HOW DO YOU IDENTIFY THE BEST PRACTICABLE ENVIRONMENTAL OPTION FOR CONSTRUCTION AND DEMOLITION WASTE?

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ABSTRACT

It has recently been estimated that 72 million tonnes of Construction and Demolition (C&D) waste arose in 1999 in England and Wales accounting for approximately 20% of total waste arisings. Of this 35% is estimated to be recycled. Improving the efficiency of the construction and demolition industry is a key objective for the UK Government, with the publication of a strategy for more sustainable construction. Much of the current attention is focused on waste arisings through the construction and demolition processes, with little focus on deconstruction and materials reuse.

The Best Practicable Environmental Option (BPEO) is a tool advocated by the UK Government for making waste management decisions emphasising that the waste hierarchy of reduce, reuse, recycle, recovery and finally disposal cannot be applied without taking into consideration, environmental, economic and social impacts. This paper concentrates on a theoretical BPEO model that has been developed for C&D waste. Data has been obtained on waste arisings and causes from BRE's waste auditing software, for a range of construction and demolition projects including housing, offices, retail, restaurants and the leisure sector. This data, when combined with other relevant data and surveys forms the baseline scenarios for determining the BPEO for the C&D waste stream. The evaluation of potential waste management routes for the identified 10 key C&D waste groups (concrete, inert, packaging, timber, ceramics, plastics, plaster and cement, metals, insulation and miscellaneous) is currently being undertaken. Life Cycle Assessment will be a key tool in identifying the impacts and a number of criteria including the ability to provide on-site solutions, improve resource recovery, reduce environmental and social impacts, improve productivity and reduce costs will be used.

KEYWORDS: Construction and Demolition Waste; Best Practicable Environmental Option; Waste Management Options; Criteria; Decision making tool

INTRODUCTION

Waste management in the UK is undergoing a period of rapid transition with a large number of EU and UK legislative drivers (e.g. The Landfill Directive, Packaging Legislation and the Landfill Tax) aimed at producers of waste. The construction, demolition and refurbishment industries will have to play an important part in increasing their resource efficiency, reducing environmental impacts and meeting legislative targets. In order for the construction and demolition industries to improve their current waste management practices, the Government has funded a study to provide clear, authoritative guidance on construction, demolition and refurbishment waste management to determine the Best Practicable Environmental Option (BPEO). This is to be achieved by:

1. Researching current waste types, amounts and waste disposal routes.

2. Analysing potential waste management routes.
3. Identifying, and where possible quantifying, impacts relating to cost, legislation, global and local environment.
4. Providing the tools and guidance to help waste producers to identify their BPEO.

The BPEO will be undertaken by identifying and analysing factors for the management of these wastes. Key variables include the environmental impact, cost, compliance and technical viability arising from the different types of waste management methods identified. These variables and other key factors will be modelled and used as a basis for testing waste management scenarios in order to identify the BPEO. By providing a decision making tool for the key players based on environmental, economic and implementation factors it is anticipated that this will reduce overall resource consumption and associated environmental impacts, increase productivity and reduce costs.

CONSTRUCTION & DEMOLITION WASTE IN THE UK

The construction industry is one of the largest industrial sectors in the UK. It employs 1.5 million people in 180,000 companies with a turnover accounting for about 10% of Gross Domestic Product (GDP). The sector is characterised by approximately 25 major companies (forming the Major Contractors Group), 200 medium sized companies and a large number of small companies. Many of these are linked in larger construction projects as contractors and specialist sub-contractors. For a building that stands for 50 years or more, the impact of C&D waste over its lifetime can be assessed by adding together three factors:

1) the C&D waste generated during initial construction
2) the C&D waste generated by subsequent renovations, and
3) the C&D waste from final demolition.

Although C&D waste and its environmental impacts at the end of a building's life may be substantial, over the building's lifetime they account for a relatively small portion of total costs and impacts. For this reason, it can often be difficult to obtain a strong commitment from developers to prevent C&D waste and the end-of-life consequences of demolition.

