AST (Appendix 3).

The Agency adopted a risk-based approach for the water sub-criteria (see Appendix 3). This approach enabled the potential for environmental harm to be highlighted, thereby emphasising the importance of a correctly formulated and implemented mitigation strategy. This placed the onus on the developer, in this case the Highways Agency, to show that the potential environmental impacts could be adequately controlled and to commit to an agreed mitigation package. It also made clear the extent to which impacts on the water environment could be controlled when they were considered early in the road design process. The need for this precautionary approach was endorsed by discussions with Regional and Area staff and the finding of the Agency's R&D project that considered past experience with highway schemes.

The Agency played an important role in the development of NATA and the AST (see DETR 1998a: b; Environment Agency (1998d, 1999a) and this provided a unique opportunity to work closely with DETR and the other statutory bodies. The attempt to integrate the appraisal of economic, social and environmental factors for decision takers was a key feature of the approach. This was pioneering within Government in the UK.

The methodology and output of the Roads Review were published as part of the Government's White Paper on Integrated Transport (DETR, 1998c). It resulted in a dramatic reduction in proposed road building in England and Wales, with several schemes withdrawn from the programme and some to be considered as part of multi-modal corridor studies (Ove Arup, 1999). It is also quoted in the Government's Strategy for Sustainable Development 'A Better Quality of Life' as a good example of appraisal (DETR, 1999).

DETR use the NATA framework for all new trunk road investment proposes (except maintenance) and for those currently in preparation. The main users of NATA are the Highways Agency (including their consultants), local authorities and private road developers. The National Centre has contributed to training of these practitioners at the invitation of the Government. NATA is used to produce an AST at various key stages during the road planning process. It is imperative to the assessment of impacts on the water environment that these groups liase closely with the relevant Environment Agency Region/Area. The Agency's role is to assist in the provision of baseline data on the sensitivity of the receiving environment and to provide expert advice during the development of impact mitigation strategies. This does not change the normal regulatory and advisory role fulfilled by the Agency in relation to road schemes.

4.4.2 Development Of NATA For Multi-Modal Transport

The DETR consider the approach to the Roads Review as one of the best examples of the use of multi-criteria appraisal techniques in the UK. The principles of the existing NATA framework were developed by DETR's consultants (MVA Ltd in association with the Institute of Transport Studies University of Leeds, Environmental Resource Management, David Simmonds Consultancy and John Bates Services). This enabled the appraisal to be used for any transport mode, or combination of modes (not only road proposals), and at a more strategic level.

The National Centre, along with the other statutory bodies, were consulted on the new guidance by DETR. To accommodate the increased breadth of the new guidance, the Agency adapted its appraisal methodology, to increase flexibility. This new methodology used the 'Environmental Capital' approach, developed jointly by the statutory environmental bodies including the Agency. Environmental Capital looks at the environment from the perspective of the services it provides rather than purely on the basis of measurable features. This means that, in addition to quantitative data, factors such as scale, rarity, and substitutability are considered when determining importance.

Guidance on the Methodology for Multi-Modal Studies (GOMMS) was produced (DETR, 2000b). Appendix 4 is the contribution to GOMMS by the Environment Agency, summarising guidance for assessing the water environment. Appendix 4 provides a systematic framework for the objective descriptive definitions of the extent of the likelihood of the impacts arising and the significance of the potential consequences based on the Environmental Capital approach. It proved a challenge to assess the impacts of strategic options (rather than specific schemes) on account of their wider scope and associated uncertainties.

The first tranche of multi-modal studies, from those identified in the Roads Review, went out to tender during 2000. When these studies get underway, the Agency's Regional and Area offices are likely to be contacted to supply baseline information on the areas concerned. The analysis of these studies should result in the identification of more integrated options to solve transport problems, not just roads schemes, and the screening out of the potentially most environmentally damaging options.

4.4.3 Guidance On The Strategic Environmental Assessment Of Multi-Modal Transport Studies By The Highways Agency.

In addition to the work by DETR, the Highways Agency initiated a project during 1998 to provide more detailed guidance on the environmental assessment of multi-modal transport studies. This guidance was completed for the Highways Agency by the Transport Research Laboratory (TRL). Such guidance was considered necessary because the Highways Agency's published Design Manual for Roads and Bridges (DMRB) Volume 11 only applied to road schemes at a project level.

The Environment Agency, represented by the National Centre, along with the other statutory bodies, were represented on the steering group for the project and had an opportunity to comment on a draft Interim Guidance Note on the Strategic Environmental Assessment of Multi-Modal Transport Studies earlier in 1999. A revised version of this guidance was received in late 1999 for further comment, prior to publication of a Volume 11a of the DMRB on SEA. A project was also initiated to revise the existing DMRB Volume 11 covering the project level (to be DMRB Volume 11b),(Environment Agency, 2000c).

The preparation of guidance on SEA and the subsequent revision of the DMRB Volume 11 provided a very important opportunity for the Environment Agency to influence the environmental assessment of transport studies and projects. While the DMRB Volume 11 was a considerable improvement on the previous manual, there are several improvements that could be made. Some of these were identified in an Agency R&D project on highways (Environment Agency, 1999h).

4.5 Planning Options

There is obviously considerable scope here for the Agency to continue to influence through the planning process, whether this is at local or regional levels. The Agency already invests considerable monies in its own Local Environment Agency Plans (LEAPs) and is involved in commenting on Regional Planning Guidance (as well as the sustainability appraisal of that guidance). Existing guidance relating to flooding and road runoff should continue to be applied, but it is possible that specific comments relating to the air quality and particularly the climatic change implications of road transport could be made. For example, the need to exclude traffic from high emission areas. An example of recent work is that of 'Greenprint for London', whereby Thames Region have attempted to influence the Mayoral Strategies for the Greater London Authority, (Environment Agency, 1999b). The Agency should take every opportunity to make sure that the climate change issue arising from road transport is not forgotten. Further specific work could be done in informing the planners of vulnerability maps for groundwater and surface water (where they exist).

4.6 Project Options

For each road project there should be a full appraisal and this should enable the Environment Agency to become involved as appropriate. In terms of the issues of road construction, flooding and road runoff there is already an ongoing input. This risk assessment has flagged up the significance of the separate issues of accidental spillages and road maintenance, both of which require appropriate on-site mitigation/ practices. There is also a need to review existing options as roads are repaired.

Table 4.3 Some Commentary on Options

Air Quality	Any alternative technologies to alleviate air quality problems are likely to have both positive and negative impacts. PM_{10} by mass is just one measure: particles (type, size and shape) may be very significant in terms of health effects Tighter controls over MOT emissions is a first step. There are particular air quality issues in urban areas: park and ride may be a solution. However, there is the arguably more difficult option of changing attitudes and behaviours
Climate Change	Options include technology to reduce CO_2, NOx emissions eg. liquid petroleum gas (LPG), fuel cells etc. However, there are likely to be both positive as well as negative impacts (eg fuel manufacture). There is also the argument put forward by road builders that more roads lead to less congestion and therefore improved vehicle efficiency
Accidental spillages	Accidental spillages of a large number of substances can occur, not just petroleum spirit. The Agency does not have direct control in the sense that it is not a 'blue light' service. The costs of clean up can be large/eg £50k to £100k for a diesel spillage. It is important that planning takes account of potable water sources and groundwater vulnerability maps published by the Environment Agency.
Road Construction	Construction is often problematic particularly if there is no sediment trap. Sufficient land take for mitigation should be considered at the planning stage. The level of fines for pollution incident are currently set very low: consideration should be given to increasing this level.
Road Maintenance	The Agency's regulatory role might be regarded as heavy handed and unhelpful in this instance. There is scope for further policy work here. Effective maintenance is likely to require more investment.
Road runoff	Technologies such as french drains and swales should be used as appropriate. One of the potentially negative impacts of reed bed technology is maintenance. The removal of

	reeds from reed bed areas every 15-25 years to landfill needs a management plan.
Flooding	Maintenance of a good floodplain policy is essential. Consideration should be given to porous asphalt and stormwater detention ponds. The problem tends to be worse in urban areas: Source control is an important area for development.
Habitat loss – quarrying	Impacts may extend to non-designated sites. There is a need for increased use of secondary aggregates in road maintenance. Improved technologies leading to more durable road surfaces are a key area for continued investigation.
New Road Construction	Mitigation at the project level

4.7 Technology Options

A number of technology options have been explored by the Environment Agency, mainly in partnership with others. For example, following earlier trials during the 1990's there has been major experimentation using reed bed technology as an alternative for attenuating runoff and treatment of water quality. Under the auspices of Research and Development work monitoring has been undertaken on reed beds specifically built at part of the Newbury bypass construction in Thames Region in 1996/97 (Environment Agency, 1998i).

The Environment Agency has also been exploring the use of fuel cells since 1998. In particular the Agency has joined the CEST (Centre for Exploitation of Science and Technology) Fuel Cell Catalysing Commercialisation consortium to ensure that it has sufficient knowledge of developments to ensure that the potential environmental advantage fuel cells offer is realised.

Fuel cells have potential applications in many areas. They use hydrogen as a fuel, with oxygen from the atmosphere, to produce electrical power. Water and heat are the only emissions. From the environmental perspective they are of interest as a source of energy, with essentially zero emissions at point of use, and silent operation. Hydrogen is difficult to store and transport, so many of the currently envisaged applications will reform fuels such as methanol to make hydrogen for the fuel cell. The reforming process will result in the release of carbon dioxide but as the fuel cell is significantly more efficient than contemporary forms of energy generation, widespread use will result in an overall reduction of *greenhouse gas* emissions.

DaimlerChrysler envisage that fuel cells will become the significant source of power in vehicles early in the next century. Environmental considerations are a major feature in the DaimlerChrysler commercialisation assessment but they also quote cost and improved vehicle quality, as significant stimuli for the development plans. Other manufacturers are also investing heavily in fuel cell vehicles.

Most fuel cells applications offer the possibility of significantly improved air quality. For the Agency there are issues concerning the environmental impact associated with the manufacture of the cells and production, transport and storage of the fuels that need to be understood. The National Centre is assessing these and will report during 2000 (Environment Agency, 2000b).

There also remains the potential for the Agency/Government to influence European Union (EU) Standards on the design of fuel tanks, given the potentially serious environmental implications of a spill of petrol from a car tank identified in this report. However construction that meets higher standards could add extra weight to a vehicle, thereby potentially decreasing air quality. A trade off will need to be made here on environmental implications.

4.8 Education/Influencing Options

Educating the public at large and the use of economic instruments are clear Government initiatives. The Environment Agency has had an impact through the appraisal methodologies developed in partnership with Government and other Statutory bodies. In terms of education the Agency has a responsibility in terms of its own vehicle fleet and education of its staff (Table 4.1, 4.2). There have been several initiatives at persuading Agency staff not to drive, not least the increased emphasis on videoconferencing and siting of Agency offices. This is a complex issue but current Agency guidelines are to use standard petrol vehicles in urban areas where there is congestion and diesel in rural areas where there are fewer air quality problems. The aspiration is for 25% of the badged fleet to be converted to LPG or a similar alternative. In addition the National Centre is currently exploring the use of alternative technology options (including fuel cells) with the Agency's Environmental Management Unit.

In 1998 the Agency produced a report and fact sheet explaining the problems relating to 'Tyres and the Environment'.(Environment Agency 1998e,f) The report concluded that more effort is needed to increase the lifetime of tyres, to reduce environmental impacts during their use, and to provide a range of sustainable ways of recovering tyres as a resource at the end of their lives. One of the specific recommendations involved encouraging better care of tyres, a reduction in mileage travelled and more careful driving in order to increase the life of tyres. It is not known how successful this material has been, particularly in the absence of an associated campaign to promote the recommendations.

