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Revision of Green Public Procurement Criteria for Road construction

Working draft in progress

Technical report

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1 EXECUTIVE SUMMARY OF THE PRELIMINARY REPORT

Public procurement constitutes approx. 19% of overall Gross Domestic Product (GDP) in Europe (EC, 2011) – and thus constitutes real leverage to influence the market and to gain significant environmental improvements in the public sector.

To reduce the environmental impact of public purchasing, it is important to identify and develop green public procurement (GPP) criteria for products, services and works with a high share of public purchasing combined with a significant improvement potential for environmental performance.

The development of GPP criteria for road construction aims therefore at helping public authorities to ensure that road construction projects are procured and implemented in an environmentally-friendly way

The development of criteria for a greener public procurement requires in-depth information about the technical and environmental performance of the procurement object in question – in this case road construction – as well as the procurement processes.

For this reason, the European Commission has developed a process aiming at bringing together both technical and procurement experts to develop a broad body of evidence and to develop in a consensus oriented manner, a proposal for criteria which promise to deliver substantial environmental improvements.

Two reports have been prepared for stakeholder consultation prior to the 1st Ad Hoc Working Group (AHWG) meeting. The first is an in-depth preliminary report providing background information relevant to the product group and describing factors related to potential GPP criteria areas. The preliminary report has been split into the following sections:

- Task 1: Stakeholder survey, statistical and legal review, scope and definition proposal
- Task 2: Market analysis
- Task 3: Technical analysis
- Supporting annexes (included in a separate document).

The second report (the Technical report) is much more concise, contains an executive summary of the preliminary report and is focussed on peculiarities of the procurement process, draft criteria proposals for GPP and the rationale behind those criteria. Aspects of both reports will be discussed at the meeting, particularly the Technical report, and these documents will be revised accordingly based on the outputs of the 1st AHWG meeting. The ultimate goal is to provide precise and verifiable criteria that can be used to specify low environmental impact roads.

Publically available information related to the development of the GPP criteria for road construction can be found at (http://susproc.jrc.ec.europa.eu/road/) hosted by the Institute for Prospective Technological Studies IPTS. It is also possible to register at this Internet page in order to be involved in the consultation process.

1.1 Scope and definitions of road construction

Definition of road

A review of the main definitions used by relevant institutions was performed in order to set a unified definition for "roads". In line with the common definitions used by the Organisation for Economic Co-operation and Development (OECD) and EUROSTAT, it is proposed to define "road" by:

"Line of communication (travelled way) open to public traffic, primarily for the use of road motor vehicles, using a stabilized base other than rails or air strips" (Eurostat, 2009)

Classification of roads

The sources analysed set different classifications of roads, but there are shared classifications between Eurostat and the International Road Federation (IRF) as shown in the following table:

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Eurostat	IRF
Motorway / freeway	*Motorways*
Express road	*Highways, main or national roads*
Road outside a built-up area	*Secondary or regional roads*
	Other roads - Rural
Road inside a built-up area: urban road	*Other roads - Urban*

The market analysis carried out in Task 2 of the project showed that the main source of market data is IRF, which provides the figures for the main statistics published by the European Commission (EC 2013a). For that reason, it is proposed to use the IRF classification. It has to be mentioned that in these statistics "other roads (rural)" and "other roads (urban)" are aggregated in one class called "other roads".

Definition of road construction and road maintenance

The previous GPP criteria for Road construction and traffic signs defined "road construction" as “the preparation and building of a road using materials, including aggregate, bituminous binders and additives that are used for the sub-base, road-base and surfacing layers of the road”. This definition is proposed to be retained in the framework of the current revision, but adding the comments received from the consultation related to the cement:

<u>Road construction</u>: the preparation and building of a road using materials, including aggregate, bituminous and hydraulic binders and additives that are used for the sub-base, road-base and surfacing layers of the road.

An additional definition of "road maintenance" is also proposed, based on the definitions provided by the Australian Asphalt Pavement Association (AAPA, 2010):

<u>Routine maintenance</u> is concerned with minor activities required to slow down or prevent deterioration of a road pavement. It tends to be preventive as well as corrective and includes such activities as:

- *crack-sealing*
- *pothole repair*
- *minor correction of surface texture deficiencies*
- *minor shape correction.*

<u>Periodic maintenance</u> primarily involves preservation of the asset using thin surfacings to restore texture or ride quality, protect the surface against entry of moisture, or prevent deterioration through ravelling and weathering.

<u>Rehabilitation</u> includes major work carried out to restore structural service levels. As such, the treatments are corrective in nature and include:

- *non-structural overlays*
- *structural asphalt overlays*
- *reconstruction or recycling of pavement materials, etc.*

Scope proposal

According to the information gathered in the Preliminary report, it is recommended that the procurement criteria cover the following scope:

- Materials production including raw materials extraction. This phase consists of the processes needed to manufacture construction materials and products and includes the entire upstream supply chain needed to produce each material (for examples extraction and production of aggregates, refining of

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crude oil for the production of bitumen). Transportation needed to move pavement materials to and from production facilities and to the project site are included in this phase. Transportation distances can vary widely based on project location. Off-site equipment used in the materials production is accounted for in this phase. This phase also includes the employment of by-products, recycled/secondary materials and recovered waste materials.

- Construction. This phase usually includes clearance of the construction site (removal of infrastructure and vegetation), earthworks including the possible construction of earth mounds, ground works including the stabilisation of the sub-grade, on-site equipment (as pavers, dozers, millers, etc.), construction of the pavement layers, construction and laying of the drainage and water run off systems, placement of road furniture. Analysis of congestion caused by the works is included.
- Use. This phase includes the daily traffic on the road pavement and thus vehicle fuel consumption during the road service life. It has to be considered that a pavement and its properties are only responsible for a fraction of the vehicle fuel consumption, namely those associated with its structural characteristics and surface texture (influencing the rolling resistance).
- Maintenance (and operation). This phase runs in parallel with the use phase, ending when the road is decommissioned. Some maintenance operations share the same materials, and hence impacts, with the construction phase. In detail, it typically includes repair (for example filling potholes in the surface), rehabilitation (resurfacing and sealing of entire sections of road surface), winter maintenance (de-icing, road salting/gritting) and substitution of lighting or road furniture elements. Analysis of congestion caused by maintenance is included.
- End-of-life (EoL). This phase can be applied to worn surface courses that are removed off-site during maintenance activities or, in rare cases, when an entire road structure is decommissioned or replaced.

Finally, it has to be specified that noise has been included in the project scope, considering noise reducing surface and noise abatement measures.

The scope proposal has been shaped according to the main European legislative requirements and standards. Analysis of existing or draft GPP criteria for road construction in various countries has also been carried out. For example the Dutch GPP criteria on roads, the French voluntary commitment between the road constructor's federation and the Ministry, the draft Italian GPP criteria on road construction and maintenance and the Australian and United States rating systems..

Exclusions

During the stakeholder's consultation, a number of exclusions were suggested in questionnaire responses:

- Road markings
- Street lighting and traffic signals
- Traffic signs
- Information systems
- Foundations or lighting of traffic signs
- Other types of road furniture (pedestrian walkways, bollards, overhead gantries and central reservations)

Road markings are products quite similar to paints and varnishes and for this reason they will be included in the EU GPP criteria for paints and varnishes[1].

The reason for the exclusion of street lighting and traffic signals is that these products are covered by separate EU GPP criteria[2].

It was recommended that traffic signs including foundations are excluded from the product scope because traffic signs are of minor importance to the total potential environmental impacts (Stripple, 2001; SUSCON, 2006; Loijos et al., 2013 – also see Chapter 3 'Technical and environmental analysis' of the preliminary report

1 http://susproc.jrc.ec.europa.eu/paints/

2 http://ec.europa.eu/environment/gpp/pdf/criteria/street_lighting.pdf

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and Annex III Literature review of the supporting document). This conclusion is in particular supported by the findings of Stripple, who calculated the approximate influence of the traffic signs below 1% of the environmental impact when considering only raw material extraction, construction, operation and maintenance. Traffic signs were also excluded from the Criteria for the Sustainable Public Procurement of Roads developed by the Dutch Ministry of Housing, Spatial Planning and the Environment in 2010 (NL Agency, VROM, 2010). Furthermore, traffic signs have not been considered in the Italian GPP criteria[3] for road construction currently under development.

Typically, information systems are energy efficient and therefore use relatively small amounts of energy compared to the energy consumption through the full life cycle of a road. For example, according to Stripple (2001), during 40 years of service life of a local road, the total energy consumption of lighting is approximately 5% of the total energy consumption during the road life cycle. Information systems only use a small fraction of the lighting energy consumption, therefore these systems do not appear as one of the main hot-spots within the environmental analysis.

Foundations and lighting of traffic signs are of minor importance to the total environmental impact. Lighting of traffic signs are energy effective and therefore use relatively small amounts of energy compared to the energy consumption through the full life cycle of a road (Stripple, 2001; Mroueh et al., 2001).

Based on a review of the literature, other types of road furniture (pedestrian walkways, bollards, overhead gantries and central reservations) are typically of minor importance to the total potential environmental impacts (Stripple, 2001). Therefore it is recommended that these products are excluded from the EU GPP criteria for road construction.

The most dominant factors that affect the environmental impacts of a road during its service life will depend on the unique characteristics of each road. The choice of relevant environmental criteria will be related to those aspects of road construction that are identified as most relevant based on the LCA of different road types

Given the diversity of roads, it is already challenging to develop usable and clear criteria for road pavement construction alone. Expanding the scope to road furniture would add further complexity to the criteria whilst only delivering comparatively small environmental improvements.

The initial approach of the scope proposal was to exclude some elements that seem to be less relevant in relation to the main environmental issues involved in the road construction and maintenance. Notwithstanding, the output from the stakeholders survey shows a concern about these exclusions, and the consequent potential improvement that might be ruled out at this stage of the project. In order to achieve the broadest view of the sector, these elements were addressed in the technical analysis carried out in Task 3. Based on the findings from the literature review on LCA, these elements result in environmental burdens that do not reach the cut-off values considered in the studies, thus, they are not analysed within the boundaries of the system. As a consequence, none of the initially excluded elements were examined in LCA studies and therefore it is proposed to keep the exclusions suggested at the beginning of the project.

1.2 Market analysis

General economic indicators in the transport sector

Roads facilitate a very important mode of transport. In Europe, about 46% of goods transport and over 80% of the passenger transport occurs on roads. General turnover for road passenger transport and road freight transport is approximately 368 billion Euro in the EU-27 (data for 2009 from ERF; 2013), accounting for 32.4% of total turnover in the transport sector.

However, while growth in freight transport kilometres was reported as 5.3%, during the same period passenger transport kilometres were shown to drop by 1.0% (ERF; 2013).

The importance of the road transport sector is supported by employment data in Europe. In 2010, an estimated 2.93 million people were employed in road freight transportation and 1.93 million in road passenger transportation, accounting for around 46.5% of all employment in the transport sector (EC, 2013a).

3 Personal communication

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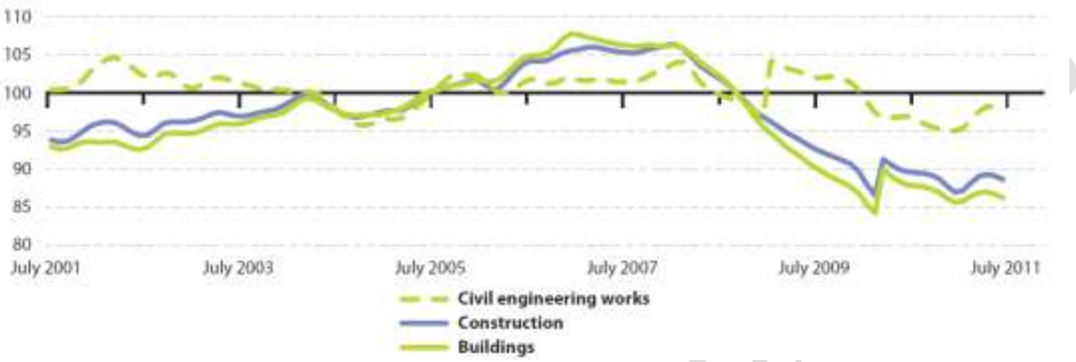
General economic indicators for the construction sector in Europe

The construction sector is split into two main categories: "buildings" and "civil engineering work". Civil engineering works are subdivided into several categories and defined as: “construction not classified under buildings, for example railways, roads, bridges, highways, airport runways and dams” (EC, 2013b). The data presented in Figure 1 shows that "production for construction" in Europe is at its lowest level during the last 10 years (data from Eurostat, 2012).

The recession is affecting many Member States. Ten Member States experienced negative rates of change during 2008-2011. Three countries (Denmark, Spain and Ireland) experienced an even longer period of downturn which lasted for 4 consecutive years. In contrast, seven Member States recorded an increase in construction output in 2010.



2005= index 100

Figure 1: Index of production for construction, EU-27, 2001-11 (trend cycles, estimates) (Eurostat, 2012)

The production value of the construction sector is a picture of the dominating activities occurring in Europe leading to employment and trade. In 2011, the production value for the construction sector in EU-28 was 1,555,007 Million Euro.

Construction materials

<u>Aggregates</u>

Aggregates are one of the most important constituent in road construction since they constitute the bulk volume of the road pavement structure. They are employed in unbound and bound mixtures in different road layers and, according to the source material, can be classified as:

- natural aggregates, produced from mineral sources; sand and gravel are natural aggregates resulting from rock erosion; crushed rock is extracted from quarries;
- recycled aggregates, produced from processing material previously used in construction;
- secondary aggregates, from by-products or secondary materials arising from industrial processes (in the CPR 2011, this category is classified as ‘manufactured aggregates’).

In EU-28, approximately 2.8 billion tonnes of aggregates were produced in 2010, representing a value of 20 billion Euros (UEPG, 2012). Total aggregate production is dominated by sand and gravel (42%) and crushed rock (48%). Recycled and manufactured aggregates only account for 6% and 2% of total production respectively. However, it is expected that the contribution of unconventional aggregates to the sustainable supply mix (SSM) of aggregates is likely to increase by a large extent in the future.

Aggregates are primarily produced by small and medium sized companies operating in about 22,400 sites across Europe. The number of employees is approximately 250,000 people including contractors.

Around 20% (some 500-600Mt) of aggregate production is used in roads, runways, railways and waterways in the EU (UEPG, see Figure 2.5). Of this quantity, at least half is considered to be used in road construction and maintenance in the EU. The type of aggregates most commonly used in roads are of the crushed rock type. For a general idea of how much aggregate is used for road construction on a per km basis, the following figures can be considered:

- 20,000 t/km for a two-lane road (EC, 2010).
- 10,000 m³/km of two lane road (OECD, 1997) which equals approximately to 20,000 t/km.
- 30,000 t/km for a motorway (EC JRC, 2009).

Asphalt material used in pavement

According to stakeholder feedback to the questionnaire distributed in 2013, in Europe the main pavement layer type is the flexible one. The UK Road Administration has reported that in the UK, 96% of pavements are flexible. The Danish Road Directorate has reported that that 100% of all pavements are flexible and in the Netherlands 97% of all pavements are flexible. It is uncertain if this simply refers to surface courses or to all types of courses involving binders.

There are three generic types of asphalt mixture that can be used: hot mix asphalt (HMA), warm mix asphalt (WMA) and cold mix asphalt (CMA). The dominant binder type is HMA, accounting for over 300 Mt each year in the EU since at least 2006. Annual production of WMA and CMA are around 7 Mt and 3 Mt respectively, totally only 2% of total asphalt production combined (EAPA, 2012). In particular, it is forecast that WMA will become much more significant as experience increases with this lower energy consumption and lower emission technique.

Concrete

European roads are roughly 90% flexible (asphalt) and 10% rigid (concrete) according to 'The Asphalt Paving Industry (NAPA and EAPA, 2011). The stakeholders also confirm this fact in the questionnaires that only approx. 5% of the roads are rigid and 95% are flexible roads. It is uncertain to whether this information refers simply to surface courses or also to underlying binder and bound base courses. Consequently it is difficult to estimate the total quantities of cement concrete used in road construction in the EU.

Waste derived materials and by-products

In 2011, the EC issued two Communications on 'A resource efficient Europe' and 'Roadmap to a Resource Efficient Europe'. The overall idea is to reconsider the whole life cycle of resource use, so as to make the European Union (EU) a 'circular economy' based on recycling and the use of waste as a resource (EC COM(2011) 21, *A resource- efficient Europe – Flagship initiative under the Europe 2020 Strategy*; COM(2011) 571, *Roadmap to a Resource Efficient Europe*). There is a strong connection with the Directive 2008/98/EC, the so-called Waste Framework Directive, which revised the legal framework for waste based on the entire life cycle, from generation to disposal, with emphasis on waste prevention, re-use, recycling and recovery (EU, 2008).

