# Sustainable Construction, Maintenance and Operations 2008/09

## Task Element 2: An overview of Highway Agency Cost Benefit Processes and Sustainability

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# TE2: An overview of Highway Agency cost benefit processes and sustainability

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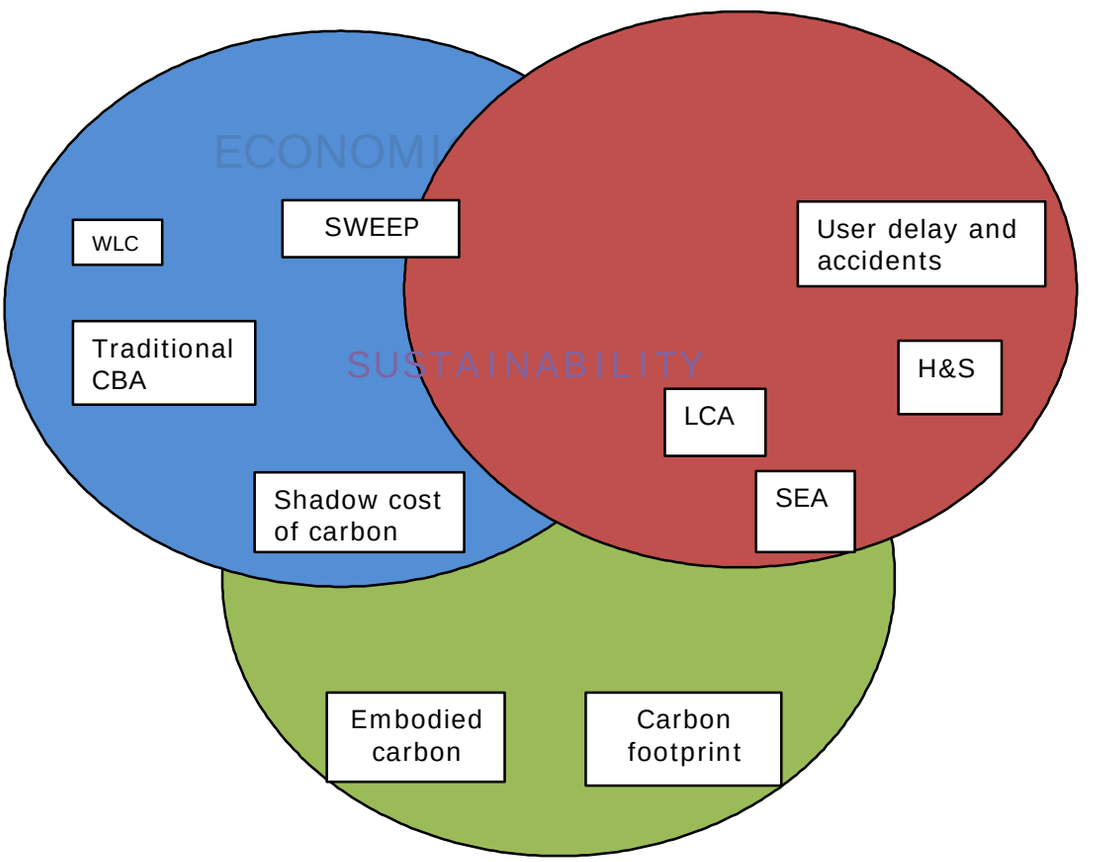
# 1 Introduction

The Highways Agency (HA) is committed to sustainability and the Sustainable Development Action Plan has drawn out key actions to deliver a more sustainable approach to the management and delivery of HA's business. Good progress is being made and the purpose of this report is to review how sustainability is currently being embedded within the HA's construction and maintenance processes and identify tools, processes and decision points where there are opportunities to increase the extent to which sustainability is considered. The report reviews the different approaches generally used to incorporate sustainability into decision making, illustrated by examples of how these approaches are being developed for sustainable construction and have been applied in other areas. It then reviews the project cycles for HA's Major Projects and maintenance schemes and the specific tools used to assess and evaluate these schemes. For each tool, it identifies the level to which sustainability is considered and then identifies specific actions that could be undertaken to improve the consideration of sustainability.

# 2 Assessing sustainability

Sustainability can be viewed as balancing the 'three pillars' of, environmental protection, economic and social development. There are a range of different types of tools and methodologies used to evaluate sustainability, many of which address two or more of these pillars. A number of the tools and approaches used in sustainable construction and the scope of their assessments are shown schematically in Figure 1. The different types of approaches and examples of their use in sustainable construction are discussed in detail in the following sections.

Figure 1. Assessing the different aspects of sustainability



## 2.1 Cost Benefit Analysis

The technique allows different options to be evaluated by calculating the costs and savings (benefits) associated with a policy or project option. The ratio, costs:benefits, for a number of options are then compared to assess the most economically favourable option. For example, the cost benefit assessment of salting the roads in winter takes account of the costs (labour, machinery and salt) compared to the benefits (costs saved through reduction in the number of accidents and disruption). In a cost benefit analysis all aspects such as time and accidents are converted into costs. A discount rate is used for evaluating the costs and savings that occur in the future.

Cost benefit analyses (CBA) can vary significantly in the level of detail and the scope considered. They are normally used to compare two or more options, e.g. carrying out a proposed highway scheme or not, using recycled aggregates or natural aggregates. Cost benefit tools currently used for highways assessments includes COBA (see Appendix, Section 1.3). This is the cost benefit system used by DfT to assess proposed highway schemes at the pre-project stage. In addition to the economic costs associated with construction and maintenance, COBA includes accident costs, driver's time and vehicle operating costs. The most recent version also includes monetisation of the changes in noise and GHG emissions before and after the construction of a highway scheme. TUBA (Transport User Benefit Appraisal) is a similar system. The sustainability of the construction methods and materials used for the options are not included in the analysis.

The Waste & Resources Action Programme (WRAP) has developed a cost benefit tool for construction waste from building sites. This takes into account the costs of developing a quality SWMP, a site logistics strategy, materials segregation and storage facilities and management and training time and compares them to the benefits achieved from the value of materials that would otherwise be wasted and the cost savings achieved by reducing the volume of waste going to landfill. The template includes the evaluation of associated carbon savings based on the reduction in waste. WRAP has also applied CBA to compare the economic costs of using recycled aggregates instead of primary aggregates, (published case studies Bangor and Essex). These are from the perspective of the cost savings to the contractor/client. The studies include construction costs only.

At a more strategic level, Defra has carried out a Cost Benefit Study on the use of Site Waste Management Plans. This compares the costs of preparing and implementing a SWMP with the costs saved through better resource management.

A European 5th Framework Programme R&D Project, FORMAT (Fully Optimised Road MAinTenance), undertaken between 2002-2005, aimed to identify methods for reducing the number, duration and size of road works for pavement maintenance purposes. It included four topics; road condition monitoring, road maintenance, traffic management and cost benefit analysis. The cost benefit work package involved the development of models to calculate the deterioration of the road structure and additional costs at road works. The costs calculated were maintenance, user delay and environmental costs. Models were constructed to calculate:

- Increased costs at roadworks due to user delays and accidents
- Cost of carrying out the maintenance including traffic management
- The effects of deterioration and maintenance on pavement value
- Environmental costs associated with the use of materials, fuel consumption and emissions due to road works and road deterioration (See Box 1)

The models were tested with real life cases and then integrated into one model to calculate costs of different maintenance options for a 30 year design life.

All costs were monetised.

Box 1: The environmental costs included in FORMAT

- $CO_2$ from material transport (derived from fuel consumption of lorry movements during maintenance). This included factors such as material quantity, transport distance and percentage of recycled material.
- Changes in $CO_2$ derived from changes in fuel consumption due to the roadworks
- Traffic noise as a result of the road works

The user inputs the distance from material sources and waste disposal sites. Use of locally sourced materials or on site recycling decreases this distance. The user also inputs the capacity of the trucks being used and their fuel consumption. The default costs and rates of working associated with the use of recycled materials for maintenance treatments take into account:

- Reduced/increased material costs
- Reduced/increased landfill tax or waste disposal levies
- Value of material removed for recycling
- Reduced/increased work rates as a function of the transportation distances
- Government incentives and incentives towards recycled materials

These figures are derived from 52 case studies on recycled aggregates.