The risk assessment results themselves present findings that can be used by the Environment Agency to influence others. Examples include the potential for the Agency/Government to influence EU Standards on the design of fuel tanks (See sections 3.9 on water quality impacts of accidental spillages and 4.7 above). Again the Government needs to acknowledge the potential significance of different particle sizes and shapes on human health rather than measuring particles by mass alone (See Section 3.11 on air quality impacts).

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Key Findings

This work builds substantially upon the Environment Agency's initial view on how the future state of the environment may be affected by the risks from road transport (Environment Agency, 1997a,b,c). This further work has not sought to duplicate the efforts of others in addressing the issue of road transport, but has imposed a risk-based framework on the information available and involved a screening of options to obtain a manageable number that the Agency can realistically influence. The report also provides an overview of the options for risk management that the Agency has been involved with over the past three years.

Linking environmental damage back to an original cause is complex and affected by uncertainty. Using a risk-based approach, not least when working at a strategic level, involved broad assumptions and these need to be recorded for transparency. Nevertheless whilst understanding how uncertainties in the information affected the final outcome, this study provided some valuable information and direction. The risk screening process prioritised a total of ten key areas for more detailed investigation, based on criteria such as the policy remit of the Environment Agency, the potential for mitigation of impacts and their significance or importance. Four of these areas were concerned with water quality issues both as a result of the road construction and road use phase. Particular aspects of the impact of raw materials, emissions and waste disposal were also screened as priorities, as well as the impact of road building on flooding.

The results of the more detailed generic risk assessment were many and varied. Perhaps the most common view of the environmental impact of road transport is the poor air quality in our towns and cities. This is supported by information of the air quality impacts of PM_{10} on human health. The work on CO_2 emissions confirmed the importance of global warming potential and the role of transport in meeting emission targets. Such mobile resources detract from the significance of the Environment Agency's achievements in reducing inputs from non-mobile sources.

Whilst air quality and climatic change are recognised as key impacts, the risk assessments on water quality impacts provided some interesting findings that may have important implications. Construction impacts on water quality are demonstrated to be particularly significant. Under average conditions, the final concentration of suspended sediment in the watercourses may be around three times the EQS. Many smaller watercourses are at greater risk because ammonia concentrations may exceed the EQS as a consequence of road maintenance. In terms of accidents and spillages, only a relatively small proportion of roads have pollution control measures such as stop valves and oil filters. Under existing conditions, an accidental spillage of motor spirits of greater than 15kg will always lead to a pollution incident in the receiving watercourse. Water pollution arising from road surfaces is ubiquitous, affecting rural as well as urban environments. By contrast, the risk assessment relating flooding to road construction confirmed that there is greater risk of the magnitude and frequency of flooding being increased in urban areas.

In terms of Regional Planning Guidance, the breakdown by Region of the habitat loss from roadstone quarrying is potentially useful. South West, Wales and East Midlands are associated with a particularly high primary roadstone production per £M spent on road building and structural maintenance. The risk assessment of the potential for sensitive habitat loss from new road construction also provided a useful tool for assessing the cumulative impact for any specific combination of road schemes in terms of landtake and development pressure. The greatest probability for loss is in the South-East and the North West generally has the greatest relative pressure on designated sites.

The final assessment concerned with the impacts of leachate arising from landfill of waste vehicle components indicated that this issue might be a lesser priority for the Environment Agency.

The risk assessment informed a number of options that the Agency might realistically pursue, covering policies, programmes, plans, projects, technologies, education and economic measures (Tables 4.2 and 4.3). The options screened were principally those for the Environment Agency itself to pursue, either on its own or in partnership with others. Other options are clearly for the Government or other bodies and organisations. Much work has already been achieved by the Agency in terms of the development of these options. This study reveals some potential gaps, particularly in terms of the findings related to accidental spillages and road maintenance practices. Every opportunity should be taken to raise the climate change issue, particularly through the planning process. The Agency itself should explore options relating to its own vehicle fleet, drivers and staff.

5.2 Next Steps And Further Work

As Government takes measures to tackle the problems surrounding the growth in demand for road transport (and other forms of transport), the Environment Agency's findings outlined in this report and experience are likely to prove useful. Furthermore as a Statutory Consultee in the planning process, and as a regulator, the Agency's experience could be valuable in contributing to the development of land use policies at the national, regional and local levels.

There is a need to ensure that the recommendations arising from this project that have not already been acted upon are fully considered by the appropriate Functions/ groups dealing with the issues on a day-to-day basis. For its part the National Centre has targetted key reports at Agency staff (see Figure 1.1). There are also key areas of work that could be taken up by others, such as the need to consider the significance of particle size, shape and chemical make-up on human health.

The risk assessment of road transport issues has been unique and the method itself relies on particular assumptions and has limitations. The road transport issue is undoubtedly complex, involving comparison of diverse issues, and the applicability of the method in other circumstances needs to be given careful consideration.

The project did not allow a more prescriptive development opportunity for options appraisal tools and techniques. Due to the complexity of the subject matter the project did not attempt to integrate the risk assessment with the economic, social, technological and planning aspects of options appraisal. Individual decisions about transport are made by balancing the benefits to the individual of a journey against the perceived private costs, both financial and in terms of time and convenience. However, when a decision is made to use road transport, the external costs to the environment and to society are rarely considered. The lack of availability of information on costs makes this a difficult area for an organisation such as the Environment Agency to pursue.

A further stage for the Agency will be to assess the screened risks in relation to risks to the environment from other sources.

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APPENDICES

APPENDIX 1: SUMMARY OF AGENCY'S RESPONSE TO THE GOVERNMENT'S CONSULTATION PAPER *A DEVELOPING AN INTEGRATED TRANSPORT POLICY*

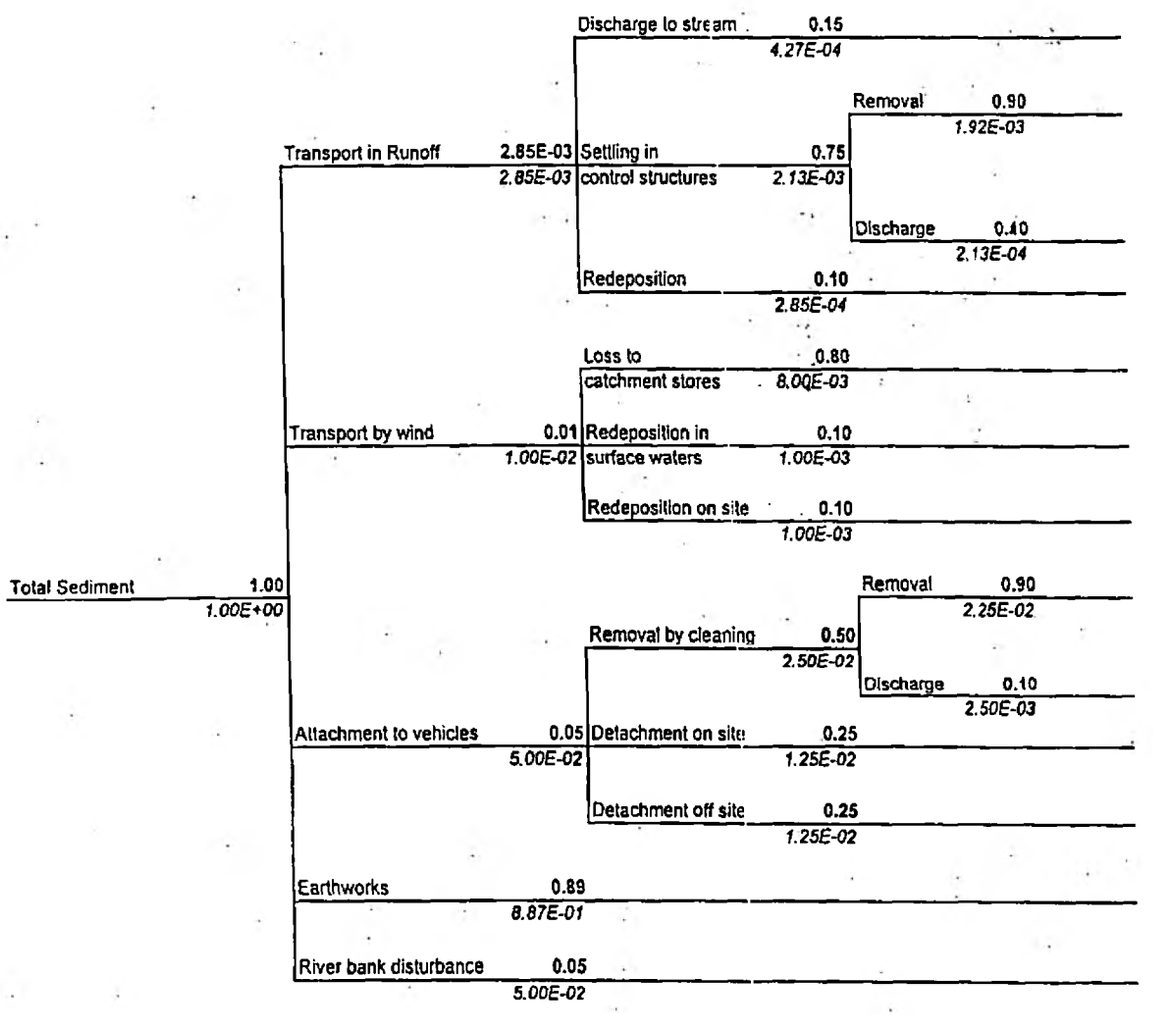
Topic	*Key Comments*
Aims of the Policy	• *balancing environmental protection and economic development is at the heart of the Agency's aim of sustainable development* • *recognising the impact and cost of todays decisions on future generations is important*
Improving our Transport System	• *a shift in emphasis away from inefficient forms of transport to more efficient mass-transit systems is essential* • *the general appreciation of the true environmental costs of various modes of transport is currently low* • *the Government should seek to direct resources to mass transport systems and promote greater choice of transport options*
The Role of Pricing, Fiscal Policies and Regulation	• *single pricing measures in support of environmental improvements would be unwise* • *a more balanced approach involving a range of levies, incentives and charges with clear environmental benefits would be preferred* • *it is recommended that fiscal mechanisms are introduced to encourage waterborne traffic and that the Agency is able to recover the costs of maintenance and improvement*
Transport Targets	• *the Agency would encourage the development of measures to assess progress and performance at a local, regional and national level, for example:* *- CO_2 emissions per passenger mile* *- NO_x emissions per passenger mile* *- level of water-borne transport* *- area of undeveloped land taken*
Improving Public Transport to Reduce Car Use	• *diversity of choice and lack of interconnectivity are major constraints* • *the promotion of positive incentives to offset any negative incentives should be a key part of any integrated policy*
Encouraging Environmentally Friendly	• *the development of more environmentally-friendly vehicles and fuels will require criteria against that the environmental benefits may be established*

Technology	• *it is recommended that the Government promotes an environmental budget for each type of fuel source* • *existing mechanisms for funding innovation should be employed for transport*
Integrating Land Use Planning and Transport	• *it is fundamental that at a strategic level an integrated approach be taken towards land use planning, the environment and infrastructure provision* • *Regional Planning Guidance needs to be strengthened and extended to cover transport planning* • *the trunk road/motorway programme should be more closely linked with development plans* • *Local Environment Agency Plans could be of value in enabling the impact of transport issues to be identified at a local level*
Prices that Reflect the Wider Environmental & Social Costs	• *the internalisation of external costs appears to be an essential step in reinforcing the message of environmental impact* • *it is recommended that an indicative environmental cost of each transport option be established and debated prior to any implementation through the taxation system*
Differing Accessibility Needs of Urban & Rural Communities	• *the Agency has a duty to take account of social and economic well-being of rural communities in exercising its functions* • *as far as possible the Government should promote diversification of transport modes in rural areas*
Increasing the Awareness of Transport Users	• *the Agency would wish to play a role in increasing public awareness* • *increased awareness will only be beneficial if the user is able to make choices*
Role of Transport in Meeting Emission Targets	• *mobile sources, such as motor vehicles, are a major source of CO_2 and NOx and are difficult to regulate. This is a concern to the Agency as these mobile sources detract from the significance of our achievements in reducing inputs from non-mobile sources* • *it is recommended that the Government considers methods such as traffic zoning, exclusion zones and tighter emission controls*