Member States in Europe have developed individual guidelines and regulation regarding the use of waste products in Europe (EC JRC, 2009), complicating the overall picture at the European level. Nevertheless, examples of used waste products and industrial by-products include:

- Construction and Demolition Waste (C&DW)
- Reclaimed asphalt pavement (RAP)
- Coal fly ash (FA) and bottom ash (BA)
- Municipal solid waste incineration MSWI bottom ash
- Slag from iron and steel production (blast furnace slag and steel slag)
- Reclaimed rubber from tyres

C&DW has been identified by the EC as a priority stream because of the large amounts that are generated and the high potential for re-use and recycling of these materials. For this reason, the WFD requires MS to take any necessary measures to achieve a minimum target of 70% (by weight) of C&DW by 2020 for preparation for re-use, recycling and other material recovery, including backfilling operations using non-hazardous C&DW to substitute other materials. The above target excludes naturally occurring material, defined under code 17 05 04 as "soil and stones" in the European Waste Catalogue.

Construction and demolition waste (C&DW) is a possible source of unconventional aggregates. According to EC JRC 2009, the mineral fraction of C&DW is seen as a potential material for producing recycled aggregates.

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Data from Eurostat (Eurostat, 2012b) indicates that the total mineral C&DW in the EU-27 is **341 Mt per year**. However, according to BIOIS (BIOIS EC, 2011) the total amount of C&DW generated in EU-27 is approx. **531 Mt per year**.

Market segmentation

Road types

The total length of the EU road network is about 5.3 million km, of which around 1.3% are motorways. The category "other roads" accounts for the largest share of road network length. The distribution of roads types in the single Member States varies significantly. A comparison between countries is complicated because different countries have different definitions for each road type. With regards to roads defined as motorways, the proportion compared to the total road network span varies from approx. 0.1% to more than 5% (ERF, 2013).

The distribution of roads by classification with individual Member States is also shown in Figure 2..

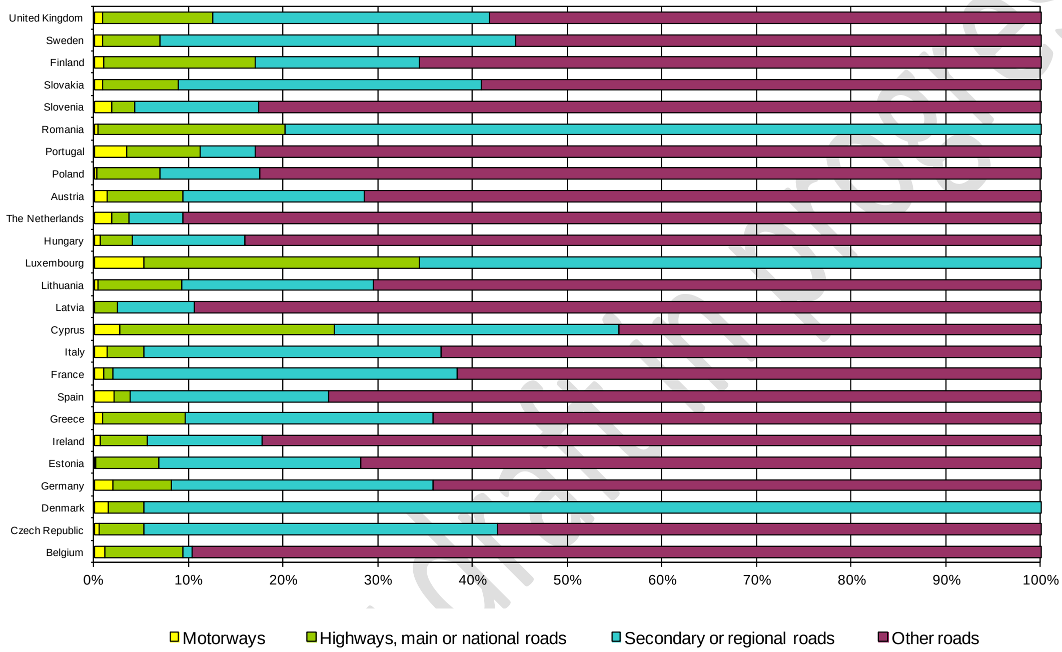

Figure 2: Distribution of roads types within the Member States of Europe (based on data ERF, 2013**)**

The road classifications from left to right are in descending order of width or traffic volume in general as per each Member State's definition. Figure 2 shows that no "other" roads were present in Romania, Luxembourg and Denmark. However, this is simply due to the definition system in these countries. In general, it is clear that the smaller "other roads" are by far the category that accounts for the majority of road length in each country.

Road pavement layer system

Roads are built in layers and three main types of road construction could be identified: flexible pavement roads, rigid (concrete) pavements and composite pavements (Sherwood, 2001).

Maintenance

The need for maintenance varies significantly depending on numerous aspects e.g. traffic volume/density, heat stress, type of road (rigid, composite or flexible), underground conditions, proximity to the coast, intense precipitation, share of heavy vehicles in traffic flow, frost depth, freeze-thaw cycles etc. (EC JRC, 2012)

Data from the European Road Statistics (ERF, 2013) reveals that the relative expenditure on maintenance in 2009 can vary significantly between different countries. The total expenditure in road maintenance for all Member States is estimated by the International Transport Federation, and summarised in the European Road Statistics (ERF, 2013), as 26 billion euro in 2009.

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1.3 The environmental impacts of road construction and maintenance

A common conclusion from the LCA literature review done in this study (see the Preliminary Report) is that almost all roads are unique and have their own specific conditions. According to Carlson (2011) and Santero et al. (2011a,b), it is impossible to perform straightforward comparisons of the results in reviewed LCA studies due to the differences in approach, scope, functional units, analysis periods, system boundaries, regional differences, input data (LCIs) (see preliminary report and Annex III literature review). This means that a flexible method is needed that can be adjusted to suit the road that you want to study.

A large range of impacts are possible for all the components of the road life cycle. Santero and Horvath (2009) stated that GHG emissions could range from negligibly small values to 60,000 t of CO_2e per lane-kilometre over a service life of 50 years. The main environmental impacts arise from daily traffic (fuel consumption by cars and heavy trucks) during the use phase of a road.

Rolling resistance associated to the pavement structure and roughness generally has the highest-impact potential, because it is directly related to the vehicle fuel consumption. According to Wang et al. (2012a), a 10% reduction in rolling resistance could lead to 1-2% of improvement in fuel economy.

Congestion can be due to factors outside of the scope of public works (like rush hour traffic, accidents, breakdowns and adverse weather conditions) or due to factors directly related to them, such as lane/road closures necessary for road construction and/or maintenance. It can greatly influence vehicle fuel consumption due to queues and associated slowdown, both in the construction and in the maintenance phase. The environmental impacts associated with congestion are dependent upon the project and site characteristics. For low traffic roads, the impacts of congestion are likely to be negligible. Conversely, on motorways and highways, the extra fuel consumption and related air emissions can easily become a prominent component of the road life cycle. In order to reduce the environmental impacts of road maintenance works, effective traffic management (lane closure, traffic diversion) and phasing of the roadwork into off-peak hours (night shifts) have to be planned and will be considered as a GPP criterion.

An important factor is the influence of **traffic flow** on the relative importance of the identified hot-spots (Fig.1):

- In high traffic roads (i.e. example motorways, highways, and main national roads), rolling resistance and congestion have the highest impacts on energy consumption and emissions. Materials production and transportation is the third most important aspect to be taken into consideration.
- In low traffic roads (i.e. secondary and other roads): higher impacts on energy consumption and emissions come from materials production and transportation rather than from rolling resistance and congestion. The relative importance of materials production and transportation increases with the decrease of the traffic flow.

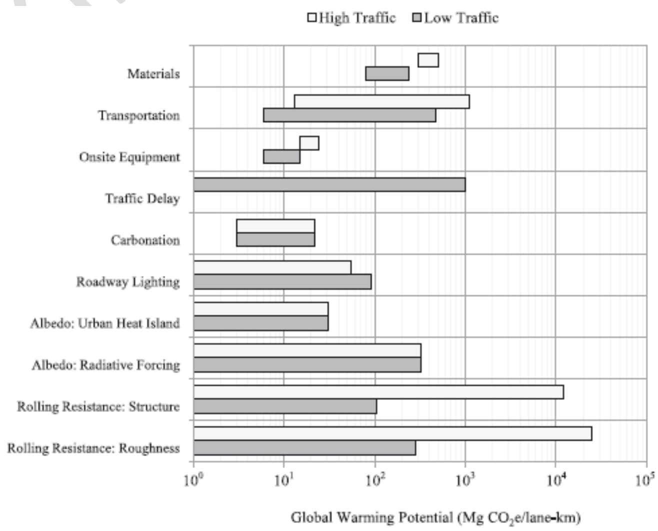

Figure 3: Comparison of GWP ranges for low and high-traffic pavements *(In this case, the low traffic scenario is modelled as 425 AADT, 8% heavy)*

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Internationally, roads with traffic flows of less than 2000 vehicles per day are denoted as low volume roads (AASHTO, 1993).

Road alignment is also a prevailing parameter on the fuel consumed by traffic during the use phase. Alignments are decided upon in the preliminary phase of the procurement route, specifically during road planning and environmental impact assessment. Therefore, road alignment will not be considered as a possible GPP criterion. Nonetheless, it is recommended that the public authorities are aware of the importance of this parameter and include this knowledge when choosing the alignment of the road construction.

The road life cycle stage with the second largest environmental impacts is indicated to be the construction phase, in which the hot-spots are related to **materials production** and **transportation**. The main environmental impacts are consumption of non-renewable resources, global warming, acidification, photochemical ozone formation and eutrophication in the majority of the investigated studies. In particular:

- In concrete pavements, **cement** production and **concrete** mix (including **aggregates**) are responsible for the main impacts.
- In asphalt pavements, **bitumen** production and **asphalt** mix (including **aggregates**) are responsible for the main impacts.
- **Materials transportation** could account up to 50% of the energy consumption and emissions, depending on the local conditions.

In the literature review no general rules have been found on the choice of the materials for the pavements construction, for example asphalt or concrete. The choice of materials depends on the uniqueness of the local conditions, as geotechnical and hydrogeological conditions, common practices of the road administrations, climate conditions, availability of natural resources and **recycled/secondary resources and by-products**, **transportation distances**, prices and weather conditions. The final choice of materials will be based on the project specific characteristics and on the needs and indications of the public authority.

With reference to the results of the market analysis and the stakeholder consultation, it can be highlighted that nowadays **maintenance and rehabilitation** is gaining an increased relevance due to decreases in new road construction. Maintenance has to be evaluated not as a simple repetition of restoration and repairing activities, but on the contrary as a complex network of design strategies including evaluation on rolling resistance, congestion and durability of road surface materials. This phase is dominated by material production and congestion, similar to the construction phase. Several studies indicate that there is a clear connection between durability and sustainability aspects including environmental impacts. Thus when durable materials are used, the need for maintenance is reduced.

Some other impacts that are not generally included in LCA studies of roads but which are of particular importance are: **environmental noise emissions** and **storm-water drainage**. The importance of these areas is reflected in the Environmental Noise Directive (2002/49/EC), the Water Framework Directive (2000/60/EC) and the EU Floods Directive (2007/60/EC).

Roads present large impermeable surface areas and are designed to rapidly convey storm water away from the road surface by gravity for obvious safety reasons. Drainage systems have traditionally been designed to simply prevent the target area from flooding, but many systems simply pass the risk of flooding to downstream areas. According to the European Environment Agency, over 175 major floods were recorded in EU member states between 1998 and 2009, with insured economic losses of around **€52 billion** (EEA, 2010).

There is a huge opportunity for road drainage systems to provide much needed **flood capacity** in flood risk areas. Today there exist two broad types of engineered drainage systems which can be distinguished as "**hard engineering**" (more concrete based) or "**soft engineering**" (less concrete based). In terms of flood management, both can be tailored to significantly reduce the risk of flooding downstream.

A number of pollutants are transferred from roads to watercourses, such as sediments, litter, worn tyre particles, oils and particulates from exhaust gases that are captured from the air by falling rain. The key to treating stormwater and removing pollutants from roads is to remove floating material (litter and oils) and solid particles (sediment). These treatments can be achieved by "hard" or "soft" engineering approaches but the success of any drainage system will depend on appropriate maintenance.

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With regards to environmental noise, road traffic is perhaps the single most dominant source across most of the EU. Within the scope of GPP, there are two possible approaches to reduce noise from road traffic:

- To specify low-noise road surfaces
- To install noise barriers

Both approaches have their advantages and disadvantages. For example, there are concerns about potentially higher maintenance requirements of certain low-noise road surfaces and noise barriers may not be practical in many urban locations. Furthermore noise barriers could result in significant environmental impacts depending on what materials are used. Nonetheless, significant improvements in environmental noise from road traffic can be achieved via this GPP product group and so potential criteria are worth considering.

1.4 Criteria areas

The Preliminary report has been carried out to provide a basis to develop a set of GPP criteria on road construction based on the environmental hotspots identified by the LCA literature review and on the analysis of the technical parameters involved in the criteria areas. Other impacts not generally included in LCA have also been considered. As a result, the following criteria areas are proposed:

- Pavement-vehicle interaction
- Congestion
- Construction materials
    - Asphalt
    - Concrete
    - Recycled and secondary aggregates and by-products
    - Soils
    - Materials transportation
- Road drainage system
    - Installing flood capacity
    - Road drainage system – reducing water pollution
- Noise emission
- Waste management plan

Furthermore, some preliminary information collected in order to prepare a GPP guidance document that will be provided together with the GPP criteria on road construction, to guide the procurers on how to effectively integrate the criteria into the procurement process, is presented in section 3.

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2 DRAFT CRITERIA AREAS

2.1 Pavement -vehicle interaction

2.1.1 Rationale

The literature review shows that rolling resistance associated with pavement structure and roughness plays an important role in the vehicle fuel consumption. Häkkinen and Mäkele (1996) have evaluated that a reduction of vehicle fuel consumption of around 0.1-0.5% due to the concrete pavement properties would bring energy consumption savings of the same order of magnitude as those used for materials production and construction of a concrete pavement and savings in CO_2 emissions of 50% compared to those from materials production and construction of a concrete pavement.

Milachowski C. et al. (2011) have analysed 1 km of asphalt and concrete motorway over a service life of 30 years and they have considered different scenarios of decreases in fuel consumption due to road surface properties. They concluded that fuel consumption could be reduced by 5-20% when the road surface is optimized, i.e. with reduced unevenness (macro-texture) and increased stiffness.

Wang et al. (2012a) analysed energy consumption and GHGs emissions from pavement rehabilitation strategies. Furthermore, case studies are described in the study to evaluate the effect of rolling resistance on the life cycle performance of the selected pavement. Concrete and asphalt pavements are included in the study where the material production, construction, use (including rolling resistance) and maintenance phases of the road life cycle are addressed.

It was concluded that traffic during the use phase dominates the life cycle impacts of a road construction with expected high traffic volume. The authors referred to studies indicating that a 10% reduction in the rolling resistance can lead to 1-2% improvement in fuel economy (Evans et al, 2009, Tiax et al, 2003 and Transportation Research Board, 2006). Furthermore, the paper identifies two main benefits of smooth pavements: reduced fuel consumption and slower rate of pavement deterioration. The latter also causes reduced materials consumption due to less need for maintenance and repair of the road surfaces.

The study also concluded that there a great potential for reduction of environmental impacts exists by reducing the roughness of the road surface to reduce rolling resistance on high-traffic roads (providing examples with 34,000, 86,000 and 11,200 AADT). For roads with less traffic volume the construction quality and the materials production become more important, due to the fact that the share of the potential environmental impacts from the use phase naturally becomes lower and because the total energy use from the traffic is lower due to reduced number of vehicles. No general rule can be given concerning the size of the potential environmental impacts caused in the use phase compared to the material and construction phases. Nevertheless an example is provided in the paper where a smaller road with 3,200 annual average daily traffic (AADT) is assessed. In this specific scenario, materials production and construction phase were calculated to be three times higher than the impacts during the use phase.

