Green Public Procurement

Road Construction and Traffic Signs Background Report

Report for the European Commission – DG Environment by AEA, Harwell, June 2010

Owner, Editor: European Commission, DG Environment-G2, B-1049, Brussels.

Table of contents

1 Introduction 1

2 Abbreviations 2

3 Definition, Scope and Background 3

3.1 Road construction 3

3.2 Traffic Signs 7

4 Key Environmental Impacts 8

4.1 Life-Cycle Phases of Roads and Traffic Signs 8

4.2 Resource Use 12

4.3 Emissions 14

4.4 Noise 15

4.5 Visual Impact 15

4.6 Waste Management and Recycling 15

5 Cost Considerations 18

6 Relevant EU Legislation and Policy 19

6.1 The Construction Products Directive (CPD) 89/106/EEC 19

6.2 The REACH Regulation 1907/2006 21

6.3 The Hazardous Waste Directive (HWD) 91/689/EC 21

6.4 Waste Framework Directive 2008/98/EC 22

6.5 The European Waste Catalogue (EWC) 22

6.6 The Landfill Directive 1999/31/EC 22

6.7 The Integrated Pollution Prevention and Control Directive (IPPC) 2008/1/EC 22

6.8 The Water Framework Directive (WFD) 2000/60/EC 23

6.9 The Chromium (VI) Directive 2003/53/EC 23

6.10 Directive 2006/38/EC, amending Directive 1999/62/EC, on the Charging of Heavy Goods Vehicles for the Use of Certain Infrastructures 23

6.11 The Classification, Packaging and Labelling of Dangerous Substances Directive 67/548/EEC is it relevant? 24

6.12 The CLP Regulation (EC) No 1272/2008 24

6.13 The EU Climate-energy Package 24

6.14 UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) 25

6.15 Environmental Impact Assessment Directive 85/337/EEC 25

6.16 Future Legislation and Standards 26

6.17 Examples of Member State Policy 26

7 Existing Standards & Ecolabels Relevant to Road Construction 27

7.1 Ecolabels for Road Construction 27

7.2 Ecolabels for Traffic Signs 31

7.3 Ecolabels for Products Related to Road Construction 32

8 Conclusions and Summary 35

9 Proposal for Core and Comprehensive Procurement Criteria 36

10 EU legislation and information sources 38

10.1 EU Legislation 38

10.2 Ecolabels and Standards 39

10.3 Studies and Other Sources of Information 39

Appendices

Appendix 1 Crushed Concrete Construction

Appendix 2 European Standards Relevant to Road Surfacing Materials and Traffic Signs

1 Introduction

Following on from previous work in developing GPP criteria for ten product groups,[1] a further ten products and sub-products have been identified for the development of GPP purchasing criteria to add to the European Commission's GPP Training Toolkit Module 3, which presents recommended GPP criteria for products and services. GPP is a voluntary instrument.

'Road Construction and Traffic Signs' has been identified as a product group for criteria development. This report provides background information on the environmental impact of road construction and traffic signs and outlines the key relevant EU legislation affecting these areas. It then goes on to describe existing standards and ecolabels that cover road construction. Finally it outlines the rationale for the core and comprehensive criteria that are being proposed.

This report accompanies the associated **Product Sheet** that contains the proposed purchasing criteria (guidelines) and ancillary information for green tender specifications. As such, both documents should be read alongside one another. **The criteria have been developed in the form of guidelines, rather than specific quantitative criteria due to there being insufficient publicly available data to set specific criteria.**

The format for the purchasing recommendations comes in the form of two sets of criteria:

- The **core criteria** are those suitable for use by any contracting authority across the Member States and address the key environmental impacts for the product in question. They are designed to be used with minimum additional verification effort or cost increases.
- The **comprehensive criteria** are for those procurers wishing to purchase the best products available on the market. These may require additional verification effort or a slight increase in cost compared to other products with the same functionality.

Within the core and comprehensive criteria, the guidance follows the various stages of a public procurement procedure and explains how best to integrate environmental criteria at each stage:

- Subject matter. It means the title of the tender, i.e. a short description of the product, works or service to be procured.
- Technical Specifications. Provide a clear, accurate and full description of the requirement and standard to which goods, works or services should conform. Description of the minimal technical specifications which all bids need to comply with. Set specific environmental criteria, including hurdles and levels that need to be met for specific products.
- Selection Criteria. It is based in the capacity / ability of the bidders to perform the contract. Assist in the identification of appropriate suppliers, for example to ensure adequately trained personnel or relevant environmental policies and procedures are in place.
- Award Criteria. The award criteria on the basis of which the contracting authority will compare the offers and base its award. Award criteria are not pass/fail criteria, meaning that offers of products that don't comply with the criteria may still be considered for the final decision, depending on their score on the other award criteria.
- Contract Performance Clause - Specify the conditions that must be met in the execution of the contract, for example as to how the goods or services are to be supplied, including information or instructions on the products to be provided by the supplier.

It should be noted that the contractor is bound by the existing legal framework.

Where the verification for the criteria states that other appropriate means of proof can be used, this could include a technical dossier from the manufacturer, a test report from a recognised body, or other relevant evidence. The contracting authority will have to satisfy itself on a case by case basis, from a technical/legal perspective, whether the submitted proof can be considered appropriate.

[1] http://www.ec.europa.eu/environment/gpp

2 Abbreviations

APEO	Alkylphenolethoxylate
BAT	Best Available Technique
BBP	Butylbenzylphthalate
BREF	BAT Reference Documents
CFC	Chlorofluorocarbons
CLRTAP	Convention on Long-range Transboundary Air Pollution
CO_2	Carbon Dioxide
CO	Carbon Monoxide
COP	Conference of Parties
CPD	Construction Products Directive
DAP	Diallylphthalate
DBP	Dibutylphthalate
DEHP	Di(2-ethylhexyl) phthalate
DEP	Diethyl Phthalate
DIBP	Disobutyl Phthalate
DMEP	Dimethoxyethyl phthalate
DMP	Dimethylphthalate
DMT	Dimethyl Terephthalate
EWC	European Waste Catalogue
GECA	Good Environmental Choice Australia
GHG	Greenhouse Gas
GPP	Green Public Procurement
GRP	Glass-resin Reinforced Polymer
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbon
HIP	High Intensity Prismatic
HWD	Hazardous Waste Directive
HWL	Hazardous Waste List
IPPC	Integrated Pollution Prevention and Control
MPGRP	Morelock Permanent GRP
NOx	Nitrogen Oxide
OECD	Organisation for Economic Cooperation and Development
PAH	Polyaromatic hydrocarbons
PFCs	Perfluorocarbons
RDF	Refuse Derived Fuel
REACH	Registration, Evaluation, Authorisation and Restriction of Chemical substances
SO_2	Sulphur Dioxide
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Volatile Organic Compound
WFD	Water Framework Directive

3 Definition, Scope and Background

Modern paved roads are an essential part of a country's infrastructure. They allow the rapid transportation of people and goods, both key aspects in ensuring the proper functioning of an economy. By way of context, in Europe 44 % of all goods are moved by lorries over roads and 85 % of people are transported by cars, buses or coaches on roads. These road transport services combine to generate 1.6 % GDP for Europe and provide jobs for 4.5 million people.[2]

Europe has a large number of roads, and this figure is increasing all the time. Each kilometre of road covers a not inconsiderable amount of land and consumes a large amount of materials and energy in its construction. As roads develop for increased capacity, land use and material use increase concomitantly. Roads must then also be maintained and repaired at regular intervals.

The construction of some roads falls within the remit of Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment. These roads include:

- Construction of motorways and express roads. (Annex 1, 7(b))
- Construction of a new road of four or more lanes, or realignment and/or widening of an existing road of two lanes or less so as to provide four or more lanes, where such new road, or realigned and/or widened section of road would be 10 km or more in a continuous length. (Annex 1 7(c)).
- Construction of roads, harbours and port installations, including fishing harbours (projects not included in Annex I) (Annex 2, 10(e)).

For further information on the requirements of the EIA Directive, see Section 6.15.

This report covers road construction and traffic signs. Road marking materials, such as paints, are outside the scope of this product group, as are other items of road furniture, such as pedestrian walkways, bollards, overhead gantries and central reservations. Street lighting and traffic signals are covered in a separate GPP product group.

A great deal of research is currently underway on the environmental impact of road construction. As a result, it was felt that it would be more appropriate to provide the criteria in the form of guidelines to the environmental impacts related to road construction and road sign materials rather than specific quantitative criteria. This would be presented as a framework of environmental impacts that should be considered in any tendering exercise, largely as award criteria, and information sought from bidders and potential contractors. For further detail see the accompanying Product Sheet for Road Construction and Traffic Signs.

3.1 Road construction

When a vehicle moves along a road it concentrates its considerable weight through the relatively small surface area of the tyres onto the road. The construction of modern paved roads is designed to spread the weight of the vehicles vertically and horizontally, so that the ground underneath the road carries the weight without distorting.[3] Materials used in the construction of roads can be described in two main ways:[4]

1. By the pavement layer
2. By the type of material.

These are described in more detail in the subsequent sections.

[2] European Commission, Transport, Overview, http://ec.europa.eu/transport/road/index_en.htm
[3] Road Structure, http://incatrad.com/highway.htm
[4] Sherwood, P. (2001) Alternative materials in road construction. 2nd ed. (Thomas Telford Ltd)

3.1.1 Pavement layers

The construction of modern paved roads proceeds along a number of stages. Initially the top soil and vegetation is removed from the area to be paved. The depth of excavation will depend on the condition of the ground, the 'subgrade'; more excavation with back filling may be required, or the ground may require compacting. The strength of the soil is dependent on its composition of solid matter, water and air. If necessary, where the soil is weak, lime or cement can be used to stabilise the upper part of the subgrade and reduce the maintenance requirements of the road during its lifetime. Advanced materials can be brought in to provide extra strength if water tables are high, or subsoil is weak.[5] Alternatively, if the road already exists but is being resurfaced or reconstructed then layers of the existing road will be removed. It is at this stage the drainage systems must be dug and installed.

Once construction begins, roads are built in layers. There are two main types of road construction:

- Flexible pavement roads (Figure 1), which can incorporate composite pavements.

Rigid (concrete) pavements (

[5] Streetworks, Flexible Roads, http://www.streetworks.fsnet.co.uk/flexible%20roads.htm

- Figure 2).

The difference between these two types of road pavements is in the main behaviour of the binder used – asphalt is more flexible than concrete.

3.1.2 Flexible Pavements

Flexible pavements reduce the level of stress being transmitted vertically through the road as a vehicle passes along it, into the soil below the road. Flexible pavements are built using a number of layers built on top of each other. The actual number varies depending on local conditions and methods of description. The layers comprise compacted granular material such as crushed rock, gravel or sand that is bound together with bitumen based binders in some layers. The thickness of the layers is dependent on the expected traffic volumes – more traffic means a greater thickness of layers is required.

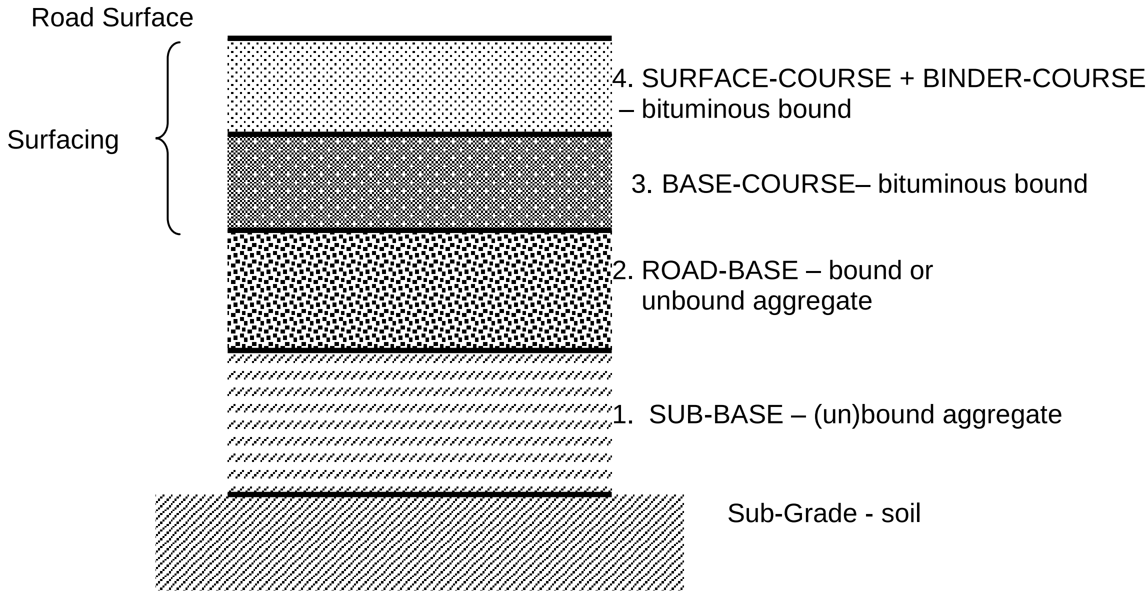
In Figure 1 an example diagram of a road illustrates the roles of the various layers, as described below:[6]

- **4. The Surface Course and Binder Course:** The surface course constitutes the top layer of the pavement and should be able to withstand high traffic- and environment-induced stresses. It should do this without exhibiting unsatisfactory cracking and rutting in order to provide an even profile for the comfort of the user and at the same time possessing a texture to ensure adequate skid resistance. Depending on local conditions, functional characteristics such as skid resistance, noise reduction and durability are often required for surface courses. In some cases, for example where spray from vehicle wheels in wet conditions could be hazardous[7], rapid drainage of surface water is desired through a porous surface while in other cases the surface course should be impermeable in order to keep water out of the pavement structure. The Binder Course is the layer between the surface course and the base course.
- **3. The Base Course:** The main function of this layer is to provide support for the top layer of the road, and to provide protection for the underlying layers of the road.
- **2. The Road-Base:** This is the load-bearing layer. The materials may therefore vary depending on the expected volume of traffic. Materials are again based on granular aggregates, and can be either unbound, or bound.
- **1. The Sub-Base:** This can be the first layer to be built and is placed directly onto the 'subgrade'; the underlying soil. It is built from aggregates compacted together. The sub-base can be unbound or stabilised with one of various additives such as cement, lime, or other chemical additives to achieve an acceptable level of stiffness and bearing capacity. The purpose of the layer is to assist the spread of weight from a vehicle over the sub-grade, and to allow drainage into the sub-grade. A sub-base course is not always needed or used.