Changes in traffic noise due to the change in pavement surface from deterioration of the pavement or resurfacing with a quieter road surface or change in traffic volume is calculated. The user inputs the population, environment (urban/rural), noise threshold and cost above the noise. The spreadsheet calculates the cost from the number of houses affected as a function of the population density and area affected.

The change in emissions due to the change in pavement conditions was also included. Deterioration increases fuel consumption and maintenance returns it to the previous level.

The social cost of carbon in 2004 was used (£75 per tonne).

The format final report "Guidelines for Delivering Fully Optimised Road Maintenance", published in 2006, describes the model in more detail. This model may provide an approach that can be used to include sustainability in the CBA tools used by HA. In particular it appears appropriate for SWEEP.S.

## 2.2 Whole life costing

WLC involves calculating all the costs involved in a scheme, by taking account of the full life cycle. For example, WLC includes the initial construction and maintenance costs when comparing the use of different types of pavements. It is used by the HA to optimise

maintenance regimes. Again this is normally based solely on economic costs and, like CBA, involves using a discount rate for costs that occur in the future.

Whole life cost tools developed for the Highways Agency include:

- SWEEP.S, which is a scheme specific tool to calculate the costs of pavement construction and maintenance. It includes user delays and accident costs.
- Scheme Analysis System (SAS) tool which calculates the WLC for geotechnical and drainage projects.
- Network Whole Life Cost Model, which currently does not include non-pavement items.

A current project being undertaken by TRL for the HA, is producing an integrated whole life cost tool which includes all highway features.

The construction resources and waste platform carried out a study suggesting standard WLC practices undervalue the impact of construction waste. The issues identified were:

- Net present value discounting.
- Waste disposal inflation.
- Design life (study period).
- Lack of cost of waste data (capital and whole life costs).

They used a house building project to demonstrate the modified methodology. Although the design life of a building project will differ from that of an infrastructure project, the other issues addressed such as taking into account rises in landfill tax and the inappropriateness of discounting waste costs are relevant. They found that implementing these changes in the WLC methodology for waste greatly increased the overall cost of the project.

## 2.3 Life Cycle Assessment

LCA considers the environmental and social impacts of a product throughout its life (cradle to grave) or for its manufacture (cradle to gate). The scope of an LCA includes looking in detail at the constituent components of a material, e.g. the environmental and social impacts of producing and transporting bitumen would be included in the LCA of a pavement. This is a major difference compared to WLC, which tends to be from the perspective of the material purchaser and maintainer and therefore assumes all the production costs (economic, social and environmental) are included in the purchase price of the materials. LCA does not put a price on impacts and cannot be used to weigh one type of impact against another; however, it is often used in conjunction with a multi-criteria analysis approach (see below) which enables such an evaluation. Databases of environmental profiles of construction materials are available for use with LCA.

TRL recently carried out a literature review of LCA on highway products for the HA. This found a number of LCAs on highways including:

- A LCA of a highway bridge carried out by Surrey County Council and Surrey University. The aim was to develop a method to assess the environmental impacts of structure management decisions. SimaPro and environmental profiles from BRE were used to undertake out a LCA of bridge maintenance within a life span of 120 years. The options of maintaining the bridge to a standard of good, average and poor were compared. The study included impacts on human health, eco-system and resources. The authors concluded that the environmental information generated by LCA could play an important part in highway maintenance decision making.

TRL is currently undertaking a collaborative project for the HA/MPA/RBA, to create a framework to allow the road construction and maintenance industry, its suppliers and clients, to measure the sustainability credentials of the products that they use and the road schemes that they produce. The project aims to produce a Sustainability Management Tool that provides transparent measurement of carbon emissions of road projects, based on a life cycle approach. It is envisaged that other environmental impacts will be incorporated in the future. TRL is developing the software tool for the industry. Initially the tool is being developed to assess the environmental impacts of highway pavement asphalt products. The original aim was to develop a tool to include WLC together with the social and environmental costs. Due to the complexity of the issues, the scope has initially been restricted to consider only carbon dioxide. The approach considers construction and maintenance, but not the subsequent use of the products. In the future the work could be expanded to include concrete pavements and other highway assets.

## 2.4 Carbon footprinting

Carbon footprinting can be considered as a 'sub-set' of LCA as it only considers carbon dioxide emissions but it does not necessarily consider the whole life cycle. Embodied carbon is similar, but normally cradle to gate.

Examples of tools and methodologies designed specifically for highway applications include:

- The HA's Carbon Calculation Methodology set out in IAN114/08. This covers activities the HA is responsible for including those of the MACs and Major Projects. The carbon emission sources have been categorised as energy, materials, transport, and waste removal. The tool includes office activities as well as construction and aims to calculate the HA's carbon footprint. Returns are filed quarterly by the MACs, Major Projects and other areas of HA's operations.

- The WRAP $CO_2$ calculator developed by TRL. This tool calculates the $CO_2$ associated with different options for pavement construction, including recycling techniques, use of hydraulically bound mixtures and recycled and secondary aggregates. The model includes transport and the embodied carbon of materials.

- The GHG calculator for the life of roads including maintenance, designed by Scott Wilson. This includes a shadow cost of carbon. They suggest the output could be used in economic and transport appraisals.

## 2.5 Strategic Environmental Assessments / Environmental impact assessments

SEA provides an objective evidence-based assessment of plans (e.g. transport or local development plans) by considering their environmental and some social and economic effects. EIA is an integral part of the planning process and provides a systematic way to assess the likely significant environmental effects of an individual project. Both involve evaluating a range of impacts and allow the comparison of different options and mitigation methods. Evaluation is usually based on subjective (expert) judgement.

## 2.6 Combining different types of assessment

Some types of assessments try to consider economic costs with the social and/or environmental impacts. There are two main approaches used, multi-criteria analysis and monetising all impacts.

### 2.6.1 Multi-criteria analysis

This uses a rating system to enable a mixture of qualitative and quantitative criteria to be assessed together. For example, the DfT's transport scheme appraisal system WebTag aims to combine cost benefit analysis with environmental impact analysis. This uses a rating system for environmental impacts. This involves some judgement by the user assessing the scheme. WebTag incorporates COBA which includes the shadow price of carbon. Appraisal Summary Tables (ASTs) are produced summarising the results of the analysis.

The WRAP Environmental Sustainability of Recycled and Secondary Aggregates (ESRA) tool, developed by TRL, estimates the relative sustainability of different types of aggregates (primary, recycled and secondary) for specified construction applications in specified locations. The model produces radar diagrams to compare different impacts, which are weighted subjectively from 1 to 3. The impacts include resource consumption, amount of water and energy used, $CO_2$ emissions, economic cost, H&S and local employment.

A Paper from the Netherlands describes a "Decision Support Model for Road Pavements" which includes WLC, LCA and MCA. The model includes economic, environmental and social impacts associated with pavement construction and maintenance. It is intended that the model will assist in the evaluation of different pavement design options. The user inputs road type, layer thicknesses, materials and other criteria, the program calculates the costs and environmental impacts. The environmental impacts include noise, land use, consumption of raw materials and energy resources and GHG emissions during production, transport, construction and use of the pavements. There are default settings for some pavement structures, but the user can add information for their specific design. The model uses both qualitative and quantitative methods to evaluate environmental aspects. Qualitative impacts are rated positive or negative against a reference option. Emissions are costed based on the price to prevent or remediate them.

### 2.6.2 Monetising environmental and social impacts

Monetising environmental and social impacts can be a useful way of ensuring they are appropriately considered in decisions. However, this can be difficult due to the lack of appropriate valuation data. A number of studies have looked at different ways to set a value on environmental and social impacts. For some impacts, such as the cost of an accident and the shadow price of carbon, these have become accepted and used in cost benefit studies. Other impacts such biodiversity and visual impacts are more difficult to cost, relying on methods such as contingent valuation. Relevant work includes:

- The HA's SWEEP model includes monetisation of some social costs, such as accidents and user delays. These are converted into monetary terms to aid the evaluation of different highway schemes or maintenance regimes.

- The shadow price of carbon– set by Defra. This is the cost set per tonne of carbon and is the value to be used in appraisals. Future emissions are discounted similarly to other costs, as cost increases with time as the damage gets closer.

- Valuing landscape impacts- report by TRL and partners. Landscape is valued on the basis of property prices and travel prices (the price people are willing to pay to visit the site).