APPENDIX 2

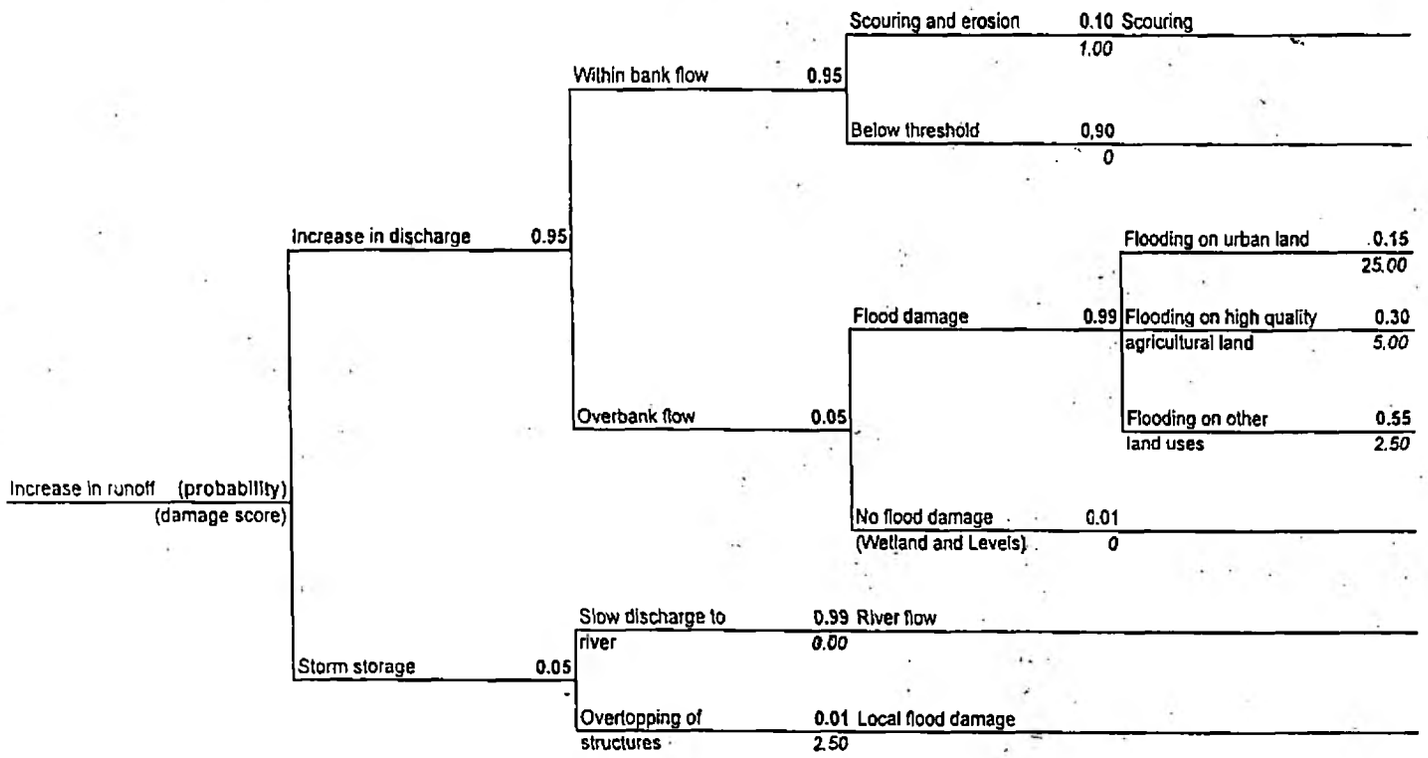
EXAMPLES OF EVENT TREES RESULTING FROM THE GENERIC RISK ASSESSMENT

2-1 Water quality impacts during road construction: Sediment



	Mass kg/km carriageway	Probability	Rank
Discharge to stream	2.03	4.27E-04	11
Removal	9.11	1.92E-03	8
Discharge	1.01	2.13E-04	13
Redeposition	1.35	2.85E-04	12
Loss to catchment stores	37.96	8.00E-03	6
Redeposition in surface waters	4.75	1.00E-03	9
Redeposition on site	4.75	1.00E-03	9
Removal	106.76	2.25E-02	3
Discharge	11.86	2.50E-03	7
Detachment on site	59.31	1.25E-02	4
Detachment off site	59.31	1.25E-02	4
Earthworks	4209.55	8.87E-01	1
River bank disturbance	237.25	5.00E-02	2

2-2 The potential for flooding due to road construction: Flooding



	Probability	Probability Rank	Probability * damage	Damage Rank
Scouring	9.12E-02	2	9.12E-02	2
Below threshold	8.11E-01	1	0	6
Flooding on urban land	7.05E-03	6	1.76E-01	1
Flooding on high quality agricultural land	1.41E-02	5	7.05E-02	3
Flooding on other land uses	2.59E-02	4	6.47E-02	4
No flood damage (Wetland and Levels)	4.75E-04	8	0	6
River flow	4.95E-02	3	0	6
Local flood damage	5.00E-04	7	1.25E-03	5

2-3 The potential for sensitive habitat loss from new road construction: impacts of habitat loss on designated sites.

Grade II Listed Buildings

Northern	0.03
North West	0.39
Yorkshire and Humberside	0.22
East Midlands	0.08
West Midlands	0.00
East Anglia	0.08
South East	0.17
South West	0.04
Total	**1.00**

Archeological sites

Northern	0.03
North West	0.39
Yorkshire and Humberside	0.22
East Midlands	0.08
West Midlands	0.00
East Anglia	0.08
South East	0.17
South West	0.04
Total	**1.00**

2-4 The potential for sensitive loss from new road construction: impacts of habitat loss on designated sites.

National Park	Northern	0.12
	North West	0.08
	Yorkshire and Humberside	0.68
	East Midlands	0.07
	West Midlands	0.00
	East Anglia	0.00
	South East	0.00
	South West	0.04
	Total	1.00
Areas of Outstanding Natural Beauty	Northern	0.04
	North West	0.36
	Yorkshire and Humberside	0.04
	East Midlands	0.02
	West Midlands	0.00
	East Anglia	0.05
	South East	0.39
	South West	0.09
	Total	1.00

2-5 The potential for sensitive habitat loss from new road construction: impacts of habitat loss on designated sites.

World Heritage Sites

Northern	0.11
North West	0.00
Yorkshire and Humberside	0.35
East Midlands	0.00
West Midlands	0.00
East Anglia	0.00
South East	0.47
South West	0.08
Total	**1.00**

Scheduled Ancient Monuments

Northern	0.04
North West	0.21
Yorkshire and Humberside	0.32
East Midlands	0.07
West Midlands	0.00
East Anglia	0.05
South East	0.22
South West	0.10
Total	**1.00**

2-6 The potential for sensitive habitat loss from new road construction: impacts of habitat loss on designated sites.

National Nature Reserves	Northern	0.06
	North West	0.48
	Yorkshire and Humberside	0.09
	East Midlands	0.10
	West Midlands	0.00
	East Anglia	0.12
	South East	0.13
	South West	0.03
	Total	**1.00**

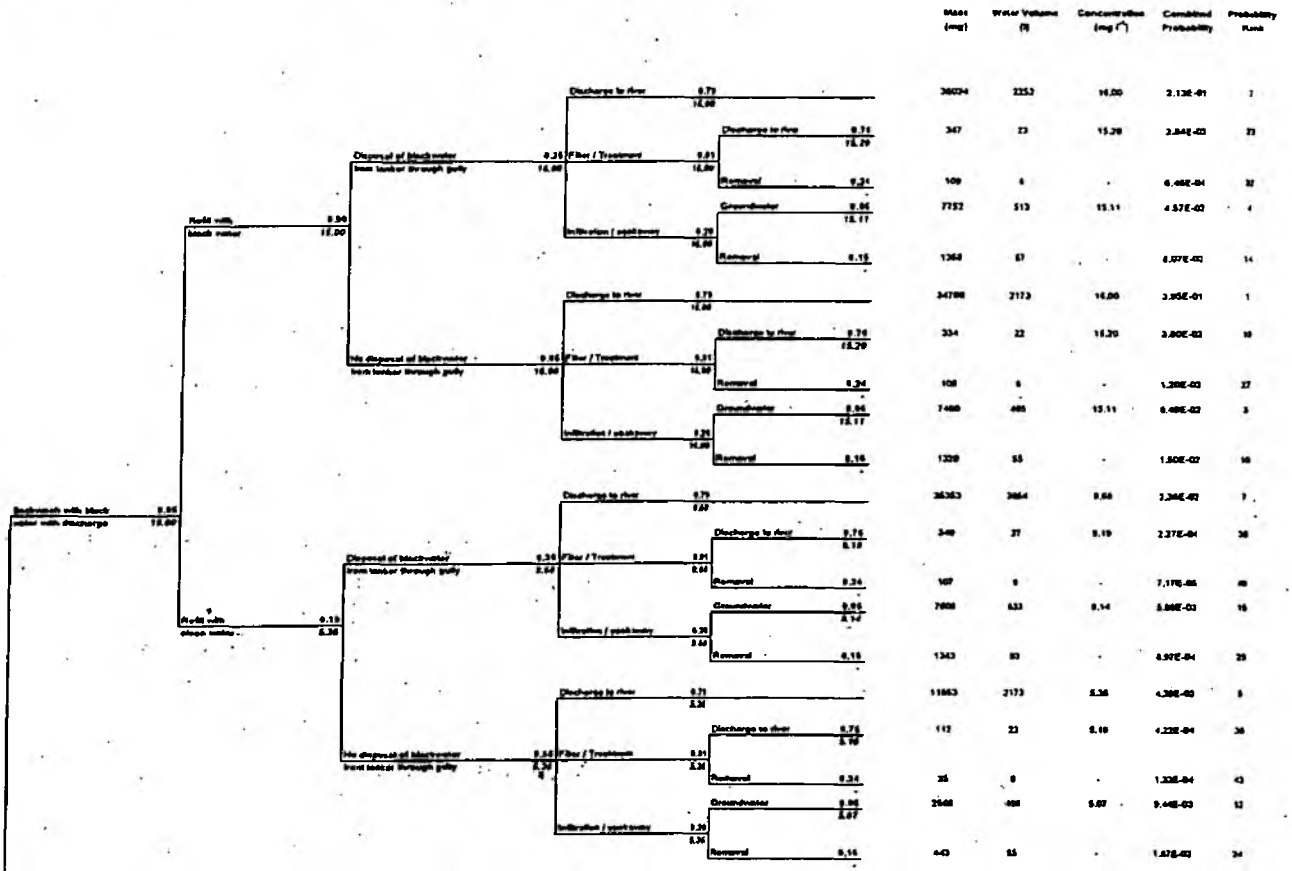
Sites of Special Scientific Interest	Northern	0.06
	North West	0.44
	Yorkshire and Humberside	0.19
	East Midlands	0.05
	West Midlands	0.00
	East Anglia	0.05
	South East	0.17
	South West	0.04
	Total	**1.00**