[6] Birgisdóttir, H. (2005) Life cycle assessment model for road construction and use of residues from waste incineration. Ph.D. Thesis (Institute of Environment & Resources, Technical University of Denmark), pg 5.

[7] http://www.highwaysmaintenance.com/drainage.htm#DRAINAGE%200F%20POROUS%20SURFACE%20COURSES

Figure 1 Diagram illustrating the 'Flexible pavement' layer system



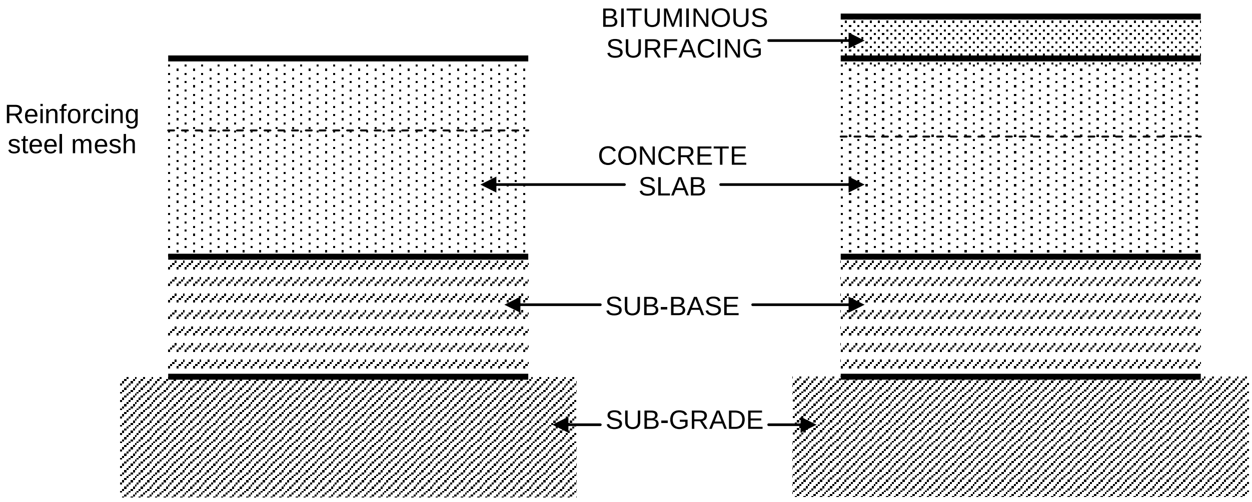
Depending on the local conditions, the bearing capacity of the subgrade, the amount of traffic the road has to carry and the available road building materials, the road base can consist of two layers (a lower and an upper layer) and the same applies for the sub-base. The thickness of the layers is influenced by the degree of mechanical compaction used in the road construction and the expected traffic volumes – more traffic can mean a greater thickness of layers is required. A composite pavement can also be formed by using hydraulically bound materials with asphalt layers.

3.1.3 Rigid Pavements

Rigid pavements are so named due to the still behaviour of the pavement. They tend to be used where high traffic loading is expected and are highly durable. It is possible to overcoat the rigid pavement with a bituminous layer that can be replaced when worn out on a more regular basis. This enhances the riding quality of the road.

Rigid pavements are usually made of concrete, and can consist of two layers above the subgrade: the concrete slab and the sub-base, as shown in Figure 2. In addition, reinforcing materials, such as mesh, can be used in the concrete slab to prevent thermal and load cracking. Likewise slip membranes may be used between the slab and sub-base to prevent moisture entering into the lower layer, and joists must be placed between specified lengths. Likewise, slip membranes may be used between the slab and sub-base to facilitate movement of the concrete layer and thus accommodate thermal expansion and contraction. In some instances a bituminous-sprayed membrane can be used as an alternative to a plastic sheet slip membrane. The concrete surface, if it is the exposed surface, must be finished at right angles to the direction of travel to enhance its skid resistance.

Figure 2 Concrete pavement layers[8]



In both types of road construction recycled materials can be used. Such materials include reclaimed asphalt material, fly ash from coal power stations, crushed concrete, or bottom ash from waste incineration or steel slag.

The framework criteria developed within this document will consider the materials used for the road layers above the sub-base layer, i.e. the concrete slab in the rigid road type, or the road-base, base-layer and surface layer in the flexible layer road type. For concrete roads a road base can also be used. Appendix 1 contains a diagram of the life-cycle phases of the materials used for each of the remaining layers.

[8] Figures 1 and 2 taken from Croney, D & Croney, P (1997) Design and Performance of Road Pavements. 3rd edition. (McGraw Hill), pg.17

3.2 Traffic Signs

Traffic signs are a key component of modern roads. Large amounts of information must be conveyed to modern drivers, concerning place locations, speed restrictions, and approaching hazards to name just a few. There are three key components in a typical road sign:

- Sign facing
- Substrate (backing)
- Fixing

All three components are necessary to provide a clearly visible and highly durable sign.

3.2.1 Sign facings

The sign face displays the intended visual message to the road user. Permanent traffic signs are generally created from vinyl, using one colour as the background layer with lettering or symbols either cut out from this layer to expose a different colour vinyl underneath, or text/symbol vinyl characters placed on top of the main background layer in an alternative vinyl colour. On top of this will be applied a highly reflective material such as High Intensity Prismatic sheeting (HIP) or Diamond Grade Reflective Sheeting which increases visibility of the sign at night time or in low visibility conditions. Such reflective materials are made from glass beads suspended within the material coatings, which create the reflective appearance. A sign that is not required to be reflective is likely to be faced with a further layer of clear vinyl. On to both types of sign is likely to be applied a further protective layer, which permits the easier removal of graffiti.

3.2.2 Substrates (backing)

The substrate is the backing material that the sign face will be attached to. Its function is to provide a durable support to the face. Cost, strength, weight and of course durability determine the material to be used for this component. Typically aluminium or steel is used for permanent traffic signs, however plastics such as GRP (Glass-resin Reinforced Polymer) are being used increasingly due to sign theft.

3.2.3 Fixings

The sign fixing is the component used to erect the sign. The materials used for this are determined by the application and location of the sign. The most common method of erecting permanent signs is to post-mount them. Temporary signs are more often frame-mounted using plywood covered with plastic to reduce weathering, aluminium, or steel.[9]

9 Road Sign Article, http://www.madehow.com/Volume-2/Road-Sign.html

4 Key Environmental Impacts

The construction of a new road can have a number of effects on the local environment. These range from high level effects that apply to any type of road, such as traffic pollution or the diversion of land from agricultural or forestry uses, to localised issues relating to the specific materials and laying techniques used in the construction of the road. The design of a road is impacted by a number of factors, including:

- Climatic conditions – temperature[10] and rainfall in the proposed geographic location. This will also impact on the road use, for example whether snow chains or studded tyres will be used on the road.
- Geological conditions – the condition of the soil to be used as a sub-grade along the length of the planned road. This also has implications for drainage.
- The type and volume of traffic expected on the road, e.g. the weight of the vehicles.
- Noise limitations – is the road located in an urban area?
- Skid resistance.
- Rolling resistance – this has impacts on fuel economy and exhaust emissions, particularly CO_2.[11]
- The intended lifespan of the road.
- Surface durability.
- The availability of materials.
- The type of road, for example in-situ 'cold' recycling may not be appropriate for major highways carrying significant traffic, but it may be more routinely used for minor roads, where its use can reduce time on site and thus reduce congestion caused by road construction work.

The location of traffic signs should be factored into the design of roads from an early stage as this will impact on the construction of the road; ideally fixings should be constructed when the road is being constructed.

4.1 Life-Cycle Phases of Roads and Traffic Signs

The life cycle of a road and its signs consists of a number of key phases, which are summarised in this section. The following section then goes on to describe the environmental impacts in more detail. A number of the environmental impacts will be addressed during an Environmental Impact Assessment if the proposed road falls within the criteria of the legislation. Further details on this can be found in Section 6.15.

4.1.1 Extraction and Processing of Raw Materials

Mining operations, including the refining of ores, consume energy, will physically disturb the landscape and potentially release pollutant emissions, which may affect land, water and air. The key bulk material used in roads is aggregate. According to Sherwood (2001) road construction accounts for about one third of the total demand for aggregate production worldwide; on average 20,000 tonnes of aggregate for each mile of motorway construction. Traffic signs use a variety of raw materials including metals and plastics that ultimately need to be sourced from mineral ores and crude oil, notwithstanding the use of recycled materials.

[10] "High and low temperature not only affect viscosity of asphalt concrete but can also have very significant impact on moisture flow within pavements." Dawson, A. (2007) Water Movement in Road Pavements and Embankments.

[11] Forum of European National Highway Research Laboratories (FEHRL) (2006) Guidance Manual for the Implementation of Low-Noise Road Surfaces. (SILVIA Project Deliverable); Eurobitume & EAPA (2004) Environmental Impacts and Fuel Efficiency of Road Pavements: Industry Report.

4.1.2 Manufacture of Materials

The manufacturing of materials such as concrete, cement, asphalt and bitumen for roads will have environmental impacts due to the volume of such materials and the energy required to make and repair Europe's roads.

Although materials such as plastics for traffic signs and additives used to improve the durability of asphalt will be used in considerably smaller quantities, such materials require significant processing energy on a per tonne basis and may use materials with hazardous properties. For example, the manufacture of traffic signs can use trichloroethylene or percholorethylene vapours to remove grease from the surface of the sign. [12]

Bituminous binders are used to bind aggregate materials. Bitumen is an oil-based substance. It is a semi-solid hydrocarbon product produced by removing the lighter fractions (such as liquid petroleum gas, petrol and diesel) from heavy crude oil during the refining process. Also a limited amount of natural asphalts can be found in nature called "Lake" or "Rock" asphalts.

4.1.3 Transport of Materials to the Site of the Road

As with all products, energy is consumed through the use of fossil fuels in the transport of the materials to the construction site, thereby producing associated air quality and GHG emissions from the delivery vehicles. Impacts on soil and water (surface and underground) could occur due to oil/petrol leakage from delivery vehicles, or accident.

4.1.4 Road Construction

The initial impact is the preparation of the site itself by removing buildings, vegetation, topsoil and soil not required for the road. This impacts land use and local biodiversity. Energy consumption of the many machines used to mix and lay the various materials will also have an impact. There may also be hazardous waste arising from the construction process that needs to be suitably treated and disposed, for example, where the road is being constructed on previously contaminated land.

4.1.5 Use Phase

One of the main effects in the use phase, however, is the energy consumption of the traffic across the life of the road. One study on the life cycle of 1km of road with two lanes in each direction demonstrated that only 2 % of the energy consumed in the life of the road was used in constructing and maintaining the road - 23 TJ compared with 1430 TJ for traffic consumption.[13]

The use phase of the road might lead to potentially increased traffic emissions in the area. However this may be balanced out by reduced emissions on alternative roads or a reduction in idling caused by traffic congestion. Suitable modelling of these trade-offs and effects should be undertaken before commissioning any new road-building project. Water pollution may result from run-off contaminating local waterways. This however should be considered in the design stage for drainage schemes used for new roads and mitigated where possible.

4.1.6 Maintenance

Over time the surface of the road will deteriorate requiring resurfacing to reduce cracking, keep noise levels low, to maintain ride quality, to prevent rutting and wear of lower pavement layers and to improve skid resistance. This will require energy to remove the existing layer and, potentially, landfill space to dispose of the waste created, although there is the potential to reuse much of this material in the new layer. Energy and raw materials are required to produce and lay the new layer. Maintenance

[12] Nilsson, R. *et al*. (2005) Design Guidelines for Durable, Noise Reducing Pavements. (SILVIA Project Deliverable)
[13] Chappat, Michel; Bilal, Julian. *The environmental road of the future. Life cycle analysis. Energy consumption and greenhouse gas emissions.* Colas report, France 2003

also includes the application of salt to the road and ploughing of snow, both of which can affect the durability of the road surface as well as the quality of surface and ground waters through the drainage system.[14] Studies have also shown that optimal maintenance of roads can limit fuel consumption and GHG emissions.[15]

Maintenance of traffic signs may require re-plating where part of a sign requires updating or to address rusting of the materials, for example, applying a coat of zinc to the steel fixing will reduce this.