- European 'Footprint' project. This looked at the marginal costs of road and rail transport and included the costing of environmental and social impacts. For example UNITE, a project by Leeds University that was referenced in the report, costed impacts such as air pollution in terms of health care costs.

- UEA paper looking at putting costs on environmental impacts and including them in COBA.

- A study for DETR carried out in 1999 to inform the introduction of aggregate levies investigated the environmental impacts of quarries. There were two phases. The environmental impacts were monetised using contingent valuation (CV) (willingness to pay) and hedonic price (HP) (house valuation) methods based on surveys of local residents and non-residents for different quarry sites across the country. The surveyors asked participants how much they would be willing to pay for a particular quarry to close early.

# 3 Review of the HA project life cycle

The majority of HA projects are either individual Major Projects or part of a programme of work carried out by the Managing Agent Contractors (MACs) contracted to manage the HA areas. The need for a specific Major Project is evaluated and tendered for individually and has to go through an extensive appraisal process. Smaller projects are proposed by the MACs as part of a four year programme of maintenance and require less evaluation (Table 1). The life cycles of the different types of project are described in the following sections together with a description of the tools employed to provide information at each stage and a discussion about the extent to which sustainability issues are considered at each point.

Table 1. Summary of the types of highway project

| | Major Projects (over £5 million) | MACs | | | |
|---|---|---|---|---|---|
| | | Local Network Management Schemes | Regional roads programme | | |
| | | | Renewals of Roads | | Routine Maintenance |
| | | | Renewal Works (over £250k) | Small Works (under £250k) | |
| Management process | Project control frame work | Value Management | Value Management | Value Management | Managed as necessary by the MACs |
| Key project Documents | Appraisals Summary Tables (AST) | Project Appraisal Report (PAR) | Renewal scheme Project Approval Form (PAF) (one for each type of asset) | Small works PAF | |
| WLC tools | COBA | COBA | SWEEP.S SAS (non-pavement assets) | SWEEP.S for projects ¡Ý £150k | |
| Scoring system | Decision made using information in AST | Different scoring system depending on the focus of the scheme | Safety, VfM, RoD and environment | Simplified version of renewal works system with same categories | |

## 3.1 Major projects

Major projects are large projects (over £5 million) which aim to extend the existing network, for example bypasses or carriageway widening. There are four divisions within Major Projects which direct this work; South, North, Midlands & South West and M25. Major roads projects are jointly initiated by the Department for Transport (DfT) and the Highways Agency through a “Strategy, Shaping and Prioritisation” process. This process: identifies and prioritises potential transport problems; shapes, investigates and assesses the viability of potential transport schemes; and initiates projects. The DfT and HA Project

Control Framework was launched in April 2008 to facilitate the management of major projects in a consistent manner. More information can be found in the Project Control Framework Handbook.

The major project lifecycle is split into three phases; options, development and construction as shown in Figure 2. The phases are further split into seven project stages. DfT is responsible for the options phase and then passes responsibility to the HA from the development phase onwards. However, both organisations are involved throughout the project lifecycle; the HA as Project Manager and the DfT as Project Sponsor. There is also a Pre-project phase, which is not shown on Figure 2.

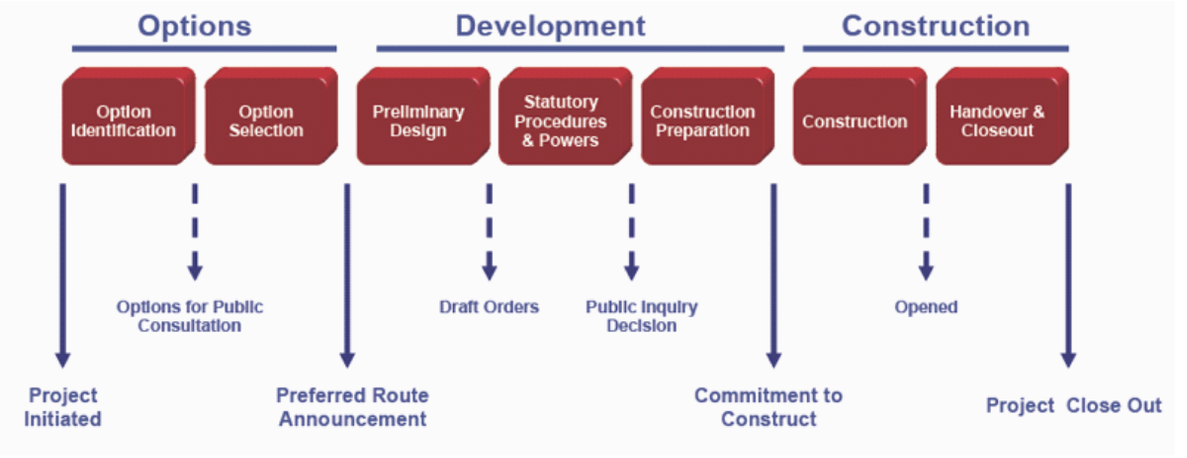



Figure 2. Major Project Life Cycle

A transport appraisal takes place in the pre-project phase, before the project initiation and the lifecycle shown in Figure 2. The transport appraisal process considers the worth of carrying out the project and whether it should be investigated further. The WebTag methodology is used for this appraisal process (see Appendix A).

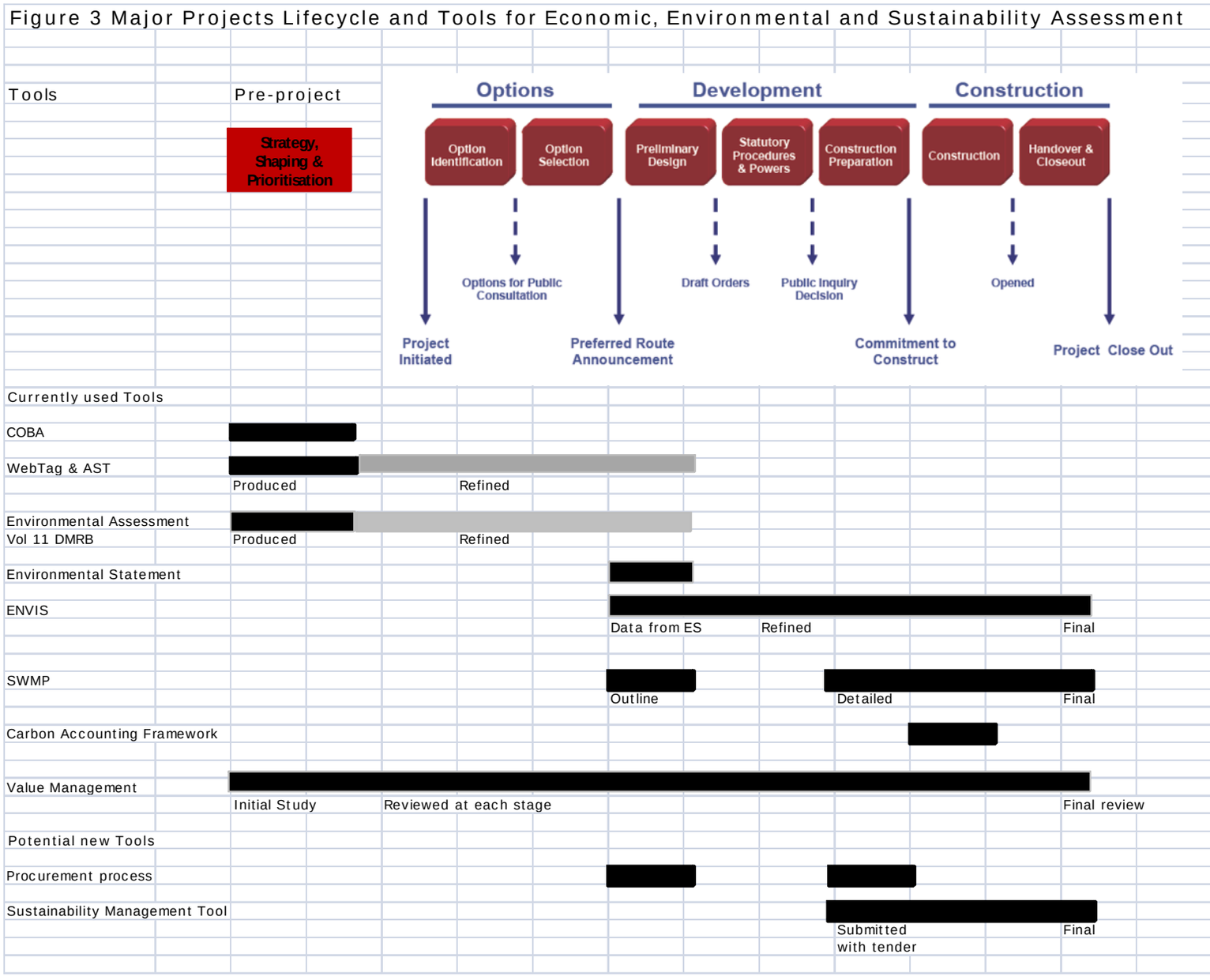
Table 2 describes for each project stage, the different assessment methodologies and principal tools that feed into the decision making process and the extent to which sustainability is included. This includes economic tools, environmental assessments and sustainability-related tools such as Site Waste Management Plans (SWMPs), EnvIS and the HA Carbon Accounting Framework. More detailed descriptions of the individual tools are included in Appendix A. We understand that HA intend to combine the existing value management and value engineering processes into a single, enhanced value management system, so only value management is shown on Table 2. Full details of information required for each stage, including the pre-project phase, can be found in the Product Matrix of the Project Control Framework Handbook.