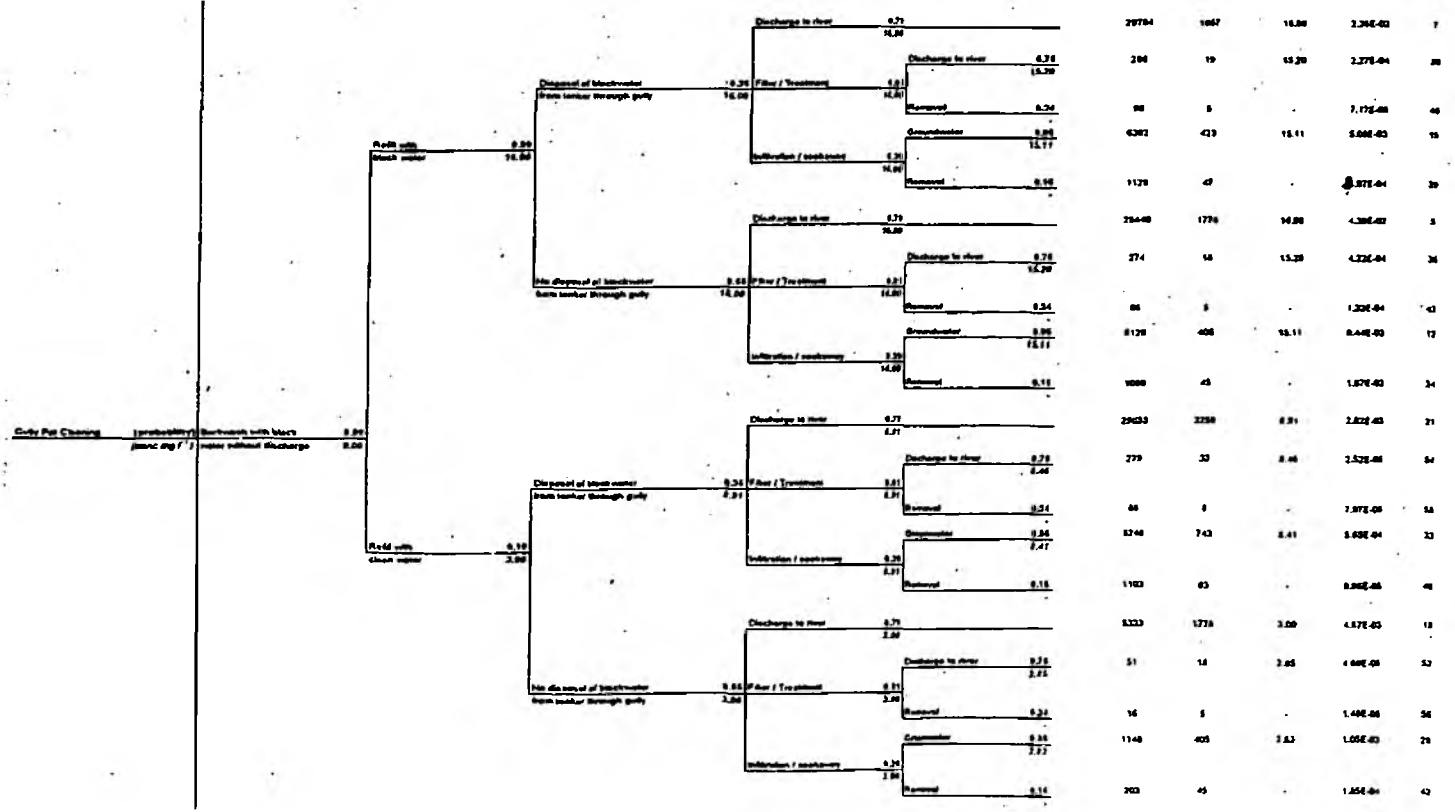
2-7 The potential for sensitive habitat loss from new road construction: impacts of habitat loss on designated sites.

Ramsar Sites	Northern	0.02
	North West	0.66
	Yorkshire and Humberside	0.06
	East Midlands	0.04
	West Midlands	0.00
	East Anglia	0.08
	South East	0.12
	South West	0.01
	Total	**1.00**

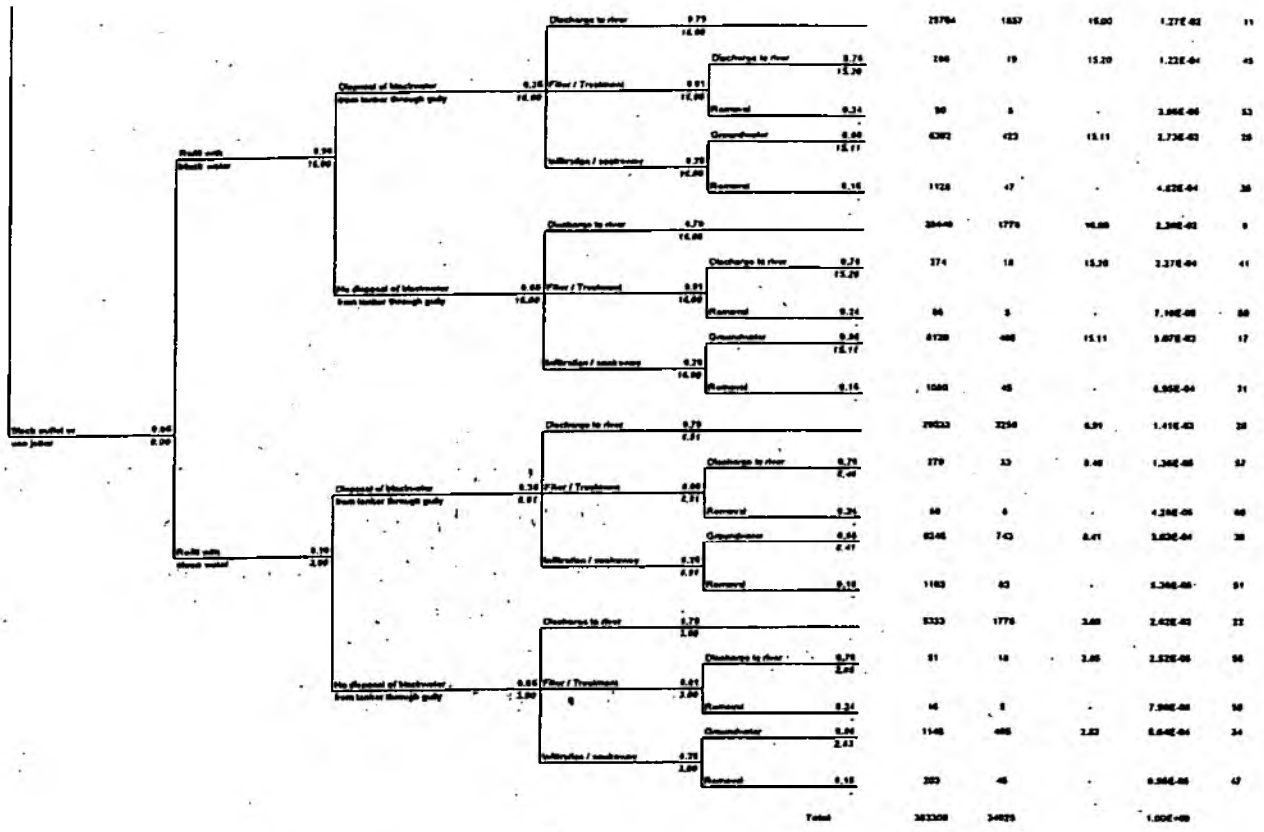
Special Areas of Conservation	Northern	0.10
	North West	0.48
	Yorkshire and Humberside	0.03
	East Midlands	0.08
	West Midlands	0.00
	East Anglia	0.12
	South East	0.16
	South West	0.03
	Total	**1.00**

2-8 Water quality impacts of road maintenance gully pots.

