30 August 2005

Green Guide Update: BRE Response to Comments on Characterisation Briefing Paper (3a)

Comments in **bold** have been provided by our Life Cycle Assessment Peer Reviewers. A list of all those who have provided comments is given at the end of the document.

General Comments on LCA methodology

- **The chosen approach is well and thoroughly considered and the chosen principles are well justified. The chosen approach is in line with the relevant ISO standards, namely the existing 14040 series of standards and the draft standard which is under preparation by the TC 59 SC 17 WG 3.**
- **Apparently, the purpose of use of the methodology will be to support the easy comparison of results concerning the environmental impacts of building materials. It should be bourn in mind that the ideal use of LCA methodology is for product specific development instead of comparison of generic results of products. However, the building sector European wide wants to develop and mobilise methodologies which support the considering of sustainability aspects of building. The BRE methodology and the chosen approach well correspond to these needs.**
- **When the environmental impacts of building materials are expressed with help of a single score, it makes it very easy to compare different products. Thus the methodology should emphasise the importance to compare different products on the basis of functional units in order to avoid unjust use of the results.**

General Questions on application of Methodology

- **I assume that manufacture includes the preproduction phase and that transport is included throughout the life-cycle.**

As described in the original Environmental Profiles Methodology, which can be downloaded from http://cig.bre.co.uk/envprofiles/downloads/BRE%20Environmental%20Profiles%20Methodology.pdf?, the preproduction phase (eg quarrying or gas extraction) and transport are included throughout the life cycle.

- How are the following accounted for?
  - The additional impact of transport for an imported or remotely produced material as opposed to a local one.

BRE take typical transport distances for materials to site. Where relevant, these include the impacts of importation from overseas, based on the typical pattern of import. Where transport has significant impact (for example for materials with low production impacts) then it may be appropriate to provide more than one model – eg UK sourced stone paving and Asian sourced stone paving.

  - The different impacts of production in different places/countries. For example: aluminium produced with hydro, or nuclear, or gas electricity.

The Energy Briefing paper provides details on BRE's proposed approach to this issue. Go to www.bre.co.uk/greenguide/update to download.

  - The variation of local impacts (e.g. particulate emission) with geography (e.g. population distribution)

BRE recognise that the same emission will have a different emission in different locations, but unfortunately LCA models are not complex enough to deal with this issue.

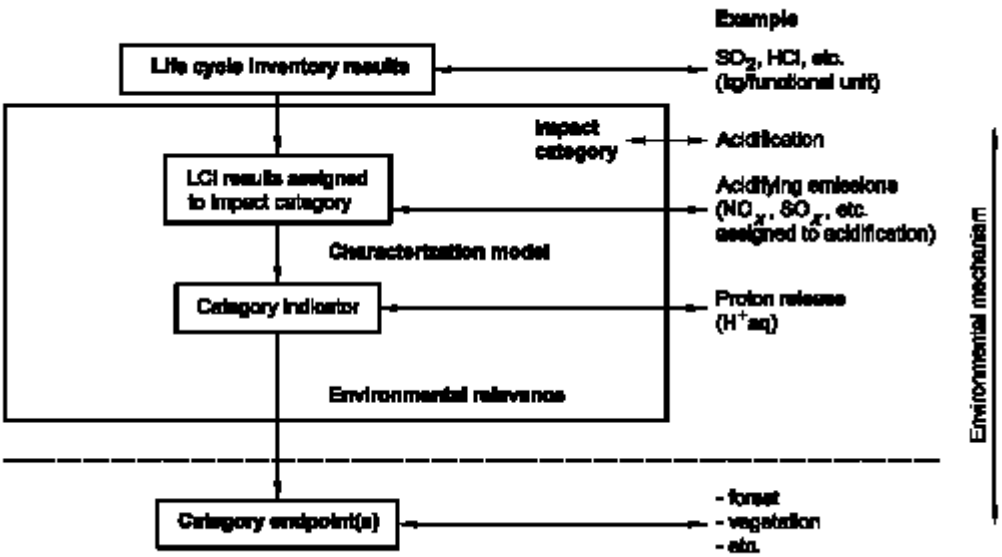
  - Background pollution concentrations.

Again, unfortunately LCA models are not complex enough to deal with this issue.

Characterisation Approach

- For understandable reasons, impact categories are restricted to which may be quantified (mass, volume, Becquerels, etc) and are mainly 'primary impacts' in that they concern the beginning of the impact chain and not the end (damage to humans, flora, fauna).
- I think a mid-point approach is appropriate.

The CML indicators use a midpoint approach which has a direct link between the inventory and endpoint. The diagram below explains this.



The above diagram is extracted from ISO14042: 2000 and shows the relationship between inventory – the emissions of substances, and the endpoint – the impact those emissions have. Indicators could be based on inventory, the end point, or a midpoint approach (or intermediate variable approach) taking account of the environmental mechanism. For example, indicators for Acidification above could be:

Inventory: kgs SO_2
Midpoint: kg of Acidifying emissions measured relative to 1 kg SO_2
Endpoint: Hectares of Forest killed by Acidification.

Use of CML Characterisation Factors

- The Web link given for CML method gives poor information. More information is required from BRE to enable an informed response.

The methodology documents referenced in the briefing paper is Guinée et al, Life cycle assessment: an operational guide to the ISO standards. CML, Leiden University 2000.. This can be downloaded in 4 parts from

Part 1: LCA in perspective: http://www.leidenuniv.nl/cml/ssp/projects/lca2/part1.pdf
Part 2a: Guide: http://www.leidenuniv.nl/cml/ssp/projects/lca2/part2a.pdf
Part 2b: Operational Annexe: http://www.leidenuniv.nl/cml/ssp/projects/lca2/part2b.pdf
Part 3: Scientific Background: http://www.leidenuniv.nl/cml/ssp/projects/lca2/part3.pdf

Part 2b provides more detail on the exact baseline methodologies and characterisation factors for the chosen category indicators..

- **ISO 14047 also provides characterisation factors but I think I prefer those of CML**

- We recognise the need to update characterisation factors (or LCIA – Life Cycle Impact Assessment methods) on a regular basis, using the latest scientific knowledge. CML are one often-used source of these factors, but we should bear in mind that CML are not the definitive source.

Provision of Supplementary Information with LCAs

- **Energy and resource depletion should each appear as separate categories. Energy should be the primary total comprising feedstock fossil fuel and renewable energy. The resource depletion should include water, minerals and fossil fuels**

In line with the draft ISO on EPDs for construction products, BRE intend to include this information within Environmental Profiles, in addition to the characterised and normalised data.