The application of the different tools and the opportunities for new tools are summarised in Figure 3. These are discussed further in Section 4.

Table 2. Project stages and inclusion of sustainability

| Project stage | Stage description | Assessment methodology and tools used and their outputs | Inclusion of Sustainability in current assessment | Opportunities for further inclusion of sustainability |
|---|---|---|---|---|
| Pre-project | Strategy, shaping and prioritisation. | Tools/Assessment methodology<br>• WebTag/AST<br>• COBA/TUBA<br>• DMRB<br><br>Outputs<br>• Appraisal summary table<br>• Environmental assessment report<br>• Order of magnitude cost estimate<br>• COBA ratio | WebTag/AST includes environmental & social impacts, before & after scheme.<br><br>COBA includes noise & $CO_2$ emissions before & after scheme.<br><br>Neither includes impact of construction. | Include materials resource management in DMRB (new IAN)<br><br>Include impacts of construction in:<br>• WebTag<br>• COBA |
| Option identification | Set of options are identified that will be taken to public consultation. | Tools/Assessment methodology<br>• DMRB Vol11<br>• Traffic forecast models<br>• Value Management<br><br>Outputs<br>• Environmental assessment report<br>• Traffic forecast | Environmental Stage 2 assessment.<br><br>Current DMRB guidance does not include resource management issues. | Include materials resource management section in the Environmental Impact Assessment Report<br><br>Include consideration of sustainable construction in value management process. |
| Option Selection | Public consultation.<br><br>The preferred option is selected and an outline business case produced. | Tools/methodology<br>• Comments from public consultation.<br>• Refined cost estimate of preferred option.<br>• Refined environmental impact<br>• Traffic forecasts and economic benefits of preferred option.<br>• Value Management. | Refined environmental assessment | Include materials resource management section in the Environmental Impact Assessment Report<br><br>Include consideration of sustainable construction in value management process. |
| Project stage | Stage description | Assessment methodology and tools used and their outputs | Inclusion of Sustainability in current assessment | Opportunities for further inclusion of sustainability |
| Preliminary design | Carry out surveys and preliminary design.<br><br>If ECI, contractor appointed and initial target cost agreed. | Tools/Assessment methodology<br>• Topographical, geotechnical and environmental surveys<br>• Refined traffic and economic appraisals<br>• Value Management | Refined environmental assessment<br><br>Environmental Statement (ES).<br><br>The ES normally focuses on impacts before and after | Include material resources section in ES.<br><br>First version of SWMP.<br><br>First version of material and waste section of EnvIS. |

Figure 3 Major Projects Lifecycle and Tools for Economic, Environmental and Sustainability Assessment



## 3.2 Area work programmes

Schemes under £5 million, maintenance works and routine maintenance and operation of the network are managed within the 14 HA areas under rolling four year work programmes. They are carried out by the Managing Agent Contractors (MACs) for each area. These different types of schemes and their key attributes were summarised previously in Table 1.

### 3.2.1 Local Network Management Schemes (LNMS)

LNMS are individual schemes which are not classified as maintenance, but are not large enough to be classified as major projects (value of LNMS is less than £5 million). These tend to be small improvement (not maintenance) projects on the existing network. The need for a LNMS is identified by the area Managing Agent Contractor (MAC) through routine condition surveys and local knowledge. Project proposals for each LNMS are submitted by the MACs to the HA. The MACs submit a brief programme, risk register and method statement, identifying each activity and sub-activity, and showing sufficient detail to enable the pricing assumptions to be understood. They include the methodology, decision processes and assumptions made to provide cost information together with health and safety and supervision requirements.

Potential schemes above a certain cost threshold go through a Value Management (VM) process and are scored against a number of criteria. LNMS are classified depending on the type of problem they are aiming to address, e.g. safety, economy, environment or integration projects. The nature of the assessment depends on the focus of the scheme; environmental schemes are assessed and scored for their effectiveness in addressing a particular environmental problem e.g. a breach of environmental legislation. The scoring system for an environmental LNMS is shown in Table 3. Although focused on environmental criteria, the scoring also includes benefits and disbenefits to other aspects. The resultant Value Management score (1 to 10) provides the priority level of the scheme. For example:

- 10 (unavoidable)
- 7 (highly worthwhile)
- 4 (worthwhile)

The first year rate of return (FYRR) is another criteria used in project assessment. This is a summation of the safety and economic benefits and disbenefits accrued in the first year after opening of the scheme, divided by the total scheme costs. It includes all the accident or journey time benefits or disbenefits that can be quantified.

For each LNMS the MACs have to prepare a Project Appraisal Report (PAR) (see Appendix A). The PAR is a summary document based on the DfT's NATA (WebTag) in which the need for the project, its costs and benefits (including those that are not monetised) are collated to assist in judging the worth and priority of the project. The information contained in the PAR feeds into the VM process. Some types of scheme (safety, economy and environment) use the PAR to automatically calculate the VM score. Others are scored subjectively during an Area Programme Value Management Workshop. These workshops discuss the potential schemes for the area and are attended by representatives from the MAC, HA and technical specialists. The schemes which are approved will be incorporated within the four year rolling programme of maintenance adopted by the HA. Schemes in the range £100k to £250k are reviewed at VM workshops held at each stage of the project

lifecycle, but with less rigour than those over £250k. More information on the VM process can be found in the VM Guidance for LNMS and the 2009 interim update.

Table 3. Scoring Definitions for Environmental Local Network Management Schemes

| | **Contribution to HA environmental policies (0.45)** | **Other (national and local) policies (0.2)** | **Quality Value (0.2)** | **Other network impacts (0.15)** |
|---|---|---|---|---|
| **4** | Proposed project is a *legislative requirement* (either relating to criminal or civil liabilities). | Proposed project is compliant with national Statutory Advisor's (CA, EA, EH or EN) policy and/or objectives | Demonstrated value with detailed consideration of options, functionality, sustainability & high success potential. | Cumulative network impact score is equal to or greater than +4. |
| **3** | Proposed project contributes to Ministerial *commitments and HA key performance measures*. | Proposed project is in direct partnership with national, regional or local organisation. | Demonstrated value, with detailed consideration of options, functionality, sustainability & medium success potential. | Cumulative network impact score is +3. |
| **2** | Proposed project contributes to Ministerial *agreed international conventions/agreements* | Proposed project is in line with national, regional or local initiatives of community groups and local organisations. | Demonstrated value, with adequate consideration of options, functionality, sustainability & medium success potential. | Cumulative network impact score is +1or+2. |
| **1** | Proposed project is compliant with national Highway Agency policy and/or objectives | Proposed project is in line with regional or local Area Strategy. | Limited demonstration of value with some consideration of functionality or sustainability or options, & low success potential. | Cumulative network impact score is 0. |
| **0** | No direct link with any national policies. | No direct link with documented local initiatives. | Poorly developed argument for value, with little consideration of alternative options | Cumulative network impact score is negative. |