4.1.7 End of Life

It is rare for a road to be removed entirely and returned to soil and therefore the end of life here refers to the *useful* life of the materials used. While the surface layer may be replaced numerous times throughout the road's life, the lower layers have a longer expected life; anything from 20 to 100 years.[16] But at the end of the lower layers' life they will need to be replaced too. Most of these materials will be reused or recycled into the new layers during the refurbishment process. In 2007 more than 50 million tons of reclaimed asphalt was produced in Europe. Of this amount more than 21 million tons (42 %) was used in the production of hot asphalt mixes; so back into the same origin. The remaining part was used for cold recycling and for unbound layers.[17]

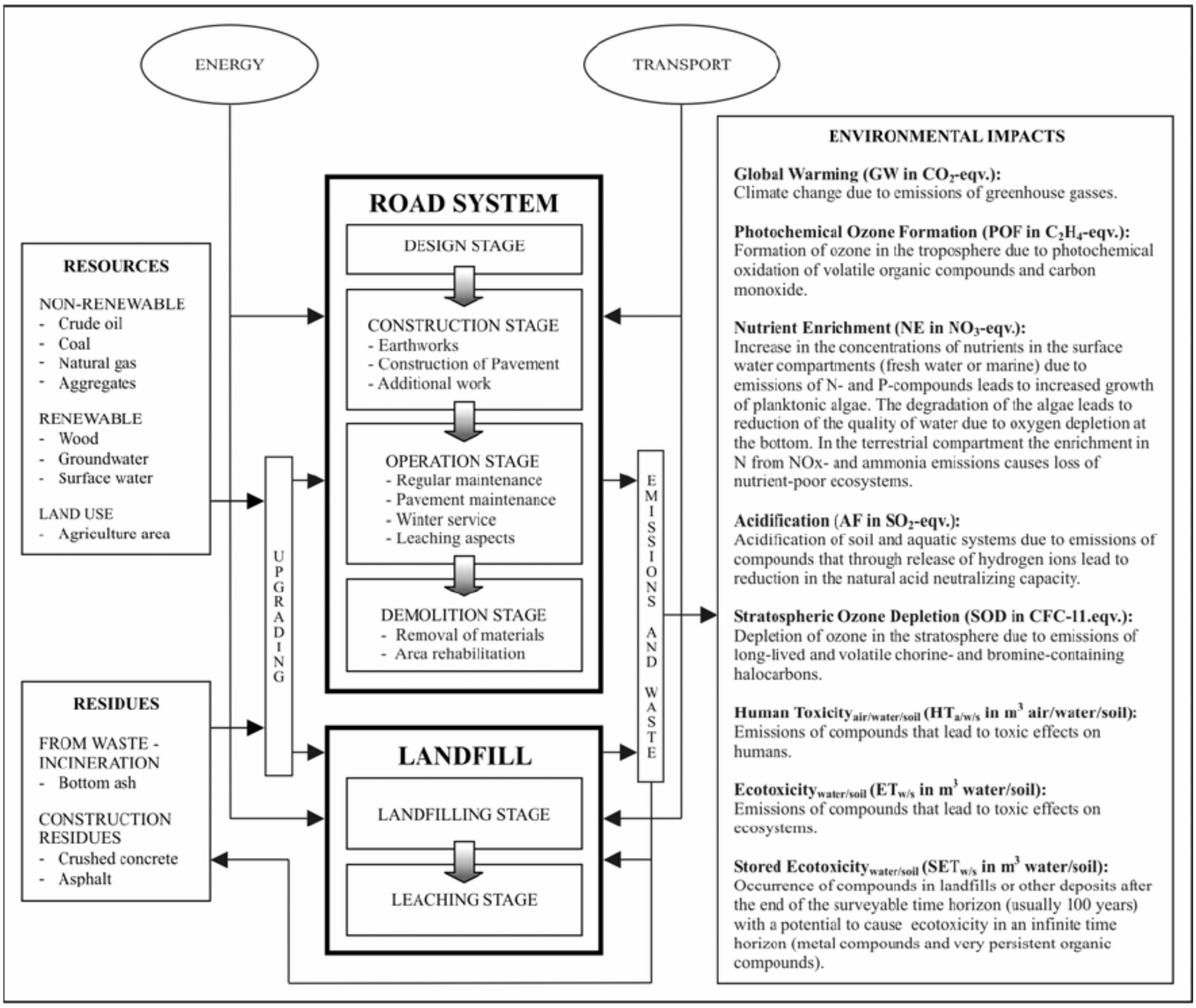
Traffic signs will stay in place for several years, but may also be replaced several times during the life of the road to reflect changes to surrounding routes and points of interest, damage to the sign or changes to legislation or technical guidance.

For each of the phases detailed above there will be an energy input depending on the different stages. Each phase will also have emissions to air, land and water and result in waste, which will either be suitable for reuse or recycling or have to be sent for disposal.

Birgisdóttir reports on the development of one model to evaluate the environmental impacts and resource consumption during the different lifecycle stages of road construction, comparing virgin materials with residues from waste incineration. This model is called ROAD-RES. The processes identified by the ROAD-RES model are shown in **Figure 3**. In this diagram the road system and landfill are the key considerations and the inputs are material resources and waste residues from other industries, energy production and transport. The environmental impacts are measured through emissions and waste via the standard eight impact categories; including the potential for global warming, ozone depletion and nutrient enrichment.

[14] Johansson, S. (2006) Road Salt and the Environment – a Complex Problem in Nordic Road and Transport Research, No.3.
[15] Eurobitume and EAPA (2004) Environmental Impact and Fuel Efficiency of Road Pavement: Industry Report.
[16] Croney, D. and Croney P. (1998) Design Performance of Road Pavements. 3rd edition. (McGraw Hill), p. 24; Birgisdóttir, H. (2005) Life cycle assessment model for road construction and use of residues from waste incineration. Ph.D. Thesis (Institute of Environment & Resources, Technical University of Denmark), p. 14.
[17] EAPA Asphalt in Figures 2007

Figure 3 ROAD-RES model



In this work Birgisdóttir found that the greatest environmental impact from road construction is from the combustion of fossil fuels: the emission of carbon dioxide (CO_2) and nitrogen dioxides (NO_2), contributing to GHG emissions and global warming, atmospheric pollution (ground level ozone creation and acidification) as well as nutrient enrichment. These emissions were spread across the entire life of the road, with the production of materials and construction of the road contributing roughly half the emissions and 100 years of maintenance and operation contributing the other half of emissions. It should be noted that this research was for a hypothetical road, and impacts will vary in the real world depending on terrain, geography and climate.

The materials used in the construction of the road have varying impacts. Asphalt was found to have the largest contribution to the environmental impacts above even though it only constitutes up to 25 % of the material used in a road. This was due to the inherent or feedstock heating value of the bitumen. Other studies take a full lifecycle approach, as demonstrated in **Figure 4**. It should be noted that other sources highlight some cement-based materials as having a greater environmental impact than asphalt based products.[18] The use of natural aggregate and crushed rock was also highlighted in terms of road construction. During road maintenance, the study also found that road salting could pollute large amounts of groundwater in the area near the road. However, the impact of resource consumption including energy use was found to account for at least ten times more impact than other impact categories, such as water pollution listed above.

[18] http://www.thegreenguide.org.uk

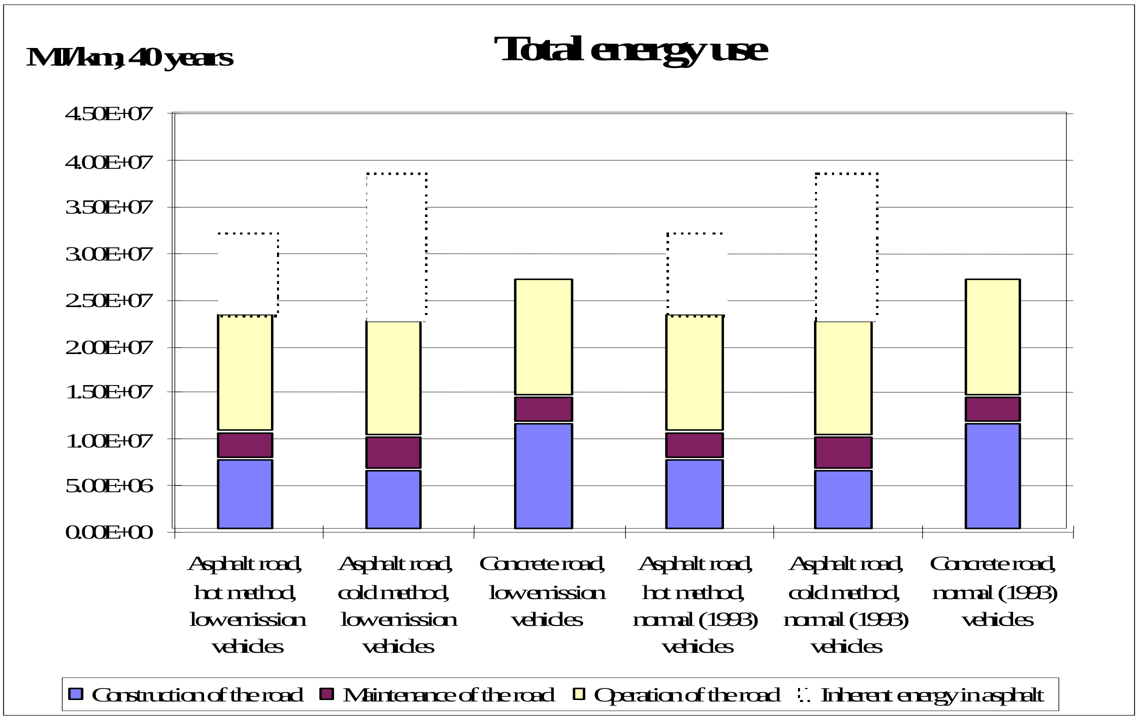


Figure 4 - Total energy consumed over a 40 year period for a 1 km long and 13 m wide road during construction and 40 years of maintenance and operation (lighting, traffic lights, and winter treatment)[19]

In another earlier study by the Finnish National Road Administration the use of raw materials, emissions of heavy metals to soil and the consumption of fuel and energy were found to be the most significant environmental impacts associated with road construction.[20]

LCA studies that have been used in the development of criteria for traffic signs and traffic signals have indicated that there is no significant environmental, life cycle advantage in using any particular material type over another in manufacturing a road sign. The main environmental gains on the other hand are to be found by extending the lifetime of the product to reduce raw material consumption and then extend this in the end of life stage by recycling and reusing the materials.[21]

The key environmental impacts identified from considering the phases of a road or its signs above are discussed in more detail in the next Section.

4.2 Resource Use

4.2.1 Natural Resources

Aggregates are the main natural resource consumed during road construction. An example best illustrates this: in Denmark the annual extraction of natural aggregates in 2003 was greater than 30 million m^3, approximately 65 % of which was used in the road construction sector.[22] This large quantity is not unusual; the OECD stated, “typically 10,000m^3 of aggregates are needed for each kilometre of two-lane road constructed.”[23]

[19] Stripple, Håkan.(2001) Life Cycle Assessment of Road. A Pilot Study for Inventory Analysis. Second Revised Edition. (IVL, Sweden)
[20] Finnish National Road Administration (2000) Life cycle assessment of road construction. http://www.tielaitos.fi/libr.htm p. 45
[21] http://www.senternovem.nl/duurzaaminkopen/Criteria/gww/verkeersregelinstallaties.asp
[22] Statistics Denmark, 2003 in Birgisdóttir, H. (2005) Life cycle assessment model for road construction and use of residues from waste incineration. Ph.D. Thesis (Institute of Environment & Resources, Technical University of Denmark), pg 1
[23] OECD (1997) Recycling strategies for road works. (Road Transport Research), pg 15

The use of fossil fuels is also an example of major natural resource consumption, required at every stage of road building, use, maintenance and replacement. In addition bitumen is derived from fossil fuels, so further increasing fossil fuel consumption. In comparison to other materials asphalt is seen by published green guides as a particularly poor performer due to its intensive industrial production process and because as a road surface it requires replacement more often than other surfacing materials.[24]

Concrete roads also require energy for the production of cement. For example, research conducted in the USA found that hot mix asphalt (HMA) pavements and Portland cement concrete (PCC) pavements had similar average service lives (33 and 34 years respectively) and that while lifecycle costs for the two pavement types was equivalent for the first 15 years, costs for PCC pavements were 2.4 times higher following an additional 25 year period.[25]

The construction of traffic signs uses plastics and metals, both of which have significant processing requirements. In addition the metal content of traffic signs makes them a valuable resource and there have been reports of signs being stolen to sell as scrap metal.

4.2.2 Energy

Road construction uses energy for the operation of equipment and the transportation of materials, for example, hot mix asphalt or cement. The energy consumption for such a construction project can therefore be influenced by using more efficient machinery and vehicles to transport the materials.

Where asphalt is used, the temperature of the asphalt mix is important to the workability and compactability of the mixture when applied. The asphalt mixture is produced in the manufacturing plant and then transported to the site of the road. This journey time should be kept as short as possible as the mixture must be laid and then compaction must take place within an appropriate temperature range over the entire paving area.

The Belgian Road Research Centre (BRRC) carried out research[26] into the possible use of cold asphalt. The temperature at which this product is manufactured is much lower than 'classic' asphalt yielding a considerable energy saving and a lower emission of fine dust. Unfortunately, the research showed cold asphalt to be less durable than hot asphalt. For this reason cold asphalt is only recommended for roads or sections without heavy loading, i.e. for local repairs. BRRC is currently conducting research on 'semi-hot' asphalt, a solution that potentially could combine the advantages of cold asphalt with the durability of ‘classic’ asphalt. A similar technology is already in use: Warm Mix Asphalt”. This asphalt mixture is produced at lower temperatures (30 to 40°C less) than the ‘classic’ asphalt. This takes the temperature of the warm-mix asphalt to slightly above 100ºC. There are different systems to reduce the temperature and benefits have been reported as reduced fuel consumption and emissions.[27] In a similar vein research is currently being undertaken in a three-year project by TRL (Transport Research Laboratories – UK) on the life cycle impacts of the individual road construction materials and thereby developing a standard methodology for industry. This project is due to report in 2010.[28]

Maintaining the road surface also requires energy. There are a variety of options for rejuvenating road surfaces, which include:

- Spraying an emulsion onto the road surface to provide a new coating for the aggregate.
- Softening the existing asphalt surface by applying heat, then removing the pavement surface, mixing this reclaimed asphalt with a recycling agent and possibly adding a proportion of virgin asphalt and/or aggregate and relaying the surface.
- Milling the existing pavement surface, then mixing the released asphalt with additives, then re-laying and compacting this, finally overlaying with new material.

The energy intensity of road construction can be reduced by recycling materials into the new road.

---

24 Anderson, J. and Shiers D. (2004) The Green Guide to Specification, 3rd edition. (Blackwell Publishing), pg 76

25 Cross, Steven A. And Robert L. Parsons (2002) *Evaluation of Expenditures on Rural Interstate Pavements in Kansas* (Kansas University Transportation Center)

26 Personal communication with BRRC, August 2008

27 US Department of Transportation Federal Highway Administration (2008) Warm-Mix Asphalt: European Practice (http://www.warmmixasphalt.com/submissions/68_20080223_FHWA-PL-08-007.pdf)

28 Personal communication with TRL, August 2008

4.2.3 Land

Prior to the construction of a new road or widening or extending an existing road (as opposed to relaying an existing road), excavation of the site must take place. This will involve diverting land from its current use, for example for agricultural activities, potential housing development or forestry. Buildings, vegetation and soil must all be removed, much of which will be sent to landfill for disposal, although the soil may be re-used to level out the sub-grade layer of the road.