In Wang et al., 2012b, total energy use and GHG emissions from materials production, construction, use and maintenance are evaluated. The paper also evaluated the effects of changing road surface roughness and macro-texture on rolling resistance. Scenarios with low and high traffic volume are evaluated and the main results are listed below:

- It is concluded that for roads with high traffic volume, when the roughness and **macro-textures** were improved, the reduction in energy consumption and GHG emissions can be significantly larger than the emissions from materials production and construction. The reduced roughness contributed to the largest savings in energy consumption and GHG emissions.
- The authors include another parameter, i.e. the increase of **surface roughness**, and consequently of the rolling resistance, during the life cycle of the road. The relationship between roughness and surface texture is described to be as follows: the most important factor for the fuel consumption is the surface roughness. An increase in International Roughness Index (IRI) of 1 m/km will increase the fuel consumption of passenger cars by about 2%, independent of velocity. For heavy trucks, this increase is about 1% at normal highway speed (96 km/h) and about 2% at low speed (56 km/h). The third pavement

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factor to influence rolling resistance is **deflection**, but the authors excluded this factor from the study because relations between pavement deflection and rolling resistance are still being researched.

- For roads with low traffic volume the share of impacts from the use phase is reduced overall compared to the impacts from the material production and construction phases.

Loijos et al. (2013) have analysed the Global Warming Potential (GWP) of 1 km of concrete pavement for 12 different structures of the US roadway network (from interstate to local roads in rural and urban areas) over a service life of 40 years. In this study, vehicle fuel consumption has been allocated to the pavement based on roughness increase over the life cycle. Thus, the pavement roughness at initial construction is taken as baseline parameter, and GHG emissions from fuel consumption are calculated based on the progressive increase from that initial roughness. This means that only the fraction of rolling resistance due to the increase of roughness, not its whole amount during the life cycle, is evaluated.

- The authors found that the majority of emissions occur during materials production and transportation (64%-80% on all roads) (see Fig. 4). In particular, cement production has the largest GWP contribution on all roads: from 43% on urban interstates to 56% on rural local roads.
- The second largest contribution derives from fuel consumed due to the increase of the rolling resistance for high traffic roads (both rural and urban). For local roads (both rural and urban) EoL disposal was the third largest contribution. In the analysed case studies, congestion (traffic delay) and construction activities were less important.
- A sensitivity analysis has shown that the results were most sensitive to traffic flow (varying the results by up to 60%), design parameters affecting cement emissions (i.e. shoulder width, lane width), aggregate transport distances and the pavement roughness value. From smaller to larger roads the results become more sensitive to rolling resistance. For smaller roads pavement design characteristics, carbonation, albedo and aggregates transportation are more important.

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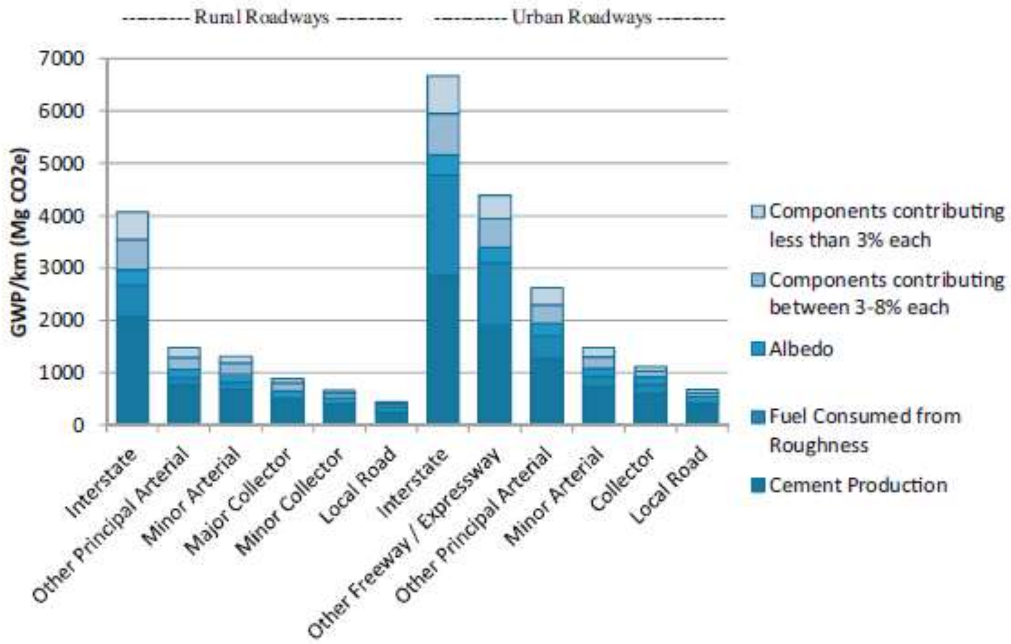

Figure 4: Life cycle GWP per km of new concrete pavements for 12 roadway classifications (Loijos et al., 2013)

The results explained above conclude that there is a relevant parameter involved in the potential decrease of fuel consumption due to the interaction pavement-vehicle: the traffic flow. For high-traffic flow roads (>2000 vehicles per day), these losses became an important factor that justifies the measures aimed at reducing them. For low-traffic roads (<2000 vehicles per day), the fuel consumption during use phase turns to be comparable to other life cycle phases.

The parameters that might be potential indicators of the pavement – vehicle interaction are the following:

- Rolling resistance
- Texture
- Unevenness (longitudinal and transversal)
- Surface defects

Rolling resistance

Currently there is no standardized method for determining the pavement contribution to rolling resistance. EU FP7 projects like MIRIAM and COOEE investigate the possibilities of using trailers for the monitoring of rolling resistance as a road surface property in analogy to skid resistance or noise emission, but those methods are not validated. The function that relates rolling resistance to texture and unevenness parameters needs to be developed enough in such way that rolling resistance could be controlled by managing these primary pavement properties, as MPD (mean profile depth) and IRI (International Roughness Index).

Practical factors related to rolling resistance must also be considered. For example, lower rolling resistance is **undesirable** in areas were vehicles have to decelerate due to the requirement for increased braking energy/distance. Therefore low rolling resistance surfaces should not be specified in any areas with frequent stop-start traffic flows and only be specified where they can be most beneficial, which is in high traffic volume road sections with steady or accelerating traffic flows most of the time.

Texture

The ISO 13473-n series of standards covers the measurement of pavement texture with profilometers and associated indices. All indices are based on filtered longitudinal height profiles of the pavement surface typically recorded with a mobile or stationary laser profilometer.

The most commonly used parameter is the MPD (mean profile depth) defined in ISO 13473-1 for an evaluation length of 100 mm It is designed to indicate the typical elevation of profile peaks above an average profile baseline.

The texture wavelength ranges that contribute to a deformation of the tyre and induce rolling resistance losses are mainly in the macro- and megatexture.

According to the technical analysis, the macrotexture seems to be parameter that is expected to both decrease and increase during the use phase of the road, and its progression depends on the type of material, traffic flow and composition (heavy traffic) and climate conditions, mainly related to wet and dry freezes (Wang, 2012). It was also found that Sweden was considering to set MPD thresholds for both maximum and minimum levels of acceptance of this parameter (COST 354). Therefore, the monitoring of the increase of this parameter during the use phase of the road seems to be reasonable to assess the level of performance in relation to the rolling resistance.

Longitudinal unevenness

It contributes to the overall road vehicle energy consumption via three mechanisms:

1. The longitudinal unevenness of pavements contributes to the rolling resistance of the tyre but in a smaller degree than texture.
2. Longitudinal unevenness induces vibrations in the wheel suspensions. These vibrations have to be reduced to ensure ride comfort, which results in a conversion of mechanical energy into heat energy.
3. High levels of longitudinal unevenness will induce drivers to reduce the vehicle speed.

The induced vertical oscillations lead to energy conversion into heat, and thus they should be considered when modelling the energy losses due to the interaction vehicle-pavement.

The European standard prEN 13036-5 “Road and airfield surface characteristics -Test methods – Part 5: Determination of Longitudinal Unevenness Indices”, specifies the measurement of longitudinal unevenness and the calculation of unevenness indices. It requires the measurement of a longitudinal road height profile with a sampling interval of 0.05 m. This profile is the basis for the calculation of different possible unevenness indices. The most common index is the IRI (International Roughness Index), which is intended to represent the reaction of a specific quarter-car model (golden car) to the road Infrastructure effects on vehicle energy consumption profile

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Transversal unevenness

The road surface will also exhibit deviations from this ideal transversal profile in the form of ruts, steps, ridges, bumps and edge slumps.

Both crossfall and transversal unevenness might induce an increase in vehicle fuel consumption. Transversal unevenness can act similar to longitudinal unevenness by inducing increased tyre deformation and suspension losses.

The measurement of transversal unevenness is defined in EN 13036-6 and EN 13036-8. While no specific measurement device is prescribed, typically a straightedge or a laser profilometer is used. The parameters used to describe the transversal unevenness are the rut depth, the height of the different irregularities and the theoretical water film depth for water accumulating in the ruts. These parameters are typically determined every 5 to 10 m and averaged for longer intervals of e.g. 100 m. Crossfall and rut depth typically constitute the major deviations from an ideal horizontal road surface and are therefore the best candidates for the inclusion in models. The main parameter used for transversal unevenness is average or maximum rut depth

Surface defects

Surface irregularities as joints or surface defects like cracks, ravelling, potholes, loss of material may influence on longitudinal and transversal unevenness, and on texture. Therefore, the impact due to these surface defects is related to the parameters associated with these surface properties. However, in the case of severely damaged surfaces there may be additional energy dissipation.

The above mentioned parameters for longitudinal and transversal unevenness would be indicators of the degree of damage, but other ones as the area or longitudinal density of surface defects could be defined. A classification of relevant surface defects in the course of already performed crack detection surveys is could be defined to take into account the predicted impact of the identified type of surface defect on fuel consumption, thus, it would work as an indicator for the predicted additional fuel consumption.

Other parameter that is related to the surface defects on the road pavement is the durability of the material, since they are caused by damages during the use phase of the road along its lifetime. Therefore, the durability (lifetime) of the material, together with the designed bearing capacity of the road, could became a factor to be consider to prevent the maintenance needs of a road.

2.1.2 Draft criteria area for rolling resistance

As preliminary step, it is recommended to evaluate the traffic flow planned during the road design. In the case of high-traffic roads (as motorways and highways), the parameters related to the pavement-vehicle interaction should be considered within the procurement process. For those roads expected to bear low traffic flows, it is advisable to focus on other criteria areas, as the improvement potential on the fuel consumption is not so relevant.

In addition, lower rolling resistance is **undesirable** in areas were vehicles have to decelerate due to the requirement for increased braking energy/distance. Therefore low rolling resistance surfaces should not be specified in any areas with frequent stop-start traffic flows.

The parameters to evaluate the pavement are commonly used by the public administrations (as National Road Administration NRA or local authorities) in the design, construction, monitoring and maintenance phases, but they are usually assessed only under safety and comfort requirements. The rationale shows that an evaluation under environmental perspective, focused on fuel consumption, should be integrated in the decision-making process about those parameters along the design, construction and maintenance.

During the design phase, the procurers should take into account the MPD and the durability associated to the construction materials to be used in the pavement. Some options would be to set a MPD performance, within the safety range of values demanded by the road, and to select the most durable materials for the particular needs of bearing capacity calculated for the road.

Before the opening of the road, the verification about the materials used in the pavement and the parameters related to the texture should be carried out by the procurers, taking into account the standardized methods to measure MPD.

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The monitoring and routine maintenance are key issues in this criteria area. Both activities are usually carried out by the public authority, in-house or by mean of maintenance service procurement. According to the rationale above, these activities should consider the fuel consumption due to the increase of the MPD, the unevenness and the surface defects, thus the monitoring of those parameters associated are recommended to be linked to thresholds or ranges that trigger the maintenance actions aimed at returning those parameters to the optimal values. These target values define the optimum condition to be achieved after maintenance measures. Threshold limits for MPD might be defined by a range between minimum required values for skid resistance and maximum desirable values for limiting fuel consumption via reduced rolling resistance.

It has been found that the most important factors that influence the rolling resistance are the macro-texture and megatexture, thus, it is recommendable to set thresholds to the MPD of the pavement together with a monitoring frequency. A maximum interval for monitoring is recommended (in literature 5 years are suggested).

This criteria area is fully linked to the maintenance and rehabilitation activities, thus the procurement process of these services should include a requirement on a maintenance and rehabilitation (M&R) strategies preliminary plan that includes:

- Monitoring frequency (< X years) and pavement performance assessment on all the parameters related to the pavement-vehicle interaction.
- Maintenance activities strategy.

Questions

Do you agree on the criteria area on pavement-vehicle interaction aimed at preventing the increase of fuel consumption during the use phase?

Do you think it is possible to integrate this criteria area in the procurement process?

Do you agree on the parameters proposed and the phases where they are suggested to be defined, monitored and corrected? Would it be needed to evaluate the climate conditions in the case of the MPD monitoring?

Is it possible to set target/threshold values for these parameters? Which constraints may be associated? Any input about this issue is very welcome.

Which monitoring frequency you consider to be optimal to assess these pavement performance parameters?

2.1.3 At what stage of the procurement process are the criteria relevant?

Preliminary scoping and feasibility – establishing environmental performance objectives: evaluation of the traffic flow expected in the road. If it is high traffic flow, rolling resistance may be a relevant environmental issue. For low traffic roads and those with frequent stop-start traffic flows, a criterion to decrease the rolling resistance is not recommended.

Detailed design and performance requirements: requirements for surface roughness and surface texture of materials and their expected service life given. Maintenance and rehabilitation (M&R) strategy plan should be presented in the design phase. This plan can be used as a baseline and shall be updated by the DBO tenderer or the tenderer appointed for the maintenance works on the base of the results of the pavement performance assessment and verification. Moreover, new more durable materials, new technologies and best available maintenance strategies should be analysed while updating the maintenance and rehabilitation (M&R) strategy plan.

Construction: verification of surface roughness and texture of materials before road opening.

Use: pavement performance assessment and monitoring and verification of surface roughness and texture

Maintenance: maintenance activities have to be realised according to the M&R strategy plan, taking into account the target values of the IRI and MPD parameters in the detailed design (if replacing the overlay frequently or doing complete rehabilitation of the surface course).

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Questions

Do you think that the tender could include specific values performance requirement for surface roughness and texture? Both immediately after construction for verification of conformity and as trigger values for subsequent maintenance tasks?

Which would be the appropriate target values to optimize the maintenance activities while keeping the parameters in the best ranges actually feasible?

According to your experience, would it be feasible to include a M&R strategies plan in the detailed plan and using it as a baseline plan to be updated? Information on experiences in this field would be most welcome.

2.2 Congestion

2.2.1 Rationale

Congestion is caused by lane and road closures necessary for road construction and/or maintenance. It can greatly influence vehicle fuel consumption due to queues and associated slowdown (Taylor P. et al., 2012).

Santero et al. (2011a) hypothesize that congestion could be a much greater portion of a pavement's environmental impact than construction materials and equipment and conclude that the environmental impacts associated with congestion are dependent upon the project and site characteristics. For low traffic rural and local roads, the impacts of congestion are likely to be negligible. Conversely, on motorways and highways, the extra fuel consumption and related air emissions can easily become a prominent component of the pavement life cycle. From an environmental perspective, a long-life pavement with high durability has less need for lane closure and thus reduces the impacts of congestion.

According to Huang et al. (2009), in order to reduce the environmental impacts of road maintenance works, effective traffic management (lane closure, traffic diversion) and phasing of the roadwork into off-peak hours (night shifts) have to be planned. Moreover, planning the use of hard shoulders during peak-hours could be beneficial in order to decrease congestion.

2.2.2 Draft criteria area for congestion

This criteria area is fully linked to the construction and maintenance activities, thus the ITT of this services should include a requirement on a traffic congestion mitigation plan that includes:

- Timeline including expected construction and/or maintenance activities for the road service life.
- Where necessary, alternative routes for diverted traffic during such activities will be provided. The use of hard shoulders should be specified.

The procurement contract would contain a clause or clauses committing the party responsible for planned maintenance to carry out such works during off-peak hours only and, where seasonal traffic fluctuations are high, during off-season periods.

Another key issue on the management of the traffic congestion is related to the information provided to the user. Thus, the road should be equipped with traffic management devices: traffic lights, information screens and variable road signs. Although the scope of the study does not cover this type of elements, meaning the criteria are not expected to include specific requirements for those elements, it is reasonable to consider the possibility of such equipment to be part of the traffic management requirements to minimize traffic congestions.

Questions

How is road congestion evaluated in your public authority? Could you recommend specific models or methods of good practice?

Would it be possible to set a criterion to manage extraordinary maintenance works, due to extreme weather events as floods or heavy snow fall, and other damages?

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2.2.3 At what stage of the procurement process are the criteria relevant?