### 3.2.2 The regional roads programme

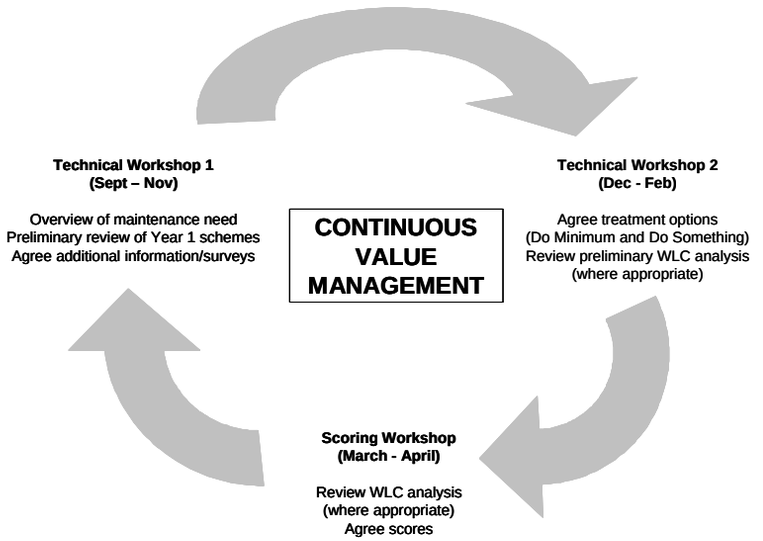
The regional roads programme consists of Renewals of Roads and Routine Maintenance (Table 1). Renewals of Roads comprises of Renewal works/schemes and Small works for pavement and non-pavement assets. Renewal works are defined as those >£250k, and typically include the replacement of existing parts of the asset e.g. reconstruction, resurfacing and joint sealing. Small works are maintenance work below £250k, typical activities include repairing potholes. The Value Management process, used in LNMS, applies to the Renewal of roads but not to routine maintenance.

A programme of Renewal works and Small works is submitted by the MAC for each area. The four stages of developing programmes of work are:

- Identification of potential projects – Identification of potential projects to meet set objectives by HA Area Teams in liaison with the MACs
- Review and prioritisation of projects (Area Level) – Assessment and review at Area level including Area Value Management
- Programme review, update and assembly (Regional Level) – RPPT's (Regional Performance, Planning and Transaction Teams) and Regional Panels review Area submissions and identify a prioritised regional programme for each MPML (Management Plan Monitoring Line) category to match the indicative allocations for the regions
- Monitor and review – Monitor programme and take necessary action to achieve the agreed outputs and resource consumption

Area value management workshops are used to review this 4 year programme each year using the same criteria as described in Section 3.2.1. The VM process is illustrated in Figure 4.

Figure 4. The Value Management Process



A project approval form (PAF) is completed for each road renewal project in the programme and submitted in advance of the VM workshops. The PAF is the main record of the project and includes the VM score and brief rationale behind the score for each criteria. The annual cycle involves two Technical Workshops followed by a Scoring workshop.

Currently VM workshops for renewal works carried out by the MACs focus on the technical need for a project with limited discussion on incorporating sustainability issues, such as the potential in different options for using recycled materials. Comments recorded on the PAF are limited to statements such as “the new surfacing will reduce noise” and “repave is the environmentally friendly option”, or just state “neutral effect”.

At the Scoring Workshop the projects are scored under four categories (see Table 4):

- Safety (20%)
- Environment (10%)
- Value for Money (VfM) (40%)
- Reduction of Disruption (RoD) (30%)

The WLC model SWEEP.S (see Appendix A) is used to determine the scores for value for money (economic indicator (EI)) and reduction of disruption. Therefore SWEEP.S outputs constitute 70% of the VM score. SWEEP.S is only carried out after the options and scope are discussed at a technical workshop. The environment score is produced by assigning +1 for an increase, 0 for no change and -1 for a decrease in noise, landscape/townscape, biodiversity, water environment and recycling. An Environmental Assessment is required for projects where environmental sensitivity has been identified.

The VM guidance for road renewals provides more information. The current version is January 2009.

Small works are assessed and scored by a local panel using a simplified version of the renewals scoring system. The environment criteria is made up in the same way as for the Renewal Works.

Table 4. Value Management Scoring Framework - Pavements

| Score Range | Criteria (and weighting factor) | | | |
|---|---|---|---|---|
| | **Safety (0.2)** | **Value for money (0.4)** | **Reduction of Disruption (0.3)** | **Environment (0.1)** |
| **≥80-100** | Substantial deficiencies and linked high accident rating, supported by an accident analysis. **The works address a proven accident problem (Unavoidable)** | The proposed option is appropriate for the defects and has an **EI > 7.0 and ≤ 20.0** compared to the ***Do Minimum*** option. | Reduction of user delay **¡Ý 80 %** relative to the ***Do Minimum*** | The works will have a strong positive impact on a significant and clearly defined environmental problem. |
| **≥50-<80** | Moderate deficiencies and linked, above average accident rating, supported by an accident analysis OR substantial deficiencies and average accident rating. | The proposed option is appropriate for the defects and has an **EI > 1.0 and ≤ 7.0,** compared to the ***Do Minimum*** option. | Reduction of user delay **¡Ý 50 % and < 80 %** relative to the ***Do Minimum*** | The works will have a moderate positive effect on a significant and clearly defined environmental problem. |
| **≥30-<50** | Moderate deficiencies and linked, average accident rating OR Substantial deficiencies and low accident rating. | The proposed option is appropriate for the defects and has an **EI >0.3 and ≤ 1.0** compared to the ***Do Minimum*** option. | Reduction of user delay **¡Ý 30 % and < 50%** relative to the ***Do Minimum*** | The works will have a slight positive effect on an identified environmental problem. |
| **≥10-<30** | Slight deficiencies and average accident rating OR Moderate deficiencies and low accident rating | The proposed option is questionable for the defects and has an **EI >0.1 and ≤ 0.3** compared to the ***Do Minimum*** option. | Reduction of user delay **¡Ý 10 %** and **< 30 %** relative to the ***Do Minimum*** | The works are expected to have a neutral effect on the environment. |
| **0-<10** | Slight deficiencies and low accident rating OR No deficiencies **The works are expected to have a neutral effect on safety.** | The proposed option is unnecessary or inappropriate and/or has an **EI >0 and ≤ 0.1** compared to the ***Do Minimum*** option. | Reduction of user delay **> 0 % and < 10%** relative to the ***Do Minimum*** | The works are likely to have a negative impact on the environment. |

| | **Quality of submission** |
|---|---|
| **3** | Technical information is sufficient and the interpretation clearly justifies the proposed treatments. Any outstanding issues can be resolved at Area level. **A robust VM score can be given**. **Year 1 projects need no further VM.** |
| **2** | The technical information is deficient or the interpretation is flawed such that the justification of the works is unclear and scoring uncertain. **Revised submission and further VM required.** |
| **1** | The supplied technical information is inadequate to support the proposed works**. New submission and VM required.** |

**Journey Time Reliability Impact**

In addition to the Reduction of Disruption assessment, the disruption caused by the main works shall be assessed and placed in one of the following categories:

Negligible/ Low - Green
Moderate - Amber
High - Red

(Refer to Para C27 of Part 1 for more information)