Choice of Impact Categories

- **The chosen impact categories and the characterisation process mainly follows the CML methodology. However, BRE intends to add four categories, which include solid waste disposal, radioactivity, minerals extraction and water extraction. Considering the characteristics of building, this choice is excellent. Especially the categories of minerals extraction and solid waste have often shown to be significant impact categories of building.**

- **The normalisation processes will later show the significance of the chosen different categories. It may be that some of the chosen categories - like for example eutrophication and abiotic depletion - will appear to be less significant.**

Characterisation of impacts

1. Abiotic Resource Depletion

BRE have provided the feedback received on the Abiotic Resource Depletion Category below. As a result of this feedback, and comments on the Minerals Extraction Category, they have decided to adopt a new approach for resource use. This is described in detail at the end of this document.

- What do BRE consider to be scarce minerals?
- There are several materials that can claim 'scarcity of resource' is not a problem, and as iron ore and coal are highly abundant, why should they be treated any different? World iron ore resources, for example, are expected to last 700 years at 2003 extraction rates.

CML's method assesses scarcity by comparing the rate of extraction with the square of the ultimate reserve (the total reserve within the earth's crust). Iron ore has one of the lower abiotic depletions, as a result of the large reserves, whereas silver and gold have some of the highest depletion factors. The relative scarcity is therefore taken into account.

- **I'm not comfortable with the Abiotic Resource Depletion measure and would like more information, especially the data sources for determining remaining reserves and rate of extraction. As you know, reserve estimates reflect economics as well as known physical quantities, and there have been many instances of reserve estimates that proved to be widely off the mark when relative prices changed. In short, I'm not sure what is gained by this apparently more sophisticated measure compared to a simple measure of quantities used.**
- We disagree with this method. Its reliability is suspect as it is based on data for known reserves, which are very difficult to calculate. The data on known reserves is constantly changing as new reserves are found and advancements in technology allow the economic extraction of resources that were once thought marginal or sub-economic. Also, the method

does not consider aggregates as a resource, which clearly they are. Instead, we propose that BRE only use Mineral Extraction to measure how much material has to be extracted.

The Abiotic Depletion Factors have been developed by JB Guinee at CML not BRE. The baseline CML factor is based on the ultimate reserve (total available resource within the earth's crust) rather than economic reserves and the current rate of extraction. Data on the ultimate reserve was sourced from a number of publications and is described in the following paper, JB Guinee & R Heijungs, A proposal for the definition of resource equivalency factors for use in product life-cycle assessment. Environmental Toxicology and Chemistry, Vol 15, No 5, pp 917-925, 1995. Further information is also given at http://www.leidenuniv.nl/cml/ssp/projects/abioticdepl.html.

- Does this include the demineralisation of soils by intensive forestry practices?

No, it only relates to the depletion of scarce minerals.

- Is it UK, Europe or World based?

It is a global indicator, any use of a material which results in an upstream use of a scarce mineral will result in abiotic depletion, wherever the mineral extraction occurs, based on the ultimate global reserve.

- Out of curiosity, why antimony?
- **I'd also like to better understand why the selection of Sb as the reference case (or any other resource, for that matter). For other measures that use characterization factors, the elemental flows can be related to the reference flow (i.e., there is an equivalency factor that relates the greenhouse gas effect of methane to that of CO2). What is the relationship between Sb depletion and that of a host of other resources unless they are found in combination with Sb? If there is none, then this seems to me to be an arbitrary, hypothetical measure that conveys little information.**

BRE believe antimony (Sb) was chosen as it makes the largest contribution to global abiotic depletion of any element (30%), ie the amount extracted globally and its scarcity result in the biggest contribution to abiotic depletion; in other words, it is the element likely to be depleted most quickly.

- CML state that when weighting Abiotic Depletion, fossil fuels and minerals should be weighted separately. Is this what BRE are proposing?

It would be BRE's intention to weight the resource use of fossil fuels and minerals separately.

- **Fossil fuel depletion and mineral extraction are not included in the impact categories given in ISO/DIS 21930. They should however be included in the use of resources list under LC Inventory results.**

ISO/DIS 21930 (Environmental Product Declarations for Construction products) has identified a number of impact categories that should always be included within EPDs for construction products. However as part of the goal and scope of an LCA study (ISO14042 – Life Cycle Assessment – Impact Assessment) any relevant impact categories should be identified and ISO14047 (Examples of application of ISO14042) mentions abiotic depletion as a common impact category used within LCA studies. BRE believe that the use of minerals and fossil fuels is a relevant impact category for the construction industry.

As a result of the feedback on this category and the minerals extraction category, BRE have proposed a new resource extraction category which is described at the end of this document.

2. Acidification

- Agree, although LCIA does not take account of regional differences in terms of which areas are more or less susceptible to acidification.

- Acidification can occur due to forestry practices leading to reduced buffering capacity of the soils and decrease in soil water pH and surface water pH. This combined with loss of minerals from the soil and acid rain can (and has) led to aluminium being released as a species that is toxic to fish as it interferes with gill function. Is this form of acidification going to be included in the methodology? If not how can this impact be captured?

The acidification may be caused by pollution from processes outside of forestry, e.g. nitrogen pollution caused by the combustion of fossil fuels and the intensification of agriculture (Hornung and Langan, 1999). This impact is very hard to measure and account for. The BRE method does account for acidification due to fertilizer use according to the method developed by the Intergovernmental Panel on Climate Change (IPCC).

- Does the calculation assume that all the SO2 or NO2 is dissolved in rain? I understand that there is an equilibrium between the gas which dissolves, and that which does not. Maybe this doesn't matter for a mid-point analysis though...

CML have based the characterisation factor on the RAINS10 model developed by the University of Amsterdam – the following download provides more details www.leidenuniv.nl/interfac/cml/ssp/projects/lca2/report_mh_iiasa2.pdf.

As a result of the consultation BRE do not intend to make any changes to this impact category.

3. Climate Change

- Does the methodology include the CO_2 released from the soils as a result of deforestation or forestry practices for timber?

The methodology does not account for CO_2 release from soils but neither does it give any credit for the increased carbon content of the soil caused by forests (see Milne, R, 2001[i]; Matthews and Broadmeadow, 2003[ii])

- As the methodology is cradle to grave – does it currently capture CO_2 produced from burning waste timber on a construction site or the methane emission from timber within landfill?

The methodology includes the emission of any greenhouse gases from timber at the end of life, for example CO_2 from on site burning or incineration or methane from landfilling, to offset the CO_2 sequestered in timber as it grows. The updated waste models will reflect current practice in terms of the disposal routes for timber and the amounts of landfill gas which are burnt or used for heat/energy recovery.