A total of 424 million tonnes of waste was produced in the UK in 2000 (1). C&D waste is 17% of the total amount of waste generated the third largest waste stream after the mining and quarrying and agriculture waste streams. C&D waste is the largest proportion of controlled waste at 33%.

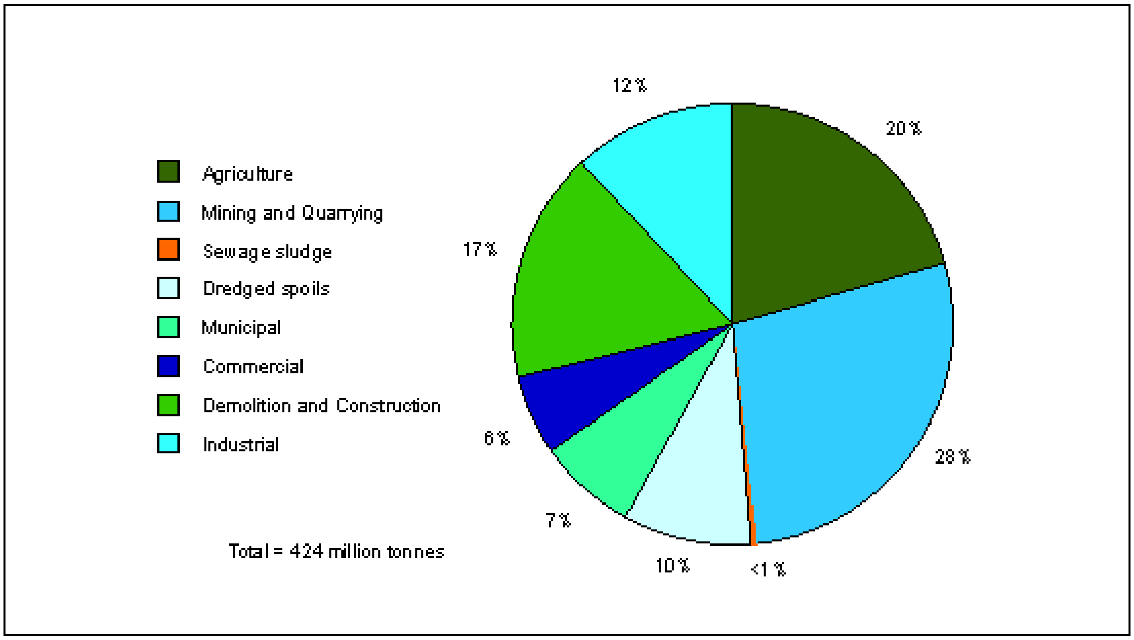

Figure 1: UK Waste Generation by Sector

The exact nature and amount of C&D waste arisings in the UK is largely unknown. The Environment Agency (EA), supported by the then Department of Environment, Transport and Regions (DETR) and the National Assembly of Wales commissioned the Symonds Group to undertake a major survey to provide consistent figures of the amounts of C&D waste produced, recycled and disposed of (2). One of the key criticisms been levelled at the Government and industry in recent years is the lack of accurate waste arisings data. Without the data it is hard for the waste industry to plan future requirements for waste management, or for the construction industry to improve its performance.

Symonds estimated that the production of C&D waste and excavated soils in England and Wales in 1999 is 72.5 million tonnes (69.2 million tonnes in England) which excludes road planings and materials reused onsite (range of +/- 35% at 95% confidence level). The survey did not cover wood, plastics or architectural salvage and reclamation, which account for the majority of waste from the construction process, excluding core C&D waste.

This 72.5 million tonnes comprises of:

- 33.8 million tonnes (46%) of C&D waste (mainly hard demolition waste such as concrete and bricks)
- 23.7 million tonnes (33%) of soil (mainly from excavation)
- 15 million tonnes (21%) of mixed C&D waste, soil, minor amounts of inert

Future surveys of C&D waste other than 'core' materials need to be undertaken. It is essential to understand where and what composition the C&D waste is. Surveys on the actual waste arising from construction sites need to be incorporated into the national surveys as well as C&D waste from other sectors such as industrial, commercial and municipal.