4.3 Emissions

4.3.1 Air Pollution and GHG Emissions

As discussed previously, road construction and use generally requires the combustion of fossil fuels for material production and energy, which leads to emissions of CO_2, NO_x (nitrogen oxides) and SO_2 (sulphur dioxide). However, a number of other air pollutants result from road construction and use, including VOCs (volatile organic compounds), carbon monoxide (CO) and particulates.

The two main components in concrete are cement and aggregate. Using cement as an example to give some feel for the scale of manufacture it can be seen that its global production for all final applications accounts for approximately 5 % of global man-made CO_2 emissions; 2.5 % from chemical reactions during its manufacture (CO_2 is given off in the process of making cement from limestone) and 2.5 % from energy consumed in processing.[29] As cement has many uses in construction, cement used in road construction will only make up a portion of this. Although there is no direct data on cement use in roads, CEMBUREAU reports that 307,452 kilo tonnes of cement were consumed in Europe in 2007. Of this, 14 % of European construction consisted of new civil engineering projects and 7 % of renovation and modernisation civil engineering projects, the two categories in which road construction is included. [30]

Similarly, asphalt production produces a number of air pollutants, including particulate matter (PM), nitrogen oxides (NO_x), sulphur oxides (SO_x), carbon monoxide (CO), volatile organic compounds (VOCs), polycyclic aromatic hydrocarbons (PAH), and carbon dioxide (CO_2).[31]

4.3.2 Soil and water pollution

Rainwater run-off from roads can carry the residues dropped by passing traffic. This can result in a number of pollutants entering the water environment. Some examples include:[32]

- Zinc, cadmium and iron from tyre wear.
- Copper from brake pads and linings.
- Hydrocarbons from fuel, fuel additives and lubricants.
- Platinum, palladium and rhodium from catalytic converters.
- Salt and grit from winter application of ice-thawing compounds.

Locating roads near to sensitive watercourse should be avoided where possible as long term leaching of heavy metals and salts from the road can render ground water as unqualified for drinking water. Alternatively the run-off water from the road can be diverted to a treatment facility prior to it re-entering a watercourse. Similarly the heavy metal content of the materials chosen for sub-base will influence the impact of leaching.

Design elements can be introduced into the road construction to reduce drainage problems. For example porous pavements can help to dissipate excess surface water by virtue of their rapid

[29] Kruse 2004 in Roaf, et al. (2007) Ecohouse. 3rd ed. (Architectural Press), pg 48
[30] CEMBUREAU (2007) Activity Report 2007. http://www.cembureau.be/Documents/Publications/Activity%20Report%202007.pdf
[31] http://www.ec.gc.ca/cleanair-airpur/Pollution_Sources/Asphalt-WS13CBCB37-1_En.htm
[32] Baeken, et al. (2007) Roads as a source of water contamination. Presentation at the International Conference on the Advanced Characterisation of Pavement & Soil Engineering Materials, Athens 2007. Accessed at: http://www.watmove.org/wip05/06-Roads-as-a-Source-of-Contamination.pdf

drainage properties. Other sustainable urban drainage systems (SUDS) include infiltration trenches/basins, swales and permeable pavements.[33]

4.4 Noise

Road construction and the subsequent use of roads both generate significant levels of noise within the surrounding geographic area. During construction limitations on working times and noise levels may be specified to reduce the disturbance to local residents. This will influence the machinery used for the process, but it may limit its size, which may impact efficiencies and as such should be taken into consideration too.

Increasing the porosity of the final road surface reduces traffic noise by reducing the compression and expansion of air trapped in the tyre tread. For that reason porous asphalt pavements are often used to reduce noise. Further mitigation of road-use phase noise creation can be achieved through tree planting or the use of rigid and flexible barriers along the sides of the roads to dissipate the sound waves generated by passing traffic.

4.5 Visual Impact

As well as noise reduction, tree planting with other landscaping on the area beside roads can also reduce the visual impact of a new road construction. The visual impact of traffic signs must likewise be considered and therefore the number and size of signs must be evaluated in light of the environmental conditions within the geographic area.[34] For example, fewer or smaller signs might be used in areas of scenic beauty. The number and dimension of traffic signs must also comply with requirements and visibility in terms of improving road safety.

4.6 Waste Management and Recycling

The demolition and reconstruction of roads generates a significant volume of waste, such as old asphalt and concrete pavement and base materials. These materials will often be recycled within the road sector, thus they become by-products rather than waste and serve to reduce the need for virgin natural resources and the amount of waste which must be disposed in landfill. A similar line of argument can be taken with traffic signs once they reach the end of their useful lives. Reasons to recycle road materials include:

- Increasing cost of landfill and the shortage of suitable landfill sites.
- Shortage of virgin raw materials.
- Pollution to air and soil caused by incineration or landfill.
- Reduction in energy use.
- Economic and technical advantages e.g. lower costs of recycled materials.

Some example by-products that could be used in road construction are shown in Table 1.

Table 1 Industrial By-products used in Road Construction, example Figures from Finland.

Material	Industrial Source	Use in Road Construction	1997-1998 Consumption in Finland (tonnes)
Coal fly ash	Energy generation	Road construction; earthfill; production of cement and concrete.	190,000
Coal bottom ash	Energy generation	Road construction.	53,300
Blast furnace slag	Metallurgic industry	Production of cement; road construction; binder in soil stabilisation.	200,000 (unground sand and slag), 120,000 (ground slag)
Crushed concrete	Construction	Road construction.	100,000
Tyres	Construction	Road and landfill construction	27,700
Pavement materials	Construction	Recycling to pavements	150,000

33 Environment Agency, Sustainable Drainage Systems (SUDS): An Introduction. http://publications.environment-agency.gov.uk/pdf/GEHO0308BNSS-e-e.pdf; Chartered Institution of Water and Environmental Management website: http://www.ciwem.org/resources/water/suds/index.asp; NetRegs website: http://www.netregs.gov.uk/netregs/101992.aspx; SEPA, SUDS for Roads: http://www.sepa.org.uk/water/water_regulation/regimes/pollution_control/suds.aspx

34 Design manual for roads and bridges. Volume 8: Traffic Signs and Lighting. (Feb 2004)

Further examples are provided in Table 2. It can be seen that, for example, around 50 % of old asphalt pavement is re-used in new road construction in Germany, amounting to six million tonnes. Furthermore, practically all the blast furnace and steel slag and coal fly ash produced is recovered for use in the road construction industry. A more recent study in 2006 demonstrates that this situation has improved further and 100 % of the 14 million tons of reclaimed asphalt was reused/ recycled in Germany (82 % to produce new hot/warm mixed asphalt and 18 % in cold recycling). There is a similar situation in both the Netherlands and in Sweden, where for many of the waste materials a full 100 % is reclaimed for re-use in roads. Furthermore, practically all the blast furnace and steel slag and coal fly ash produced is recovered for use in the road construction industry. This has benefits, such as a reduction in the use of aggregate quarry, reduced emissions relating to mining activities and a reduction in disposal to landfill.

There have been concerns in the past regarding the quality of recycled aggregate and therefore there was initially some reluctance to use recycled products, however advances in technology and processes have overcome these issues and recycled aggregate is now widely accepted. For example a technical specification for recycled aggregate has been developed by the Minnesota Department of Transportation.[35]

[35] http://www.rethinkrecycling.com/government/eppg/-buy-products-services/vehicles/road-aggregate

Table 2. Recovered Material used in Roads (million metric tonnes)[36]

Country	Sweden		Netherlands		Germany		France		USA		Application
	Prod'n	Amount used	Prod'n	Amount used	Prod'n	Amount used	Prod'n	Amount used	Prod'n	Amount used	
Mixed construction waste	1.5-2.0	Small quantities	9.2	9.2	10.0	0.0	5.0	Not provided			As fill material; some test sections/subbase
Old asphalt pavement	0.8 (1999)	0.76	7.7	7.7	12.0	6.0	Not provided	1-2			In new asphalt (cold or hot recycling)
Rubble			3.0	3.0	23.0	4.0					1.8 in hot mix asphalt; 1,200 mostly in cement bound
Blast furnace slag	1.0 (1999)	0.7	1.2	1.2	8.3	8.3	5.0	1.1	14	12.6	As aggregate in unbound layers (crushed, air-cooled); cement production
Steel slag	0.2	0.2	0.5	0.5	4.8	4.4	1.3	0.2	Not available	7.0 to 7.5	Some in demonstrations/research
WTE bottom ash	0.34	0.34	0.8	0.8					8.0	Small amounts	Subbase and base in roads within facility boundary; some in demonstrations.
Electric coal bottom ash			0.08	0.08					14.5	4.4	Lightweight aggregate; some exported to Belgium for use in concrete blocks
Coal fly ash			0.85	0.85	3.1	2.7	1.0	0.25	53.5	14.6	Used in cement, concrete and asphalt filler, and as aggregate

[36] US Department of Transportation Federal Highway Administration (Oct 2000) Recycled Materials in European Highway Environments: Uses, Technologies and Policies.

5 Cost Considerations

The cost of a road will be split across the construction and maintenance phases. The proportion of the costs falling in each segment will be determined by the design of the road, its intended lifespan and the materials and machinery used for construction and maintenance. The environmental impact of the road is directly influenced by the same factors.

A study conducted by the European Investment Bank in 2006 found that road construction projects funded through public-private partnerships (PPP) exhibit higher up-front costs than traditional non-PPP projects. This occurs because PPP contracts combine the costs of construction, operation and maintenance, creating an incentive for the private sector partner to invest in materials and equipment at the construction stage that will ensure lower lifecycle operation and maintenance costs across the life of the road.[37] This higher initial cost may therefore lead to lower overall costs across the life of the road and less disruption for traffic due to less frequent repairs. This demonstrates the need to take decisions based on the life cycle cost of the project/construction works.

The use of recycled aggregate is being encouraged to eliminate the environmental impact of road construction; however in countries where natural aggregate is abundant the economic benefits of using secondary aggregates are not significant. With fuel prices rising globally this could change, for example, by using locally available recycled and secondary aggregates over 300,000 km of lorry movements, which would have consumed 128,000 litres of fuel, were saved in the construction of the a town bypass in the UK.[38] Consideration must also be given to the avoidance of waste disposal charges if recycled or secondary aggregate is used.

In terms of the cost of traffic signs the first stage is to decide how many and of what size and quality are required. There is a body of evidence that suggests overuse of signs can cause confusion and accidents. The visual content of the signs should also be kept to a minimum, for example UK road guidance recommends that the total number of destinations on a directional sign should not exceed six.

As discussed in Section 4.2.2, the Belgian Road Research Centre has undertaken research into the impacts of manufacturing and using cold asphalt as opposed to the more conventional hot asphalt. The findings showed that whilst it might save energy and therefore cost of production it has the trade off in that it has to be replaced more frequently, thus incurring maintenance and capital costs.

Similarly there is a Dutch example, described in section 6.17.1, which shows that whilst you can re-use older tar-containing road aggregate materials you still have to undertake certain restorative procedures to extract the useful aggregate material and eliminate the environmental impact of the tar; the consequence is whilst there is lower raw material consumption (aggregate) there could be an increase in the energy consumed in this process.

Ideally therefore when two or more such options are available comparative life cycle analyses of the environmental effects and concomitant cost-benefit analysis of the whole life costs should be undertaken to understand where the balance of impacts lies and thus which of the options is the most suitable for the intended purpose. Care should be taken at all times to ensure the environmentally preferable solution does not negatively impact on the safety of the road.

[37] European Investment Bank (2006) Ex Ante Construction Costs in the European Road Sector: A Comparison of Public-Private Partnerships and Traditional Public Procurement (Economic and Financial Report 2006/01)

[38] http://www.contractjournal.com/Articles/2007/08/22/55985/recycled-aggregates-are-the-future-specialist-focus-quarrying.html

6 Relevant EU Legislation and Policy

This section details EU legislation that is relevant to road materials, which is important in setting the background context on which standards and labels have been developed. Contracting authorities should also be aware of any additional local, regional or national legislation and policy pertinent to their situation with respect to road materials and road signage, especially health and safety factors, taking local conditions of climate and topography in to account.

6.1 The Construction Products Directive (CPD) 89/106/EEC

The Construction Products Directive[39] (CPD) is aimed at creating a single market for construction products, through the use of CE Marking. It defines the Essential Requirements of construction works (buildings, civil engineering works) which indirectly determines the requirements for construction products (in function of the works design and the climatic and geological conditions in the place where the construction works are situated).

Construction products must declare their performance for mechanical strength and stability, fire safety, health and environment effects, safety of use, sound nuisance and energy economy if EU or national regulatory requirements exist. Under the Directive the Commission may give a mandate to standardisation organisations such as CEN to develop standards in consultation with industry. A list of the adopted standards can be found on the European Commission's website[40]. Where harmonised standards are not available, existing national standards apply. There are a number of standards that relate to road construction and to ancillary parts such as markings and traffic signs. These are listed in Appendix 2.

Environmental conditions are now being included during the revision of European standards relevant to construction products, as being overseen by technical committee TC 351.

It should be noted also that Directive 93/68/EEC[41] amended the CPD 89/106/EEC on the approximation of laws, regulations and administrative provisions of the Member States relating to Construction Products.

The Commission has adopted a proposal to replace Council Directive 89/106/EEC by a Regulation with the aim to better define the objectives of Community legislation and make its implementation easier.[42] It now includes a specific extra essential requirement related to the sustainable use of natural resources, stating that:

"The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and ensure the following:

(a) Recyclability of the construction works, their materials and parts after demolition.
(b) Durability of the construction works.
(c) Use of environmentally compatible raw and secondary materials in the construction works."

CEN TC 350

Based on Mandate 350 European technical standards are is currently under development in CEN and when complete will provide a methodology for the voluntary delivery of environmental information for construction products, in a similar way to an environmental product declaration (EPD). It will provide information to allow purchasers to compare the technical and environmental performance of products.

39 OJ L 40, 11.2.1989, p. 12–26 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31989L0106:EN:HTML
40 http://ec.europa.eu/enterprise/newapproach/standardization/harmstds/reflist/construc.html
41 OJ L 220, 30.8.1993, p. 1–22 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993L0068:EN:HTML
42 http://ec.europa.eu/enterprise/construction/index_en.htm

The European standardisation approach Mandate is based on a lifecycle assessment methodology covering production (mandatory), construction, use (including maintenance) and end of life stages (all optional). The standardisation work Mandate will also consider social and economic aspects of sustainability.