Preliminary scoping and feasibility: the current required road capacity (number of lanes and appropriate speed limit) will be defined based on current and possibly future predicted traffic flows. Furthermore, the congestion might be caused by an ill designed capacity of the road. It is recommendable to study the traffic flow expected on the road along its lifetime, especially in urban roads as rings and distributors. In those cases, the decision on the road capacity should take into account the land-use plan of the urban area and the future demographic scenarios. For this purpose, it is suggested to take into consideration in the strategic planning the following:

- The road capacity design will be compared with modelling of future traffic flow during its design service life – taking into account land-use planning in the road catchment area and accounting for different future demographic scenarios.

Detailed design and performance requirements: the design team, D&B tenderer or DBO tenderer should provide a preliminary traffic congestion mitigation plan. Moreover, traffic management devices as traffic lights, information screens and variable road signs should be planned in order to manage congestion.

Maintenance: specific contract clauses related to planned maintenance commitments shall be included.

Questions

How common is the application of the DBO model, i.e. the construction company also assumes responsibility for maintenance requirements?

In such cases, are the maintenance activities fixed in the contract regardless of road condition or is the contractor simply required to maintain the road surface in suitable condition, which could result in more or less maintenance activities than originally planned?

2.3 Resource efficient construction

2.3.1 Rationale

According to life cycle assessment literature for roads, the second largest source of environmental impacts is the production and transportation of construction materials. In low traffic roads, this can in fact be the most significant source of environmental impacts. The durability of road materials is a key factor that will influence the requirement for maintenance. The impacts of maintenance activities themselves are dominated by impacts from materials production/transport and also congestion as mentioned in the previous section.

Materials production and **transportation** are environmental hot-spots in both the construction and the maintenance phase. The main environmental impacts are consumption of non-renewable resources, global warming, acidification, photochemical ozone formation and eutrophication in the majority of the investigated studies.

The main materials used in road construction are:

Asphalt: A composite material consisting of aggregates, filler, bitumen binder and possible additives that are heated and mixed together before placement.

Concrete: A composite material consisting of aggregates, filler, Portland cement binder and possible additives that are mixed with water before placement. Reinforced concrete and concrete slabs also contain steel reinforcement bars and dowels.

Aggregates: Used in both asphalt and concrete but also in unbound form for road subgrade or sub-base.

Factors that influence the choice of materials include the uniqueness of the local conditions, geotechnical and hydro-geological conditions, common practices of the relevant road administrations, climate conditions, availability of natural resources and recycled/secondary resources and by-products, transportation distances, prices, weather conditions. The same GPP criteria area has been highlighted in the Australian greening road procurement (Lehtiranta et al., 2012).

In the literature review it is highlighted that potential environmental savings can be reached with the following materials:

- **Warm mix asphalt (WMA)** in substitution of hot mix asphalt (HMA)

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- **Recycled/secondary materials and by-products,** and the most important appears**:**
  - **Reclaimed asphalt pavement (RAP)** in bound and unbound applications
  - **Fly ash** used to replace clinker in cement or cement in concrete mixes in bound and unbound applications (concrete and grout applications)
  - **Recycled aggregates from C&DW,** used usually in unbound applications
  - **Recycling concrete**, used in bound and unbound applications, and **excavated soils**, re-used preferably in close loop inside the same worksite
  - **Secondary aggregates and by-products as blast furnace slag (BFS), bottom ashes and municipal Solid Waste Incinerator (MSWI) bottom ash**, used usually in unbound applications

The potential environmental savings above mentioned have been also identified in the study "Assessment of Scenarios and Options towards a Resource Efficient Europe. Topical Paper 4: Validation of technical improvement options for resource efficiency of buildings and infrastructure" done by PE international in behalf of DG-ENV in 2013 and included in a broader study on the assessment of the scenarios towards a Resource Efficient Europe 2030. The study suggests 10 improvement options regarding resource efficiency for residential buildings, commercial buildings and roads, evaluated by means of an LCA approach. With reference to road construction, the study ranks the improvement options for roads according to their ability to improve resource efficiency in Europe by 2030 (PE EC DG-ENV, 2013). The main improvements in material are listed below (prioritised according to improvement potential by reduced primary energy demand reported in this report).

- Recycling of **RAP**
- Use of stockpiled **fly ash** to replace fly ash to replace cement in concrete applications or as grout/aggregate
- Use of **WMA** in substitution of HMA
- Use of **recycled aggregates from C&DW** in road base and building fill
- Re-use **concrete and excavated soil**
- **Cold asphalt** (This option is not considered as prominent in the report, however combined with the production of WMA, reveals great improvement potentials)

The decision on applying GPP criteria on sustainable materials depends on the local strategies carried out by the public authority and has to be discussed as a priority during the planning phase. Therefore, the following proposed criteria are not envisaged to oblige contractors to only use certain materials but instead to provide a logical framework which encourages the use of materials with lower environmental impacts (according to the literature review and the assessment of the scenarios towards a Resource Efficient Europe 2030 done by PE international in behalf of DG-ENV) where possible and practical, including their transportation. The public authority during the planning phase can suggest and define a list of the most important materials to undergo an assessment/evaluation and indicate them in the ITT.

Due to the different nature of each of these materials, separate criteria for asphalt, cement, concrete, aggregates and soils are provided below.

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2.3.2 Asphalt

2.3.2.1 Rationale

Traditionally, this material is referred to what is known as a "hot mix" process, the product being referred to as **Hot Mix Asphalt** (HMA – 150-190°C). Where asphalt is specified in road construction, there exist a number possibilities to reduce the environmental impact associated with its production. These can be by using a lower temperature mixing process such as **Warm Mix Asphalt** (WMA, 110-140°C) **Half Warm Mix Asphalt** (HWMA, 70-95°C) or **Cold Mix Asphalt** (CMA, <60°C) (EAPA, 2007; D'Angelo et al., 2008; EAPA, 2010; Capitão et al., 2012; Rubio et al., 2012).

Not only do lower temperature mixing processes save energy, they have been associated with significantly lower VOC, PAH, CO, SO_2 and NO_x emissions, which is important both from an occupational safety and an environmental point of view (EAPA, 2010; D'Angelo et al., 2008; Wayman et al., 2012). Indeed, the reduction in mixing temperature in WMA, HWMA and CMA results in significant improvement of the health and safety conditions of workers.

In terms of technical performance, there is a lack of long term experience with WMA, HWMA and especially CMA although results with WMA seem comparable to HMA (Capitão et al., 2012). According to the market analysis WMA is the most widely used lower temperature option but still only accounted for 2% of the total production of bituminous mixtures in the EU (EAPA, 2012). Nonetheless, the trend in employing WMA is increasing, for example in France the WMA production increased by 5 times from 2008 to 2012 (up to 7.3% of total French asphalt production). Due to the low market share of WMA (and even less for HWMA and CMA) there may be a lack of suitable experience with such mixtures that would impede making such criteria broadly applicable.

Another method of reducing the environmental impact of asphalt is to use **Reclaimed Asphalt Pavement** (RAP). RAP is produced by milling the overlay and demolishing the surface course. It can be re-used by adding directly to the asphalt mixtures along with new aggregates and new bitumen (recycling). RAP can also be used as recycled aggregates in road base material, being stabilised with bitumen emulsion and/or cement (downcycling). It can also be recycled as an unbound material in the road sub-base (downcycling).

Today in Europe around 56 Mt/a of RAP is produced and more than 85% is re-used back into pavement materials (EAPA, 2013). The EU research project Re-road (http://re-road.fehrl.org/) focused particularly on the analysis of end of life strategies of asphalt pavements (Kalman et al., 2013). According to the outcomes of this project, in Europe the experience in reusing RAP in new asphalt production is well consolidated, even if there is a significant variation in the Member States and the consequence is that nowadays a large amount of demolished asphalt pavement is still down cycled as unbound granular material in the sub-base layers. From a LCA point of view (Wayman et al., 2012), the main benefits coming from the reuse and recycling of RAP are related to avoiding the need for bitumen production. Results demonstrate that greater benefits are achieved by means of bound RAP recycling rather than unbound in the sub-base course. Moreover, it is evaluated that RAP is significantly more environmentally beneficial than WMA. Although in RAP sourced from older pavements, stakeholders have expressed concern about coal tar content. Therefore it is proposed that any RAP from pavements older than X years be evaluated for coal tar content and pre-treated if necessary prior to reuse.

There is no technical limit on reclaimed asphalt content in new asphalt mixtures as long as adequate performance is achieved. However, optimum content of RAP in asphalt mixtures varies from country to country, from 7 to 50% by mass (Kalman et al., 2013).

2.3.2.2 Draft criteria area for asphalt

Based on the rationale above, it is recommendable to consider the following proposed criteria area:

- Any waste asphalt from mixing operations either on-site or in an asphalt plant off-site should be re-incorporated into later asphalt mixes to result in zero waste of asphalt.
- Any RAP used from older pavements (> X yrs) shall be tested for coal tar content and pre-treated to remove the tar if necessary.

The following criteria areas are suggested which could be considered as potential award criteria:

- As long as the final? asphalt technical performance requirements are met, additional points will be awarded for the proposed use of lower temperature asphalt mixing operations. The points allocation would be in the order of CMA > HWMA > WMA. The mixing temperature and the laying temperature ranges used would also be specified. Lowering the laying temperature of bituminous mixtures would reduce the emissions and thus the exposure of workers to VOC.
- Additional points shall be awarded for planned maintenance and rehabilitation works that account for 100% re-use of reclaimed asphalt into new asphalt, complying with the national legislation

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requirements and the EN 13108-8. Points awarded shall be in the order of re-use in new asphalt mixes for surface courses > re-use in bound base courses. It is proposed that no additional points shall be awarded for reuse of RAP in the sub-base course, since this could present a leaching risk and presents lower overall environmental benefits.

- It is proposed to consider if additional points shall also be awarded if all the asphalt mixtures employed during construction have a specified % RAP, with points rising in line with the % RAP content.

Questions

Do you agree in considering WMA/HWMA/CMA as a possible criteria area?

Would it be better to simply focus the criterion on WMA, which is better established than CWA and HWMA?

What is your opinion on the performance aspects of WMA vs HMA?

What temperature limits, if any, could be set for laying of asphalt?

Do you agree about criteria for RAP content in all the asphalt mixtures? If so, in your opinion, should a minimum percentage of RAP be specified in an asphalt mixture?

Should waste from mixing operations in off-site asphalt plats also be defined as RAP?

Would it be better to require that all RAP be reused onsite during maintenance operations due to concerns with the interpretation of the Waste Framework Directive?

Do you agree with the requirement for a) analysing for coal tar in RAP and b) if sufficiently high in tar, then pre-treated RAP prior to reuse? Could you provide information about the age of the roads that should be covered by this criterion?

What would be a reasonable limit and test method to specify for coal tar in RAP?

Do you think that these above mentioned criteria area would be proposed as award criteria or do you see the possibility for any technical specification?

Do you foresee any problems with the verification of this criterion? Would be easily verifiable by procurers?

According to stakeholder feedback to the questionnaire distributed in 2013, in Europe the main pavement layer type is the flexible (more than 95%). Do you think that this data is referred to the surface courses or to all types of courses involving binders?

2.3.2.3 At what stage of the procurement process are the criteria relevant?

Detailed design and performance requirements: where relevant, the design team or the DB tenderer or the BDO tenderer shall specify the use of WMA, the mixing temperature range and % RAP to be used, both for construction and maintenance.

Construction: test mixtures will be assessed to ensure conformity of performance prior to construction works. Any waste asphalt shall be reused and the quantities recorded.

Maintenance – performance requirements: any waste asphalt produced from planned maintenance tasks will be reused onsite as far as is practical and any asphalt taken from site shall be recorded and sent to an offsite asphalt plant for reuse.

Questions

Could you provide any information about the procurement contracts that include this kind of materials?

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2.3.3 Concrete

2.3.3.1 Rationale

Concrete is a fundamental component in road construction that can be used in road base, binder courses and surface courses. It is a composite material which on a % wt. basis consists of approximately 5-7.5% water, 10-15% cement with the remainder being aggregates (coarse and fine).

By far the most common cement used in concrete, either in road construction or any other application, is Portland cement. Although cement only accounts for 10-15% of concrete mass, it is by far the most significant factor in terms of the environmental impact of concrete (Stripple, 2001). To produce 1 tonne of Portland cement, approximately 1.5t of raw materials (mainly limestone and clay) are fired in a rotary kiln at temperatures of around 1450°C. Approximately 0.55t of the raw material is lost as CO_2 from limestone decarbonation or as kiln dust. The remaining 0.95t forms Portland cement clinker, which is then ground together with 0.05t of gypsum to form 1t of CEM I type Portland cement.

Already in Europe, efforts to reduce the environmental impact of Portland cement manufacture via improved kiln technology and the use of alternative fuels for kiln firing have reached an advanced stage in many Member States. The simplest remaining option is to reduce the "**clinker factor**". The CEM I type cement mentioned in the previous paragraph can be considered to have a clinker factor of 0.95 (95% by dry mass clinker). However, decades of research have revealed that cement clinker can be partially replaced by any one of a number of "**supplementary cementitious materials**" (SCM's). These materials are either industrial by-products (e.g. coal fly ash, blast furnace slag) or natural materials (e.g. limestone, natural pozzolana) and in all cases possess a much lower embodied energy than Portland cement clinker itself. Regulations regarding the use of SCM's in the Portland cement to be marketed in the EU are covered by EN 197-1 and the EN 196 series.

CEM I type Portland cement (95% clinker) is today only one of 27 different categories of Portland cement described in EN 197-1. All of the remaining categories are split into four types (CEM II, CEM III, CEM IV and CEM V). These categories specify reduced clinker contents, and thus reduced environmental impacts. Between the categories, clinker can be replaced by ranges from 6% up to 55%, or specifically in the case of blast furnace slag, up to 95%. Already in the EU cement market sales of CEM II are higher than CEM I. In terms of availability of SCM's, it is possible that in some regions, certain materials will not be available. However, in all cases, blended cements using limestone as a SCM will be feasible since this is the primary raw material used in Portland cement manufacture. Furthermore, cement blended with limestone should not only have lower environmental impact, but be considerably cheaper to produce.

2.3.3.2 Draft criteria area for concrete

Based on the rationale above, it is proposed that the following areas should be discussed at the AHWG meeting regarding the development of potential GPP criteria for concrete:

- Requirements already covered by EN 206 and EN 13877 and how these can aid the procurement process by defining roles and responsibilities of the parties involved.
- Discuss experience with cement types and categories used in real life road construction and maintenance operations. Details that are generally specified for cement (and concrete) performance. Discuss data provided by suppliers, for example do they ever state the precise % content of clinker instead of simply the % range of clinker that can already be derived from its category classification.
- For assessing impacts due to transport, the logistics of cement supply from factory to the ready mix concrete plant shall be stated as well as the location of the ready mix concrete plant.

The following criteria areas are suggested which could be considered as potential awarding criteria:

- Portland cement with higher contents of SCM's will be scored higher due to the implied lower clinker content and lower associated environmental impact. Where ranges of clinker only are supplied, different cements with the same range of clinker content shall be scored equally.
- Aggregate from wasted batches of fresh concrete (from testing procedures at the ready mix plant) will be reclaimed by washing with high pressure water jets.

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Questions

Do you agree that the clinker content of the cement used is a reasonable criterion? May any of the above mentioned criteria areas by difficult to verify?

Do you think that these above mentioned criteria area would be proposed as award criteria or do you see the possibility for any technical specification? For example, are there any technical criteria for road concrete that may only be possible to meet by using CEM I or could the use of other CEM types be encouraged?

Should the cement content of the concrete also be an award criterion? (i.e. kg cement / m^3 concrete)?

Is the EN 206 standard sufficiently robust for the verification of cement and concrete technical specifications?

Would it be relevant to mention other cements that are not based on Portland cement here?

2.3.3.3 At what stage of the procurement process are the criteria relevant?

Detailed design and performance requirements: the type of cement, required strength class and other technical criteria would be specified by the design team and communicated to the cement supplier.

Construction: The cement supplier would have to demonstrate the compliance of the concrete's technical properties using the specified cement type and aggregates and prepare batches accordingly in ready-mix concrete plant.

Questions

Would any on site testing of fresh concrete be required for verification e.g. slump etc.?

Would any on site testing of hardened concrete be required for verification after the road has been laid? e.g. slab thickness or core samples.