- Do BRE plan to include carbonation in their methodology.

Yes, the carbonation of cement and lime is included within 60 year life profiles. Details of how BRE account for carbonation are included in the original Environmental Profiles Methodology in Appendix A7. BRE would welcome input from industry to update this methodology.

As a result of the consultation, BRE do not intend to make any changes to this impact category.

4/5 Ecotoxicity to freshwater and land

- We feel that it is inappropriate to ignore ecotoxicity to marine environments.

There are considerable doubts within the LCA community as to the robustness of the marine ecotoxicity characterisation factors and for this reason this category has not been included. The error which causes the greatest problem relates to emissions of Hydrogen Fluoride (HF), where the model uses a residence time in the oceans of 80 million years rather than 1 million years. Although it would be possible to change the resulting factor for HF, the residence times for all other emissions should be reviewed using the same assumptions to ensure consistency, and this has not yet been undertaken. In the meantime, CML do not recommend that the marine ecotoxicity factors are used.

- Sedimentary ecotoxicity factors and marine ecotoxicity categories are not to be included – why? A more detailed explanation is required from BRE.

Sedimentary ecotoxicity is not included as a CML Baseline category and therefore has not been included within the methodology. For marine ecotoxicity, see above.

- Do BRE measure turbidity, suspended solids and Biological Oxygen Demand (BOD) anywhere? Forestry activities can significantly increase sedimentation of water bodies leading to increased turbidity, low light levels and decreases in available oxygen, how is this to be captured? This also leads to an impact as loss of soil, how is this to be captured?

BRE collect data on suspended solids and BOD from a variety of processes. However BOD is only referenced by one Danish impact assessment method, and suspended solids by none. Forestry can also be used to achieve resolve sediment problems (Nisbet et al., 2004iii).

- Disagree. Scientific understanding of ecotoxicity is still developing, so the characterisation factors cannot be relied upon. In addition, the impact is localised, whereas LCIA considers global impacts. Toxic emissions may be released at several different locations around the world (e.g. from iron ore mining) whereas LCIA will only consider the total emission from all sources.

Other impacts included within LCA such as eutrophication are localised rather than globalised impacts. ISO 14047 recognises the Ecotoxicity is a commonly used impact category within LCIA.

- In terms of metals, current ecotoxicity impact assessments do not take account of bio-availability, essentiality, and spatial effects as detailed in the "Declaration of Apeldoorn on LCIA of Non-Ferro Metals," available on the CML website. In the declaration it is made clear that decisions should not be made based on the results of ecotoxicity LCIA

This declaration resulted from an event funded by the metals industry, where their influence was dominant. BRE believe that ecotoxicity is a key issue which must be addressed by Environmental Profiles and the Green Guide, and have attempted to find the most relevant models to assess this impact category. It is recognised that toxicity models are still developing.

As a result of the consultation, BRE do not intend to make any changes to this impact category.

6. Eutrophication

- Does the forestry industry apply fertilizers and if so do they apply any scientific reasoning to their application (Beven *et al*)? If they do how is it to be measured within the methodology?

The forest industry does use fertilisers. The amounts used are based on the site needs, e.g. soil nutrient content and projected tree growth. Direct and indirect impacts of fertilisers are included in the method. The direct impacts are from production of the fertilisers and the indirect ones are calculated using the IPCC method to estimate emissions to water causing Eutrophication.

- Agree, although LCIA does not take account of regional differences in terms of which areas are more or less susceptible to eutrophication.

As a result of the consultation, BRE do not intend to make any changes to this impact category.

7. Human Toxicity

- Note OECD workshop on consideration of chemical safety in green procurement, 8-10 November 2005, Seoul, Korea. May be of interest to manufacturers.

- Disagree. Scientific understanding of toxicity is still developing, so the characterisation factors cannot be relied upon. In addition, the impact is localised, whereas LCIA considers global impacts. Toxic emissions may be released at several different locations around the world whereas LCIA will only consider the total emission from all sources. In particular, exposure to emissions and the corresponding dose to humans, will be highly case specific.

It is true that the impact of a release of chemical will depend on location and the susceptibility of anyone who comes into contact with it. However the Human Toxicity factors are based on a common measure of response, and no-one has yet produced a model complex enough to deal with the location of releases.

As a result of the consultation, BRE do not intend to make any changes to this impact category.

8. Photochemical Ozone Creation

- VOCs from timber treatment processes, the treated timber and housing – how is it captured in the methodology?

The evaporation of solvents used in timber treatment processes, cleaning, paints etc is included within the methodology. Where possible, accurate data on emissions, or rate of top up is used to calculate the amount which evaporates.

- POCP does not equate to summer smog – smog is a thing, not the potential for the thing.

We will ensure the text reflects this.

- Agree, although this again is predominantly a local impact, whereas VOC and NOx emissions used in LCA may not actually occur at the same location.

As a result of the consultation, BRE do not intend to make any changes to this impact category.

9. Stratospheric Ozone Depletion

- Does the methodology consider materials that are used as treatments or coatings for other materials eg fire coatings for steel and anti-root treatment for timber?

Source: Andrew Frost & Tom De Saulles
The Concrete Centre / British Cement Association

Where BRE are aware that any use or emission of any chemical is likely to cause ozone depletion, then they will try to source an Ozone Depletion Potential for the chemical, and use this within the impact assessment. BRE understand Methyl Bromide (an ozone depleting gas) may still be used in some developing countries as a pesticide but its use within the countries where most construction timber is sourced has been banned by the Montreal Protocol. BRE have been unable to source any Life Cycle Inventory data for intumescent coatings for steel.

As a result of the consultation, BRE do not intend to make any changes to this impact category.

Additional Characterisation Issues – General Comments

- We support the BRE's approach to supplement the CML impact assessments where important environmental impacts are not taken into account by CML.

- We know from our own experience of LCA data collection that water extraction data is supplied to the BRE for inclusion. Does this therefore mean that the CML 1992 Method also did not include the four issues or does it mean that Water Extraction hasn't previously been included.

The CML 1992 method did not include indicators for water extraction, minerals extraction or radioactivity, although waste was included. However BRE introduced their own indicators for water extraction and minerals extraction, as described in the 1999 methodology, available from www.bre.co.uk/envprofiles.

10. Solid Waste Disposal.

BRE have included the feedback provided on the solid waste category below. As a result of this feedback, they have decided to slightly modify the category. This is described at the end of this section.