The following diagram demonstrates the various stages considered.

Product			**Construction**		**Use**					**End of life**			
Raw materials supply	Transport	Manufacturing	Transport	Construction/ installation	Use	Maintenance	Repair	Replacement	Refurbishment	Deconstruction/ demolition	Transport	Reuse/recycling	Disposal

Within these stages the following environmental indicators are being developed:

1. Life Cycle Impact Assessment (LCIA) emission indicators (output):
   - Climate change
   - Destruction of the stratospheric ozone layer
   - Acidification of land and water resources
   - Eutrophication
   - Formation of ground level ozone

2. Resource use indicators (input):
   - Use of non-renewable materials
   - Use of renewable materials
   - Use of secondary materials
   - Use of non-renewable primary energy
   - Use of renewable primary energy
   - Use of freshwater resources

3. Waste indicators
   - Construction and demolition waste to recycling
   - Construction and demolition waste to energy recovery
   - Non-hazardous waste to disposal
   - Hazardous waste to disposal
   - Radioactive waste to disposal

CEN TC 350 is working on a standardised voluntary approach across Europe for the delivery of environmental information on construction products, and to assess the environmental performance of building products and new and existing buildings. It will specify what information should be declared on the labels of construction products, however, the declarations will not specify benchmarks or standards that products should aspire to, which will be done by other instruments like GPP. Until the CEN TC 350 work is complete the EU GPP criteria have been developed using the current evidence base available that is provided by the existing ecolabels.

The following timetable for CEN 350 has been provided by EURIMA:

WI	Standard	Title of standard	Comment
	prEN 15643-2	Sustainability of construction works- Framework for Environmental Performance	**Enquiry September 2008**
WI 350002	EN	Sustainability of construction works – Assessment of environmental performance of buildings – Calculation methods	**Enquiry Nov 08**
WI 350003	EN	Sustainability of construction works - Assessment of environmental performance of buildings - Use of the EPD	**Enquiry June 09**

WI 350004	prEN 15804	Sustainability of construction works - Assessment of environmental performance of buildings- Product category rules	**Enquiry September 2008**
WI 350005	EN	Sustainability of construction works – Environmental product declarations Communications format	**Enquiry January 2009**
WI 350006	TR	Sustainability of construction works – Environmental product declarations – Methodology and data for generic data	**Vote January 2009**

ISO standards exist for determining life cycle impacts. The interested reader is guided towards EN ISO 14040: 2006, EN ISO 14044: 2006, EN ISO 14025: 2005 and EN ISO 21930:2007 for further details.

CEN TC 351

Mandate 351 was established in 2005 under the framework of the Construction Products Directive (89/106/EEC - CPD with the title "Construction products: Assessment of release of dangerous substances"). It deals with the emission of dangerous substances from construction products, as defined in the Construction Products Directive (CPD) that may have harmful impacts on human health and the environment (Essential Requirements 3 (ER3) of the CPD). Its mandate is to develop horizontal standardised assessment methods for harmonised approaches relating to dangerous substances are developed under the CPD and relates to emissions to indoor air and release to soil, surface water and ground water. These horizontal assessment methods will be used in product specific harmonised European standards under the framework of the CPD. Technical reports for CEN 351 were due in April 2009.[43] By January 2010, despite a number of documents having been reviewed, no TC 351 documents were approved for enquiry/ formal vote.[44]

6.2 The REACH Regulation 1907/2006

The REACH Regulation[45] came into force on 1 June 2007 and deals with the Registration, Evaluation, Authorisation and Restriction of Chemical substances. It provides an improved and streamlined legislative framework for chemicals in the EU, with the aim of improving protection of human health and the environment and enhancing competitiveness of the chemicals industry in Europe.

REACH places the responsibility for assessing and managing the risks posed by chemicals and providing safety information to users in industry instead of public authorities, promotes competition across the internal market and innovation.

Manufacturers are required to register the details of the properties of their chemical substances on a central database, which is run by the European Chemicals Agency in Helsinki. The Regulation also requires the most dangerous chemicals to be progressively replaced as suitable alternatives develop.

6.3 The Hazardous Waste Directive (HWD) 91/689/EC

The European HWD[46] sets out requirements for the controlled management and movement of hazardous (special) waste within Member States of the European Community. The aim of the Directive is to provide a consistent European definition of hazardous waste, which it has done by identifying the properties of hazardous waste and using these to identify which wastes in the European Waste Catalogue (EWC) are hazardous. The original list of wastes resulting from this methodology was called the Hazardous Waste List (HWL); however this has since been updated and combined with the EWC.

---

[43] http://www2.nen.nl/cmsprod/groups/public/documents/bestand/249543.pdf

[44] http://www.normapme.com/docs/expertsmeeting/presentations/experts/

[45] OJ L 396, 30.12.2006, p. 1–849 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:396:0001:0849:EN:PDF

[46] OJ L 377, 31.12.1991, p. 20–27 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0689:EN:HTML

This Directive is due to be repealed in December 2010 by the revised Waste Framework Directive.

6.4 Waste Framework Directive 2008/98/EC

The revised Waste Framework Directive47 was signed on behalf of the European Parliament and the Council on 19 November 2008. The revised Directive replaces the existing Waste Framework Directive (2006/12/EC), the Hazardous Waste Directive and the Waste Oil Directive. These Directives will all be repealed in December 2010, once the requirements of the revised Waste Framework Directive have been transposed by Member States into national legislation.

The revised Waste Framework Directive sets the basic concepts and definitions related to waste management and lays down waste management principles such as the "polluter pays principle" and the "waste hierarchy". In relation to construction waste recycling targets of 70% are to be achieved by 2020:

“b) by 2020, the preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste excluding naturally occurring material … shall be increased to a minimum of 70% by weight”

It also provides clarification regarding the definition of waste and other concepts such as recycling and recovery.

6.5 The European Waste Catalogue (EWC)

The EWC was developed through the Waste Framework Directive and has been amended since its original version to include classifications for hazardous and non-hazardous wastes. Each waste is assigned a six-digit code, which has to be used on Duty of Care documentation, such as transfer notes.

Road construction materials are categorised as construction waste within Chapter 17 ‘Construction and Demolition’ of the EWC. In the following list an asterisk * denotes a hazardous waste:

- 17 01 01 concrete
- 17 03 01* bituminous mixtures containing coal tar
- 17 03 02 bituminous mixtures other than those mentioned in 17 03 01
- 17 03 03* coal tar and tarred products

6.6 The Landfill Directive 1999/31/EC

This Directive[48] aims to encourage waste minimisation and increased levels of recycling and recovery of waste, thus reduce the negative effects of landfilling on the environment. One requirement of the legislation, which is relevant to solvent based concrete additives, is the ban on the co-disposal of hazardous with non-hazardous waste in landfills.

6.7 The Integrated Pollution Prevention and Control Directive (IPPC) 2008/1/EC

The IPPC Directive[49] (originally 1996/61/EC) provides a framework for permitting and controlling pollution from industrial sites. This Directive has recently been codified as 2008/1/EC to consolidate previous amendments and make minor linguistic changes.

47 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0003:EN:PDF
48 OJ L182, 16.07.1999, p. 1-9 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:HTML
49 OJ L 24, 29.1.2008, p. 8–29 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:024:0008:0029:EN:PDF

The IPPC Directive provides an integrated approach, promotes best available techniques (BAT), allows flexibility and encourages public participation. To assist in the determination of BAT, a number of BAT Reference Documents (BREFs) have been produced for different industrial sectors. In relation to road construction the BREF for cement and lime production is of particular relevance.

It should be noted that the European Commission adopted a Proposal for a Directive on Industrial Emissions[50] in December 2007. This recasts seven existing Directives related to industrial emissions into a single Directive, including the IPPC Directive. This is not due to come into effect for several years.

6.8 The Water Framework Directive (WFD) 2000/60/EC

The Water Framework Directive[51] (WFD) is aimed at improving and integrating the management of water bodies throughout Europe. The Directive will promote the sustainable use of water, prevent deterioration of aquatic systems / wetlands, and reduce pollution of water and groundwater resources.

This will be of particular relevance in the construction, maintenance and use phases of the roads as surface water runoff, especially where salt has been applied to the road. The IPPC directive will also control various discharges, for example if a manufacturing plant is required to be permitted under that Directive.

6.9 The Chromium (VI) Directive 2003/53/EC

The Chromium (VI) Directive[52] was published on 17 July 2003 following reports of allergic contact dermatitis following contact with certain wet cement products. It restricts the marketing and use of cement and cement based preparations, where they contain, when hydrated, more than 0.0002 % (2ppm - parts per million) soluble chromium (VI) of the dry weight of the cement (except in closed automated processes where there is no possibility of skin contact). Compliance with the legislation is mandatory for all manufacturers, formulators and suppliers of cement and cement-based preparations who produce or import such products into the European Economic Area.

To reduce the concentration (ppm) limit manufacturers will typically use reducing agents. Due to the limited lifespan of these agents, such as ferrous sulphate, the Directive specifies that packaging must be marked with the packing date, storage conditions and storage period for which the reducing agent remains effective.[53]

6.10 Directive 2006/38/EC, amending Directive 1999/62/EC, on the Charging of Heavy Goods Vehicles for the Use of Certain Infrastructures

This Directive[54] regulates the tolls and charges that are levied on heavy goods vehicles to ensure consistency across the Member States in the way that infrastructure costs are charged. It is appropriate to road construction, as the fees charged in many Member States will be used to fund road infrastructure improvements, especially where they may be incurring greater than usual costs through having to consider other issues such as noise reduction surfaces.

[50] http://ec.europa.eu/environment/ippc/proposal.htm

[51] OJ L 327, 22.12.2000 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF

[52] OJ L 178 , 17/07/2003 P. 0024 – 0027 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32003L0053:EN:HTML

[53] Cement Industry Update: Special Issue on Chromium (VI) Directive. http://www.cementindustry.co.uk/PDF/Special%20Cement%20Industry%20Update%20on%20Chromium%20(VI).pdf

[54] OJ L 157, 09.06.2006, p. 8–23 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:157:0008:0023:EN:PDF

6.11 The Classification, Packaging and Labelling of Dangerous Substances Directive 67/548/EEC is it relevant?

This Directive[55] is concerned with chemical safety. It categorises substances that are considered to be dangerous under the following headings: explosives (E), oxidizing agents (O), flammable (F or F+), toxic (T or T+), harmful (Xn), corrosive (C), irritants (Xi), sensitisers, carcinogens (Carc.), mutagens (Mut.), dangerous to the environment (N), and toxic for reproduction (Repr.). Some of these headings will be applicable to certain road construction materials.

A major update of the Directive in September 2008 added several hundred chemical compounds to the list of substances. The classification and labelling provisions themselves are about to be revised.[56]

The requirements under this Directive will ultimately be replaced by the CLP Regulation (No.1272/2008).

6.12 The CLP Regulation (EC) No 1272/2008

The Regulation of 16 December 2008[57] on classification, labelling and packaging of substances and mixtures entered into force on 20 January 2009 and will ultimately replace the current rules on classification, labelling and packaging of substances (Directive 67/548/EEC) and preparations (Directive 1999/45/EC). Substance classification and labelling must all be consistent with the new rules by 1 December 2010 and for mixtures 1 June 2015.

The Regulation aims to ensure a high level of protection of human health and the environment, as well as the free movement of chemical substances, mixtures and certain specific articles, whilst enhancing competitiveness and innovation. This should be achieved by ensuring that the same hazards will be described and labelled in the same way all around the world.

6.13 The EU Climate-energy Package

In March 2007 the EU's leaders endorsed an integrated approach to climate and energy policy that aims to combat climate change and increase the EU's energy security while strengthening its competitiveness. They committed Europe to transforming itself into a highly energy-efficient, low carbon economy.

To kick-start this process, the EU Heads of State and Government set a series of demanding climate and energy targets to be met by 2020. These are:

- A reduction in EU greenhouse gas emissions of at least 20% below 1990 levels.
- 20% of EU energy consumption to come from renewable resources.
- A 20% reduction in primary energy use compared with projected levels, to be achieved by improving energy efficiency.

Collectively they are known as the 20-20-20 targets[58].

[55] OJ 196, 16.08.1967 p.1 – 98 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31967L0548:EN:HTML

[57] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:en:PDF

[58] http://ec.europa.eu/environment/climat/climate_action.htm

6.14 UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP)

Since 1979 CLRTAP[59] has addressed major environmental issues through scientific collaboration and policy negotiation. The aim of the Convention is that Parties shall endeavour to limit and, as far as possible, gradually reduce and prevent air pollution including long-range transboundary air pollution.

The convention has been extended on eight occasions by a number of different protocols.

Of particular interest in relation to road construction is the Protocol on Volatile Organic Compounds (1991), which entered into force on 29th September 1997. This protocol targets the reduction of hydrocarbon emissions.

6.15 Environmental Impact Assessment Directive 85/337/EEC

The EIA Directive[60] on the assessment of the effects of certain public and private projects on the environment was adopted in 1985 and amended by Directives 97/11/EC[61], 2003/35/EC[62] and 2009/31/EC[63]. Member States had to transpose the amended EIA Directive by 14 March 1999 at the latest.

The EIA procedure ensures that environmental consequences of projects are identified and assessed before authorisation is given. The public shall be informed, whether by public notices or other appropriate means such as electronic media where available, of the request for development consent and details about the availability of information and public participation early in the environmental decision-making procedures and, at the latest, as soon as information can reasonably be provided. The EIA Directive outlines which project categories shall be made subject to an EIA, which procedure shall be followed and the content of the assessment. The following project categories are specifically relevant to road construction[64]:

- Construction of motorways and express roads. (Annex 1, 7(b))
- Construction of a new road of four or more lanes, or realignment and/or widening of an existing road of two lanes or less so as to provide four or more lanes, where such new road, or realigned and/or widened section of road would be 10 km or more in a continuous length. (Annex 1 7(c)).
- Construction of roads, harbours and port installations, including fishing harbours (projects not included in Annex I) (Annex 2, 10(e)).

It should be noted that the Directive provides the provision for Member States to decide, on a case-by-case basis if so provided under national law, not to apply this Directive to projects serving national defence purposes, if they deem that such application would have an adverse effect on these purposes.