2.3.4 Recycled and secondary aggregates and by-products

2.3.4.1 Rationale

Aggregates can be defined as granular material used in the manufacture of construction products. According to the Construction Product Regulation CPR 305/2011, recycled and secondary materials complying with the harmonized standards have to be considered equal to products based on primary materials. Recycled aggregates are produced from processing materials previously used in construction (i.e. C&DW). Secondary aggregates and by-products arise from industrial production (e.g. coal combustion ashes, municipal solid waste inceneration MSWI bottom ash, slags from iron and steel production, reclaimed rubber from tyres etc.). According to the literature review, the use of recycled aggregates from C&DW can play a key role in the delivery of environmental policy and green public procurement objectives (ETC/SCR, 2009). In terms of C&DW as recycled aggregates, the Waste Framework Directive has set a target of at least 70% recycling by 2020. Road construction represents an excellent opportunity to recycle C&DW either as unbound aggregates in the subgrade and sub-base or in bound materials in base and binder courses.

Performance criteria for aggregates can be sub-divided into physical properties (such as particle size distribution or frost-susceptibility) and chemical properties. The same physical-mechanical performances are required both to natural aggregates and recycled/secondary aggregates in unbound mixtures (EN 13285) and in bound applications in road construction (EN 13043 and 13242). Chemical/environmental properties of recycled/secondary aggregates relate to soluble substances or elements, which may leach into soil, ground or surface waters and pose adverse environment impacts. Several Member States have defined limiting values in terms of chemical contamination in relation to possible leachate (following the EN 12457 test). These often have an associated labelling / classification schemes and / or quality assurance to certify that the recycled end product complies with these limits (BRV et al., 2007a, b, c; standard "LAGA 20"; Quality Protocol for Aggregates WRAP, 2005b, Setra, 2011). Further use of by-products has to be lawful, according to all relevant products, environmental and health protection requirements (art. 5 of the WFD).

According to the guidelines of WRAP on recycled roads (WRAP, 2005a), benefits of using recycled and secondary materials in road construction include:

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- Economic benefits: specific cost savings include the avoidance of waste disposal charges and landfill tax. Moreover, the use of recycled products can significantly shorten the time needed for maintenance work and, therefore, decreasing traffic congestion.
- Environmental benefit: the use of recycled materials delivers clear environmental advantages by substituting for virgin materials, decreasing energy consumption and diverting waste from landfill.
- Social benefit: reducing haulage activities, congestion and increasing road safety and cutting air pollution.

However, specification of recycled/secondary aggregates and by-products cannot be considered as having a lower environmental impact than natural aggregates by default. An important factor will be the relative transport distances between the recycled aggregate source and site, and the natural aggregate source and the site. For example, some LCA studies state that recycled aggregate has a lower impact than natural aggregate only as long as the transport distance is less than up to three times (Chowdhury et al., 2010; Blengini and Garbarino, 2010) that of the distance for natural aggregates. Another important point to consider is whether RAP, when used as aggregate in new asphalt, should be considered as a recycled aggregate. It is proposed that in such a scenario, RAP should not be considered as a recycled aggregate since it is already covered by proposed criteria for asphalt. However, should the RAP be instead used in the road base as unbound aggregate, it would be considered as recycled aggregate.

2.3.4.2 Draft criteria area for recycled/secondary aggregates and by-products

The use of recycled/secondary materials and by-products should be incentivised as long as all the technical and environmental requirements are fulfilled. It is suggested that in the ITT there are incentives to contractors to use recycled/secondary materials and by-products to the highest possible extent. Based on the above rationale, suggested requirements to consider as proposed criteria area would be:

- The design team, DB tenderer or DBO tenderer shall identify potential sources of recycled / secondary aggregates and natural aggregates and calculate the transport distances from source to site (or asphalt/concrete plant where relevant).
- Where the transport distance from the recycled aggregate source is <3 times longer than that from the natural aggregate source, the bidder shall request conformity of production information relevant to legislation in place of use from the supplier of recycled / secondary aggregate (CE marking).
- If conformity is demonstrated, the bidder shall then evaluate the aggregate according to relevant EN standards relevant to final use of aggregate (sub-grade, sub –base, binder course etc.).
- Furthermore, it is proposed that additional points could be awarded for using recycled or secondary aggregates and stating the % proportion of total aggregate usage that can be applied to such materials. Points allocated may increase as the % recycled / secondary aggregate fraction increases.

Questions

Are the terms recycled and secondary aggregates appropriate? If not, what other terms could apply?

Should there be a minimum recycled content for recycled and secondary aggregates to be included as a technical specification?

Should recycled / secondary aggregates be limited only to unbound applications?

Do you have any evidence that the transportation rules for alternative materials in comparison to natural materials could be applied also to by-products?

Do you foresee any problems with the verification of this criterion? Would be easily verifiable by procurers?

2.3.4.3 At what stage of the procurement process are the criteria relevant?

Preliminary scoping and feasibility: the public authority's strategic objectives and procurement policy on waste minimization have to be taken into consideration. In this phase an important activity could be the definition of the sustainable supply mix (SSM) of aggregates: "*a procurement of aggregates from multiple sources, including environmental considerations*". An early contractor involvement is essential in this phase in order to bring their knowledge in the strategic plannig phase.

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Design phase and performance requirements: the design team or the DB tenderer or the DBO tenderer shall quantify the proportional contribution of the recycled content to the overall value of the road infrastructure. Realistic recycled / secondary aggregate contents in different road layers will need to be evaluated based on technical literature.

Construction phase: testing of road materials or layers will be required to ensure that the standards are still met when recycled/secondary aggregates are used. Quantities of total and of recycled / secondary aggregates must be recorded. A contract clause will ask for the verification of the incorporation of the recycled content.

Questions

Are the procurement stages for recycled/secondary aggregates and by-products well described? Information on experiences in this field would be most welcome.

2.3.5 Soils

2.3.5.1 Rationale

Soil is a vulnerable and essentially non-renewable resource. Some of the most significant impacts on soil properties occur as a result of construction activities (DEFRA, 2009).

The re-use of soil is a strategic factor in the Waste Framework Directive WFD 2008/98/EC. Article 2c) states:

"uncontaminated soil and other naturally occurring material excavated in the course of construction activities where it is certain that the material will be used for the purposes of construction in its natural state on the site from which it was excavated…"

...**are excluded** from the scope of the Directive. Excavated soil can also be employed as by-products or recycled/recovered materials. Data from BIOIS (BIOIS, EC, 2011) reveals that the production of excavation waste (1350-2900 Mt/yr) is significantly larger than what is defined as C&DW (341-531 Mt/yr).

The LCA literature review shows that, in complex orography conditions, when embankments and ground works are needed, the impacts related to earthworks can account for the main part of total emission during construction (Barandica et al., 2013) and account for up to 30% of the project (Hampson et al., 2012, Barandica et al., 2013). From a GPP development perspective, the information in this section highlights the potential importance of planning a closed-loop reuse of soils, particularly within the same worksite.

In situations where soils are unsuitable as sub-grade material, relative environmental impacts and economic costs of soil excavation and replacement versus in-situ lime/cement stabilisation must be considered (Mroueh et al., 2000). In greenfield construction sites, valuable topsoil should be managed separately and reincorporated into the site if possible or into other sites. All of the aforementioned aspects should be covered in a soil management plan for the project.

2.3.5.2 Draft criteria area for soil management plan

A criteria area based on the soil management plan is proposed (as an award criterion). Points could be awarded as a function of:

- Specifying quantities of soil to be moved permanently offsite and an overall site soil balance. It is proposed that the tender will be evaluated on the base of the larger proportion of soil reused in the worksite. For example, a technical proposal with a completely closed soil balance may be evaluated higher than one which does not have a completely closed soil balance.
- Identification of soil not suitable as sub-grade material, an evaluation of different stabilisation options shall identify the lowest environmental impact stabilisation agent. For example, at the same % addition, impacts can be ordered Portland cement > lime > lime+fly ash.
- Management strategies that outline the separate management of topsoil and its reincorporation into the site or other sites where relevant, including
    - areas of soil to be protected from earthworks and construction activities;

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- areas, types and volume of topsoil and subsoil to be stripped and stockpile locations;
- methods for stripping, stockpiling, re-spreading and ameliorating the soils
- expected after-use for each soil

Questions

Do you think that the criterion on a soil management plan could be applied?

How is the decision on which soil stabilisation agent to use reached in real-life projects? If environmental criteria are a factor, how are these evaluated?

Would it be advisable to set a minimum percentage of excavated soil to be re-used on site?

Do you foresee any problems with the verification of this criterion? Would they be easily verifiable by procurers?

Information on experiences in this field would be most welcome.

2.3.5.3 At what stage of the procurement process are the criteria relevant?

Preliminary scoping and feasibility: the ECI (early contractor involvement) is important in this phase in order to optimise the decision on road alignment and subsequent consequences the amount of excavated soil.

Design phase and performance requirements: the design team/design and build tenderer/DBO tenderer shall quantify the maximum amount of re-used soils within the soil management plan and the management activities on the reserves of topsoil and subsoil

Construction: shall demonstrate conformance to the soil management plan via site inspections.

Questions

Do you have any experience with the use, development or requirement for a soil management plan in construction projects? Would you be able to provide any examples of such plans?

2.3.6 Materials transportation

2.3.6.1 Rationale

Transport of materials is unique to the specific road construction projects and can be optimized by using local materials as far as is practical. In the practical method for greening road procurement proposed by Hampson et al., (2012), **mass haul**, defined as "*the movement of soil, aggregate and rock",* is a significant producer of GHG emissions related to fuel consumption. These materials easily account for over 90% of all material mass transported in road construction, since bitumen and cement only account for small fractions of asphalt and concrete respectively and are not used in unbound layers.

Transport of these materials is almost always by trucks and is especially inefficient over short distances in terms of fuel consumption. Thus it is recommended that transport is included in the GPP criteria for road construction. It is suggested to keep transport distances as a separate criterion except when recycled/secondary aggregates are assessed against natural aggregates – as specified in section 3.3.4.

2.3.6.2 Draft criteria area for mass haul plan

It is proposed to consider a criteria area on transport distances of materials for the road construction site that have to be assessed for the most important construction materials used for the road construction. The importance of the materials is in this context based on the volumes used for the road construction. The transport distances must be reasonable from an environmental point of view by assessing the energy and emissions caused by the transport and the impacts caused by the chosen materials for the road construction.

The criteria can be verified by demanding a table of mass-haul information:

1. Material type

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2. Volume of the material

3. Transport distances from the source of the material and to the road construction site

Materials	Source	Destination	V Volume	g density	d Transport distances	Eventually uphill and downhill Δz
			(m^3)	(kg/m^3)	(m)	(m)

It has to be considered that in the design phase, a baseline mass haul plan should be proposed based on predefined locations and the optimal solution for material haulage. The practical mass-haul plan should follow the baseline plan with any deviations requiring justification from the contractor, for example due to unforeseen events, new resource availabilities or limitations, as well as other project constraints. The practical mass haul plan should be updated regularly during the construction and the maintenance works. The baseline plan provides a reference against which the practical plan can be compared during the construction phase. The baseline plan provides a starting point for re-optimisation as well as forecasting mass-haul activities to accommodate the real issues and actual hauls as the project continues.

Questions

Do you think the haul plan functional unit should be km, tonne/km or something more generic like total fuel consumption, which would encourage the use of more fuel efficient trucks?

Would any award criteria for fuel efficient trucks be of relevance? For example, data for relatively new trucks in terms of CO_2 emissions per km should be available directly from manufacturers.

Would fuel consumption be easy to verify (for example via GPS online truck fuel consumption systems)?

What is your opinion on including a contract clause requiring that the contractor must demonstrate sufficient economical/environmental justification for any deviation in the practical mass haul from the baseline mass haul plan?

Do you see any constraint for the verification of this criterion? Would be easily verifiable by procurers?

Information on experiences in this field would be most welcome.

2.3.6.3 At what stage of the procurement process are the criteria relevant?

Preliminary scoping and feasibility: integrated project delivery procurement systems and early contractor involvement (ECI) could provide early opportunities before fixing the alignment. Early use of contractor knowledge during the design can help minimise hauls, not just optimise hauls.

Detailed design and performance requirements: a specific requirement for the mass haul table has to be included in the tender evaluation, comparison of different haul solutions presented in tables of hauls and assessment the practicality of the earthworks methodology statement. The design team, DB tenderer or DBO tenderer shall consider material suitability and site constraints such as haul routes, timing of material availability, alternative material use and sustainable supply mix. They are able to identify hauls of excessive length or other minor changes that can nevertheless significantly impact on the total movement of materials. Specialised consultants can be engaged during the design phase to provide detailed constructability analysis, including knowledge of mass haul, to assist in design development. Hampson et al., (2012) case study demonstrated how ECI helped achieve total savings in fuel consumption of approximately 60% by optimizing the mass haul.

In the contract clauses, the inclusion of incentives as well as specifics of performance, based on measurable criteria, in the contract document, is intended to motivate continuing sustainable practices by the contractor during the project. The inclusion of the optimised table-of-hauls in the contract document as a baseline mass-haul plan is important.

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2.3.7 Environmental performance improvement of road (based on LCA)

It is proposed that the use of resource efficient materials with low energy and resource consumption and related emissions during the full life cycle of the materials could be also evaluated by means of a LCA analysis, according to ISO 14040. According to the market analysis and the literature review, the most important materials that should be considered within this assessment are asphalt, concrete, aggregates (natural, recycled and secondary) and by-products and soils, including lime and other stabilizers. However, it is suggested that, during the strategic planning, the contracting authority would better define the main materials to be considered, taking into account the local conditions and public strategies.

Moreover transportation distances should be also addressed and the need for maintenance (including energy consumption) over the pavement service life should be considered. Furthermore, it is suggested also to take into consideration the road use phase. For example a higher embodied energy or less durable road surface could be justified if it presents a lower rolling resistance and thus lower fuel consumption for vehicles. The relative importance of this will depend greatly on the traffic flow and whether or not the road is designed to be freely flowing or not.

According to the preliminary report, there are several tools, mainly focused on the evaluation of the CO_2 emissions of road construction and maintenance. In most cases, these tools are country-specific and could be used in other countries by means of adaptation of the LCI. For example the tool Dubocalc contains a detailed inventory of Dutch data and Aspect (asphalt pavement embodied carbon tool) and Aggregain of UK data. A non-exhaustive list of other tools could include CHANGER, SEVE (used in France), ROAD-RES in the Scandinavian countries, joulesave, CO2nstruct. It has to be mentioned that the EU research project CEREAL (CO2 Emission Reduction in roAd Lifecycles) is developing a tool that will be concentrated on maintenance and rehabilitation activities in Europe.

It is suggested to discuss with the stakeholders if and how the procurer shall award points based on the improvement in the life cycle performance of the main road elements. A report justifying the choice of materials based on LCA data will be provided by the design team, the DB tenderer or the DBO tenderer. Additional points will be awarded for demonstrating clearly why one material is considered more suitable than another for the particular project in question – these may not relate to LCA but to local weather conditions etc.

It is also proposed to discuss with the stakeholders if the selection of a preferred pavement design could be based on an assessment of the material types by the presentation of available Ecolabels or Environmental Product Declarations (according to EN 15804).

Questions

Is it realistic to ask for an LCA for all road construction projects or only projects above a certain scale?

Do you think that the LCA criteria could potentially substitute other criteria for materials previously mentioned?

Would it be too complicated to include the use phase in the LCA assessment to due uncertainties over the final surface roughness / rolling resistance on vehicle fuel consumption?

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2.4 Road drainage system

2.4.1 Rationale for road drainage system – installing flood capacity

The European Environment Agency states that flooding during the period 1998-2009 in the EU resulted in insured economic losses of €52 billion and the displacement of around 500,000 people. Many areas that have never experienced serious flooding before have been subject to recent floods. Part of the reason may be changes in rainfall patterns and more intense storm events although a definite reason is the continued increase in impermeable areas and the continued reliance upon drainage systems designed to simply to convey water rapidly away from the site of interest. Such systems only create larger peak runoff rates downstream, effectively passing on the flood risk. There is a real need for modern drainage systems that retain stormwater from the site and only release it slowly to nearby watercourses, mimicking natural runoff patterns from greenfield sites. In areas of high flood risk, drainage systems may need to provide extra capacity to attenuate peak storm runoff rates not only from the site but from upstream catchment areas too.

Areas at risk of flooding across the EU have already been identified by member states under the requirements of the EU Flood Directive (2007/60/EC) and detailed flood risk management plans will need to be prepared for those areas by 2015. Roads present extremely large impermeable areas and comprise a key component of drainage infrastructure. There is a huge opportunity to increase drainage capacity either in new road construction or by retrofitting storage modules into existing drainage systems as a pro-active approach to flood risk management in both urban and rural areas.