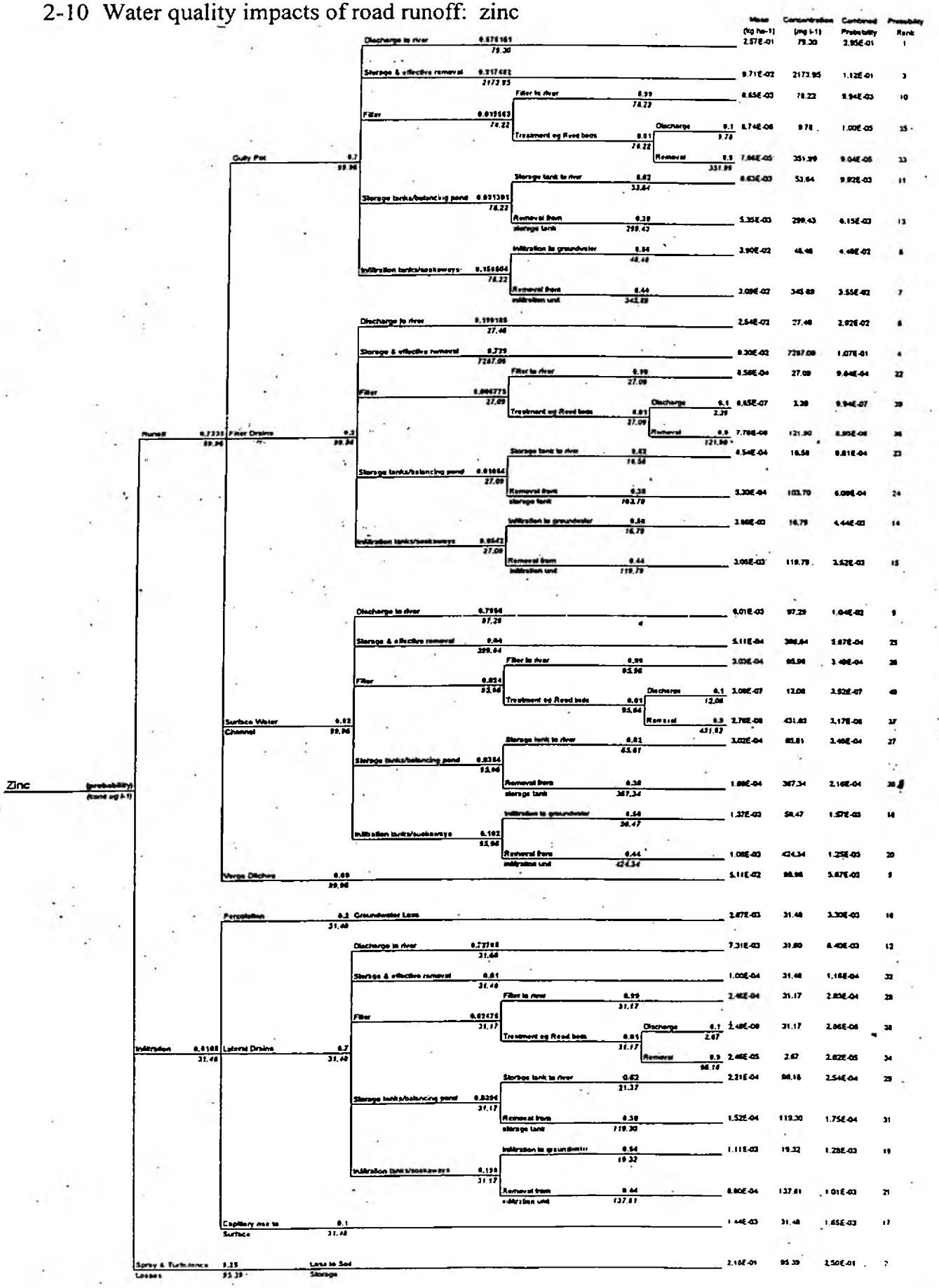




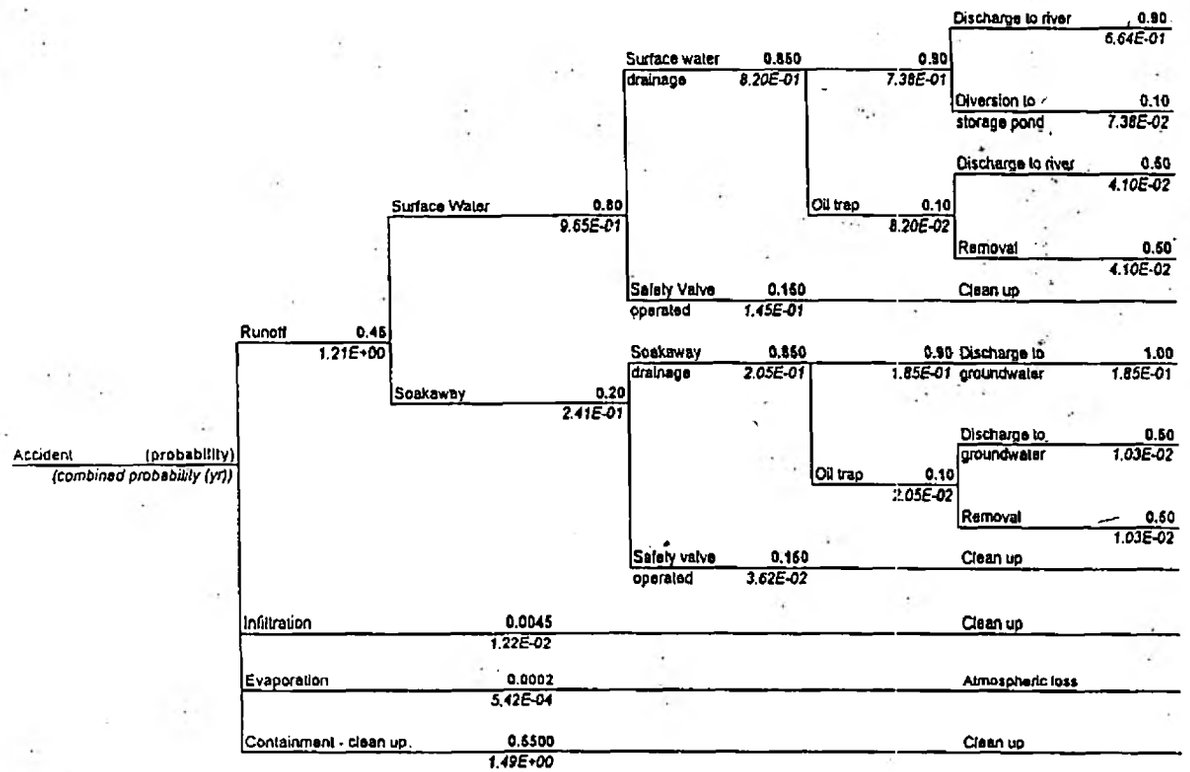
2-9 Water quality impacts of road maintenance gully pots



2-10 Water quality impacts of road runoff: zinc

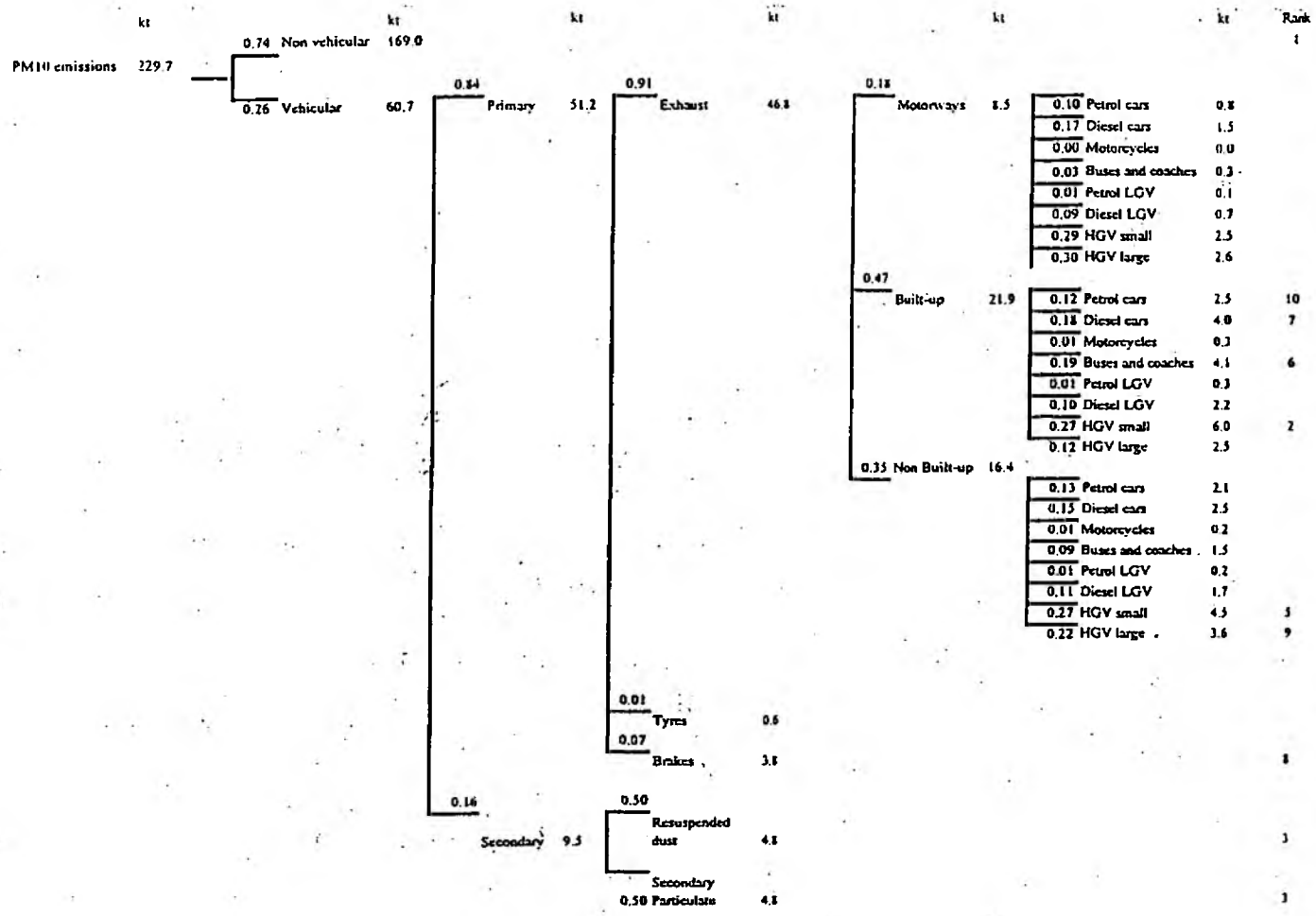


2-11 Water quality impacts of accidental spillages motor spirits



Mass kg	Probability yr	Combined Probability	Annual Mass kg yr-1	Combined Annual Probability	Probability Rank
3.679	6.64E-01	2.45E-01	9.97	1.80	2
0.409	7.38E-02	2.73E-02	1.11	0.20	5
0.227	4.10E-02	1.51E-02	0.62	0.11	6
0.227	4.10E-02	1.51E-02	0.62	0.11	6
0.802	1.45E-01	5.34E-02	2.17	0.39	4
1.022	1.85E-01	6.81E-02	2.77	0.50	3
0.057	1.03E-02	3.79E-03	0.15	0.03	10
0.057	1.03E-02	3.79E-03	0.15	0.03	10
0.200	3.62E-02	1.34E-02	0.54	0.10	8
0.068	1.22E-02	4.50E-03	0.18	0.03	9
0.003	5.42E-04	2.00E-04	0.01	0.00	12
6.250	1.49E+00	5.50E-01	22.36	4.04	1

2-12 Air quality impacts of road traffic: impact of PM_{10} on human health



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APPENDIX 3:

NEW APPRAISAL FRAMEWORK FOR TRANSPORT SCHEMES:

ENVIRONMENT AGENCY GUIDANCE FOR ASSESSING THE EFFECTS ON THE WATER ENVIRONMENT

Introduction

This guidance sets out the Environment Agency's proposed approach for assessing the impacts of road schemes included in the potential short term programme on the water environment, as part of the development of a new appraisal framework. This version of the Agency's advise builds on the approach proposed in the Agency's response of 1 December 1997. It is considered to be an improvement on the most recent version of 'proforma B' that only covers 'water quality'; does not consider the nature or scale of the proposed scheme; and assumes that protection measures will always be included.

Approach

The Environment Agency recommend that a risk-based approach is initially used to assess the potential negative impacts of road schemes on the water environment. This approach is recommended because of the particular factors that influence impacts on the water environment of a scheme in any one location. The impacts are largely dependant on three key factors:

1. the detailed design of the scheme;
2. the working practices that are operated during construction; and
3. the design and effective implementation and management of mitigation/attenuation measures.

The different stages reached by the schemes in the potential short term programme and the Agency's past experience of the construction and management of road schemes, makes it difficult in the Agency's opinion to be certain about these three key factors at the stage that most of the schemes have reached. It is therefore proposed, in order to identify the scale of risk posed by each scheme, that an assessment is made of the sensitivity of the receiving environment and the potential of the scheme to cause harm.

The risk based approach will only provide a neutral or negative score on the scale of effects proposed by the DETR (see below). However, it is acknowledged that it may be possible to manage these risks in such a way as to reduce the likely effects (ie. to make the likely effects less negative). It may also be possible that a road improvement scheme could include attenuation that

will reduce the effects of an existing road that is causing an impact on water quality or land drainage. In such a case, if the negative effects of constructing and operating the road improvement scheme are managed adequately to negate any negative effects and attenuation measures are included to reduce the problem with the existing road, it may be possible to achieve an overall positive effect. It is the opinion of the Environment Agency that the onus should be on the Highways Agency to demonstrate that the risk of negative effects can be managed or that a scheme would have a net beneficial effect.

The DETRs proposed seven point scale for each environmental sub-criteria, is:

- Serious adverse effects*
- Intermediate adverse effects
- Slight adverse effects
- No significant effects
- Minor positive effects
- Intermediate positive effects
- Major positive effects

Note: * an eighth point on the scale is proposed for 'national disasters' over and above 'serious adverse effects' that will be included as a comment in the qualitative column of the appraisal form.

Note that no quantitative measures are currently proposed for the water sub-criteria.

STAGE 1: Assessing the Sensitivity of the Water Environment

The criteria for assessing the sensitivity of the water environment to a road scheme are divided into:

1. water quality; and
2. land drainage/flood defence.

There are a total of nine criteria proposed as indicators under these two aspects of the water environment (see Tables A and B). For each of these criteria, categories are presented that may give a score of 'high', 'medium' or 'low' sensitivity. A 'high' score for four of the categories (indicated by an asterisk) are considered to be particularly significant (GQA Grade A, EC Salmonid Fishery, public water supply abstraction point and Zone 1 or 2 Source Protection Zone) and this is reflected in the assigning of an overall score (see below). To determine an overall score of 'high', 'medium' or 'low' for water quality and an overall score of 'high', 'medium' or 'low' for land drainage/flood defence from the individual scores, the following rules should be applied:

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Overall 'High' score:

- a scheme receiving one or more 'High' score(s) for one of the key criteria (ie. those marked with an asterisk in Table A);
- a scheme receiving two or more 'High' scores for the other criteria (ie. those without an asterisk in Table A or B).

Overall 'Medium score':

- a scheme receiving only one 'High' score for one of the other criteria (ie. those without an asterisk in Table A or B);
- a scheme receiving one or more 'Medium' score(s), but no 'High' score(s).

Overall 'Low' score':

- a scheme receiving one or more 'Low' score(s), but no 'Medium' or 'High' score(s).