- **I can agree with the inclusion of solid waste disposal.**

- **BRE intends to add four categories, which include solid waste disposal, radioactivity, minerals extraction and water extraction. Considering the characteristics of building, this choice is excellent. Especially the categories of minerals extraction and solid waste have often shown to be significant impact categories of building.**

- The description states that mass is to be used – is volume not a more suitable unit of measurement considering it is the available space in landfill that is the main issue

BRE agree that volume of waste landfilled reflects the rate at which landfill sites are used up. However mass is a good proxy for the loss of resource implied by waste disposal. The volume of waste is dependent on the degree of compaction so assumptions would need to be made about final volumes of uncompacted waste if this was used as an indicator. Most manufacturers have been able to provide BRE with masses of waste, and existing LCA studies normally measure mass of waste. It is unclear whether volume of waste data would be available for use.

- **Waste disposal is not included in the impact categories given in ISO/DIS 21930. They should however be included in the use of resources list under LC Inventory results.**

ISO/DIS 21930 (Environmental Product Declarations for Construction products) has identified a number of impact categories that should always be included within EPDs for construction products. However as part of the goal and scope of an LCA study (ISO14042 – Life Cycle Assessment – Impact Assessment) any relevant impact categories should be identified. BRE believe that the disposal of waste is a relevant impact category for the construction industry.

- **I agree with the selection of impact categories proposed with one exception on additional impact categories. I have my reservations with regard to the category "solid waste disposal.**

- **According to the briefing note, "other environmental issues associated with landfilling such as dust, noise and odour shall be implicitly considered by using this impact category." Dust emissions should be taken into account in the modelling of the landfill site. Noise is most probably not considered on construction sites nor of lorry transportation. Odour is neither a particular problem of landfill sites and may occur in chemical industry as well, where it is not considered in the respective LCIs.**

BRE agree that other processes cause dust, odour and noise, and that different wastes will cause different impacts. BRE do feel that the loss of resource is a significant issue which is not a function of other industries, unless they produce waste.

- **The only impact I would agree is the loss of resource. But even here, incineration leads to resource losses as well (maybe even more so).**

BRE also accept that waste which is incinerated is also a significant loss of resource, particularly if there is no associated heat or energy recovery or recycling of residues.

- **Furthermore, the revision of the ecological scarcity method 2005 will most probably skip the land fill ecofactor just due to the reasons listed above. I therefore recommend to skip this category.**

- *"No differentiation will be made between hazardous, inert or organic wastes..."* - No mention is made of non-hazardous waste.

This should have read "No differentiation will be made between hazardous, non-hazardous, inert or organic wastes.

- The early part of the text appears to contradict itself, it states that...*"The updated Environmental Profiles Methodology will take into account the impact from emissions and infrastructure associated with waste disposal, for example, the emissions associated with landfill, incineration and composting. However, this will not cover other environmental issues associated with landfilling such as dust, noise and odour, and the loss of resource implied by the final disposal of waste".*
- The BRE description is vague and talks about emissions. If this is the case, is there not going to be double counting re climate change, photochemical ozone creation and human toxicity?
- Incinerated waste: how is this dealt with? It does have environmental consequences, e.g. release of dioxins.
- Is the waste that is incinerated included in the global warming and acidification potential etc?

Yes, where waste is incinerated, the waste disposal models include emissions of CO_2, NOx, SOx dioxins etc with corresponding global warming, acidification and toxicity impacts.
The other impacts described by the Briefing Note related to dust, noise and odour which are not included within the waste treatment modules. BRE recognise that these emissions can be caused by a number of other industries, and are not caused by all landfills.

- **In contrast to that, the modelling of underground hazardous waste storage is much more like nuclear waste repositories, where the quantification of emissions is much dependent on the behaviour of the deposit. I therefore suggest to include a category "hazardous waste to underground storage". Maybe minerals (especially metals) mining overburdens might also be considered separately due to their longterm leaching emissions.**

The use of underground hazardous waste storage is not common within the UK and BRE do not think it is a relevant category for inclusion within the Environmental Profiles methodology at this point in time..

Proposed Revision to Category for Waste Disposal
As a result of the feedback provided above, BRE have decided to amend this indicator. They therefore suggest that this impact category:

- *is renamed Waste Disposal;*
- *only reflects the loss of resource implied by waste disposal as opposed to recycling or reuse;*
- *does not include any other impacts associated with landfill or incineration;*
- *the mass of waste is used as a proxy for the loss of resource;*
- *includes waste sent to incineration and landfill or any other form of final disposal (eg dumping on land or in the sea);*
- *does not differentiate between hazardous, non-hazardous, inert or organic wastes;*
- *where heat recovery, energy recovery or other material recovery (eg recovery/recycling of ash, metal residues etc) are undertaken as part of incineration or landfill, then value is used to calculate the loss of resource.*
    - *For example, if an incineration process makes 50% of its income from processing waste, 25% from heat recovery and 25% from sale of residues/ash, then only 0.5 tonnes of final waste disposal is attributed per tonne of waste treated.*
    - *Similarly, if a landfill site makes 90% of its income from receiving waste, and 10% from energy recovery from landfill gas, then 0.9 tonnes of final waste disposal is attributed per tonne of waste received.*

11. Radioactivity – now "Nuclear Waste"

- The term 'Radioactivity' should be renamed 'Radioactive Waste,' to better reflect the impact being described.
- **Please label the nuclear waste issue what it is. At a first glance, I assumed that you intend to consider radionuclide releases from NPPs and up- and downstream activities such as nuclear fuel reprocessing and uranium enrichment. I suggest to name it "nuclear (or radioactive) waste". It helps to distinguish from indoor radioactivity issues (radon in dwellings).**

BRE agree with this comment and have renamed the category Nuclear Waste accordingly.

- The text talks about spent fuel and intermediate level waste – are these high level wastes?.

BRE intend the indicator to cover high level waste, spent fuel and intermediate level radioactive waste. All of these wastes:

- *are highly radioactive, accounting in total for more than 99% of the radioactivity attributed to the nuclear industry;*
- *have no agreed form of permanent disposal anywhere in the world;*
- *require storage for at least 1000 years before they may be safe. #*

Unfortunately there is no phrase which comprehensively describes all these wastes as a single category. BRE will ensure that the extent of category is well described within the weighting exercise.

- **I support the consideration of nuclear waste.**

- **I'm not sure about the inclusion of radioactivity as a relevant intended category**

- I am unsure of how relevant/useful this information is to the construction industry, as it will mainly be influenced by electricity grid mix.
- We are unsure as to how this fits into the methodology and more information would be appreciated. If this section is to be included due to the use of electricity in the production of

building materials, allowance should be made for the onsite generation of electricity (where appropriate).