### 3.2.3 Summary

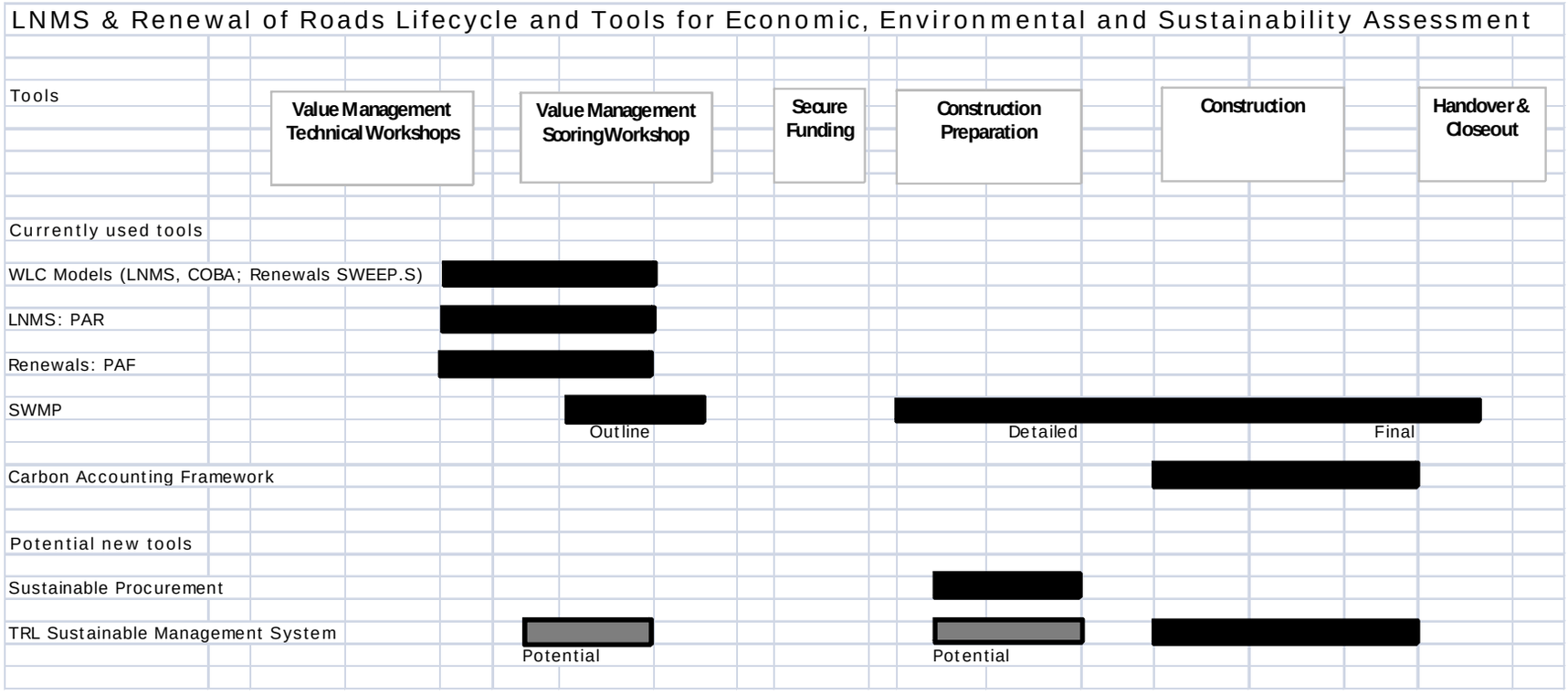
The evaluation methodologies and tools used for the Local Network Management Schemes and Regional Roads Programme have been described in the previous Sections. These are summarised in Table 5. The extent to which sustainability is already incorporated within the evaluation is noted together with opportunities to increase its consideration. This is discussed further in Section 4. Figure 5 summarises the different project cycles and the tools employed.

More detailed descriptions of the individual tools are included in Appendix A.

Table 5. Summary of Assessment Methodologies used in Area Work Programmes

| Project type | Description | Assessment methodology and tools used and their outputs | Inclusion of Sustainability in current assessment | Opportunities for further inclusion of sustainability |
|---|---|---|---|---|
| Local Network Management Schemes | Small improvement (not maintenance) projects on the existing network below £5 million | Tools/Assessment methodology<br>• NATA<br>• COBA<br>• Value Management Process<br><br>Outputs<br>• Project Appraisal Report (PAR)<br>• VM score | PAR environmental sub-objectives as in WebTag | Include impacts during construction in:<br>• PAR<br>• COBA<br><br>Use of SWMPs<br><br>Discussion point in VM workshops. Include in VM score for all types of project |
| Renewal works/schemes | Works above £250k which replace existing parts of the asset | Tools/Assessment methodology<br>• SWEEP.S<br>• VM<br>• Environmental assessment for some projects<br>Outputs<br>• PAF<br>• VM score | Some discussion of environmental impacts and use of recycled materials included in VM Workshops | Include impacts during construction in SWEEP.S<br><br>Use of SWMPs<br><br>Discussion point for VM workshops<br>Use of Netwaste Infrastructure tool (to be developed by WRAP) to produce waste estimate which can be discussed in VM workshop |
| Small works | Works below £250k which replace existing parts of the asset | Tools/Assessment methodology<br>• VM<br>• SWEEP.S for projects ¡Ý £150k<br><br>Outputs<br>• VM score<br>• Small works PAF | Some discussion of environmental impacts and use of recycled materials included in VM Workshops | Incorporation into SWEEP.S<br><br>Discussion point for VM workshops<br>Use of Netwaste Infrastructure tool (to be developed by WRAP) to produce waste estimate which can be discussed in VM workshop |

Figure 5


LNMS & Renewal of Roads Lifecycle and Tools for Economic, Environmental and Sustainability Assessment
Tools
Value Management Technical Workshops
Value Management Scoring Workshop
Secure Funding
Construction Preparation
Construction
Handover & Closeout
Currently used tools
WLC Models (LNMS, COBA; Renewals SWEEP.S)
LNMS: PAR
Renewals: PAF
SWMP
Outline
Detailed
Final
Carbon Accounting Framework
Potential new tools
Sustainable Procurement
TRL Sustainable Management System
Potential
Potential

# 4 Incorporating sustainability into the project lifecycle

## 4.1 Major projects

The greatest opportunities to implement sustainable construction practices, such as maximising resource efficiency and minimising wastes, occur during the Options and Development phases of the project cycle. The specific opportunities identified during the review of the methodologies and tools are discussed in the following sections.

### 4.1.1 At the options phase

Aim: To include an evaluation of the potential for sustainable construction for the options being considered, not just in terms of before and after the scheme has been built, but also during construction. E.g. What opportunities are there for including recycled materials for each option? Will one option produce significantly more waste or use significantly more resources.

#### Potential opportunities for greater inclusion of sustainability

The WebTag methodology used to evaluate transport schemes currently includes 'Environment' as one of the 5 main criteria and a set of environmental sub-objectives. It does not include a sub-objective relating to material resources or waste arisings. The recently developed IAN 'Guidance on a framework for the assessment of materials' which is intended for inclusion in DMRB Vol 11, will provide data for materials and wastes for inclusion in the Environmental Impact Assessment and Environmental Statement which could also be included in the WebTag evaluation.

COBA, the cost benefit analysis tool used to assess proposed highways schemes includes the calculation of carbon emissions with and without the proposed scheme, monetised using the shadow price of carbon. The results feed into the overall CBA calculation and the 'Economic' evaluation within WebTag. Two potential opportunities exist to improve the consideration of sustainability. First, to include within COBA, the carbon emissions arising during the construction phase. This would take account of the different level of emissions associated with different construction products and procedures. Secondly, it may be possible to take account of a broader range of environmental and social impacts by quantifying and monetising them. These could include impacts during the construction and operational phases of a scheme. For example, during construction the impacts associated with quarrying, transportation and recycling of materials. During operation possible consideration of the social and health impacts associated with noise and air quality.

### 4.1.2 At the development phase

Aim: To consider sustainability issues at the early design stage and during the assessment of tenders.

#### Potential opportunities for greater inclusion of sustainability

During the development stage the environment and economic assessments are refined, hence additional sustainability considerations introduced during the Options stage will

continue to be included. In addition, the development stage offers further opportunities for a greater incorporation of sustainability within the decision making processes.
Major benefits can be gained by the consideration of sustainable construction during the design of a scheme. A wide selection of different options can be considered, including:

- recycling and re-use of materials (e.g. aggregates, top soil)
- re-use or adaptation of exisiting or temporary structures
- balancing cut and fill requirements
- review of locally available resources
- consideration of alternative processes e.g. double width paving, mobile asphalt plant
- 'just in time' stock control to reduce storage and wastage

The potential benefits associated with a number of these options are given in the 'Managing Down Costs Toolbox'.

The SWMP can be used as a key tool during the development phase. The use of an outline SWMP at the preliminary design stage can facilitate material resource efficiency and waste minimisation by helping to identify options for re-use and recycling. The application of SWMPs to HA construction and maintenance schemes is discussed in the SWMP IAN. WRAP are developing an Outline Design Tool for Infrastructure that will enable designers to select a number of options for reducing waste and evaluate their effect in terms of waste quantities, cost, recycled content and $CO_2$ emissions.

Procurement processes provide an excellent opportunity to ensure sustainable construction is embedded within the contractor's procedures. First, during the tendering stage, when the contractor can be asked to demonstrate sustainability has been considered within their proposed approach. The Sustainability Management System, currently under development by HA in collaboration with MPA and RBA could provide a useful tool for such an assessment. Secondly, specific clauses can be included within Contractors contracts to reinforce sustainable practices, examples of which have already been developed by WRAP and EA.