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Table A: Water Quality (Surface Water and Groundwater)

Quality Criteria	***Category***	***Sensitivity***		
		High	***Medium***	***Low***
1. GQA Grade (Chemical)	*Grade A*	✔*		
	Grade B/C		✔	
(General Quality Assessment)	*Grade D/E/F*			✔
2. EC Freshwater Fisheries Directive	*Designated salmonid fishery*	✔*		
	Designated cyprinid fishery		✔	
3. Water Abstraction Points	*Abstraction for public water supply within critical travel time downstream*	✔*		
(note: critical travel time to be defined)	*Abstraction for other purpose within critical travel time downstream*		✔	
4. Groundwater Vulnerability	*Major Aquifer*	✔		
	Minor Aquifer		✔	
	Non Aquifer			✔
5. Location of Boreholes	*Within Zone 1 or 2 of a Source Protection Zone*	✔*		
	Within Zone 3 of a Source Protection Zone		✔	
	Not within a Source Protection Zone			✔

Note: the surface water quality criteria relate to the watercourse(s) into that a scheme could discharge and the groundwater quality criteria relate to the location of the scheme or the groundwater into that a scheme could discharge.

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Table B: Land Drainage/Flood Defence

Land Drainage Criteria	***Category***	***Sensitivity***		
		High	***Medium***	***Low***
6. Floodplain *(further guidance on 'major' and 'minor' works will be required)*	*Major works located in floodplain*	✔		
	Only minor works located in floodplain		✔	
7. Watercourses	*Scheme crosses a watercourse*		✔	
	Scheme does not cross a watercourse			✔
8. River Corridors *(conservation value of any watercourse crossed/impacted upon by the scheme)* *Note: if the river corridor is a riverine SSSI, this criteria should be excluded as the impact on the SSSI will be considered by English Nature*	*The sensitivity of the watercourse can be divided into 'high' (1), medium' (2, 3 or 4) or 'low' (5) based on a combined score from the River Habitat Survey information (Habitat Modification Index and Habitat Quality Index)*	✔		
			✔	
				✔
9. Flood Risk *Additional risk of flooding downstream due to discharge (further guidance on the definition of these categories is required)*	*Major increase in risk of flooding*	✔		
	Minor increase in risk of flooding		✔	
	Current situation likely to remain			✔

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STAGE 2: Assessing the Potential of the Scheme to Cause Harm

Having determined the score for the sensitivity of the environment both in terms of water quality and land drainage, the second stage is to determine the potential of the scheme to cause harm. This will be influenced by a large number of variables, however for simplicity, two criteria have been selected to determine the potential of the scheme to cause harm to water quality and land drainage/flood defence respectively (see Tables C and D):

1. additional traffic flows; and
2. the area of the scheme (land take).

The proposed thresholds for a 'high', 'medium' and 'low' score for these two criteria are shown in Tables C and D.

Table C: Potential of the Scheme to Cause Harm - Water Quality

Criteria	*Category*	*Potential to Cause Harm*		
		High	*Medium*	*Low*
Additional Traffic Flows Resulting from the Scheme	*> 30,000 AADT*	✔		
	15,000-30,000 AADT		✔	
(Thresholds based on information in CIRIA Report 142. This information is available for most schemes from Proforma A)	*< 15,000 AADT*			✔
AADT = Annual Average Daily Traffic				

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Table D: Potential of the Scheme to Cause Harm - Land Drainage

Criteria	*Category*	*Potential to Cause Harm*		
		High	*Medium*	*Low*
Area of the Scheme *(This information is available for most schemes from Proforma A. For improvement schemes within an existing highway boundary the area should be estimated from the width and length of the new carriageways)*	*> 40 ha*	✔		
	10 - 40 ha		✔	
	< 10 ha			✔

These categories for the potential to cause harm, on both water quality and land drainage/flood defence, are not intended to be totally prescriptive and if circumstances warrant the upgrading or downgrading of a scheme this is acceptable, but a justification for such a revision in the score should be included as a comment with the assessment.

The Agency is particularly concerned about the impacts on the water environment (particularly water quality) at the construction stage and it is important that this risk is reflected as part of the process of assigning a score for the scheme's potential to cause harm. Therefore, if any of the following elements form part of the scheme, consideration should be given to upgrading the score to reflect this additional risk:

- route crosses, or is in close proximity (250m) of a landfill site or contaminated land;
- scheme incorporates the bridging of a watercourse;
- scheme incorporates the realignment of a watercourse;
- scheme incorporates major cuttings or embankments;
- scheme will require significant infrastructure during construction (hall roads etc);
- scheme incorporates a tunnel.

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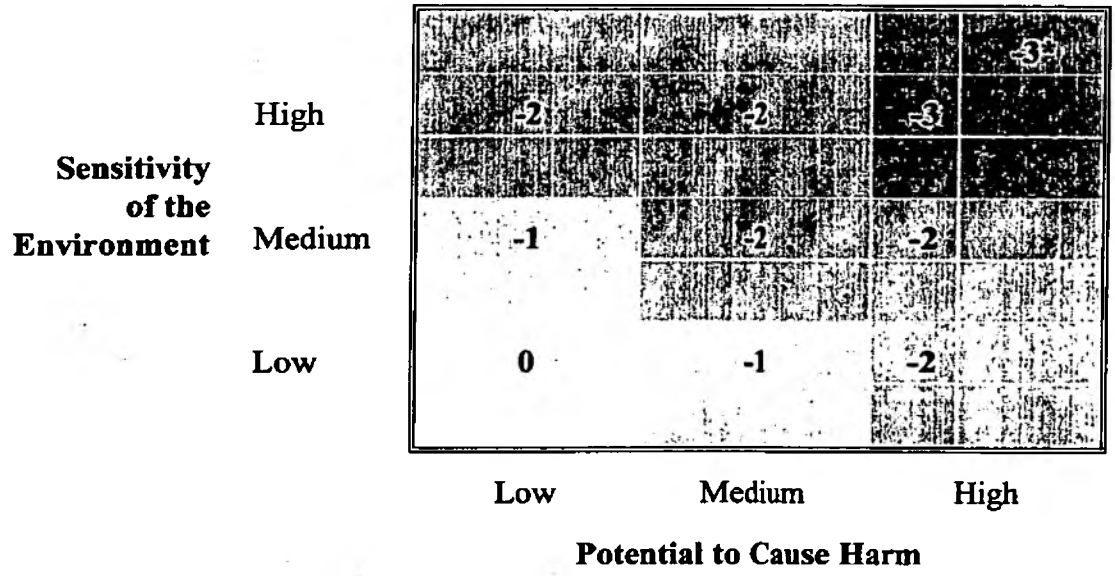
STAGE 3: Determining an Overall Risk-Based Score

Having derived a score for the sensitivity of the environment and for the potential of the scheme to cause harm for both water quality and land drainage/flood defence, an overall score for each (based upon the proposed scale of effect) is obtained using the matrix below:

Severity of Negative Effects Matrix:



Key: -3 Serious adverse effects*

-2 Intermediate adverse effects

-1 Slight adverse effects

0 No significant effect

STAGE 4: Opportunities for Mitigation and Enhancement

It is acknowledged, as stated above, that a risk based approach will only identify the potential negative impacts of proposed schemes. However, through the design of the scheme and the implementation of appropriate mitigation/attenuation measures, it may be possible to ameliorate the level of impact of a particular scheme on the water environment. Therefore, a less severe negative impact may ultimately result than the level indicated by a risk-based approach.

If the Highways Agency can demonstrate that for an individual scheme that the current proposals will sufficiently manage the negative effects or that the Environment Agency have already agreed the mitigation package, then the scores can be amended as follows:

- a score of -3 can be reduced to a score of -2 or -1 as appropriate;
- a score of -2 can be reduced to a score of -1;
- a score of -1 can be reduced to a score of 0.

A justification for such a revision in the score, included the details of mitigation measures, should be included as a comment with the assessment.

A road improvement scheme may also provide the opportunity to enhance the current level of attenuation provided by an existing road and therefore result in an overall positive effect, if all the negative effects of the improvement scheme are also attenuated. If the Highways Agency can demonstrate that for an individual scheme that the necessary attenuation and enhancements will be in place to achieve a positive effect, a score of up to +1 can be used (with the impact of the improvement scheme, it is considered that a net effect of greater than +1 will never be achieved). A justification for such a revision in the score, included the details of mitigation measures/enhancements, should be included as a comment with the assessment.

STAGE 5: Determining a Final Score for the Appraisal Form

As a result of Stage 3 (and Stage 4 where appropriate) two scores should have been obtained one for water quality and one for land drainage/flood defence for each scheme. It is proposed that the single score that appears on the appraisal form is the most adverse/least positive score from the two scores. The qualitative column should very briefly describe the main area of concern and the mitigation measures/enhancements that have been assumed to be included in the scheme to obtain the final score.

APPENDIX 4

Guidance on Methodology for Multi-Modal Studies GOMMS: Environment Agency Guidance for Assessing the Water Environment

Water

Introduction

This methodology provides an appraisal framework for taking the outputs of the environmental impact assessment process (that may be presented in an environmental statement) and analysing the key information of relevance to the water environment. The guidance does not provide information on undertaking the impact assessment process itself, rather it provides a method by which the significance of the identified potential impacts can be appraised consistently by decision-makers. It is based on guidance prepared by the Environment Agency (see Appendix 3, this report) and builds on the water assessment methodology in DMRB 11.

Approach

The approach to appraisal is the same for all levels of study, and comprises four stages:

1. Review of the activities proposed and the potential impacts identified;
2. Appraisal of the importance of the water environment within the study area;
3. Appraisal of the potential impacts of the proposal on the important attributes;
4. Final appraisal summary.

The methodology for describing the importance of the water environment (Stage 2) is the same at all scales (although the level of detail obtained will vary). However, the assessment of impact magnitude and significance (Stage 3) is conducted differently for route and area studies, reflecting the available data for each study type. The differing methods for assessing impacts make it necessary for different worksheets to be completed to record the appraisal information and for different criteria for generating a final appraisal score (Stage 4). The appraisal for route based studies is recorded in Worksheet 5*, while that for area strategic based studies is recorded in Worksheet 6*. This guidance initially provides guidance on Stages 1 to 4 for route based studies and then provides separate guidance for Stages 3 and 4 for area based studies.

*** NB: Table numbers are those given in the final version of GOMMS.**

Stages 1 to 3 of the appraisal may have a risk component, where the exact impacts of the scheme are unknown because of uncertainties in exposure and effect. Where uncertainties of this sort are identified in the environmental impact assessment they should be made explicit in the appraisal process. As mentioned previously it is recommended that the precautionary principle be employed. However, it should also be remembered that at more strategic levels, where there is likely to be greater uncertainty regarding the potential impacts, there still remains the opportunity to incorporate mitigation measures when the proposals are considered in more detail. In these cases it will be necessary to determine whether the potential risks identified justify invoking the precautionary principle, or whether it will be sufficient to flag them up as issues for more detailed consideration at a later stage. The treatment of uncertainty is discussed further in Stage 3.

Stage 1: Review of the activities proposed and the potential impacts identified

Stage 1 of the methodology is aimed at obtaining information relating to the potential impacts of the proposal and the scale over which they are significant. This enables the size of the study area, and the water features in this area that may be affected, to be determined. During Stage 1 it will also be possible to determine whether the study fits into the spatially detailed or spatially aggregate category and consequently the appropriate methodologies to be used in Stages 3 and 4 of the appraisal.

The nature of the proposal may vary widely from the introduction of road traffic calming measures to the construction of a new transport route, for example. These measures will obviously have different potential impacts on the water environment. A useful distinction is made between impacts arising from construction of new transport infrastructure (e.g. an upgraded rail line, road widening or car parks), and changes in the use pattern of existing infrastructure (such as promotion of cycling or walking, improvements to bus services or traffic flow control technologies). Any transport proposal should fit into one, or both, of these categories.

The potential impacts arising from the proposals should be identified during the environmental impact assessment process. Once the potential impacts of the proposal have been identified its zone of influence can be determined. For releases to a watercourse, for example, this may be the length of river over which a noticeable change in quality is predicted, while for the creation of new hardstanding, it may represent the area which could be exposed to an increased flood risk.