The Energy Briefing paper makes it clear that manufacturers generating their own electricity, or sourcing green tariff electricity, will be assessed on the basis of that production, rather than generic electricity models including nuclear electricity.

- Is the methodology going to consider the impacts of differing decay mechanisms i.e. gamma emissions and alpha decay, with respect of their ionizing potential and their potential hazard to human health.

The Nuclear Waste indicator is only looking at the mass of high and intermediate level radioactive waste and spent fuel which are all caused by the nuclear power industry, from spent fuel rods and the decommissioning of nuclear power stations. What is at issue is the difficulty of storing these wastes for the extremely long periods necessary for the radioactivity to decay to acceptable levels (1000 years+), whilst maintaining their security and ensuring that no radioactivity is released into the environment. It is therefore not relevant to review the different types of radioactivity released by these wastes or other sources.

- How does OSPAR fit into this? http://www.ospar.org/eng/html/welcome.html

OSPAR is an international treaty to limits release of radioactive material into maritime waters. It is intended to ban any emission which increases levels after 2020. The high and intermediate level wastes covered by the Nuclear Waste issue are currently kept securely in temporary storage whilst a final storage location is found. No country has yet identified such a location for their nuclear waste. At present, there is very little risk that any releases to maritime waters can be made by these wastes because of their current location.

- Are BRE looking at routine discharges or solely waste?

The indicator only covers high and intermediate level waste, not radioactive discharges from any source.

With the exception of renaming this category Nuclear Waste, BRE do not intend to amend this category.

12. Minerals Extraction

BRE have provided the feedback received on the Abiotic Resource Depletion Category below. As a result of this feedback, and comments on the Minerals Extraction Category, they have decided to adopt a new approach for resource use. This is described in detail at the end of this document.

- **BRE intends to add four categories, which include solid waste disposal, radioactivity, minerals extraction and water extraction. Considering the characteristics of building, this choice is excellent. Especially the categories of minerals extraction and solid waste have often shown to be significant impact categories of building.**
- **I support the consideration of minerals extraction**.
- **I can agree with the inclusion of minerals extraction.**
- Agree. We agree with the idea of trying to capture the impacts of mineral extraction, including aggregates that are not covered in the abiotic resource depletion impact.

- The approach taken in Briefing note 3a to outline the environmental impacts of mineral extraction is overly simplistic and likely to generate conclusions which are both unreasonable and inaccurate.

- With specific reference to aggregates extraction and supply, which comprises the largest volume of the UK minerals industry, the Briefing sets out a very superficial assessment of environmental impacts associated with the industry.

- We feel that it is unfair to include some minerals in both mineral extraction and abiotic depletion categories, so it would be better if abiotic resource depletion was not used altogether. This would avoid any suggestion of double counting for some materials but not for others.

BRE recognise that if the minerals extraction category is used to represent resource use, then there is an element of double counting with the depletion of resource represented by the abiotic depletion category. They have taken this into account in their new approach for resource use described at the end of this document.

- An important aspect that needs to be considered is the environmental impact when mining on a large scale in remote areas compared to mining on a small scale but at may different locations in populated areas. One could argue that the environmental impacts per tonne are different.
- In practical terms, the use of physical measures of output is a very poor proxy for environmental impacts. The existence of such impacts, if significant, will clearly vary from site to site. The potential for such variations depends upon issues such as the type of quarry (sand and gravel, limestone, hard rock) and the local population density. What is the relevance of such issues to the supply of marine dredged aggregates, for example?
- Also, what is the proxy for the additional environmental impacts of extraction and how is it calculated?

BRE recognise that different quarries and mines will have very different implications in terms of their environmental impacts and resource use. They have taken this into account in their new approach for resource use described at the end of this document.

- Noise and dust would be covered under an EIA and if a site was in operation before EIAs became a requirement the impacts of dust and noise are covered by the Environment Agency – quarries have to screen conveyor belts, put wheel-washers in and only drop a certain amount of material at a time, for example, depending on how close the quarry is to the community it effects.
- The Briefing Note surprisingly makes no reference to key policy guidance on the issue recently published by the Office of the Deputy Prime minister – Minerals Policy Statement 2: Controlling and Mitigating the Environmental Effects of Minerals Extraction in England. The introduction to this guidance states:

  > *"Since minerals can only be worked where they are found, and this may be in environmentally sensitive or designated landscape areas and / or in close proximity to communities, the need to keep these impacts to an acceptable minimum in the planning and operating of extraction sites is a high priority. Where adverse environmental impacts cannot be adequately controlled or mitigated through the design of proposals of the attachment of conditions, planning permission should be refused".*

  In other words, potential impacts such as dust and noise have to be addressed by the planning and operating conditions attached to the site. If such mitigation is not possible, the quarry will not receive planning permission. The operation of the mineral planning system is a significant element of the very strict regulatory regime within which the industry operates. If the BRE intends to use aggregates output as a proxy for noise and dust, it should demonstrate and validate that these impacts actually comprise significant environmental impacts. If such evidence is not available , then the case for the introduction of the impact category – measured by such a simplistic and inaccurate proxy – is not substantiated.

- Research commissioned by Government into the Environmental Costs of Aggregates Extraction, prior to the introduction of the levy, surveyed the extent to which local residents regarded various quarrying impacts as environmental costs. Of the 5000 residents surveyed, the proportions identifying noise, dust and "adverse effect on nature" (proxy for biodiversity impact ?) as environmental costs comprised only 1.3%, 1.3% and 2.8% respectively of the survey sample. The same research calculated that the environmental costs of sites producing aggregates from recycled materials were significantly higher than the environmental costs of aggregates quarries.

The argument that an impact should not be included within life cycle assessment because it is covered by legislation is not valid. Regulators have a remit to ensure that industry operates to good environmental standards but do not have responsibility to reduce emissions to a level which ensures no environmental damage. An industry could be operating legally yet still be responsible for considerable impacts. As above, the full environmental impact of any material should be provided and used to assess it and other alternatives for the given function, allowing users to determine whether the need to use the material warrants incurring the environmental impact associated with it.

However, BRE recognise that the amount of dust and noise generated by mining and quarrying can vary between quarries, and that its impact will depend on the proximity and attitude of the local population.

BRE also recognise that other industries, and in particular the demolition and recycling industry, can be responsible for similar or greater levels of dust and noise as quarrying, and often in more densely populated areas.