### 4.1.3 At the construction phase

Aim: To ensure that all opportunities for reusing materials, incorporating recycled materials and sending materials to be reycled are taken.

Potential opportunities for greater inclusion of sustainability

During the construction phase, further opportunities for the implementation of resource efficiency and minimisation of wastes are likely to become apparent during the regular update of SWMPs, and quarterly reporting of material resources and wastes to ENVIS and carbon emissions within the carbon accounting framework.

Further application of the Sustainability Management System may help identify alternative more sustainable operational processes and products.

On completion of the scheme it would be beneficial to routinely include evaluation of the sustainability of the scheme. The final version of the SWMP should include a comparison of actual and expected waste quantities and lessons learned for future projects.

## 4.2 Area work programmes

### 4.2.1 Local Network Management Schemes

Aim: To increase the extent to which sustainable construction considerations are included in the evaluation of different construction options.

Potential opportunities for greater inclusion of sustainability

Local Network Management Schemes are evaluated by means of a Value Management process. Environmental considerations are fed into this process through the PAR. The PAR tool, like WebTag on which it is based, includes environmental criteria. There is the opportunity to include consideration of material resources and waste within this evaluation.

Economic information for PAR is provided by COBA. As discussed previously for Major Projects, two potential opportunities exist to improve the consideration of sustainability within COBA. First, to include the carbon emissions arising during the construction phase and secondly, it may be possible to take account of a broader range of environmental and social impacts by quantifying and monetising them.

All LNMS require SWMPs which provide an excellent tool for the identification of opportunities for re-use and recycling of materials and for waste minimisation. As noted for Major Projects, the most effective resource management is when it is considered at the design stage of a scheme. The TRL Sustainability Management System offers a more detailed LCA approach to the evaluation of carbon emissions associated with road projects. WRAP are developing an Outline Design Tool for Infrastructure that will enable designers to select a number of options for reducing waste and evaluate their effect in terms of waste quantities, cost, recycled content and $CO_2$ emissions.

### 4.2.2 Renewal roads

Aim: To increase the extent to which sustainable construction considerations are included in the evaluation of different construction options.

Potential opportunities for greater inclusion of sustainability

Renewal of Roads projects are also evaluated using the Value Management Process. The first stages in this process are Technical Workshops to agree treatment options and review preliminary WLC analysis. The SWEEP.S tool is used to provide WLC estimates. There are good opportunities to improve the consideration of resource management and carbon emissions within SWEEP.S (see Section 2.1). The final stage in the value management process is the Scoring Workshop. This includes evaluation against four criteria: Safety, Value for Money, Reduction of Disruption and Environment (Table 4). Again the SWEEP.S tool provides the input for two criteria, Value for Money and Disruption, hence improved consideration of sustainability within SWEEP.S will be included within this final stage of the Value Management process. The use of re-cycled materials already contributes to the environment score in the VM process but only in a qualitative way. Presently MACs need to submit evidence that this is realistic.

As for other road schemes the use of SWMPs, and LCA tools such as TRL's Sustainability Management tool will facilitate a greater consideration of sustainability within the scheme. WRAP are developing an Outline Design Tool for Infrastructure that will enable designers to select a number of options for reducing waste and evaluate their effect in terms of waste quantities, cost, recycled content and $CO_2$ emissions.

# 5 Conclusions

There are good opportunities to increase the extent to which sustainable construction is considered within the evaluation of different HA construction and maintenance projects. This review has identified a number of decision points within the project life cycles where resource efficiency and waste management criteria could be included. For example, through monetising impacts and including them in cost benefit tools such as COBA and SWEEP.S, already used by HA. Through their inclusion in these tools, sustainability would be included in the economic evaluations used by WebTag, the Project Appraisal Reports and Project Approval Forms. The further development of COBA or SWEEP.S would be able to draw on the experience gained during previous work done on European and UK research projects, as reviewed in this report.

In addition, for Major Projects, the inclusion of guidance for the assessment of materials and waste arisings in DMRB Vol 11 will facilitate the inclusion of sustainable construction considerations within the preparation of the environmental assessment and Environmental Statement. This data could be directly included into the WebTag evaluation by the inclusion of an environmental sub-objective on resource management and waste. Likewise a similar approach could be adopted within the PAR for Local Network Management Schemes.

The statutory requirement to use SWMPs on all projects over £300k also offers good opportunities to increase resource management and minimise wastes. The recent IAN on SWMPs provides guidance on their application and encourages their use from early in the design stage to help identify resource efficiency options.

The LCA based Sustainable Management System currently being developed by TRL for the HA/MPA/RPA, will provide an assessment framework for the detailed evaluation of the carbon emissions from road schemes. This will be applicable for use by contractors during the design and evaluation of different technical and materials options.

Finally, sustainable procurement processes have been identified as providing a powerful tool in ensuring that sustainability is considered in the work undertaken by both Major Project contractors and MACs. The inclusion of requirements in both tender evaluations and contracts would help to embed sustainability throughout HAs construction and maintenance programmes.

# Appendix A: Highway assessment tools and information

## 1. Tools used at the scheme appraisal level

The decision on whether a scheme goes ahead or not is informed by a range of information depending on the size of the potential scheme. This includes:

- Cost benefit studies
- Traffic models and tools
- Environmental assessment
- Public inquiry
- Statutory consultees

Below are descriptions of the types of information and tools used to evaluate a project at a scheme level i.e. at the pre-project stage. These sources of information are also used at the options level to aid in selecting the preferred solution for particular transport problem, for example deciding between constructing a bridge or a tunnel.

### 1.1 WebTag

The Department for Transport (DfT)'s New Approach to Appraisal (NATA) is set out in WebTag (Transport Analysis Guidance website). The methodology evaluates transport schemes according to the following five criteria:

- Environment
- Safety
- Economy
- Accessibility
- Integration

There are sub-objectives set out under each of these criteria, for example under the environmental heading the objectives are:

- To reduce noise
- To improve local air quality
- To reduce greenhouse gases
- To protect and enhance the landscape
- To protect and enhance the townscape
- To protect the heritage of historic resources
- To support biodiversity
- To protect the water environment
- To encourage physical fitness
- To improve journey ambience

Projects are assessed against these sub-objectives, some of these assessments produce quantitative and some qualitative outputs. The criteria are summarised in an Appraisal Summary Table (AST). An example for a highway project can be found here. The AST is used to aid decision makers on whether the scheme represents value for money. The sustainability of the materials and methods used to construct the scheme are not considered.

The information collated in the AST is generated from a range of sources, including tools such as COBA or TUBA for the economic impacts and environmental assessments for the environmental impacts. The environmental assessments follow the guidance set out in DMRB 11.3.1. Most environmental impacts are given scores rather than monetised. However the increase or decrease in greenhouse gases as a result of the scheme is given in cost terms using the shadow price of carbon. This is calculated from the fuel consumption for the 60 year appraisal period with and without the scheme in place and does not include emissions emitted as a result of construction or maintenance.

The latest versions of COBA and TUBA include monetised carbon emissions from fuel consumption. There is a TAG greenhouse gas Excel sheet to calculate this if COBA or TUBA are not used. There are links with the GHG sheet given in DMRB Vol11, but the DMRB sheet is for only one year and does not monetise the emissions. The TAG sheet involves the user inputting the carbon emissions with and without the scheme.