There exist two broad types of road drainage components: "hard engineered" (more concrete based) and "soft engineered" (i.e. SuDS, more earth based). The soft engineered components have a lower adverse environmental impact but often require more space and sometimes more maintenance. Therefore it is not proposed to insist on soft engineered for flood capacity storage as this may not always be possible or practical but instead to place SuDS type flood capacity in award criteria.

2.4.1.1 Draft criteria area for road drainage systems – flood capacity

Based on the rationale above, it is suggested that the following considerations should be taken into account, particularly for road construction in river catchments that have already been identified to have flooding risks.

- Appropriate design of the drainage system shall be verified by calculating design storm intensities using approved methods at the individual Member State level and simulating the performance of the drainage system using hydraulic modelling software.

Questions

Do you have any examples of design storm events being specified in order to size road drainage systems correctly?

Do appropriate calculation methods for the definition of design storms exist in your Member State? (i.e. based on historical rainfall data at the regional level).

Should a minimum design storm event flood capacity also be defined for areas in river basins with no previous identified flood risks? If so, what type of design storm event would you suggest?

2.4.1.2 At what stage of the procurement process are the criteria relevant?

Detailed Design and performance requirements: One or more drainage system options should be provided that can be demonstrated to comply with the requirements via hydraulic modelling simulation software.

Construction: Constructor should demonstrate to the client by site inspection that the drainage system matches the plans in the detailed design, highlighting compliance with important design features such as pipe/channel dimensions and sloping.

Questions

Is visual inspection of the drainage system during construction normal?

If so, who would be responsible for inspection? i.e. the planning authority, the highway maintenance staff, the environment agency or any other type of representative?

2.4.2 Rationale for road drainage system – reducing water pollution

Increasing attention is being given to the pollution status of watercourses due to the Water Framework Directive (2000/60/EC). With combined sewers during heavy storm events, untreated sewage can be discharged directly to watercourses. Road drainage represents the input of a significant range of other pollutants including:

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- Zinc (Zn) and Sulfur (S) in tyre particles in concentrations up to 9,000mg/kg and 12,000mg/kg respectively (Kreider et al., 2010).
- Highly variable loads of elements such as Sodium (Na), Potassium (K) and chloride (Cl), due to the use of road grits when snow/ice on roads is expected.
- Polycyclic aromatic hydrocarbons (PAH's), from atmospheric deposition of exhaust gases / exhaust particulates (Dong and Lee, 2009).
- Oils and aromatic compounds from vehicle leaks.
- Metals from brake pad wear such as Copper (Cu) (Hulskotte et al., 2006), Zinc (Zn) (Armstrong, 1994) and where stainless steel brake pads are used, Iron (Fe), Nickel (Ni) and Chromium (Cr) in road particles.
- Precious metals Platinum, Palladium and Rhodium (Pt, Pa and Rh) from catalytic converters can be found in road dust in concentrations up to around 1mg/kg (Pritchard et al., 2009).

Most traditional drainage systems offer little or no treatment of stormwater. During the last decade there has been a large increase in the adoption of alternative, soft-engineered sustainable drainage systems (SuDS). These can offer treatment via physical processes such as filtration and sedimentation as well as biological treatment such as microbial degradation of soluble organic pollutants and incorporation into plant biomass. In concrete pipe and tank systems, sediment accumulation has to eventually be manually removed whereas in grassed swales for example, sediment is incorporated into the underlying soil. Some other potential advantages of SuDS may include ease of visual inspection, aesthetic value and habitat creation. Some potential disadvantages are higher space requirements and higher maintenance costs. However, there exists a suitably large range of SuDS components to facilitate their incorporation in the majority of road construction projects. From the LCA review in the preliminary report, Birgisdottir (2005) and Birgisdottir et al., (2007) showed that salt from de-icing operations can be the dominant factor behind ecotoxicity during the road use phase.

2.4.2.1 Draft criteria area on road drainage system – reducing water pollution

Based on the above rationale, it is considered that the following factors may be of particular relevance to this criteria area:

- Requesting that road drainage shall not be connected to combined sewers
- Specifying the drainage system to achieve a minimum degree of sediment removal efficiency and oil interception capacity.
- If the road surface is non-porous, grit (lower salt content) and not road salt shall be used for de-icing.

Possible award criteria that may be considered more environmentally friendly due to potential habitat creation and aesthetic value where space is available:

- The installation of SuDS drainage components at the "regional drainage level" i.e. detention ponds, created wetlands or retention basins with sediment removal capacity.
- The installation of SuDS drainage components for stormwater "conveyance" that provide a degree of sediment removal i.e. filter drains or swales.

Questions

Is it realistic to define a minimum degree of sediment/oil removal capacity? Can this be verified or is design enough?

Would separating storm sewers potentially cause a problem with poor flushing of sewers (i.e. sewers with low longitudinal gradients)?

2.4.2.2 At what stage of the procurement process are the criteria relevant?

<u>Detailed design and performance requirements</u>: technical drawings will clearly demonstrate connection (or not) to mains sewers. The placement of any sediment traps, oil interceptors or acceptable equivalent SuDS components will be shown.

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Construction: Constructor should demonstrate that the drainage system matches the plans in the detailed design to the client due to the importance of dimensions and sloping.

Questions

Is visual inspection of the drainage system during construction normal?

If so, who would be responsible for inspection? i.e. the planning authority, the highway maintenance staff, the environment agency or any other type of representative?

2.5 Noise emission

2.5.1 Rationale

Environmental noise pollution has been identified as an extremely important but under-regulated impact that affects both human health and wider economic factors such as property value. The importance of the issue is already reflected in **Directive 2002/49/EC** relating to the assessment and management of environmental noise. Member states are required to map noise levels on roads with traffic flows >6 million vehicles per year and urban agglomerations of >250,000 inhabitants. Noise from road traffic is a dominant source of environmental noise and can potentially be managed in road construction GPP by:

- Criteria for low noise road surfaces.
- Criteria for noise barriers.

Low noise road surfaces

Low noise surfaces include porous materials like single or double layer porous asphalt or porous cement concrete, which are characterised by a high content of open and interconnected air-voids. Other low-noise surfaces include thin surfacings and poro-elastic asphalt of which the latter is still under development. These materials may present other disadvantages such as poorer durability and different/higher maintenance requirements. Of the three main sources of road traffic noise (engine, road-tyre contact and air turbulence) the road surface affects road-tyre contact noise. It is generally understood that road-tyre noise only becomes the dominant source of noise in free flowing traffic of moderate speeds (50-80 km/h).

Noise measurement requires specialised equipment and technicians and spot data cannot always be directly compared with data from other roads due to background noise from other sources, changes in temperature, wind and humidity and different vehicles passing along the road, each at individual velocities. The measurement using specially equipped and standardised procedures makes measurement more complicated.

The noise performance of a road surface can generally be estimated as a function of certain physical properties: namely surface texture (macrotexture), porosity and in some rare cases, stiffness.

Based on the above comments, we suggest that a common sense approach to noise criteria for road surfaces can be taken where a surface type that is widely known to be of a low-noise type can be specified by the procurer and that, where possible, collaboration with the relevant authorities responsible for meeting the requirements of Directive 2002/49/EC can result in the assessment of low-noise road surfaces as soon as is practical after construction and optionally at regular intervals (e.g. every 2 years) afterwards. An alternative for compliance and verification would be to require analysis of the newly constructed road surface macrotexture. Unfortunately this can only be measured over small areas using current techniques and so it would be difficult to justify as a core criteria.

Noise barriers

In dense urban environments, noise barriers may not be possible, but should certainly be required for rural roads and motorways where possible. The key environmental impacts of the noise barriers are related to the materials used in their construction. The optimum material will depend on local availability and the embodied energy associated with the material. The procurer should specify a given noise reduction performance of the barrier (e.g. 5dB, 10dB or 15dB reduction for example) for a defined source and receptor area. This can later be assessed in-situ following methods described in CEN/TS 1793-5, EN 1793-6 and EN 14389-1.

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Thus the noise reduction performance therefore would represent a verifiable core criterion and the choice of materials for the barrier could be evaluated as an award criterion, stating an order of preference of material based on its approximate embodied energy.

2.5.2 Draft criteria area on noise

Based on the above rationale, it would be logical to split any requirements/criteria between low-noise road surfaces and noise barriers. Potential areas of interest for low-noise pavements include:

- The road surface type specified shall be proven to present noise reductions compared to normal road surfaces based on laboratory studies and technical literature.
- For porous surfaces, the open porosity of test mixes by the contractor shall be measured to ensure conformity as per EN 13108-20 for porous asphalt or EN 12350 for porous concrete.

Potential award criteria may include

- Measurement of road surface macrotexture prior to opening.
- Measurement of noise emission via SPB + CPX methods prior to opening.
- Monitoring of noise emission of same road section by SPB and CPX at regular periods during the lifetime of the road.

Areas that are relevant specifically to noise barriers would include:

- The noise reduction requirement of the noise barrier between a defined source and receptor area shall by **X** dB (where X is any value ≥5 and typically ≤20 and chosen by the procurer).

Questions

Should there be a mandatory requirement for a shift to low-noise pavements?

If so, should this be only in certain situations (like free flowing/ accelerating traffic sections) or by default?

Is it feasible to require macrotexture analysis of new road surfaces? If so, what values would be specified?

Any suggestions/opinions about the idea behind scoring for materials in noise barriers?

Should criteria for noise only apply to road construction projects above a certain minimum scale? If yes, which scale?

2.5.3 At what stage of the procurement process are the criteria relevant

Detailed design and performance requirements: Any noise barriers shall be included in technical plans for site. Calculations predicting acoustic performance of the barriers shall be presented.

Construction: If porous surface courses are specified, open porosity data for test mixtures shall be presented to the client in conformity with specified air void content range. Prior to road opening any comprehensive criteria testing for noise emission by SPB and CPX methods or macrotexture measurement shall be carried out.

Use: in-situ performance of noise barriers will be assessed at regular intervals as specified in the contract. Optional further monitoring of noise emissions from road and/or deterioration in surface macrotexture where applicable.

Questions

Is there any existing relationship between the authority responsible for noise mapping in agreement with Directive 2007/60/EC and road maintenance authorities? Any experience in such partnerships could be of significant interest.

Would the availability of specialised equipment/personnel for road surface assessment for macrotexture and noise emission be a problem in your Member State?

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2.6 Waste Management Plan

2.6.1 Rationale

The importance of waste management is reflected in the development of the Waste Framework Directive. Of particular relevance to road construction, article 11.2 states:

(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 (C&DW) *excluding naturally occurring material defined in category 17 05 04 in the list of waste shall be increased to a minimum of 70 % by weight.*

C&DW has been identified as a priority waste stream by the European Union because there is a high potential for recycling and re-use of this waste type. The potential is assessed to be large due to the existing level of recycling and re-use of C&DW which varies greatly (between less than 10% and over 90%) in the Member States. (EC, 2013b). BIOIS (2011) has reported an average recycling percentage of 46% across the EU.

2.6.2 Draft criteria on waste management plan

Based on the rationale, it is considered that the development of a waste management plan would be appropriate as a technical specification; this plan should include aspects such as:

- A waste management plan for the construction/maintenance/decomissioning project shall be provided.
- The plan shall demonstrate how, for example as core criteria, that at least 70% of C&DW shall be prepared for re-use, recycling and other material recovery, including backfilling operations and referring to reclaimed asphalt pavement (RAP) and any other bound or unbound materials present in pavement layers. A suggested comprehensive level could require >90% instead of >70%.

The materials, products and elements identified shall be itemised in a Demolition Bill of Quantities. Material segregation and recovery shall respect the waste hierarchy in Directive 2008/98/EC.

Questions

Is road decommissioning a common practice in road construction?

2.6.3 At what stage of the procurement process are the criteria relevant

Design phase and performance requirements: the design team, DB contractor and DBO contractor shall prepare the waste management plan

Construction: the lead construction contractor/DB contractor/DBO contractor shall submit a site waste management plan prior to work onsite consisting of:

- A bill of materials with estimates for waste production based on good practice,
- Estimates of the % re-use potential based on separate collection during the construction process,
- An estimation of the % recycling and recovery potential based on separate collection

2.7 Competencies of the project manager and the design team

2.7.1 Draft criteria area on the competency of the project manager and the design team

The appointment of the successful tenderer/consultant for the road construction project consists typically of a two-step approach.

First of all, the criteria for selection of consultants (engineers, planners and architects) cover the requirements for pre-qualification in order to be eligible to submit a proposal for the consultancy services. The criteria for pre-qualification are normally the consultants' experience with implementing similar road construction projects in terms of size and complexity. Secondly, the successful tenderer is appointed for the contract based upon defined award criteria.

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The award criteria comprise the GPP related criteria used in the tender evaluation to define the GPP related score of the consultant's tender for the requested consultancy services inclusive other award criteria such as cost. The GPP related award criteria constitute only one part of the overall award criteria to appoint the successful tenderer.

- For the selection criteria, the consultants (engineers, planners and architects) shall demonstrate that suitably qualified and experienced personnel will undertake the required services. The consultant must describe the composition and qualifications of the team that is to undertake the services.

Qualifications and abilities in road construction projects can include experience and technical capacities as regards one or more of the following fields/areas:

- Planning and design of road construction (specific aspects concerning the road e.g. drainage systems, reducing rolling resistance and noise, materials etc. should be specified)
- Environmental impact assessment and environmental management including incorporation of measures to reduce the total environmental impacts from the road construction during the full life cycle of the road

The revision of the Public Procurement Directive (2004/18/EC), expected to be in force as of March 2014, will provide the possibility to argue that the organisation, qualification and experience of staff assigned to perform the contract can improve the level of performance of the contract and thus be considered as award criteria.

2.8 Contractor competency

2.8.1 Draft criteria area on the competency of the construction/ maintenance/ rehabilitation contractors

The appointment of the successful tenderer for a road construction project typically consists of a two-step approach.

First, the contractors to be invited to submit tenders are normally selected through a pre-qualification procedure. Environmental selection criteria for this stage relate to the experience of the contractor in performing similar road construction projects in terms of size and environmental complexity. Secondly, the successful tenderer is appointed for the contract based upon defined award criteria.

The award criteria assess the quality and cost of the contractor's tender for the design/construction/ operation of the project.

The construction contracts are defined to cover:

- Construction and/or operation of the road construction with reduced consumption of non-renewable energy, primary resources, low rolling resistance etc. or
- Renovation and/or operation of the road construction with reduced consumption of non-renewable energy, primary resources, low rolling resistance etc.

The selection criteria can include experience and technical capacities from one or more of the following fields/areas:

- Experience in construction of road construction with focus on reduction of environmental impacts (energy efficient equipment and working methods, specific items within materials, techniques related to reduction of the rolling resistance, compliance regarding the use of industrial by-products etc. should be specified)
- Experience in operation of road construction with focus on reduction of environmental impacts (specific items within maintenance of roads to ensure a reduced need for repairs, maintaining the projected low rolling resistance etc. should be specified)
- Ensuring effective protection of flora and fauna during construction of the road
- Experience in environmental management of a construction site.

As wih the project manager and design team, the procurement reform foresees the possibility to evaluate the experience and qualifications of a team at the award stage.

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2.9 Conclusions

In order to contextualize and individualize GPP criteria, it could be helpful for the public authority to contextualize the analysis of a road project in order to choose the GPP strategy. As it is shown in Table 1, for pavements that match the criteria described in the worst scenario, it is likely that improvements can be made to that component. Conversely, if a pavement is already near the ideal scenario, then it may be more effective to focus efforts on other life-cycle components.

Table 1.

GPP criteria	**Scenario where GPP criteria has little or no beneficial impact**	**Scenario where GPP criteria can have a potentially large beneficial impact**
Rolling resistance Roughness (IRI) Macrotexture	Smooth pavements with low vehicle traffic High stiffness pavement structures on low traffic section. Low heavy traffic	Rough pavements with high vehicle traffic Low stiffness pavement structures on high traffic sections. High heavy traffic
Congestion	Pavement sections with low traffic or where capacity is much higher than demand. Sections with readily available detours. Use of lane closures during off-peak traffic periods	Pavement sections with high traffic or where capacity is comparable to demand. Sections where detours are not readily available. Lane closures occur during peak traffic periods
Materials	Pavements with low structural demands (e.g., low AADTT, temperate climate) that require less material. Use of recycled or other low-impact materials. High quality construction practices that facilitate longer service lives.	Pavements with high structural demands (e.g., high AADTT, extreme climate) that require more material. Use of virgin materials. Low quality construction practices that decrease pavement service lives.
Transportation	Low overall material demand. Locally available materials, especially aggregates. Use of *in situ* recycling strategies. Any long-distance travel utilizes efficient transportation modes (i.e. by train)	High overall material demand. Materials need to be shipped over long distances, especially aggregates. Long-distance travel using inefficient modes. Use of virgin materials for each process.
Noise – low noise pavement	Roads remote from populated areas. In low traffic roads. In low speed limit roads (<50km/h).	In medium-high speed roads (>50km/h) of freely flowing traffic.
Noise barriers	In areas with limited available space. Roads with low speed limits. Roads remote from populated areas.	In rural areas near villages. Roads with medium-high speed limits. Roads with high surface roughness.
Drainage - flooding	In arid areas with no previous history of flooding.	In river basins with identified flood risks. In areas with high urban development.
Drainage - water pollution	In arid areas with little rainfall. In areas remote from sensitive water bodies. In low traffic flow roads.	In areas near sensitive water bodies. In high traffic flow roads.