BRE have taken these concerns into account in their new approach for resource use described at the end of this document

- **I think that dust emissions should be considered directly when modelling the mines.**
- Also bear in mind that the environmental impacts associated with iron ore mining are already included in LCI data. The BRE should not try to directly relate dust emissions to tonnes of mineral extracted by the use of factors for example, otherwise this would be double accounting.

Emissions of dust and particulates are included within many mining and quarrying models although many quarries are unable to quantify their emissions of these substances. Even where included within models however, no existing impact category currently covers these emissions in terms of providing an impact – ie they do not cause toxicity or any other impact included within the methodology. BRE hoped to be able to use minerals extraction as a proxy for the annoyance caused by these emissions, but have taken the concerns over the fairness of this approach into account in developing their new approach for resource use described at the end of this document.

- **The justification for considering the minerals extraction is clearly explained and points out the essential impacts of building. Building and its use of minerals materials is much responsible for the biodiversity effects in European countries.**
- **Loss of biodiversity can be considered via land use quantification.**
- You speak of biodiversity losses but even the custodian of ecology, English Nature, does not know whether or not there has been a net loss of biodiversity through mineral extraction. No quantitative study has been undertaken, therefore to assume a loss and count this in the impacts is an assumption too far.
- A new quarry requires an EIA and most quarries have ongoing regeneration and reclamation work during operation. This is seen by many as a borrowing of the land, at the end of which it is returned to either its former glory or enhanced. Biodiversity is often enhanced which is why over 700 former quarries have been given SSSI status. They often also give us an insight into the geology of an area and if they are in a RIGG or SSSI are

managed accordingly. How are these factors to be measured in the methodology? Also the value of the material, the enhanced value of the landscape at the end of extraction, the often much needed employment that they bring to the area and as the document mentions, the revenue that goes to Government and back to the communities effected by quarrying via the aggregate levy?

- The question of biodiversity impacts is unclear. The regulatory system within which the industry operates is specifically intended to avoid such impacts, and there are a range of other corporate and industry initiatives aimed at enhancing biodiversity, for example the Quarry Products Association / English Nature Memorandum of Understanding. Has the BRE any evidence that aggregates/mineral extraction has a negative net impact on biodiversity ? Approximately 700 SSSIs have their origins in mineral extraction, and quarries operate with restoration and aftercare conditions which will often result in beneficial net biodiversity impacts compared with the original pre-quarry land use. The case for basing a minerals extraction impact category upon an assumption that mineral extraction causes net damage to biodiversity needs to be demonstrated with hard evidence by BRE, if that case is to stand up.

BRE agree that within the UK, there is evidence that the quarrying industry has embraced restoration of quarrying sites and that many of our SSSIs are located in old quarries. This is not the case globally, and there is considerable concern at the implications of large scale extraction of minerals in the developing world. The impacts on biodiversity when quarrying is initiated may not be so beneficial, and many quarries can operate for very long periods of time before restoration is commenced.

BRE also recognise that other industries may be responsible for impacts on biodiversity.

BRE hoped to be able to use minerals extraction as a proxy for the disruption to biodiversity caused by mining and quarrying, but have taken the concerns over the fairness of this approach into account in developing their new approach for resource use described at the end of this document

- Why is overburden included in the impact evaluation of mineral extraction. Almost without exception, overburden is replaced during the restoration phase of a site. The strict rules of soil handling see to this.

Mining and quarrying can produce overburden (the material lying over the mineral to be extracted, interburden (the material lying between mineral to be extracted, spoil (material extracted at the same time as the mineral to be extracted), tailings (waste material following processing of the extracted mineral), mineral material which is not of a suitable quality for sale and mineral material which as a result of processing is not suitable for sale (eg small chips of marble or slate). BRE believe that the impact of mining or quarrying is not dependent on the amount of final product extracted but on the amount of overall material extracted including all the materials mentioned above. BRE accept that this material can be returned to the mine or quarry as part of restoration, but this often occurs at some considerable time in the future, or is not possible because the waste occupies a greater volume than the overall extraction.

- The minerals extraction category is particular inappropriate with regard to the quarrying of limestone for cement production, since cement is a material that cannot be replaced, and should not be subject to Green Guide penalties largely aimed at encouraging the use of recycled aggregates. Evidence to support this can be found in a report entitled Cement Raw Materials (March 2004) published by the British Geological Survey which states that both concrete and cement are vital, and essentially irreplaceable construction materials for the building and civil engineering industries.

The argument that because a material is essential, its impacts should be ignored is not valid. The full environmental impact of any material should be provided and used to assess it and other alternatives for the given function, allowing users to determine whether the need to use the material warrants incurring the environmental impact associated with it.

- Quarrying is already tightly regulated by the Mineral Planning Authorities, and all mineral extraction must comply with a range of legislation including the Mine Waste Directive, and the EU Soils Framework Directive. It is therefore inappropriate to include a new Impact Category for mineral extraction.
- If this Impact category is included, to what extent will it take account of the legislation and planning authority requirements relating to dust and noise and landscape restoration?
- The Briefing note uses the government decision to introduce an aggregates levy as supporting "evidence" that there are environmental impacts which justify the introduction of this impact category. This "evidence" requires further consideration, for example:
    - In successive Pre Budget Reports and Budgets, Government has produced no evidence to validate claims of adverse net environmental impacts from aggregates extraction.
    - Research commissioned by Government into the Environmental Costs of Aggregates Extraction, prior to the introduction of the levy, surveyed the extent to which local residents regarded various quarrying impacts as environmental costs. Of the 5000 residents surveyed, the proportions identifying noise, dust and "adverse effect on nature" (proxy for biodiversity impact ?) as environmental costs comprised only 1.3%, 1.3% and 2.8% respectively of the survey sample.
    - The same research calculated that the environmental costs of sites producing aggregates from recycled materials were significantly higher than the environmental costs of aggregates quarries.
- In conclusion, the rationale set out in the Briefing note to justify the introduction of a minerals extraction impact category, based upon tonnes extracted, is not robust enough to justify this introduction. There appears little evidence from the aggregates sector to support the underlying assumption that there are significant negative environmental impacts associated with noise, dust and biodiversity to justify the additional impact category. We would of course welcome the opportunity to discuss these issues with the BRE.

The argument that an impact should not be included within life cycle assessment because it is covered by legislation is not valid. Regulators have a remit to ensure that industry operates to good environmental standards but do not have responsibility to reduce emissions to a level which ensures no environmental damage. An industry could be operating legally yet still be responsible for considerable impacts. As above, the full environmental impact of any material should be provided and used to assess it and other alternatives for the given function, allowing users to determine whether the need to use the material warrants incurring the environmental impact associated with it.