Stage 2: Appraisal of the value of the water environment within the study area

The value of the water environment within the study area is characterised by identifying and analysing its attributes. This process is consistent with an environmental capital approach because the water environment is being assessed in terms of the services it provides rather than on purely measurable criteria. No prescriptive guidance is given for determining the value of different attributes, because this will depend on the location of the proposal and factors such as quality, scale, rarity and substitutability (these are described in more detail below). However, because the majority of the available water data is based on its quality, these can help to indicate the value of the attributes or services provided by a water feature.

Table 4.15 provides information on the key features of the water environment, their attributes and the indicators to determine their 'quality' as a water feature. Table 4.16 provides guidance for estimating the importance an attribute based on the indicators recorded in Worksheet 5 (quality, scale, rarity and substitutability).

Indicators

The indicators used to make a judgement on the importance of an attribute under consideration include quality, scale, rarity and substitutability. Where all other factors are equal, and explicit, it may be possible to make judgements of value based on the quality indicators provided (eg. GQA Grade A is more important than GQA Grade C). However, this level of consistency will rarely be possible, because in the majority of situations and the other indicators described below (scale, rarity and substitutability) will also have important roles in determining importance.

For large study areas quality data may be the only importance indicator available, because the large amount of qualitative data required to assess other indicators may not be practically obtainable

Quality - this criterion provides a measure of the physical condition of the attribute. Table 4.15 provides guidance on available indicators of quality that can be used for specific attributes. The Environment Agency maintains data on these quality indicators at a national, or regional, level, usually in digital format.

Scale - this allows consideration of the geographical scale at which the attribute matters to both policy makers and stakeholders, at all levels. It is unlikely that any water features will have significance at a national or global scale (assuming that biodiversity interests are appraised independently), however major aquifers, floodplains, or fisheries may be important at a regional scale. It is important to consider the scale at which each attribute matters, rather than the feature as a whole, because subsequent appraisals of the rarity, substitutability, and importance will assess the attribute at this determined scale.

Generally the greater the scale at which the attribute is valued the greater its importance, however this will not always be the case. For example, where the feature is of great value to a community as the only source of potable water, or for providing significant proportion of local employment.

Rarity - allows consideration of whether the water attribute being evaluated is commonplace or scarce, at the scale at which it matters. For example an attribute that is abundant nationally (such as potable water) will be of high importance if it is locally rare.

Substitutability - allows consideration of whether water attributes are replaceable over a given time frame. The significance of the length of time before substitution could be achieved will be linked to the urgency with which the attribute is required (a long time frame may be acceptable for inessential attributes such as recreation, but less so for others, such as supply of potable water). Again the potential for substitution of the attribute should be considered in relation to scale at which it matters, but should also consider the risks of failure. Different attributes of the same feature may differ in their potential for substitution.

Limited potential for substitution recognises that while it is theoretically possible for most water attributes to be substituted by some means, this will not always be viable within the funds of the proposal. Substitution should therefore be considered in terms of whether it is feasible rather than whether it is possible. Where no information is available relating to the substitutability of the attribute it should be assumed that no substitution is possible.

Table 4.15: Water features, their attributes and indicators of quality

Feature	Attribute/Service	Indicator of quality	Possible measure
River	Water Supply	• Use for water supply (potable, industrial or agricultural)	–Location and number of abstraction points –Volume of water abstracted –Use of water (potable most important)
		• Chemical water quality	–Existing chemical GQA grade (A/B=good, C/D=fair, and E=poor, F=bad) –Likelihood of a change in grade arising (+ve or –ve)
	Transport and dilution of waste products	• Presence of surface water discharge points	–Location and number of discharge points –Volume of effluent discharged
		• Contribution of discharges to total river flow	–Proportion of flow made up by effluent at different times of the year
	Biodiversity	• Biological water quality	–Existing biological GQA grade (A/B=good, C/D=fair, and E=poor, F=bad) –Likelihood of a change in grade arising (+ve or –ve)
		• Fisheries quality	–EC Fishery designation (Salmonid, Cyprinid or undesignated)
		• Conservation value of river corridor[1]	–Results of River Habitat Survey –Presence of designations (e.g. SSSI, NNR, LNR, SINCs) –Presence of protected species or BAP species
	Aesthetics	• Contribution to landscape character and quality[2]	–Results of river landscape assessment
	Cultural heritage	• Presence of historic features associated with river[3]	–Results of heritage assessment –Presence of designations (e.g. SAMs, listed buildings)
	Recreation	• Riverside access	–Presence of route and importance (i.e. is it a nation or strategic route, such as the Thames Path)
		• Use of river for recreation	–Presence of facilities and clubs for using the river environment –Use for angling (number of clubs / membership)
	Value to economy	• Value of the uses of the river (e.g. commercial fishing, abstractions, discharges, navigation, leisure and riverside development land)	–Value to local economy (e.g. employment, relative property prices, cost of alternatives, etc.)
	Conveyance of flow and material	• Presence of watercourses	–Number and size of watercourses –Existing flood risk
Floodplain	Conveyance of flood flows	• Presence of floodplain	–Existing flood risk/flood return period
		• Flood flow routes	–Location / importance of flood flow routes
	Biodiversity	• Conservation value of river corridor[1]	–Results of River Habitat Survey –Presence of designations (e.g. SSSI, NNR, LNR, SINCs) –Presence of protected species or BAP species
	Aesthetics	• Contribution to landscape character and quality[2]	–Results of river landscape assessment

Ground-water	*Water supply*	• *Use for water supply (potable, industrial or agricultural)*	*–Location and number of abstraction points* *–Volume of water abstracted* *–Use of water (potable most important)*
		• *Groundwater vulnerability*	*–Location and grade of source protection zone* *–Classification of aquifer vulnerability*
	Transport and dilution of waste products	• *Presence of discharge points*	*–Location and number of discharge points* *–Volume of effluent discharged*
	Value to economy	• *Value of the uses of the groundwater (e.g. abstractions and discharges)*	*–Value to local economy (e.g. employment, cost of alternatives, etc.)*
	Biodiversity	• *Conservation value of areas fed by groundwater*[1]	*–Results of River Habitat Survey* *–Presence of designations (e.g. SSSI, NNR, LNR, SINCs)* *–Presence of protected species or BAP species*
	Conveyance of flood flows	• *Flow routes*	*–Location and importance of flow routes*
		• *Groundwater levels*	*–Charges in levels and recharge*
Sea / Estuaries	*Water supply*	• *Use for water supply*	*–Location and number of abstraction points* *–Volume of water abstracted*
	Transport and dilution of waste products	• *Presence of discharge points*	*–Location and number of discharge points* *–Volume of effluent discharged*
	Biodiversity	• *Water quality*	*–Chemical and biological quality (data availability will be variable)*
		• *Fisheries quality*	*–Results of surveys etc (numbers / biomass of species and individuals)*
		• *Invertebrate populations*	*–Results of surveys etc (numbers / biomass of species and individuals)*
		• *Conservation value of marine/estuary environment*[1]	*–Presence of designations (e.g. MNR, SSSI, NNR, LNR, SINCs)* *–Presence of protected species or BAP species*
	Aesthetics	• *Contribution to landscape character and quality*[2]	*–Results of river landscape assessment*
	Cultural heritage	• *Presence of historic features associated with sea/estuary*[3]	*–Results of heritage assessment* *–Presence of designations (e.g. SAMs, listed buildings)*
	Recreation	• *Bathing beaches*	*–Compliance with EC water bathing standards*
		• *Other recreation uses*	*–Presence of facilities and clubs* *–Use for angling (number of clubs / membership)*

	Value to economy	• *Value of the uses of the sea/estuary (e.g. commercial fishing, abstractions, discharges, navigation, leisure and waterside development land)*	*–Value to local economy (e.g. employment, relative property prices, cost of alternatives, etc.)*
Stillwaters (Lakes / Ponds)	*Biodiversity*	• *Water quality*	*–Classification system to be developed*
		• *Conservation value of stillwaters*[1]	*–Presence of designations (e.g. SSSI, NNR, LNR, SINCs)* *–Presence of protected species or BAP species*
		• *Fisheries quality*	*–Results of surveys etc (numbers / biomass of species and individuals)*
		• *Invertebrate populations*	*–Results of surveys etc (numbers / biomass of species and individuals)*
	Aesthetics	• *Contribution to landscape character and quality*[2]	*–Results of river landscape assessment*
	Recreation	• *Use of still water for recreation*	*–Presence of facilities and clubs for using lake/pond* *–Use for angling (number of clubs / membership)*

Notes: [1] Include in Biodiversity sub-objective
[2] Include in Landscape sub-objective
[3] Include in Heritage sub-objective

Table 4.19: Definitions of overall assessment scores - Water

Score	*Comment*
Large Beneficial Impact	*it is extremely unlikely that any proposal incorporating the construction of a new transport route (road or rail) would fit into this category. However, proposals could have a large positive impact if it is predicted that it will result in a 'very' or 'highly' significant improvement to a water attribute(s), with insignificant adverse impacts on other water attributes.*
Moderate Beneficial Impact	*Where the proposal provides an opportunity to enhance the water environment, because it results in predicted:* • *significant improvements for at least one water attribute, with insignificant adverse impacts on other attributes;* • *very or highly significant improvements, but with some adverse impacts of a much lower significance.* *The predicted improvements achieved by the proposal should greatly outweigh any potential negative impacts.*
Slight Beneficial Impact	*Where the proposal provides an opportunity to enhance the water environment, because it provides improvements in water attributes which are of greater significance than the adverse effects.*
Neutral	*Where the net impact of the proposals is neutral, because:* • *they have no appreciable effect, either positive or negative, on the identified attributes;* • *the proposals would result in a combination of effects, some positive and some negative, which balance to give an overall neutral impact. In most cases these will be slight or moderate positive and negative impacts. It may be possible to balance impacts of greater significance, however, in these cases great care will be required to ensure that the impacts are comparable in terms of their potential environmental impacts and the perception of these impacts.*
Slight Adverse Impacts	*Where the proposal may result in a degradation of the water environment, because the predicted adverse impacts are of greater significance than the predicted improvements.*
Moderate Adverse Impacts	*Where the proposal may result in a degradation of the water environment, because it results in predicted:* • *significant adverse impacts on at least one attribute, with insignificant predicted improvements to other attributes;* • *very or highly significant adverse impacts, but with some improvements which are of a much lower significance and are insufficient positive impacts to offset the negative impacts of the proposal.*
Large Adverse Impact	*Where the proposal may result in a degradation of the water environment, because it results in predicted:* • *highly significant adverse impacts on a water attribute;* • *significant adverse impacts on several water attributes.*
Very Large Adverse Impact	*Where the proposal may result in a degradation of the water environment because it results in predicted:* • *very significant adverse impacts on at least one water attribute;* • *highly significant adverse impacts on several water attributes.*

Table 4.16: Guidance for estimating the value of environmental attributes

Value	*Criteria*	*Examples*
Very High	• *attribute with a high quality and rarity, regional or national scale and limited potential for substitution*	• *Aquifer providing potable water to a large population* • *EC designated Salmonid fishery*
High	• *attribute with a high quality and rarity, local scale and limited potential for substitution* • *attribute with a medium quality and rarity, regional or national scale and limited potential for substitution*	• *GQA Grade A reach of river* • *aquifer providing potable water to a small population* • *EC designated Cyprinid fishery*
Medium	• *attribute with a medium quality and rarity, local scale and limited potential for substitution* • *attribute with a low quality and rarity, regional or national scale and limited potential for substitution*	• *GQA Grade B / C reach or river* • *Aquifer providing abstraction water for agricultural or industrial use*
Low	• *attribute with a low quality and rarity, local scale and limited potential for substitution*	• *Floodplain with limited existing development*

Stage 2 enables the completion of the environmental capital sections (features, attributes, and importance criteria) of Worksheet 5 for project and spatially detailed based corridor studies and Worksheet 6 for strategic and spatially aggregate based corridor studies.