The environmental impact assessment shall identify, describe and assess the direct and indirect effects of a project on the following factors:

- Human beings, fauna and flora.
- Soil, water, air, climate and the landscape.
- Material assets and the cultural heritage.
- The interaction between the factors mentioned in the first, second and third indents.

[59] http://www.unece.org/env/lrtap/
[60] OJ L 175, 5.7.1985, p. 40–48 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31985L0337:EN:NOT
[61] OJ L 73, 14.3.1997, p. 5–15 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31997L0011:EN:NOT
[62] OJL 156, 25.06.2003, p. 17-25 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32003L0035:EN:HTML
[63] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0114:0135:EN:PDF
[64] http://ec.europa.eu/environment/eia/full-legal-text/9711.htm

6.16 Future Legislation and Standards

6.16.1 Soil Framework Directive

The proposal for a Soil Framework Directive (COM(2006) 232) was adopted by the EU along with the Soil Thematic Strategy (COM(2006) 231) on 22 September 2006. The framework sets out common principles, objectives and actions with the aim of protecting soils across the EU. Member States would be required to identify areas where there is risk of erosion, organic matter decline, compaction, salinisation and landslides and set risk reduction targets as well as integrating soil protection into other policies.[65]

The Directive would not only directly impact the road construction industry, it could have impacts on the availability and quality of materials as activities like mining and quarrying will be subject to the policies implemented.

6.17 Examples of Member State Policy

6.17.1 Member State example – Product Specific Restrictions

Some Member States have specific legislation covering the re-use of old road materials and aggregates. In the Netherlands for example it has been prohibited since January 2001 to use the tar-containing products in roads[66]. Likewise, there are restrictions when recycling the tar-containing asphalt commonly used in the 1970s for re-use in new roads. To re-use this kind of asphalt in new roads they have to undergo a combustion process to completely remove the tar from the rest of the product, mainly aggregate[67]. There is a similar situation in Belgium.

6.17.2 Example 2 – Responsible Sourcing Standards

In August 2008 BSI, the British Standards Institute, announced it is to start work on developing standards that will assist organisations with responsible sourcing.[68] It is proposed that the work will initially focus on the responsible sourcing of construction products, including civil engineering. This work will draw on existing industry practice and knowledge, with the objective of providing commonly agreed, widely applicable specifications for responsible sourcing of all construction products. The standard is intended to provide transparent and reliable ways of measuring and improving performance that are practical and relevant to specific sectors.

[65] http://ec.europa.eu/environment/soil/index_en.htm

[66] http://www.senternovem.nl/mmfiles/Consultatie%20criteriadocument%20Wegennet_tcm24-274400.pdf

[67] Personal communication with a representative from the Dutch Public Works and Water Management (Rijkswaterstaat), responsible for Roads.

[68] http://www.bsigroup.com/en/About-BSI/News-Room/BSI-News-Content/Sectors/Construction--Building/Responsible-Sourcing-announcement

7 Existing Standards & Ecolabels Relevant to Road Construction

There are a number of standards for road construction already in existence. Although there is no European Ecolabel for road construction or traffic signs, a number of other Type 1 Ecolabel criteria[69] for these areas do exist, as well as for related products. An outline of these different standards is provided below.

7.1 Ecolabels for Road Construction

7.1.1 Hungary

The Hungarian Ecolabel[70] for *Bituminous road pavements and road surface coats for maintenance* was valid until June 2009, however has been extended. A new validity date is not provided. The criteria apply to bituminous binding materials used for new road pavements and road construction used for maintenance. Compliance with the label is ascertained through comparison with an identical product manufactured by traditional or standard technologies.

The Hungarian label states that energy consumption throughout the lifecycle of the product (from raw material production to paving) should be 10 % less than that of an equivalent product manufactured by the traditional method. Alternatively, if the product offers an additional technical or financial advantage than the equivalent, such as a longer lifetime, then the total energy consumption shall be at least identical to the traditional product.

The label refers to ISO 9001 and ISO 14001 as example quality and environmental management systems and specifies that the manufacturer must have such systems in place. It also requires that emissions from manufacturing the road construction be considerably lower than the emissions generated during the manufacture of comparative materials by traditional methods. It states that any process must comply with the official air pollution limits for dust, SO_2, NO_x and polyaromatic hydrocarbons (PAH).

With regard to water pollution the Hungarian label states that the technology used during the construction process must comply with official water pollution limits; applicants must prove that water used is emitted back to the environment at an appropriate quality and that materials have not been emitted to the soil.

The label specifies that the binding material used in road construction must not be diluted bitumen and must not contain volatile organic compounds (VOC). Similarly it must not contain formaldehyde derivatives, halogenated hydrocarbons or compounds containing soluble toxic heavy metals.

The label states that noise emissions shall not exceed the effective limits during the whole procedure of producing road pavement. Noise emission of the used equipment shall be documented.

The Hungarian label states that a waste-reducing technology shall be used for manufacturing the bituminous mixtures. It also requires documentation to be kept on the waste recycled for use as secondary raw material. Finally, the modifying agent in modified bitumen must be recyclable.

7.1.2 Netherlands

Milieukeur, the Dutch national Ecolabel does not have criteria specifically for roads but does have criteria on concrete products such as slabs and tiles – *"Betonbanden, betonstraatstenen en betontegels"*.[71] The environmental criteria are concerned with the amount and type of coarse concrete material used in the substrate. It is not clear how these could be used to develop GPP criteria.

[69] Type 1 Ecolabel criteria are independently verified and set in accordance with ISO14024
[70] http://www.kornyezetbarat-termek.hu/minositesi-feltetelrendszerek-20.html
[71] http://www.milieukeur.nl/nl-NL/Content.aspx?type=criteria&id=8

There is current research being undertaken in the Netherlands by SenterNovem on GPP criteria of *"Wegennet* - Road Networks" for various types of roads, foot and cycle paths as well as squares and yards that includes wider sustainability issues. Development started in June 2007 and there was a consultation period on the draft criteria during the summer of 2008. The draft considers sustainable materials and energy consumption, reuse of aggregate materials, removal of tar-containing asphalt, as well as quality control, land use, noise and impacts on soil and water. The criteria were expected to be finalised towards the end of 2008 however the results are still not available on their website.[72]

As the criteria are in draft form the recommendations are generally qualitative, stating that criteria should strive for energy savings during construction. It also suggests that applicants apply asphalt at low temperatures, minimise transport distances and use renewable energy and/ or biomass to power the project site.

The criteria specify that environmental pressures should be calculated using an environmental life cycle approach to ensure they are as low as possible and less than for a reference design. The SenterNovem document is the only standard to mention land use. It recommends the application of a wildlife barrier during construction, green corridors around the roads to limit any potential damage to the landscape, nature and culture.

The label also refers to the prevention of water pollution by minimising the disruption to the natural quality of the groundwater during construction and use, reducing pollutant run-off from the road and avoiding exposure to harmful substances from storm water. It also recommends the construction works reduce discomfort caused by noise and vibration.

7.1.3 Japan

The Japanese Eco Mark criteria for *Products for "Civil Engineering Version 1.8"*[73] relate to concrete materials, including cement, aggregates and additives, concrete products and pavement materials, including rubber pavement materials and recycled sub-base materials and recycled asphalt mixture. Start and end dates are not provided for the validity of the criteria which focus on recycled content and quality criteria.

This label states that the production stage of the product shall give consideration to energy consumption and CO_2 emissions. It refers to specific Japanese standards, such as JIS TR A0016 "Fine Aggregates for Concrete" however it also looks at balancing economic, ecological, and social benefits. It specifies that the criteria shall comply with *Agenda 21* [74] and observe related international agreements and conventions.

The label requires that products must not extract harmful substances including heavy metals, cadmium, lead, hexavalent chromium, arsenic, total mercury, and selenium, during construction or use. It also outlines percentages for recycled content for a variety of products. These are presented in Figure 5.

Furthermore, the label specifies that an instruction manual accompany the product, concerning its construction, use, maintenance, management, disassembly, disposal and recycling. This document must be given to the constructor and the owner of a structure. The instruction manual shall provide the following information:

- Information regarding the extraction of harmful substances and the emission of particulate (dust) materials containing harmful substances as a result of abrasion, etc. in the use and construction of the permeable concrete or recycled materials and in the use, maintenance and management of the product.
- Information regarding construction, use, maintenance and management of the structure.
- Information regarding disassembly and disposal of the structure.
- Information regarding the recycling of the product.
- The requirement to retain the instruction manual until the structure is disassembled, disposed of, and/or recycled.

72 http://www.senternovem.nl/duurzaaminkopen/Criteria/gww/wegennet.asp
73 http://www.ecomark.jp/english/pdf/131eC18.pdf
74 http://www.un.org/esa/sustdev/documents/agenda21/index.htm

The products shall be recyclable after use, or they should be separable from other products.

Figure 5. Recycled content for construction products

Product	Minimum recycled content
Aggregate produced from crushed chunks of concrete	100 %
Vitrified material aggregates such as non-industrial wastes and sewage sludge	100 %
Slag aggregates (blast furnace slag, ferro-nickel slag and copper slag and electric furnace oxidizing slag)	100 %
Cement (see Figure 6 for list of materials)	40 %
Eco-cement	50 %
Concrete admixture (powder dust of blast furnace slag*, fly ash, silica fume)	100 %
Rubber pavement material and anti-freezing pavement material containing rubber particles.**	100%
Recycled sub-base materials and recycled asphalt mixture (see Figure 6 for list of materials)	50 %

* Gypsum can be added within the scope of the standards.
** Anti-freezing pavement material containing rubber particles shall be adequately recyclable by a modification facility after disposal.

Figure 6. Recycled materials for making cement and sub-base materials.

Recycled materials usable for making cement	Recycled materials usable for sub-base materials and asphalt mixture
Recycled materials	Recycled materials
Blast furnace slag	Modified asphalt
Coal ash	Asphalt-concrete block, concrete block
By-product lime	Quarrying and ceramic industry waste soil
Sludge	Micro-silica sand obtained during the water washing of silica sand (mica
Non-steel slag	powder)
Steelmaking slag	Steel slag
Combustion residues (excluding coal ash), soot, dust	Foundry sand
Coal refuse	Ceramic waste
Foundry sand	Coal ash
Waste tires	Recycled plastic
Recycled oil	Shells
Waste oils	Glass cullet
Waste clay	Construction sludge
Waste plastics	Paper-manufacturing sludge
Wood chips	
RDF	
Other non-industrial wastes and industrial wastes designated under the "Law Concerning Waste Disposal and Cleansing," shall be appropriate as cement constituents, fuels or mixing materials	

7.1.4 Korea

The Korean Ecolabel[75] has also been in existence since 1992. It is a voluntary standard run by the Ministry of Environment. Since 1995 Korean public services have been obliged to buy products with the Ecolabel in compliance with the Act on the Promotion of the Purchase of Environmentally-Friendly Products. There are three Korean ecolabels relevant to road construction materials:

- *Water-permeable Concrete Pavements.*
- *Recycled Construction Material.*
- *Recycled Slag Products.*

The criteria include requirements for recycled content, hazardous waste content and quality specifications.

[75] http://www.koeco.or.kr/eng/business/business01_03.asp?search=1_3

Durability across a variety of climatic conditions is important and the Korean label for water permeable pavements specifies that the product must be able to withstand a test where the product is frozen and thawed 100 times without crumbling.

The labels specify Korean quality standards; for example, fine powder shall satisfy the quality criteria of KS F 3501 (filling material for bituminous pavement) and KS L 5405(fly ash), cement shall satisfy the quality criteria of KS L 5211(fly ash cement). The criteria state that where no Korean industrial standard exists for a product, it shall satisfy the Korean industrial standards for products with the same or similar function.

The Korean label for recycled construction products specifies that harmful elements, including heavy metals within the recycled waste products, must satisfy the criteria specified in Figure 7.

Figure 7. Standard Amount of Harmful Elements

Item	Standard Amount [mg/L]	Item	Standard Amount [mg/L]
Cadmium (Cd)	<0.3	6+ Chrome (Cr+6)	<1.5
Lead (Pb)	<3	Cyanide (CN-)	<1
Copper (Cu)	<3	Organic Phosphorus	<1
Arsenic (As)	<1.5	Trichloroethylene	<0.3
Mercury (Hg)	<0.005	Tetrachloroethylene	<0.1

Korea's label for water permeable pavements states that lead and cadmium compounds shall not be used in admixtures and pigments, which are used as the constituent materials of the product.

The label for recycled construction products provides recycled content recommendations for the manufacturing stage of different types of waste material. These are shown in Figure 8. The label also specifies the installation and operation of a recycling system that recovers used water for reuse.

Figure 8. Usage rates for waste materials

	Usage Rate of Waste Material [weight%]	
	Firing processing product	Non-firing processing product
Waste lime, waste plaster	≥50	≥60
Incineration residue, waste glass, waste ceramic material, waste moulding sand	≥40	≥50
Waste lime power	≥40	≥40
Inorganic sludge	≥10	≥10
Other	≥40	≥50

Note: In case of mixing and using more than 2 types of waste materials, the total waste material use rate shall satisfy the waste material use rate of main raw materials.

7.1.5 Enrobé à Module Elevé (EME2)

EME2 is a French high modulus asphalt Class 2 material. The use of EME2 reduces the number of layers of bituminous material laid, making use of comparatively small aggregates and a high binder content that gives a more homogeneous mix that is less likely to segregate. This is more easily compacted and has lower air voids content,[76] saving time, labour, plant costs and maintenance, whilst providing greater resistance to deformation.

Mix design is a crucial matter for EME2 with each blend of aggregate and binder designed to meet exacting performance criteria. This means that each site or stretch of road has to be individually assessed increasing the cost of construction, however it is considered that these costs will be recovered through longer life spans and reduced maintenance costs.

[76] http://www.nce.co.uk/transport/news/its_time_to_get_tough.html

7.2 Ecolabels for Traffic Signs

7.2.1 Netherlands

SenterNovem in the Netherlands have developed criteria for traffic management installations - *"Verkeersregelinstallaties",* which encompasses traffic lights, traffic information systems and street signage. Development of the criteria started in June 2007 and criteria were published on their website[77] in August 2008 after a period of consultation. The criteria are concerned with energy efficiency (such as energy efficient and dimmable lighting in lit systems for example), material use, as well as sustainable design and traffic management systems and they are largely descriptive in nature, e.g. 'class II' energy efficient lights sources must be installed in new systems.