- What about the loss of soil in forestry, the loss of minerals from soil due to forestry and the reduction in the buffering capacity of the soils – are these covered under mineral extraction? How does the methodology account for the impact that a logging road can have on biodiversity (4v area = number of species present in area), or how changes to the shape of a woodland due to forestry can and does impact on population dynamics and biodiversity? Much forestry in this country and others still consists of single species cultivation offering limited biodiversity, how is the homogenisation of the environment captured?

The issue of biodiversity is not well addressed by LCA – it is hard to generate meaningful measures that can be accrued over a lifetime. Calculating useful normalisation data and attributing importance is equally difficult. For forestry, the issue is probably best addressed by sustainable forest certification schemes, which are incorporated into EcoHomes and BREEAM.

- Does the methodology cover the impacts of material extraction from countries other than the UK and impacts such as acid mine drainage?

- Will the impact be material / country / source - specific, or will there be some grouping of materials / countries / sources?

The methodology traces upstream impacts (the impacts associated with the sourcing of raw materials) and includes them wherever they occur. Where possible, BRE try to source material/country/source specific data – however sometimes it may only be possible to find a single source of LCA data – BRE then consider whether it is possible to adapt the data, or find another source for particularly relevant parts of the data set or whether the data needs to be adjusted (see the Data Briefing Note at www.bre.co.uk/greenguide/update).

As a result of the feedback on this category and the abiotic depletion category, BRE have proposed a new resource extraction category which is described at the end of this document.

13. Water Extraction.

- **I support the consideration of water extraction.**
- **I can agree with the inclusion of water extraction.**
- **Water extraction is not included in the impact categories given in ISO/DIS 21930. It should however be included in the use of resources list under LC Inventory results.**
-
- Water extraction is already tightly regulated by legislation such as the Water Framework Directive, the Water Act, CAMS/River basin planning etc. Consequently, is it appropriate to include this Impact Category?
- The Environment Agency works with water authorities and is involved in the issuing of licenses for Private Water Abstraction for example from a borehole. This licensing is done not only to help maintain biodiversity and support surface features but also to ensure continuous supply for abstraction by water companies and to minimise risk to aquifers in respect of water quality and threat to saline intrusion in coastal areas. These abstractions are monitored and regularly assessed (do water companies still work to a five year AMP?) and action taken if limits are broken. Our point is if the activity was not sustainable the water authorities and Environment Agency would not allow the abstraction in the first place. Why include it in the methodology?

The argument that an impact should not be included within life cycle assessment because it is covered by legislation is not valid. Regulators have a remit to ensure that industry operates to good environmental standards but do not have responsibility to reduce reduce resource use to a level which ensures no environmental damage. An industry could be operating legally yet still be responsible for considerable impacts. If the above comment was correct then there would be no need for hosepipe bans. As above, the full environmental impact of any material should be provided and used to assess it and other alternatives for the given function, allowing users to determine whether the need to use the material warrants incurring the environmental impact associated with it.

- It makes good sense to use non-potable water where potable water is not required, to not only protect and maintain the resource, but for economic reasons also – it costs a lot of money to treat and deliver the portable water required for domestic and industrial use.

The methodology will only attribute the impacts of water treatment to the use of mains water. Where sites are treating water themselves these impacts should be included within the LCI for the site.

- **With regard to water extraction, the collection of rainwater for storage on site can affect groundwater recharge and even surface flows, depending on the volumes collected. What is the fundamental difference between intercepting and storing a**

given volume of rainwater for subsequent use and extracting that exact same volume from a surface source after the rain fall. The hydrologic cycle is affected either way.

BRE believe it is unlikely that so much rainwater would be intercepted as to affect the hydrological cycle, especially as most rainwater collection systems operate in place of allowing water to run-off to drainage/sewer systems which would have a similar affect on the hydrological cycle.

- For water that is extracted from a source and used onsite, and then re-used or recycled for the same and/or another purpose, is this going to be captured by a mass balance calculation?

Only the initial water extraction would have an impact, where water is recycled or reused on site this does not have an impact within the water extraction category. Mass balance calculations are undertaken however to ensure that all inputs and outputs to the system have been considered.

- Sea water: an impact here in terms of energy required, e.g. to desalinate?

Where sea water is desalinated, then the impacts of desalination should be included within the Environmental Profile.

- **The water extraction discussion implicitly assumes a neutrality when water is extracted for cooling or power generation compared to water extracted and used within a plant for cleaning, quenching, etc. (e.g., in a steel mill). However, that water can also be returned to the same source, sometimes in better condition than when it was extracted, depending on the treatment facilities in the plant.**

If water is returned to a source in a better condition than when extracted, then BRE would consider this as a "negative emission" to be included, along with the impacts of treatment, within the system boundary of the Environmental Profile. For example, if water input had a concentration of Phosphate of 2 mg/m^3 when extracted and 1 mg/m^3 when returned, then the process would have an emission of -1 mg/m^3 calculated on the return volume of water allocated to the process, and the water treatment process itself (eg energy use etc) would need to be included within the system boundary.

- **Together with the information on how much water is required, one needs to know whether or not this water is used in areas with only little water available. Hence, I suggest to group the water use according to a few categories.**

BRE recognise that the amount of water varies from region to region but it is not possible to reflect this level of complexity within Life Cycle Assessment.

- **What is "top-up water from other sources"?**

Where water is recycled within a process, this refers to any additional water used to make up for losses from evaporation, wastage etc.

- How does the methodology examine the impact of forestry on groundwater and surface water?
- How does the methodology account for the important hydrological role that a forest, woodland or stand of trees has as a buffer in a rainfall event or in creating 'dead' zones and the back water effects on a floodplain, to lower and slow the peak hydrograph and dampen a catchments response to a rainfall event or the impact of a forest on the water table?

This impact category assesses resource use. Forestry can also have beneficial impacts on water sources.

As a result of the consultation, BRE do not intend to make any changes to this impact category.

Missing Impacts

- As I understand it, there are impacts do not fit into the 12 categories, for example:
  - Habitat loss through land used for processes such as mineral extraction or timber production.
  - Ecosystem damage caused by the production of materials such as timber, monoculture plant material for fabrics, GM crops, etc.
  - Human injury/death because of occupational (e.g. mining) or public exposure (e.g. road deaths caused by transport).
  - Impact of non routine nuclear event because of accident/terrorism.
  - etc, etc

  I realise that some of these impacts are controlled by regulation, or have other labelling systems, etc, but not all.
- Building also uses biotic resources. It depends on the sustainability of forestry whether this also causes adverse biodiversity effects. According to the briefing note 3a the BRE methodology will ignore the use of biotic resources. This may well be justified, but the methodology should explain the choice.