Available data

The geographic scale of the proposal will determine the availability of data more than the strategic scale. Nationally the Environment Agency has digital datasets available for:

- Chemical GQA, Rivers and Catchment Areas, Groundwater Vulnerability, Source Protection Zones (from July 1999), EC Designated Fisheries, and Flood risk zones (currently held regionally, available nationally from September 1999).

It should be possible to use these at both a small and large scale in conjunction with GIS data on the proposal. The degree to which qualitative interpretation of water feature data (such as rigorous identification of attributes and their scale, rarity and substitutability) can be made will vary with the size of the study area. Because strategic studies are more likely to cover a large area, they will be less amenable to interpretation of this sort. However, where the study area is small it should be possible to comment on the importance of specific attributes of the water features identified.

Stage 3: Appraisal of the potential impacts of the proposal on valuable attributes

The potential impacts of a transport proposal should be considered for each valuable water attribute identified. The impacts of a specific scheme will be identified during the environmental impact assessment process and these will then be used in the appraisal. Potential impacts are appraised in two steps, estimation of impact magnitude and estimation of impact significance.

Magnitude

At these levels it should be possible to identify the potential impacts (both positive and negative) of the route based proposals to a reasonable level of detail. Their magnitude can be determined by appraising the effects predicted for exposed attributes. Table 4.17 provides guidance on the magnitude criteria for potential impacts, with some examples. The magnitude of the potential impact is completely independent of the value of the attribute affected and therefore gives no indication of significance when considered alone.

Table 4.17: Criteria for determining impact magnitude

Magnitude	*Criteria*	*Example*
Major	*Results in loss (or gain) of the attribute*	• *change in GQA grade of river reach* • *compromises (or generates) an employment source* • *loss of EC designated Salmonid fishery* • *major loss of flood storage* • *pollution (or reduction of pollution) of a source of potable abstraction*
Moderate	*Results in impact on integrity of attribute or loss (or gain) of part of attribute*	• *change in productivity of a fishery* • *change in the contribution of effluent in the receiving river, but insufficient to change its GQA grade* • *reduction (or increase) in the economic value of the feature*
Minor	*Measurable changes in an attribute, but of insufficient size to affect its function*	• *discharges to watercourse but no significant change in fishery quality, productivity or biodiversity*
Negligible	*Results in an impact on attribute but where the effects on the attribute are not noticeable*	• *no significant impact on the economic value of the feature* • *no significant change in flood risk*

For each attribute identified the magnitude of the impact should be recorded in the magnitude column of Worksheet 5.

Significance

The significance of a potential impact is estimated by its magnitude and the value of the affected attribute. Table 4.18 provides guidance for determining the significance of a potential impact based on its magnitude and the importance of the attribute

Table 4.18: Criteria for estimating the significance of potential impacts

Magnitude of potential impact	*VALUE OF ATTRIBUTE*			
	Very High	*High*	*Medium*	*Low*
Major	*Very Significant*	*Highly Significant*	*Significant*	*Low Significance*
Moderate	*Highly Significant*	*Significant*	*Low Significance*	*Insignificant*
Minor	*Significant*	*Low Significance*	*Insignificant*	*Insignificant*
Negligible	***Low Significance***	***Insignificant***	***Insignificant***	***Insignificant***

Where the predicted potential impact is highly uncertain as a result of lack of information or insufficient design details, this should be considered as part of the appraisal. If a more significant, but less probable impact is identified, then this may warrant a higher classification to take account of the potential for a more significant impact. Uncertainty will require the use of best judgement by the appraiser, based on the relative probability of the possible outcomes and their significance.

The significance of the impact on each attribute should be recorded in the Significance column of Worksheet 5.

Stage 4: Overall assessment score

The overall impacts of the proposal are summarised by a qualitative comment and an overall assessment 'score' entered in the relevant worksheet. For route based studies, the assessment score is on a textual seven-point scale (Slight, Moderate, and Large, positive and negative impacts; and Neutral).

It is unlikely that the construction of a new transport route (rail or road) will have a net positive impact on the water environment, although it may help to achieve benefits (e.g. upgraded pollution prevention measures on the new route, or carrying river restoration as part of a scheme). Proposals aimed at modal or route shift have greater potential for beneficial impacts by reducing or redistributing traffic in areas where it is currently causing adverse impacts.

Where a proposal affects a number of sites a judgement will need to be made concerning the cumulative impacts of the proposal. The proposal should be classified as a whole and the potential impacts on individual features, or attributes, combined in the overall classification. In some cases the impacts on one important attribute will be sufficient for a moderate or severe adverse impact classification for the whole proposal, while for others a series of cumulative or conflicting impacts will need to be considered.

It is not useful to provide prescriptive guidance for determining an assessment score, because each combination of positive and negative impacts will be different. Where more than one feature is involved, judgements about the overall assessment score will be required, to compare the relative significance of one group of impacts with another. The indicative

criteria below can be used for guidance, but each experience and an understanding of the proposal will also be required. The qualitative comment box should be used to provide further information on the basis for reaching the assessment score for that option.

Where a proposal is under continuing development and refinement it is possible (or even probable) that the assessment score will change. This may be a result of changes in the proposal, or the agreement of certain mitigation options to moderate any impacts identified at an earlier stage. Therefore the assessment score given for the proposal should be based on current understanding of its content, or expected mitigation, rather than on assumption that measures to counter any adverse impacts identified will be incorporated if this has not been agreed.

The scoring categories described below should not be considered as comparable with those determined for other environmental sub-objectives, due to qualitative differences between them.

Qualitative comment on the effects of a scheme

This qualitative box on the Appraisal Summary Table should state whether features and elements present in the water environment are typical of the locality and summarise the overall effect of the project or proposal on the water environment.

Methodology for strategies

Stages 1 and 2 of the methodology for area studies will be the same as that for appraisal of studies where route information is known. However, the level of detail available on the potential impacts will be considerably less when no route specific information is available. Although data on the importance of environmental attributes may be relatively detailed it is likely that the available impact data will be limited to changes in vehicle kilometerage and gross landtake within an area. In these cases it may only be possible to say whether an option has a positive or negative affect within the sub-area being considered.

Stage 3: Appraisal of the potential impacts of the proposal on valuable attributes

Impact significance is determined using a series of environmental objectives for the region affected by the proposal. These objectives are determined in two ways; firstly, using national and regional environmental policy objectives; and secondly, using sub-area specific objectives determined from the review of the environmental capital in the area.

Because of the lack of impact detail available at the strategic level, impact significance can only be presented as supporting or contradicting the objectives which apply to it. Examples of objectives based on a review of environmental capital are:

- the prevention of additional hardstanding in an area where there is an existing flood risk;
- reduction in traffic flows in areas with particularly important surface waters;
- redirection of hazardous waste movements away from areas of high groundwater vulnerability.

Where an option being considered contradicts a national, regional or environmental capital derived objective this is recorded in Worksheet 6 as a negative impact. Where it supports an objective this should be recorded as a positive impact, while if there is no discernible impact arising from the proposal this should be recorded as neutral.

Stage 4: Overall appraisal score

For area based proposals of this scale the assessment score will necessarily be much less precise than for studies where specific route options have been defined. The assessment score derived is based on the degree to which the proposal supports or contradicts the environmental and specific water related objectives that are relevant to the study area. The proposals are assessed

using a four-point scale (significant positive contribution, significant negative contribution, mixed contribution and insignificant contribution). The uncertainty in impact evaluation makes it more appropriate to use a mixed contribution 'score' rather than slight, or moderate positive and negative scores, because it avoids making an unrealistically confident prediction of impacts which might be taken out of context. In the case of a mixed contribution score the qualitative comment box will be important for identifying the positive and negative impacts considered.

Clearly, in many cases the proposal will have mixed impacts and it will be necessary to compare the relative and cumulative importance of different impacts. This requires the appraiser to use judgement based on their experience and understanding of the proposal. Some indicative criteria are presented below to assist in appraisal, the qualitative comments box should be used to provide further information on the basis for reaching the assessment score for that option.

Significant Positive Contribution – where the proposal may result in a positive impact on the water environment, because it either:

- supports the water relevant objectives which apply to the study area;
- has mixed positive and negative impacts, but the positive impacts are much more significant than the negative impacts (this requires judgement and should be justified in the qualitative comments box).

Significant Negative Contribution – where the proposal may result in a negative impact on the water environment, because it either:

- contradicts the water relevant objectives which apply to the study area;
- has mixed positive and negative impact, but the negative impact are much more significant than the positive impacts (this requires judgement and should be justified in the qualitative comments box).

Mixed Contribution – this score should be used where the project has positive and negative impacts, which cannot be considered insignificant, but do not clearly indicate that the overall impact will be significantly positive or negative.

Insignificant Contribution – where the project has no significant impacts on water related objectives for the study area

Worksheet 5: Environment - Water (Project Level)

Description of study area / Summary of potential impacts	**Feature**	**Attributes / Services**	**Quality**	**Scale**	**Rarity**	**Substitutability**	**Importance**	**Magnitude**	**Significance**
Study Area:									
Potential Impacts:									

Reference source(s): .....

Assessment score: .....

Qualitative comment: .....

Worksheet 6: Environment - Water (Strategies)

Objectives	**Positive, Negative or Insignificant Impact**
Environmental Capital Based Objectives:	
Regional Objectives:	
National Objectives:	

Reference source(s): .....

Assessment score: .....

Qualitative comment: .....

ENVIRONMENT AGENCY

PUBLICATIONS: CUSTOMER FEEDBACK

Road Transport and the Environment Risk Assessment and Options Appraisal: Final Summary Report. Report No. 37

We are continually trying to improve Centre outputs. To assist us we would be grateful if you would take a few moments to complete this questionnaire.

1. Content

How useful did you find the material in the report?

Excellent	Good	Satisfactory	Poor

2. Presentation

How clearly was the material presented?

Excellent	Good	Satisfactory	Poor

3. Follow up

If you contacted NCRAOA staff about the report, how helpful was our response?

Excellent	Good	Satisfactory	Poor

Name (Optional) _____ Region: _____

If you have other comments you would like to add please do so overleaf.

COMMENTS:

Thank you for taking the time to complete this questionnaire, which should be returned to:

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ENVIRONMENT AGENCY

memo

To	See below	Our ref	AB/00100/pg
From	Andrew Brookes	Your ref	
Ext Number	710 6818	Date	14 August 2000

Please find enclosed a report that summarises work on road transport issues. This work originally started with a Risk Profile, launched in 1997, and progressed to a risk assessment based on an event tree approach. The approach was pioneering and limitations and assumptions are made explicit in the report. Iteration of the work was limited by the funds available. Nevertheless the results do provide a number of useful pointers. The work proved valuable for Agency in meetings with Government. Perhaps the greatest impact to date has been through our input to DETR's 'New Approach to Appraisal', referred to as a key appraisal document in the Governments Strategy for Sustainable Development. We also influenced the 'Roads Review', which led directly to the a substantial reduction in the number of road schemes proposed for construction, and have been integrally involved with subsequent methodologies for transport, including Guidance on Methods for Multi-modal transport studies.

Your comments on the report would be welcome and a feedback form is attached. However whilst this work demonstrates the way the Agency can significantly influence others in areas that are not directly its responsibility, work on transport has had a mixed reception. knitting'. Your suggestions on future work for the Centre on transport would be welcome, particularly as we have recently entered a phase of beginning to define next year's work programme.

For members of the project board of the original risk project please find enclosed a copy of the relatively large report documenting the detailed results of risk screening and more quantitative risk assessment. This work is summarised in the main report but if anyone else feels they would like a copy please request one.

Thank you

A. Brookes

ANDREW BROOKES
OPTIONS APPRAISAL MANAGER

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