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The information can perhaps be presented in a better way using the following table:

Table 2.

	Rolling resistance	Congestion	Construction materials	Soils	Materials Transportation	LCA	Drainage - flooding	Drainage water pollution	Noise – low noise pavements	Noise barriers
Low traffic flow	green	green	red	yellow	yellow	red	yellow	green	green	green
High traffic flow	red	red	green	yellow	yellow	red	yellow	yellow	red	red
Freely flowing	red	yellow	yellow	yellow	yellow	yellow	yellow	yellow	red	yellow
Not freely flowing	green	red	yellow	yellow	yellow	yellow	yellow	yellow	green	yellow
Low speed road (<50km/h)	yellow	red	red	yellow	yellow	yellow	yellow	yellow	green	yellow
Medium-high speed road (>50km/h)	red	red	yellow	yellow	yellow	yellow	yellow	yellow	red	red
Rural road near populated area	yellow	red	yellow	yellow	red	yellow	red	red	red	red
Rural road remote from populated area	yellow	green	yellow	yellow	yellow	yellow	green	green	green	green
Urban road	yellow	red	yellow	yellow	red	yellow	red	red	red	red
Within river catchment with known flooding risk	yellow	yellow	yellow	red	yellow	yellow	red	red	yellow	yellow
Within arid area with no previous flooding risk	yellow	yellow	yellow	yellow	yellow	yellow	green	green	yellow	yellow
Road area with unsuitable subgrade soil	yellow	yellow	yellow	red	yellow	red	red	yellow	yellow	yellow

* green the criterion is not important for the scenario stated

**yellow indicates that the criterion may be important but it would depend on other information.

*** red indicates that the criterion is important under that particular scenario.

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3 PRELIMINARY INFORMATION FOR THE GUIDANCE DOCUMENT FOR ROAD CONSTRUCTION PROCUREMENT

3.1 Background to this guidance

The aim of this section is to propose some preliminary information collected in order to prepare a GPP guidance, which will be provided together with the GPP criteria on road construction in order to provide procurers with orientation on how to effectively integrate the GPP criteria for road construction into the procurement process. They will be specified to address the most significant environmental impacts of a new road, road rehabilitation and reconstruction of existing road.

Designing and procuring a road infrastructure with a reduced environmental impact, whether it be new construction, its rehabilitation or reconstruction, is a complex process. As was highlighted by the SCI (Sustainable Construction and Innovation through Procurement) Network in their guide for European Public Authorities, the form of procurement can have a significant influence on the outcome (Clement et al., 2012). This is because each type of contract brings with it distinct interactions between the procurer, the design team, the contractors used and the asset managers. Moreover, they each have advantages and disadvantages in seeking to procure an improved environmental outcome.

It is therefore important to identify the main points in the sequence of procurement activities where GPP criteria should be integrated. The guidance will be structured to reflect the key activities and decision points in the procurement process, as well as some of the common contract forms that are used in the European Union.

3.2 Indicative sequence of procurement activities

The process of constructing a new road or carrying out maintenance and rehabilitation activities tends to consist of a distinct sequence of procurement activities. Each contract relates indicatively to distinct phases of activity as a project proceeds:

- Preliminary scoping and feasibility
- Design
- Construction
- Maintenance
- End of life (decommissioning)

The procurement procedures identified by the Public Sector Procurement Directive (2004/18/EC) are open procedure, restricted procedure, negotiated Procedure and competitive dialogue. In detail, the restricted procedure comprises a two stage process: in the first stage the suppliers need to pre-qualify before being allowed to submit a tender and a short list is identified. In a second stage, the identified suppliers are invited to respond to an Invitation to Tender (ITT). The competitive dialogue is used for more complex procurement contracts. Similar to negotiated procedure in that it specifically permits dialogue between the contracting authorities and providers during the stages of the procurement process. It enables contracting authorities to develop specifications with the input of tenderers.

The manner of involving the private sector for construction of roads depends on prevailing national practices for outsourcing. Numerous procurement and contract models are applied in the Member States for road construction projects. According to the SCI-Network (Clement et al, 2012) there are generally three main types of procurement models for infrastructure projects:

- **Separation of design (D) and build contracts (B)** where the design is prepared by the public authority in house or by a consultant(s) selected via a tendering process. Often the tender documents are also prepared by the public authority or the consultant(s). The constructor is chosen via a tendering process where interested or invited construction companies are competing to win the contract to construct the tendered project. This is the most typically used contract type in the public sector. The interaction between

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the public authority and the construction company is usually reduced. The advantage of this procurement model is that the public authority has close control of the project and process.

- **Combination of design and build (DB)** the main contractor takes responsibility for both design and construction, and will either use in-house designers or employ consultants to carry out the design. The contractor tenders against a client brief, and will often follow an initial concept design prepared in house by the public authority (source: National Road Administration NRA) or by consultants appointed to advise the contracting authority. The design will be developed by the contractor and the works will be completed. In this type of procurement model the interaction between the public authority and the contractor is higher but this procurement model reduces the public authority's control over the process.

- **Design, build and operate (DBO)** and **Design, build, finance and operate (DBFO)**. These types of contracts are used in a variety of ways in the Member States. The contract types differ from design and build by including operation and maintenance and project financing.

- In case of separation of design and build contracts (B) and combination of design and build (DB), maintenance and operation activities will be procured by means of separate contracts, as it is analysed in section 2.2.4. In this case, different typologies of contracts are employed, as frameworks, joint ventures or single/multiple providers.

Depending on the procurement route adopted, some of these contracts may be awarded to the same contractor but in most cases they are let separately. Some contracts may be integrated in a design and build (DB) or a design, build and operate (DBO) arrangement, with the detailed design process, the main construction contract and even asset management all potentially co-ordinated by one contractor. Specifically, different procurement routes and contract types could be applied in case of large scale and long terms road infrastructure projects. Preliminary information have been collected from HM Treasury & Infrastructure UK (2013), HA Highway Agency (2009) and WRAP (2005). In detail, according to a preliminary analysis, contract types that seem to be widely applied for road infrastructure are:

- Delivery consortia for long term capital investment programmes of low to medium value projects.

- Development/delivery partners for publicly procured mega-projects and major infrastructure enhancements.

- Alliancing for low to medium value projects with long term capital Investment programmes.

- Frameworks contracts are used to appoint preferred suppliers in advance of either directly awarding work or competing in a subsequent mini-competition if more than one supplier is appointed. Frameworks can be single contract or include more providers.

- Private finance initiative (PFI) for high value, strategic projects. Over an extended contract, the private sector assumes responsibility for the operation and maintenance of a length of existing or new road. A PFI contract is basically an agreement between the contractor (which is usually part of a consortium) and the public authority to design, build, finance and subsequently operate a road asset. The consortium usually includes a design and build contractor, a facilities management provider, and a funder. The public authority effectively rents the asset for the contract period, after which it will own it.

- Public Private Partnership: there are a number of Public Private Partnership (PPP) models, characterised by joint working and risk sharing between the public and private sectors. These can include relatively simple outsourcing-type partnerships – where services are provided on short or medium-term contracts – or longer-run private finance partnerships. In general, PPP contracts are widely used in the road construction sector (IRF, 2013; IISD, 2012). When using PPP contract models the public authority contracts a private partner to take responsibility of the design, construction, maintenance and operation of a road. Most PPP contracts focus on performances and quality of the tendered construction. Among other benefits this contract type provides incentives for continued quality and maintenance of the road which e.g. is demonstrated by the use of materials with longer life times and reduced need for maintenance. In the case of a more comprehensive PPP contract, the contractor may be given the right to exploit the infrastructure and thus recover costs, including investments, through the tariffs charged to the customers (for example for road toll). In these cases, the contractual relationship between the parties will often take the form of a concession. In the case of concession with e.g. 30 years duration, the establishment of GPP criteria in the

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tender documents should be considered carefully, because the main part of the environmental impacts occurs during the use of the road.

- Another important form of contract is the Early Contractor Involvement (ECI). This form of contract allows supplier engagement at an early stage in a project, to draw in industry experience to the design and preparation stages. ECI contracts remain an option for major road schemes where there is significant scope for input from the supply chain. Suppliers' knowledge and abilities to influence project decisions could have relevant impact in terms of project timing, quality and cost.

The project implementation phases bring together various requirements of the public authorities, the many stakeholders, the consultant(s) and/or the contractor(s) to reach the best way to construct the road project terms of defined objectives. The process can be viewed as acting through a number of logical stages as described below. An overview of the different phases for development and implementation of a road project and the related procurement phases is shown in Fig. 5.

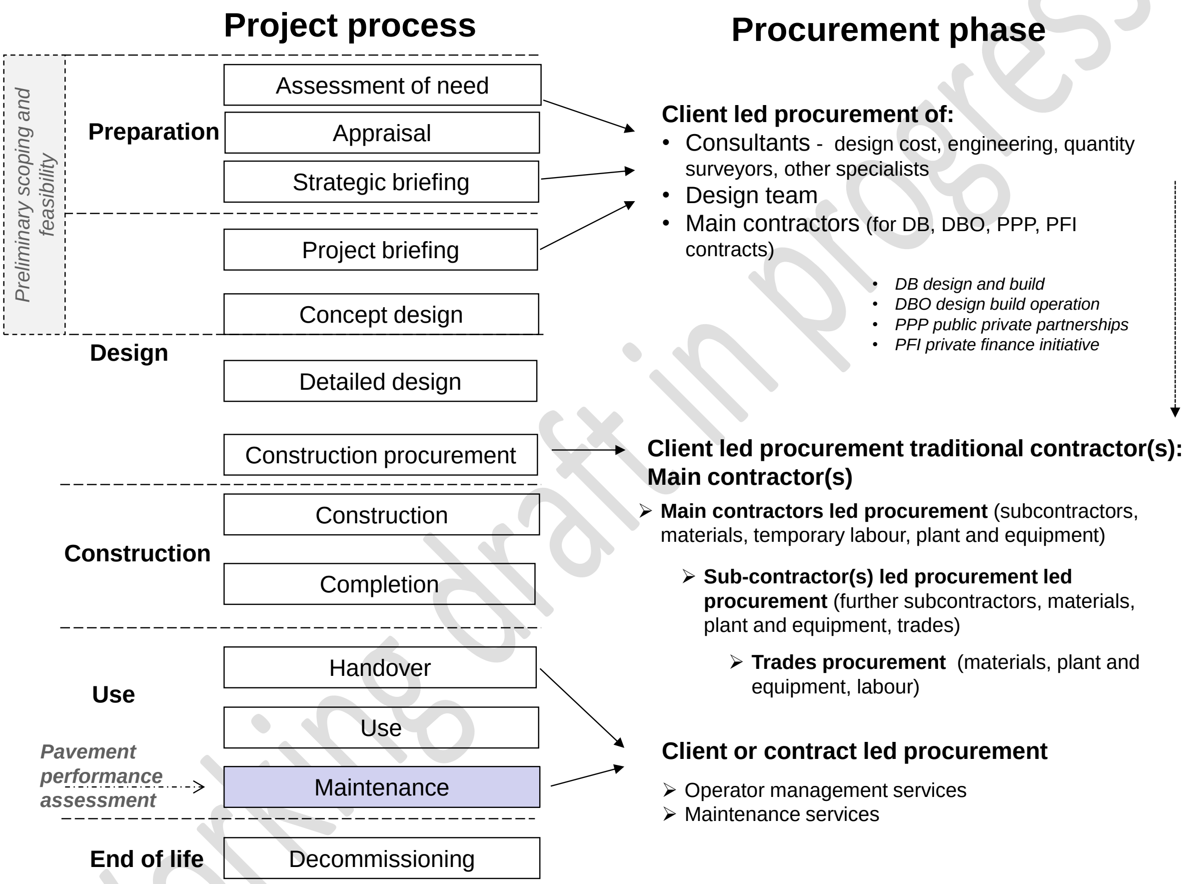

Figure 5: Project process and procurement phases for road infrastructure (based on information provided in Berry and McCarthy (2011) Harmer at al. 2012, SUNRA project)

Early inclusion of GPP criteria requirements into contracts is vital to ensuring that sustainability considerations are fully integrated into the project and to limit additional costs.

3.2.1 Preliminary scoping and feasibility

Assessment of the need

The need for a road infrastructure is decided at a strategic level. A road project is formulated in terms of overall objectives and it is discussed typically at a political level and may be part of a master plan developed in discussion with local authorities and supply chain stakeholders with relevant knowledge and interests in the project. The exchange of ideas, opinions and experience between relevant parties for tackling issues such as; identifying the optimal alignment, technical problems and improving service levels to create a set of defined

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and realistic project objectives is crucial. Integrating sustainability into the assessment of need enables questions to be asked about the broader impact of the infrastructure. This starts at the point of whether a new road or major reconstruction is required at all, whether it is the most appropriate solution and how it should integrate with other transport modes. The assessment of need can also identify the parameters within which it is appropriate to build a new road e.g. its size, service life and potential future improvements.

Strategic briefing

At the strategic briefing the contracting authority invests resources to investigate the project. The development of options which will meet the required need will be likely required. The project definition clearly sets out the strategic aims of the project. Its objective is usually to create a clear brief for the internal project team, including the procurer. A consultant could be tendered or the national road administration (NRA) or local administration could pass the project to the technical in-house lead. The project definition should include the environmental priorities of the contracting authority, as reflected in policies and plans, at a corporate level and in local planning policies.

At the feasibility stage, the general project outline is examined in detail by studying relevant design options, assessing which are feasible and selecting the most feasible solution for implementation - in respect of the project objectives. In this stage each project option is examined in view of construction methods and service life costs and environmental, social and economic impacts. Typical elements to be considered in the feasibility study may be estimated construction costs for each option, Life Cycle Costs (LCC) for each stage of the project including build and operation, Cost Benefit Analysis (including traffic studies), a preliminary Life Cycle Assessment (LCA), development /assessment of financial strategy, risk analysis and mitigation for each optional solution under consideration.

Project briefing

A preferred option is developed and a briefing prepared for the design team. The contracting authority can set the parameters for this process and incorporate the principles of sustainable development. Public authorities will instruct the designer to consider the sustainable development principles in design. This may be through a further procurement process to a design team, a design and build team, as a technical brief to in-house staff or as part of a contract management process with a consultant.

Environmental planning

According to IRF (2013), the Strategic Environmental Assessment (SEA Directive 2001/42/EC) should be a fundamental component of road-network planning, as it can help in ensuring legality and consistency, understanding environmental impacts at the strategic level, improved collaboration and efficiency in decision-making, positive effects on subsequent project assessments, transparency and public participation.

The earlier in the procurement cycle design changes to the road alignment are considered, the more potential economic and environmental savings can be obtained. To benefit from the possible reductions in energy consumption and GHG emissions during construction of major roadworks, design should not be separated from the opportunity to optimise length of the road, earthworks and materials transportation. The length of the road is vital to the total impacts caused by a road construction. The reason is that the use phase is typically the most significant parameter and causes the largest environmental impact for road with a considerable traffic volume. Typically the road alignment is decided upon in the feasibility stage and assessed by the EIA (according to Article 4(2) Annex II of the EIA Directive 2011/92/EU). Thus, it is assessed that the length of the road construction is decided before the GPP criteria come into play. It is recommended that the public authorities are aware of the importance of this parameter and include this knowledge when choosing the alignment of the road construction which? it has to be assessed by means of a preliminary LCA analysis (Liljenström C., 2013; Faith-Ell C., 2005).

Concept design

Before moving into the detailed design phase, an options appraisal is usually carried out in order to inform the business case for the project.