The criteria document states for sustainable material use that there is no advantage to be found in LCA studies for any particular material type. The main environmental gains are in recycling and reusing the materials, in particular poles and mounts. Sustainable material use is handled through a qualitative award criterion asking for a weighted approach to reducing the use of raw materials, energy use in manufacture, and maximising product lifetime, durability and recyclability. The more energy that is saved and the lower the environmental impact, the more the product is awarded points.

7.2.2 Japan

The Japanese Ecomark has criteria for *Products for Civil Engineering nr 131.* This standard[78] includes a variety of civil engineering materials such as wood, plastics, and waste glass. It also has criteria by products, including road traffic signs. The focus is on the use of recycled materials (for plastics, concrete and metals) and restrictions on hazardous substances used in the plastic parts. Although there is merit in these criteria, it is not clear how they may work in the European setting due to different manufacturing processes and legal regimes. Furthermore, gaining proof of compliance and verification may prove difficult for procurement officials.

The Japanese label states that energy consumption and CO_2 emissions should be considered at all stages in the manufacture of the road sign product. It specifies that the plastic materials used for the sign facing must not contain lead (Pb)-based chemical compounds, cadmium (Cd)-based chemical compounds, tributyl tin compound (TBT), triphenyl tin compound (TPT), dibutyl tin compound (DBT), diphenyl tin compound (DFT), and monophenyl tin compound (MFT). Furthermore, there are restrictions on the substances that can come out of the sign materials, namely on heavy metals: cadmium, lead, chromium (VI), arsenic, mercury and selenium. The materials must also be designed to allow separation and sorting for maintenance and at the end of the sign's life.

The label specifies that the sign facing must be reused when it is removed and that the total mass of recycled materials shall be 70 % or more of the entire product mass. However if plastic and concrete materials account for more than 50 % by weight of the product, the recycled content shall be 50 % or more.

The label also requires that an instruction manual accompany the product, concerning its construction, use, maintenance and subsequent disassembly and disposal or recycling. This document must be given to the constructor and the owner of a structure. The instruction manual shall provide the following information:

- Information regarding construction, use and maintenance of the sign.
- Information regarding the specification and durability of the sign.
- Information regarding disassembly, disposal and recycling of the sign.

77 http://www.senternovem.nl/duurzaaminkopen/Criteria/gww/verkeersregelinstallaties.asp
78 http://www.ecomark.jp/english/pdf/131eC18.pdf

7.3 Ecolabels for Products Related to Road Construction

This section lists some of the main Ecolabels for products that are related to road construction and surfaces, such as for de-icing roads in winter and for maintaining road-manufacturing equipment.

7.3.1 Germany

The German Blue Angel label for *Low-Solvent Bitumen Coatings and Adhesives* was launched in 2006.[79] A review date is not provided for the criteria, however the usage instructions specify that contracts for use of the label will run until 2010 and can then be extended by periods of one year each. The criterion covers roofing applications but also civil engineering applications “with or without ground contact against weather related environmental influences (water)”.

The label specifies the drying time required to achieve complete dryness must be ≤ 5 hours. The solid content of the bitumen emulsion must be > 55 % of the weight. The label also prohibits the use of substances that are carcinogenic, however it uses Annex I to Directive 67/548/EEC to classify these substances. It prohibits substances in categories Carc. Cat.1, Carc. Cat 2, Mut.Cat.1, Mut.Cat.2, Repr. Cat.1 and Repr. Cat. 2. exempted are two-component products where one component contains cement. If the product formulation includes a cement-containing component the cement must, for the protection of the user, be low in chromate content. The label also prohibits products containing APEO being added to bitumen coatings or adhesives and specifies that the content of VOCs in bitumen emulsions must not exceed 1 % of the finished product’s weight.

7.3.2 Czech Republic

The Czech Republic Ecologically Friendly Product label criteria applies to *Abrasive light aggregate spreading material for winter maintenance of roadways*.[80] To qualify a product must demonstrate that its quality and functionality compared with a non-environmentally friendly equivalent has not been compromised. The product will then be assessed for raw material use, energy savings, the use of secondary raw materials, the use of renewable sources of energy, reduced emissions of pollutants, reduction or elimination of harmful and toxic substances or waste.

7.3.3 Australia

The Good Environmental Choice Australia (GECA) Standard for *Recycled Rubber Products* is a voluntary standard that was launched in 2008. The standard is valid for three years and is applicable to a number of products, including civil engineering products (road constructions, footpath constructions, traffic management and road safety products).[81] All products must be fit for their intended purpose and must meet or exceed the requirements of any relevant Australian standards before GECA certification can be granted.

The label specifies that products shall not emit carcinogenic substances in categories 1 or 2A as classified by the International Agency for Research on Cancer. The GECA also prohibits the use of substances in category 2B at levels greater than 5 % of national exposure standards during the in-use phase.

The label also specifies that the following compounds, their functional derivatives or in-situ precursors shall not be added to finished products, their component parts or be used at any stage of the manufacturing process, including as preparatory agents, cleaners or degreasers in the production facility:

- Halogenated organic solvents or binding agents.
- Elemental halogens (e.g., fluorine, chlorine, including in-situ precursors from halide salts).
- Fluoropolymer additives or coatings.
- Analine based amines.
- The phthalates DEHP, DBP, DAP, BBP, DMP, DMT, DEP, DMEP and DIBP.

79 http://www.blauer-engel.de/_downloads/vergabegrundlagen_en/e-UZ-115.pdf
80 http://www.env.cz/osv/edice.nsf/dc5eea7884f86f6ac12570110041b047/$file/d5.htm
81 http://www.aela.org.au/StandardsRegister.htm

- Aziridine or polyaziridines.
- Pigments and additives that contain lead, tin, arsenic, cadmium, mercury or their compounds.
- CFC, HCFC, HFC or any ozone depleting substances.
- Polybrominated diphenyl ethers, or chlorinated organic flame retardants.
- 1,3 butadiene. If 1,3 butadiene is suspected as being present, its concentration shall be less than 1 mg / kg.

The GECA limits the VOC concentrations for different categories of recycled rubber product. For civil engineering products, which include road construction, the maximum VOC concentration is 2 mg/m^3 within seven days of unpacking.

The label requires that non-recycled monomer or other petrochemical products for use as raw materials must be sourced from a production facility that complies with relevant environmental legislation and government orders at the local, state, and commonwealth levels, if these have been issued. Where an applicant is from an overseas jurisdiction, that jurisdiction's environmental regulations apply.

In terms of recycled content the criteria state a requirement of 50 % for civil engineering products, road constructions, footpath constructions, traffic management and road safety products. Where the product contains components other than rubber the percentage requirement applies to the rubber component and the total weight of the rubber component only.

Furthermore if the product is not recyclable (or separable into recyclable parts) in mainstream local recycling systems, the manufacturer must accept their product without additional cost (excluding transportation costs) for further recycling, or have arrangements with a local recycler to accept the product, or have an established product stewardship program that will divert the majority of recovered material from landfill.

7.3.4 Canada

Canada's Environmental Choice Program first published criteria for *Asphalt and Concrete Release Agents* in 2004.[82] The next review was scheduled for 2008, however the product group is not currently listed as being under review on the ecolabel's website. The criteria cover the substances used to remove asphalt or concrete from the equipment used in their production and transportation. Products must satisfy all applicable government and industrial safety and performance standards, including legislation for the disposal of waste arising from the manufacturing process.

The label specifies that the products must effectively remove asphalt residues from asphalt equipment, and concrete residues from concrete equipment, as determined by an acceptable test method. They must not damage or degrade the asphalt or concrete surfaces. Furthermore the products shall not emit carcinogenic substances in categories 1 or 2A as classified by the International Agency for Research on Cancer. It goes on to state that the products must not be formulated or manufactured with soaps or detergents containing:

- Phosphates
- Nitrilotriacetic acid (NTA)
- Ethylenediaminetetraacetic acid (EDTA)
- Alkylphenolethoxylate (APEO)

or contain solvents that are wholly or partially comprised of:

- halogenated organic compounds
- butoxy-ethanol
- any ethylene glycol ether listed as being a reproductive risk

This label specifies that the materials used to make the asphalt and concrete release agents must be biodegradable and not be toxic to aquatic life. Furthermore, asphalt release agents must not use non-renewable resources as the main base ingredient and must not be formulated or manufactured with diesel or other petroleum distillates. Concrete release agents must not be formulated or manufactured with more than 55 % diesel or other petroleum distillates and must not contain any non-renewable resources within its non-petroleum-based ingredients.

82 http://www.ecologo.org/

The label for asphalt release agents also specifies that the product must not contain VOCs in excess of 5 % by weight and concrete release agents must not contain VOCs in excess of 450 mg/m^3, as demonstrated through calculation from records of the amounts of constituents used to make the product.

8 Conclusions and Summary

The previous sections have demonstrated that there are several ecolabels in existence that include road construction and traffic signs in their scope, whilst others in development, let alone those that cover ancillary materials used on roads or with the road making equipment. Whilst they describe the environmental impacts of these products well in a qualitative way it is believed that they alone are not sufficient for the development of specific quantitative criteria.

This position was investigated further by speaking to key industry and Government experts involved in road construction policy and research.[83]

There was a general consensus. In short it was stated that this is a complex area in which a great deal of research and development is currently being undertaken. Although life cycle studies have been undertaken indicating the main areas of impact, as discussed and referred to in this document, to date there are no definitive answers in terms of benchmarking the environmental aspects of road construction, in particular with a view to using them as procurement criteria. Furthermore, there is a very wide range of road types depending on a variety of factors, not limited to terrain, climate, volume and type of traffic and choice of materials. As such, setting a set of standards or benchmarks might not be appropriate. Nonetheless, the environmental impact of road construction, maintenance and use is recognised and concomitantly there is a large amount of investment in researching the various issues.

For example, research is being conducted[84] into the sustainability of asphalt and asphalt-related products. The outcome of this will be life cycle analyses including data on carbon footprints, water and resource consumption of the individual materials used in road construction, such as asphalt, bituminous binders and related materials. A standard methodology or protocol by which to assess the materials will also be developed that will allow suppliers to assess the impacts of their products and thereby be able to provide suitable information in the future. This three-year project is part way through and is due to deliver its results in 2010. This will feed into the Standard on Responsible Sourcing in Construction that are currently being developed by the British Standards Institute, BSI, with input from industry experts.

The case is similar for traffic signs in that the available information is of a more qualitative nature, focussing materials and chemical substances. Also, those non-EU labels and their criteria might well not be applicable to the EU situation. Furthermore, full life cycle data would be required in order to set limits on the amounts that particular chemicals could be in road sign manufacture. For although certain toxic materials might be used in small amounts, over the whole life cycle of a road sign their impacts might be small in comparison to other impacts such as energy consumption in manufacture or end of life disposal impacts. Indeed, the research work for the SenterNovem criteria for traffic signals and signs (*Verkeersregelinstallaties*) states that there is no clearly preferable material in terms of sustainability for traffic signs and that the main environmental benefits are through recycling of materials at the end of the product's life.

Therefore, due to the research currently being undertaken in this area it was felt that it would be more appropriate to provide the criteria in the form of guidelines to the environmental impacts related to road construction and road sign materials rather than specific quantitative criteria. This would be presented as a framework of environmental impacts that should be considered in any tendering exercise, largely as award criteria, and information sought from bidders and potential contractors. Local circumstances will dictate what is appropriate to request in terms of the profile and characteristics of a road and its effect on the surroundings, similarly for traffic signs.

[83] Personal communications with Forum of European National Highway Research Laboratories (FEHRL) and the Highways Agency, part of the Department for Transport, UK, August, September 2008

[84] By the Transport Research Laboratory, UK, supported by the Highways Agency, Quarry Products Association (QPA) and Refined Bitumen Association (RBA).

9 Proposal for Core and Comprehensive Procurement Criteria

It is proposed to set core and comprehensive procurement criteria (guidelines) for both road construction and traffic signs. The proposed GPP criteria are designed to reflect the key environmental risks. This approach is summarised in the following table. Please note that the order of impacts does not necessarily translate to the order of their importance.

Key Environmental Impacts	GPP Approach
• Extraction and use of raw materials. • Energy required to produce raw materials and subsequent products. • Energy consumption during the construction of the road or road sign. • Pollution of air, land and water due to the use of fossil fuels to power machinery. • Generation of waste material, including hazardous wastes. • Noise and visual impacts	• Reuse of road building material where possible. • Use secondary aggregate where possible. • Reduce energy use during production. • Reduce energy intensity of construction through the purchase of energy efficient machinery. • Use road surfacing materials that do not contain, or have low concentrations of, hazardous materials such as heavy metals. • Waste reduction through using recycled materials, recycling wastes where possible and extending product lifetimes. • Promoting materials and construction approaches that reduce noise and visual impacts. • Promoting design and materials facilitating the end-of-life recycling processes.

The preceding chapters have shown that the greatest environmental impact from road construction is from the combustion of fossil fuels. These associated emissions are spread across the entire life cycle of the road; the production of materials and construction of the road contributes to roughly half of the emissions whilst a maintenance and operation period of 100 years contributes the other half. Other impacts occur from the use of natural resources as materials and their final end of life impact on waste disposal, as well as some of the substances used in the materials for road surfacing.

For traffic signs the available information states that the greatest environmental gains can be made by designing materials to be durable and recyclable and subsequently recycling them at their useful end of life. Other improvements can be made in maximising energy efficiency of product manufacture.

Green Procurement Criteria have therefore been developed along these lines. The core procurement criteria represent the key environmental issues associated with road construction:

- Energy consumption
- Recycled content
- Hazardous substances – volatile organic chemicals and heavy metals

Whilst the comprehensive procurement criteria cover additional environmental impacts related to:

- Drainage requirements.
- Noise pollution.
- Air pollutants.

For traffic signs procurement criteria have been developed along the lines of reduced raw material use, energy efficiency in manufacture, and maximising product lifetime, durability and recyclability.

The criteria have been devised such that they can be used as award or specification criteria depending on how they are implemented.