## 1.2 Highways Agency Project Appraisal Report (PAR)

The HA Project Appraisal Report (PAR) is mandatory for smaller HA improvement projects (not major projects) that are not classed as maintenance (LNMS). Brief, short or full versions are required depending on the project value. The PAR is a summary document based on the DfT's NATA in which the need for the project, its costs and benefits (including those that are not monetised) are collated to aid in judging the worth and priority of the project. PARs are submitted by the Service Providers to the HA Service Managers and should be updated at each key decision stage. The document allows the benefits to be assessed against the DfT's five objectives for transport (environment, safety, economy, accessibility and integration). A Value Management Score is produced. The latest version is PAR5 which was published in March 2009. PAR5 consists of an Excel workbook and guidance. The latest version has been modified to monetises greenhouse gas emissions and noise. Noise is valued according to the TAG noise spreadsheet and GHG emissions are also valued using the TAG guidance. Other environmental impacts are rated according to the WebTag guidance. COBA, TUBA, JUICE may be used to obtain construction costs, but manual assessments are allowed for smaller projects. A cost benefit ratio is calculated using the monetised items. This can include carbon and noise if monetised for the full PAR. The sustainability of options for construction and maintenance of the improvement is not considered. The PAR provides data for the Value Management process.

| | | NON-APPRAISABLE SCHEMES | APPRAISABLE SCHEMES | | |
|---|---|---|---|---|---|
| | | | Scheme Costs | | |
| | | | <£25K | £25K – £250K | >£250K |
| PROJECT STAGE | Conception | Brief | <none> | Short | Short |
| | Pre-Public Consultation | <none> | <none> | Short | Full |
| | Pref. Solution Decision | <none> | <none> | Short | Full |
| | Draft Order Publication | <none> | <none> | Short | Full |
| | Commitment of Works Expenditure | Brief | Brief | Short | Full |

## 1.3 COBA

COBA (COst Benefit Analysis) is a programme developed by TRL for the Department for Transport (DfT) to assess proposed highway schemes. It compares the costs of providing the road scheme with the benefits to the road users in terms of user time, vehicle operating costs and accidents. These are all monetised. It is based on a design life of 30 years. The latest version of the programme is COBA11 R11 which was last revised in January 2009. The programs are supplied with a certain amount of default UK data, but most data can be customised by the user.

COBA calculates the construction, land and property costs involved in carrying out the road improvement, including preparation and supervision costs. This includes costs of surveys, public inquires and public consultation. Maintenance costs per year for that type of road are input and the cost of accidents and user delays included. QUADRO can be used to calculate the cost of user delays. All costs need to approved by the HA's quantity surveyors. The costs used in COBA do not take account of locality. COBA produces a cost benefit ratio. The higher the value the better value for money the project provides.

The latest version of COBA includes the calculation of the carbon emissions with and without the proposed scheme. This is derived from the fuel consumption of the project traffic and is monetised using the shadow price of carbon. The calculations are given for the opening year and the whole appraisal period. The results feed into the overall value of benefits which contributes to the cost benefit ratio. The cost/saving of carbon emissions also feeds into the AST. More information can be found in the COBA User Manual. However, carbon emissions and other sustainability measures for construction and maintenance of the scheme are not considered.

A UEA paper published in 1993 discussed monetising environmental and social impacts and incorporating them in to COBA. The paper lays out different methods of monetising different impacts and describes how these could be incorporated into the COBA methodology. The paper was written before WebTag was introduced in 1998 and environmental impact assessments were carried out separately to COBA, but raises some points which are still relevant. Since then climate change impacts have been included in COBA. The authors suggest impacts which aren't monetised, but only described qualitatively may not be valued appropriately. Methods of assigning costs to environmental or social impacts include "willingness to pay", "cost of prevention", "cost of mitigation", "shadow projects" and "dose-response". Examples include the cost of installing double glazing to reduce highway noise, the cost of health care due to poor air quality, the cost of creating a wildlife habitat to replace that used for highway construction and the damage to agricultural crops due to $SO_2$ emissions.

## 1.4 TUBA

TUBA (Transport Users Benefit Appraisal) is a DfT software programme which is used to evaluate highway and/or public transport projects. It is an economic appraisal system developed by Mott MacDonald that was last revised in 2006 (version 1.7a). It is used to compare "do-something" and "do-minimum" scenarios. It looks at transport projects at the journey level, with vehicles disaggregated by vehicle type, journey purpose and person type (e.g. driver and passenger). Road and rail journeys can be compared.

The user inputs the costs associated with the do-minimum and do-something schemes. TUBA will then calculate the user benefits in terms of:

- Time – monetised. Different for business and personal
- Fuel vehicle operating costs (VOC) – cost of fuel for petrol and diesel
- Non-fuel VOC and charge- based on vehicle type. Tax,
- Operator and government revenues – from taxes.
- Scheme costs – construction costs. Includes project supervision, land use. The project cost is input into the programme by the user.

The values are discounted to the present value year. Values calculated from input model data will be interpolated and extrapolated to cover the full appraisal period as necessary. The output file contains all these results for various degrees of disaggregation and also presents the data in a series of summary tables showing the economic efficiency of the transport system, known as TEE (Transport Economics and Efficiency) tables. Results are reported as perceived costs and market prices.

Accident costs are not included.

Carbon emissions from fuel consumption are calculated and monetised using low, central and high values for carbon emissions. This includes the impacts of the use of biofuels and park and ride schemes on carbon emissions. The TUBA User Manual gives more detail.

### 1.5 JUICE

JUICE (Junction User Interface Cost Evaluation).

### 1.6 QUADRO

QUADRO (QUeues And Delays at ROadworks) is a programme developed by TRL for DfT to estimate the total cost of major road maintenance works including direct works costs and user costs. The user costs include delay (value of time), vehicle operating costs and accident costs. Individual roadworks jobs can be combined to produce the total cost of maintaining the road over time. The latest version is QUADRO4 R9 which was released in January 2009. The User Manual is Volume 14 of the DMRB.

### 1.7 TEMPRO

This tool provides information on traffic growth which is an input to appraisal models.

### 1.8 DMRB Vol 11 – Environmental assessment

Volume 11 of the Design Manual for Roads and Bridges sets out how to assess highway projects for their impact on the environment. The environmental impact assessment forms part of the scheme appraisal process. Vol 11 provides frameworks for the evaluation of a broad range of environmental impacts. A recently prepared IAN provides an assessment framework for undertaking the assessment of materials and waste arisings.

### 1.9 Other assessment

In some cases waste has been assessed for scheme study reports. For example, the A417 Cowley to Brockworth Bypass Improvement. This study report compares the waste

generated by the three different options put forward for this project. It estimates the quantities of waste produced and opportunities for using this type of waste in the local area.

## 2. Tools to assess projects at the design level

There are a number of tools to aid in selecting different construction options and maintenance regimes need to be evaluated.

### 2.1 SWEEP.S

SWEEP.S (Software for the Whole life Economic Evaluation of Pavement Schemes) is the economic analysis software used by the MACs to prioritise between various maintenance options (i.e. a do-minimum versus other do-something options). It allows maintenance regimes for a pavement scheme to be evaluated on a WLC basis for a 60 year design life. It is applied to the potential schemes submitted by the MACs. It links to the HAPMS which has details of the scheme location, lanes, layout, construction materials, traffic information, condition data, speed limits and diversion routes. It includes the costs of the maintenance, traffic management and also accident and user delay costs.

SWEEP.S is used in the Value Management process and feeds into Value Management score. It needs to be run for all potential renewal projects submitted by the MACs. SWEEP.S produces an EI value which is used to score the Value for Money criteria and a percentage which is the score for the reduction of disruption criteria.

### 2.2 CEEQUAL

CEEQUAL (The Civil Engineering Environmental QUality Assessment and Award Scheme) was developed by ICE with Government funding and launched in 2003. It is an assessment scheme which encourages sustainable construction methods. An assessor evaluates a project that has applied for the award using the CEEQUAL manual and scoring sheet (Version 4 was released in November 2008). It evaluates environmental and social impacts such as the use of water, energy and land, ecology, landscape, noise and dust, archaeology, waste minimisation and management, and community amenity. ICE recommends that the application for a CEEQUAL award is made early in the project. A pass, good, very good and excellent can be awarded. The applicant pays to register and to train an assessor. Highways Agency highway schemes have applied and been awarded excellent under this scheme.

### 2.3 ESRSA

The WRAP Environmental Sustainability of Recycled and Secondary Aggregates (ESRSA) tool developed by TRL estimates the relative sustainability of different types of aggregates (primary, recycled and secondary) for specified construction applications in specified locations. The impacts evaluated include resource consumption, the amount of water and energy used, $CO_2$ emissions, economic cost, H&S and local employment. Some of the impacts are measured quantitatively e.g. $CO_2$ emissions in tonnes, others are assigned a score or rated low, medium or high. All the impacts are then rated with 1 being the option with the lowest value, 2 average and 3 highest. The ratings on plotted on a radar diagram, allowing an easy comparison of the different levels of impact for each option.

The user inputs details such as distance from material sources or landfill sites and selects the types of material they would like to compare. Default values can be used for the average impacts for that type of material or the user can input their own values. Users can weight the impact which is the most important to them.