It is required to develop a concept design as part of the feasibility study in sufficient detail including inputs (materials, alignment and transport requirements) for the cost benefit analysis (CBA), the EIA, SEA, LCC Analysis and LCA of design concepts and options. The concept design covers further work to assure the contracting authority that risks are reduced, the costs are more accurate and to provide design-build

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contractors with sufficient information to understand the proposal. The concept design takes a first view on public authority's requirements that will include among others:

- the functional requirements capacity, size, quality of the works, laid out in a sufficiently comprehensive way to ensure that they are understood in the same manner by each of the tenderers
- Requirements to the Contractor's design and design criteria to be used
- A presentation of the physical conditions on site or specifications to tenderers, as to which investigations they should carry out as part of their tender and existing permissions. This could include borders of land, site available, access roads, topographic, soil and ground conditions, utilities.
- Possible environmental constraints during construction
- Permissions required to be obtained by the Public Authority or Contractor (as construction permit).

Establishing environmental performance objectives

It is recommended that the public authority evaluates its actual needs and possibilities for incorporating environmental issues in each step in the procurement process. Each project is unique, therefore, some criteria might have to be strengthened, others omitted. Moreover, the degree to which the procurement process includes the various phases (design, construction and operation) will also determine choice and formulation of GPP criteria. Therefore, it is important that both minimum technical requirements and possible areas of focus for award criteria are established during this preliminary phase. This will ensure their clear communication throughout the tendering process and will help build a common understanding. Initially the focus could be dedicated to a few key strategic environmental targets, for example related to pavement performance or construction materials. Further environmental targets may be added in further procurements steps.

Putting the team together: preliminary stages

At the preliminary stage the aim should be to draw upon internal expertise to support the procurement process. Using internal expertise through in-house led technical departments will ensure greater ownership over the project. The internal project team will also then be more informed when managing external contractors, being able to maintain better control over the environmental specifications it requires.

Where possible personnel with relevant expertise should be identified and assigned to the project. This might include, for example expertise in capital projects, finance, highways, maintenance and environmental management. Some authorities may also have in-house engineers and designers.

Experience also suggests that the involvement of the supply chain, maintenance manager and future facilities managers can help to ensure that the road infrastructure is designed to meet their needs and is practical to operate and maintain.

Preliminary appraisals and outline designs may be carried out in-house with support from external consultants to make up gaps in expertise. Support to be procured could include Environmental Impact Assessments, Transport Assessments, Life Cycle Costing, sustainable design.

Early assumptions about capital and life cycle costs

At this stage initial assumptions about the cost of environmental improvements can be integrated into the cost planning for the project. Life Cycle Costing (LCC), done before tendering, can be used as a technique to inform decisions on the cost and benefit of requiring specific GPP criteria (see the description of LCC below). Reference road concepts used internally to appraise the possible costs may be included in the Invitation To Tender (ITT) for design teams and construction contracts. Provided that they include a bill of construction materials they could be used as the basis for comparative assessments of environmental improvement options for the construction.

Life Cycle Costing (LCC)

Life Cycle Costing is a technique that *'enables comparative cost assessments to be made over a specified period of time, taking into account all relevant economic factors both in terms of initial capital costs and future operational and asset replacement cost'* (Langdon, 2007). It is particularly relevant to achieving an improved environmental performance because higher initial capital costs may be required to achieve lower life cycle running costs. LCC exercises should be carried out with reference to ISO 15685-5.

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Applying LCC requires specialist technical skills that should be procured by the contracting authority (if it does not exist in-house) to support initial appraisals and development of the Invitation To Tender (ITT) for main construction contract. Cost consultants will tend to be able to offer this expertise.

LCC is particularly important in Design, Build and Operate arrangements, which can be structured in order to incentivise the contractor to minimise long-term operating costs. *Further information about LCC is available from the EU GPP website:* http://ec.europa.eu/environment/gpp/lcc.htm

3.2.2 Detailed design

The contracting authority will have determined what needs to be considered in this process at the project brief stage and the concept design stage.

Specifying the brief and performance requirements

a) Under conventional (employer design) contracting arrangements

In a conventional contracting arrangement a design is procured for the road project and then a contractor is procured to construct this design (also referred to as an 'employer design' contract). A brief is therefore required setting out the contracting authorities design requirements. The brief would form the basis for the ITT for a design team.

b) Under integrated design and construction arrangements

Where design and construction are to be procured together (in ''design and build'' or ''design, build and operate'' contracts) the contracting authorities performance requirements assume greater importance. This is because they will form the basis for the ITT for the main construction contractor and their design team. It is therefore important in these two types of contracts that GPP criteria are fully addressed within the performance requirements. It may be necessary to procure expertise at this stage in order to prepare the performance requirements. Where the design and build are to be integrated in one contract there will tend to be less direct control over the final design. The performance requirements to be communicated to potential contractors are therefore important in formally specifying GPP requirements.

Putting the team together: developing performance requirements and designs

As the project enters the detailed design stage the contracting authority may wish to procure an external project manager with experience of innovative construction projects. Their role could include supporting development of the brief and/or the performance requirements as the basis for the ITT. They could also support the procurer by helping to troubleshoot issues or barriers to the delivery of GPP specifications.

Experience suggests that the core design team will require experience and expertise in a number of key areas which are identified in more detail in the GPP Selection Criteria:

Engineers: Knowledge and experience of designing and specifying environmentally improved road infrastructure.

Specialist environmental consultants: Knowledge and experience in providing advice on innovation in areas such as materials sourcing, waste management and certification schemes, as well as the capacity to carry out specialist analysis such as LCA.

Cost consultant: Knowledge and experience of environmentally improved specifications and construction systems, as well the capacity to carry out specialist analysis such as Life Cycle Costing (LCC).

It is important that experience and expertise is verified by references from clients and/or recognised certifications and qualifications. The criteria should be included in the ITT for all forms of contract.

In the reform of the public procurement directives (adoption expected for March 2014, to be transposed by Member States within 24 months), it is explicitly stated (Art. 66) that the organisation, qualification and experience of staff assigned to performing the contract (where the quality of the staff assigned can have a significant impact on the level of performance of the contract) can be a criterion for **awarding a contract**. This can be put in addition to selection criteria. For complex contracts as road construction and maintenance it can usually be expected that the quality of the staff can have a significant impact on the performance of the project.

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Commencing detailed design

Detailed design is carried out by a design team, the members of which can either be individually selected or called down from a framework contract. The process then varies according to the form of contract:

- In a *conventional construction contract (also referred to as employer design)*, where there is a separation between the designer and the construction contractor, the design team is instructed by the technical lead department of the NRA or local road administration (or consultant(s)) who is accountable to the contracting authority.
- In a *design and build or a design, build and operate contract* the design team is usually controlled by the main construction contractor, although it may be possible to 'novate' (transfer) the contracting authority's design team to the chosen contractor.

The core design team will generally include project manager, cost consultant, consulting engineers (civil, structures and services) and specialist environmental consultants. Technical tools used by this team to meet GPP requirements will include building energy modelling and Life Cycle Assessment (LCA) software.

Life Cycle Assessment (LCA)

Life Cycle Assessment is a tool that can be used to analyse the environmental impacts of different road designs and specifications. It is specified in the GPP criteria as a means of quantifying improvements in the environmental impacts of roads.

Using LCA requires specialist technical skills that should be procured as part of the design team. This technical capability should go hand in hand with practical knowledge and experience of the available improvement options, their material composition, their availability in the supply chain and their cost and design implications.

Preparation of the tender documentation in traditional contracts

The detailed design forms the basis for the ITT which will be used to procure the main construction contractor. It is therefore important that it incorporates GPP requirements. This could include requirements relating to:

- Design performance, such as structural parameters, rolling resistance, noise and drainage
- Material specifications, such as specific combinations of the main materials and products identified by LCA analysis,
- Execution of the contract, including site waste management

The contracting authority may also require the bidder to carry out a Life Cycle Cost assessment, or to provide information that allow the contracting authority to make its LCC calculation. Bids may then be compared on the basis of the 'Most Economically Advantageous Tender' (MEAT) considering life cycle costs. This would include the long-term cost of maintenance, utilities and waste management. It is recommended that LCC is assessed as a global figure (i.e. all lifetime costs added together) and not as separately weighted award criteria.

3.2.3 Construction

After the design is finalised the contractor is appointed through a procurement process. The tender process may have been initiated prior to design or at the end of design to appoint a contractor.

a) Conventional (employer design) contracts

It is therefore important that the contractor has a clear understanding of the GPP performance requirements and has the capability to respond to them. The potential to include GPP criteria should already have been explored earlier in the process by the design team, but the nature of the contract will still allow for contractors to identify cost effective and innovative responses.

b) Integrated design and build contracts

In a contract with integrated design and build the contractor will have been selected at an earlier stage on the basis of their capabilities and their design team's response to the contracting authorities' performance

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requirements. The main advantage of this contract form is that it integrates the design team and the construction contractor, which can help to minimise risk and uncertainty in delivering innovative specifications. It also affords the contractor greater flexibility in meeting the performance requirements, but this places a strong emphasis on ensuring that performance requirements are carefully defined.

c) Design, Building and Operate (DBO) contracts

In a Design, Build and Operate contract which includes project financing, the risks associated with the project are transferred to the contractor, who is usually responsible for the road asset over a 30-40 year timeframe. The contracting authority sets out its road asset performance assessment in a specification.

The advantage of DBO arrangements is that asset management and the asset performance monitoring are integrated within the contract. Life Cycle Costing therefore becomes an important consideration because the contractor will seek to minimise running costs. This can be further incentivised in how the operating fee is structured. The disadvantage is that the contractor will seek to minimise upfront investment costs. GPP requirements such as those relating to construction materials should therefore be prioritised during contractor selection. The DBO consortium's knowledge and experience of how to appraise and manage the supply chain to meet GPP requirements is important. DBO contractors that are experienced in meeting environmental specifications may, for instance, have developed cost effective construction systems.

3.2.4 Maintenance

According to Sjögren et al. (2012, He-road project), a road asset management is a holistic approach that integrates the strategic and systematic process of operating, maintaining, upgrading and expanding physical assets effectively throughout their life cycle. A road asset management includes pre-investigation, planning, design, building, daily operations, planned maintenance, improvement and decisions on re-cycling or removal (Fig. 6). Furthermore the road user perspective has become a target area to be considered.

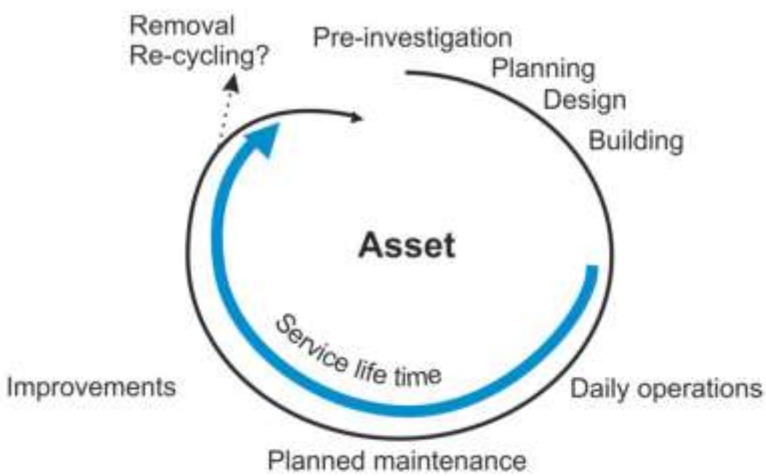

Figure 6: The life time stage of an asset (Sjögren et al., 2012)

The interventions for maintenance are different to that of major projects, with the work in this area often identified in programmes for particular areas or regions. Figure 7 shows the typical intervention points for network maintenance are.

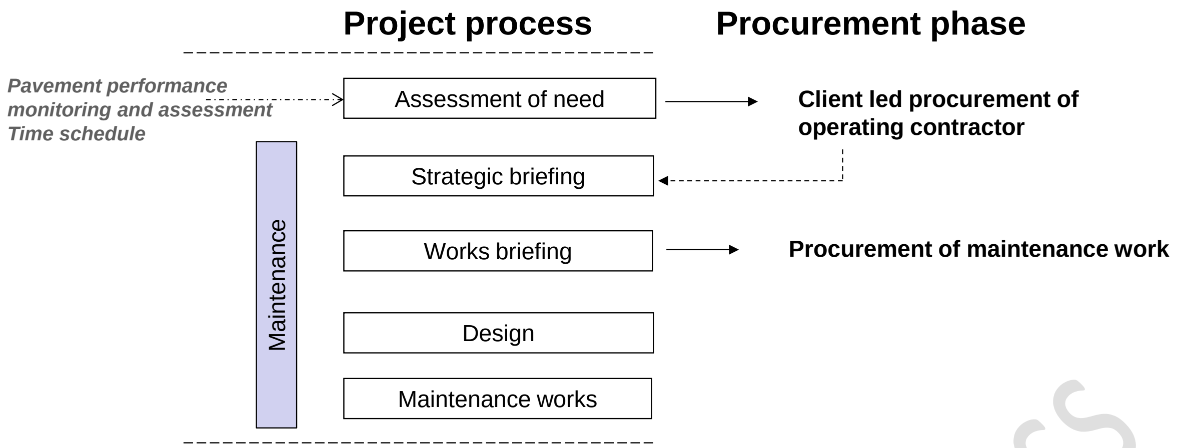

Figure 7: Project process and procurement phases for maintenance (based on information provided in Harmer at al. 2012, SUNRA project)

Assessment of need

The public authority (NRA or local administration) identifies the need for maintenance for the network. This assessment of need is often based on the condition of the network and the available finance to maintain and enhance the network. Including a holistic sustainable approach to the assessment of need should ensure that the public authority gets the true value from allocated funds. This intervention may be through the procurement of an operating contractor.

Strategic Briefing

The contracting authority invests resources to investigate the programme of works. Within the programme of work will be small works and maintenance projects that will need to be prioritised. The contracting authority should work with the maintenance teams (whether internal or external) to prioritise the works. Maintenance works are planned according to budget prioritization, shared cost collaboration.

Project Brief

A technical description of routine maintenance or planned maintenance is developed in this phase. A project will be developed and should be worked up based on recommendations from the strategic briefing. Any options to improve performance should be taken in this phase.

Design and Construction

In routine maintenance (small works) and planned maintenance, the intervention points are limited to the contract management actions of the client. These can vary from assessment of targets, required processes or required awards. Contractor value engineering and project management should deliver sustainability outcomes identified in design and through construction processes. The delivery of the programme is monitored by the NRA or the local authority to ensure performance targets are met.

The maintenance management of road construction may be carried out by the public authority (NRA or local authority) or may be let as a separate contract to a specialist company. This would tend to include the operation of road, water and waste management systems. The relevant GPP requirements should therefore be incorporated into the ITT. Performance measurement and management, linked to incentivised continual improvement, are key contract principles.

According to a preliminary analysis HMEP (2013), procurement routes and contract models that seem to be widely applied for road maintenance and rehabilitation are:

- Managing Agent Contractor. The contracts have usually a limited time (for examples 5 years) and can be extended dependent upon performance.
- Private funding: a long term contract between a public authority and a private sector organisation to provide a service to or on behalf of the authority. It is based on a concession agreement that usually requires construction and maintenance and rehabilitation of road infrastructures, including debt finance.

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The private sector organisation is then paid a tariff for the provision of the service. This contract could be used for toll roads.

- Single Provider: a single contract with a single service provider to deliver for example all highways related services for a defined time period. The authority retains a small team to manage the contract with the selected service provider. This arrangement requires a long term commitment between the parties.

- Multiple Providers: a contract with multiple service providers to deliver the various highways related maintenance services for a defined time period. The authority retains a team to manage the contract with the various providers. This option offers the benefit of ensuring specialist organisations deliver the road maintenance service element such as street lighting.

- Framework: consists in assuming more than one provider with similar skill set to allow mini competitions to be held for appointment against work packages. The authority enters into a series of framework contracts for the provision of particular services. The frameworks may cover individual disciplines e.g. surface dressing or may include a number of multi-discipline design services. Frameworks can be single provider frameworks or include more providers. The maximum duration of a framework under European Union Regulations is 4 years (HMEP, 2013)

- Joint Venture (Public/Private): a joint venture company (arrangement between private organizations with its own legal identity) enters into a contract for the provision of the services with the public authority.

- In-house: public authorities deliver services via in-House teams. This model allows for internal provision of the road services by the authority and staff remaining within the employment of the authority. It is possible to procure some elements of the service via contracts with external organizations, whether it is a single service area or multiple service area (in-house with top up).

Questions

Is the indicative sequence of procurement activities well described?

Do you think that the described type of procurement models could be applied usually to the common infrastructure projects?

Are the process stages well identified?

Do you think that the described type of procurement models for maintenance activities could be applied usually to the common maintenance and rehabilitation projects?

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