Full details of the proposed green procurement criteria are provided in the associated Product Sheet for this product group.

10 EU legislation and information sources

10.1 EU Legislation

- The Construction Products Directive (CPD) 89/106/EEC
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31989L0106:en:HTML

- Council Directive 93/68/EEC amending many Directives including 89/106/EEC (construction products)
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31993L0068:EN:HTML

- The REACH Regulation 1907/2006
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:396:0001:0849:EN:PDF

- The Hazardous Waste Directive (HWD) 91/689/EC
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0689:EN:HTML

- The Waste Framework Directive 2008/98/EC
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0003:EN:PDF

- The European Waste Catalogue (EWC)
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32000D0532:EN:HTML

- The Landfill Directive 1999/31/EC
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31999L0031:EN:HTML

- The Integrated Pollution Prevention and Control Directive 2008/1/EC
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:024:0008:0029:EN:PDF

- The Water Framework Directive (WFD) 2000/60/EC
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF

- The Chromium (VI) Directive 2003/53/EC
  http://eur-lex.europa.eu/pri/en/oj/dat/2003/l_178/l_17820030717en00240027.pdf

- Directive 2006/38/EC of the European Parliament and of the Council of 17 May 2006 amending Directive 1999/62/EC on the charging of heavy goods vehicles for the use of certain infrastructures
  http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!CELEXnumdoc&lg=EN&numdoc=32006L0038

- The Classification, Packaging and Labelling of Dangerous Substances Directive 67/548/EEC
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31967L0548:EN:HTML

- The CLP Regulation (EC) No 1272/2008
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:en:PDF

- The EU Climate-energy Package, http://ec.europa.eu/environment/climat/climate_action.htm

- UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP)
  http://www.unece.org/env/lrtap/

- Environmental Impact Assessment Directive 85/337/EEC
  http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31985L0337:EN:NOT

- Soil Framework Directive
  http://ec.europa.eu/environment/soil/index_en.htm

10.2 Ecolabels and Standards

- Hungarian Eco-label: Bituminous road pavements and road surface coats for maintenance
  http://www.kornyezetbarat-termek.hu/afr31l.htm

- Netherlands Ecolabel, Milieukeur, *Betonbanden, betonstraatstenen en betontegels*
  http://www.milieukeur.nl/nl-NL/Content.aspx?type=criteria&id=8

- German Blue Angel Label: Low-Solvent Bitumen Coatings and Adhesives.
  http://www.blauer-engel.de/_downloads/vergabegrundlagen_en/e-UZ-115.pdf

- Czech Republic Ecologically Friendly Product label: Abrasive light aggregate spreading material for winter maintenance of roadways
  http://www.env.cz/osv/edice.nsf/dc5eea7884f86f6ac12570110041b047/$file/d5.htm

- Good Environmental Choice Australia (GECA) Standard: Recycled Rubber Products
  http://www.aela.org.au/StandardsRegister.htm

- Environment Canada's Environmental Choice Program: Asphalt and Concrete Release Agents
  http://www.ecologo.org/

- Japanese Eco Mark: Products for "Civil Engineering Version 1.8"
  http://www.ecomark.jp/english/pdf/131eC18.pdf

- Korea Ecolabel:
    - Water-permeable Concrete Pavements.
    - Recycled Construction Material.
    - Recycled Slag Products.

  http://www.koeco.or.kr/eng/business/business01_03.asp?search=1_3

- Enrobé à Module Elevé (EME2)
  http://www.trl.co.uk/store/report_detail.asp?srid=2781&pid=174

10.3 Studies and Other Sources of Information

- Anderson, J. and Shiers D. (2004) The Green Guide to Specification, 3rd edition. (Blackwell Publishing)

- Baeken, et al. (2007) Roads as a source of water contamination. Presentation at the International Conference on the Advanced Characterisation of Pavement & Soil Engineering Materials, Athens 2007. Accessed at: http://www.watmove.org/wip05/06-Roads-as-a-Source-of-Contamination.pdf

- Berge, B. (2000) The Ecology of Building Materials. (Architectural Press)

- Birgisdóttir, et al. (2006) Environmental Impact of roads constructed with and without bottom ash from municipal solid waste incineration. *Transportation Research Part D, Vol 11. pg 358-368*

- Birgisdóttir, H. (2005) Life cycle assessment model for road construction and use of residues from waste incineration. Ph.D. Thesis (Institute of Environment & Resources, Technical University of Denmark)

- Cement Industry Update: Special Issue on Chromium (VI) Directive

- CEMBUREAU (2007) Activity Report 2007.
  http://www.cembureau.be/Documents/Publications/Activity%20Report%202007.pdf

- CIRIA (1997) Use of industrial by-products in road construction – water quality effects. (Report 167)
- Croney, D. and Croney P. (1998) Design Performance of Road Pavements. 3rd edition. (McGraw Hill)
- Dawson, A. (2007) Water Movement in Road Pavements and Embankments. http://www.watmove.org/FinalReport.pdf
- Design manual for roads and bridges. Volume 8: Traffic Signs and Lighting. (Feb 2004)
- Environment Agency, Sustainable Drainage Systems (SUDS): An Introduction. http://publications.environment-agency.gov.uk/pdf/GEHO0308BNSS-e-e.pdf
- European Commission's GPP Training Toolkit: http://www.ec.europa.eu/environment/gpp
- European Investment Bank (2006) Ex Ante Construction Costs in the European Road Sector: A Comparison of Public-Private Partnerships and Traditional Public Procurement (Economic and Financial Report 2006/01)
- FEHRL (2006) Guidance Manual for the Implementation of Low-Noise Road Surfaces. (SILVIA Project Deliverable)
- Finnish National Road Administration (2000) Life cycle assessment of road construction. http://www.tielaitos.fi/libr.htm
- Johansson, S. (2006) Road Salt and the Environment – a Complex Problem in Nordic Road and Transport Research, No.3. Pg 12.
- Nilsson, R. *et al*. (2005) Design Guidelines for Durable, Noise Reducing Pavements. (SILVIA Project Deliverable)
- OECD (1997) Recycling strategies for road works. (Road Transport Research)
- Road Research Laboratory, Department of Scientific and Industrial Research. (1962) Bituminous materials in road construction.
- Roaf, et al. (2007) Ecohouse. 3rd ed. (Architectural Press)
- Sanders, P.J. and Nunn, M. (2005) The application of Enrobé à Module Elevé in flexible pavements. (TRL Report TRL636)
- Sherwood, P. (2001) Alternative materials in road construction. 2nd ed. (Thomas Telford Ltd)
- US Department of Transportation Federal Highway Administration (Oct 2000) Recycled Materials in European Highway Environments: Uses, Technologies and Policies. http://international.fhwa.dot.gov/pdfs/recycolor.pdf
- http://www.contractjournal.com
- http://www.ec.gc.ca/cleanair-airpur/Pollution_Sources/Asphalt-WS13CBCB37-1_En.htm
- http://www.hag.co.uk/pdf/specs/07_SPECA.PDF;
- http://www.garagedoors-sw.com/subprod/steel-coated-0000304.aspx
- http://www.madehow.com/Volume-2/Road-Sign.html
- http://www.rethinkrecycling.com/government/eppg/-buy-products-services/vehicles/road-aggregate

Appendices

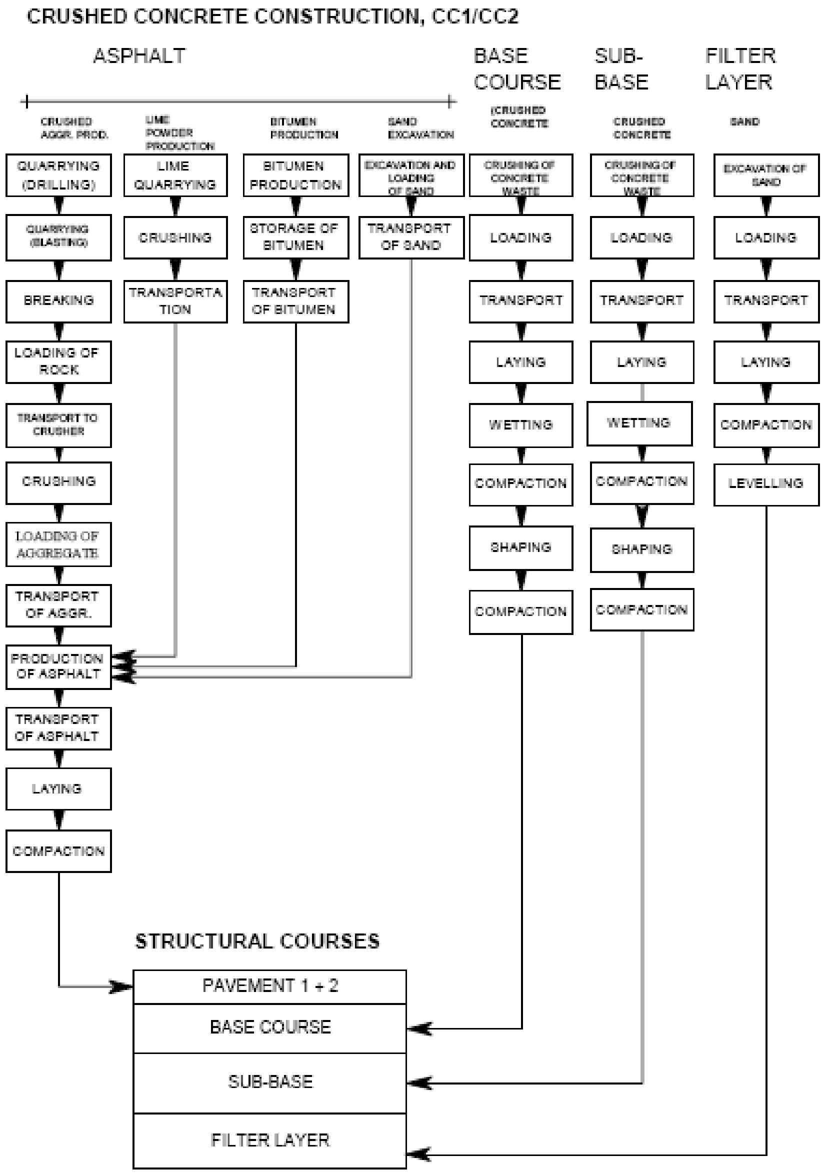
Appendix 1 – Life-cycle phases for materials used in constructing layers of a crushed concrete road

Appendix 2 – European Standards Relevant to Road Construction

Appendix 1 –

Life-cycle phases for materials used in constructing layers of a crushed concrete road

From the Finnish National Road Administration (2000) - Appendix 2



Appendix 2 – European Standards Relevant to Road Construction and Traffic Signs

- EN 197:2000/ A1:2004 - Cement - Part 1: Composition, specifications and conformity criteria for common cements, and Part 4: covering low early strength blast-furnace cements.
- EN206:2000 - Concrete. Specification, performance, production and conformity.
- EN 450:2005 - Fly ash for concrete - Part 1: Definition, specifications and conformity criteria.
- EN 459:2001 - Building lime - Part 1: Definitions, specifications and conformity criteria.
- EN 934: 2001/A2:2005 Part 2- Admixtures for concrete, Definitions, requirements, conformity, marking and labelling.
- EN 1317-5:2007 - EN 1317-5:2007 - Road restraint systems - Part 5: Product requirements and evaluation of conformity for vehicle restraint systems.
- EN 1338:2003/AC: 2006 - Concrete paving blocks - Requirements and test methods.
- EN 1344:2002 - Clay pavers - Requirements and test methods.
- EN 1423:1997/A1:2003 - Road marking materials - Drop on materials - Glass beads, antiskid aggregates and mixtures of the two.
- EN 1433:2002/A1:2005 - Drainage channels for vehicular and pedestrian areas - Classification, design and testing requirements, marking and evaluation of conformity.
- EN 1436 – Road marking materials – road marking performances for road users
- EN 1871 – Road marking materials – physical properties
- EN 12620:2002 - Aggregates for concrete.
- EN 12899: 2007 - Permanent traffic signs, which relates to the construction of traffic signs.
- EN 12966:2005 - Road vertical signs - Variable message traffic signs - Part 1: Product standard.
- EN 13043:2002/AC:2004 - EN 13043:2002/AC:2004 - Aggregates for bituminous mixtures and surface treatments for roads, airfields and other trafficked areas.
- EN 13055:2002 - Lightweight aggregates - Part 1: Lightweight aggregates for concrete, mortar and grout, Part 2: for bituminous mixtures and surface treatments and for unbound and bound applications.
- EN 13108-1:2006 - Bituminous mixtures - Material specifications – Part 1: Asphalt Concrete
- EN 13108-2:2006 - Bituminous mixtures - Material specifications – Part 2: Asphalt Concrete for very thin layers
- EN 13108-3:2006 - Bituminous mixtures - Material specifications - Parts 3: Soft Asphalt
- EN 13108-4:2006 - Bituminous mixtures - Material specifications - Parts 4: Hot Rolled Asphalt
- EN 13108-5:2006 - Bituminous mixtures - Material specifications - Parts 5: Stone Mastic Asphalt
- EN 13108-6:2006 - Bituminous mixtures - Material specifications – Part 6: Mastic Asphalt
- EN 13108-7:2006 - Bituminous mixtures - Material specifications – Part 7: Porous Asphalt,
- EN 13108-8:2006 - Bituminous mixtures - Material specifications – Part 8: Reclaimed Asphalt.

- EN 12591:2005 Bitumen and bituminous binders — Specifications for paving grade bitumens.
- EN 13808: 2005 Bitumen and bituminous binders - Framework for specifying cationic bituminous emulsions
- EN 14023:2005, Bitumen and bituminous binders – Framework specification for polymer modified bitumens
- EN 13139:2002 - Aggregates for mortar.
- EN 13242 – Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction
- EN 13285:2003 -Unbound mixtures - Specification
- EN 13877 :2004 - Concrete pavements.
- EN 14216:2004 – Cement Composition, specifications and conformity criteria for very low heat special cements.
- EN 14227:2004 Parts 1, 3, 4 and 5 - Hydraulically bound mixtures. Specifications. Cement bound granular mixtures, Fly ash bound mixtures, Hydraulic road binder bound mixtures.