BRE have investigated the possibility of including some sort of category covering biotic depletion – however they have been unable to find any system which is able to distinguish between, for example, illegally clear felling amazon rainforest and the sourcing of FSC certified temperate softwood, where biodiversity, resource use and other environmental factors are clearly differentiated. BRE believe these issues are probably best addressed by the use of sustainable forest certification schemes. EcoHomes and BREEAM recognise the importance of sustainable forest management and credits are available for using sustainably sourced timber.

- I think my concern is leaving something out because it can't be calculated or compared quantitatively easily isn't always a good idea.

BRE recognise that ignoring an impact is unsatisfactory, but any impact category must be robust, quantifiable and scientifically justified.

- Where does indoor air quality and human health fit? The Green Guide states that it cannot model this yet recognises it as an issue. It is not captured in EcoHomes either, even though there is a section for Health and Wellbeing, How can this be amended?
- Timber would not be infestation, fire and rot resistant if it was not treated and would hence have no chance of lasting the 60 years of the LCA. Research shows that there are concerns re the impact of these preservatives on indoor air quality and human health, so why is it not covered in the methodology?
- Why is IAQ excluded? How is it excluded, or rather what is included – only emissions externally? Note the Finnish IAQ rating scheme [www.rts.fi/emission_classification_of_building_materials.htm], which has handled this issue pretty well [see also www.emicode.com]. This is an issue of great importance to specifiers and building users, especially given the shift towards sealed buildings in the UK via the Building Regulations (which also explicitly address IA emissions from cavity insulation).

Indoor air quality is an issue recognised by the draft ISO standard for EPDs for construction products as an important area where information should be provided. However it states that information should be provided using the relevant national guidelines and calculation methods – currently no such standards exist in the UK or for Europe overall. Some BREEAM schemes do include credits which deal with this issue peripherally, ie in terms of providing adequate ventilation and BREEAM Schools has a credit for review of finishes and fittings in terms of VOC emissions. We have forwarded the details of the Finnish scheme to the BREEAM team who would be keen to include more on this issue in future developments of the scheme.

New Resource Use Categories

As a result of the consultation, BRE have decided to omit the Abiotic Depletion and Mineral Extraction categories, as explained above. In their place, they intend to include two new categories, Fossil Fuel Depletion and Mineral Resource Depletion.

Fossil Fuel Depletion

Fossil fuels provide a valuable source of energy and feedstock for materials such as plastics. Although there are alternatives, these are only able to replace a small proportion of our current use. There are a number of approaches which BRE would use to measure fossil fuel depletion:

- They could use the abiotic depletion potentials used by CML for fossil fuels, but these are measured relative to antimony, which is not an obvious unit to use in measuring fuel and energy use.
- Alternatively, BRE could measure fossil fuel use using the same abiotic depletion methodology, but relative to a reference case of for example natural gas or crude oil.
- Finally, BRE could use an absolute measure based on the energy content of the fossil fuel in the same way as the existing fossil fuel depletion category within the current Environmental Profiles Methodology. This would not take into account the relative scarcity of the different fossil fuels, but in fact these only vary by 17% between coal (the most common) and gas (the most scarce).

In view of the small difference in scarcity between the different fossil fuels, BRE suggest using the third approach, the energy content of the fuels, using tonnes of oil equivalent as the unit.

Mineral Resource Depletion

This impact category is related to the consumption of all virgin mineral material, eg the extraction of aggregates, metal ores and minerals. The consumption of such substances can mean that the natural carrying capacity of the earth is exceeded and can make them unavailable for use by future generations. This indicator is intended to relate purely to resource use, with no coverage of other environmental impacts which might be associated with mining or quarrying, or the relative scarcity of resources.

The indicator would be based on the Total Material Requirement (TMR) indicators used by the European Union and developed by the Wuppertal Institute, based on earlier work for the World Resources Institute. However the indicators covering fossil fuel, biomass (mainly agricultural product) and soil erosion (only covered for agriculture, not forestry) would not be included. Further details can be obtained in the Eurostat working papers which can be downloaded from http://epp.eurostat.cec.eu.int/portal/page?_pageid=1073,46587259&_dad=portal&_schema=PORTAL&p_product_code=KS-AO-01-002.

The indicator calculates the total resource use associated with any use of any non-energy, abiotic materials within the EU, wherever the resource use occurs. For example, for steel use, it traces back to tonnes of iron ore extraction wherever this occurs. The TMR indicator includes material that is extracted as a result of economic activities, but not used as input for production or consumption activities, for example mining overburden. Excavated and dredged material is also included. For normalisation purposes the Eurostat data provides relevant figures covering imports of materials as well as resource use within Europe.

Consultees who provided comment: (* = Methodology Peer Reviewer)

Rolf Frischknecht, ESU-services, Switzerland*
W. B. Trusty, Athena Sustainable Materials Institute*

John Bowdidge, representing Construction Products Association*
Tarja Häkkinen, VTT Building and Transport, Finland *
Andrew Frost & Tom De Saulles, The Concrete Centre / British Cement Association
Dr C Perkins, Senior Scientist, Arup Materials Consulting
Dr Mark Barrett, Director, Sustainable Environment Consultants (SENCO)
John Gelder, NBS
Nick Avery, Corus Research Development and Technology
Jerry McLaughlin, Director, Economics and Public Affairs, Quarry Products Association
Simon van der Byl, Director General, QPA
Miles Watkins, Aggregate Industries
Chris McFarlane, Forbo Flooring
Ieuan Compton, Kingspan

Process regarding BRE response to Stakeholders feedback on briefing notes
The following process will be adopted for the communication of BRE's position on stakeholders feedback to this briefing note:

- Feedback from all respondents has been collated by BRE and a response prepared. This document is BRE's position on the points raised, including a justification and rationale for the position taken.
- Any disagreement should in the first instance be immediately tabled to BRE, by response to this mail and by 15 September 2005.
- BRE will then consult with the relevant parties to try to seek resolution.
- If there is still a disagreement on BRE's position, the issue will be tabled to the Project Steering Group (PSG), either via email, or at the next meeting (which ever is soonest) to seek resolution.
- If resolution cannot be achieved, any member of the PSG can take the issue further by tabling the issue (with BRE support) to the Sustainable Construction Board, an independent committee of industry representatives who will make the final decision (see PSG Terms of Reference for governance structure).

Please direct all further responses to:-

greenguide@bre.co.uk

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BRE, Garston, Watford, WD25 9XX

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