Demolition waste is thought to be approximately 30 million tonnes per year and is taken to include waste from the demolition of structures and parts of structures and include recycled/reclaimed materials where appropriate. However, there is much variation between estimates of how much waste is generated, most reports use figures from previous work, which are often based on estimation or informed guesswork. Of the 72.5 million tonnes of C&D waste identified:

- 25.1 million tonnes (35%) (24.4 million tonnes in England) were recycled (by screening and/or crushing);
- 9.5 million tonnes (13%) (9.1 million tonnes in England) were re-used on licensed landfills for site engineering (including daily cover) and restoration;
- 20.3 million tonnes (28%) (19.0 million tonnes in England) were spread on sites registered as exempt from waste management licensing under specific exemptions and
- 17.5 million tonnes (24%) (16.7 million tonnes in England) were disposed of to landfill.

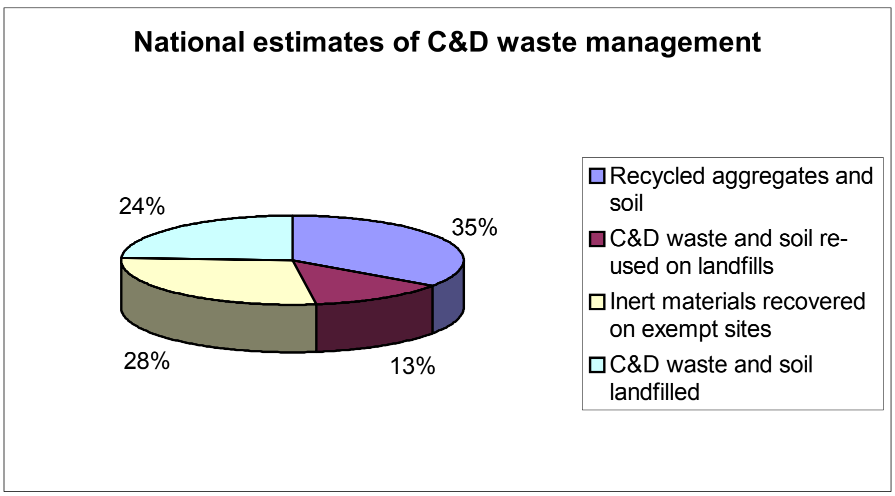

Figure 2: National estimates of C&D waste management

Inert and C&D waste has been traditionally disposed to landfill, often sites specifically licensed for this waste stream. However, it is worth noting that inert waste is often referred to as 'core' C&D waste that only includes concrete, bricks and blocks, but excludes clays, soils, asphalt and 'other materials'. The introduction of the landfill tax has resulted in an increasing proportion of inert C&D waste going to sites exempt from licensing or it is being treated in screening and crushing plants prior to re-use or as an aggregate or fill. The changes in waste management practices have led to some difficulty in quantifying the amount of C&D waste produced.

SMARTWaste^{TM}

SMARTWaste^{TM} is a waste-auditing tool designed by BRE for C&D waste, and has been in operation for 2 years on construction, demolition, refurbishment and manufacturing sites. The following product groups for waste have been derived as:

- Timber
- Concrete
- Inert
- Ceramic
- Insulation
- Plastic
- Packaging
- Metal
- Plaster and Cement
- Miscellaneous
- Furniture
- Electrical equipment

These 12 waste groups form the basis of the BPEO model. These are similar to other waste classification systems as they are based on material groups. Within these material groups are individual products. Material groups help identify the recycling potential and products within those groups. These enables waste management strategies on sites to be more effective as actual product wastes can be addressed. They were also introduced for ease of use on a construction site as the European Waste Classification System can be problematic to use on a site level.

From the SMARTWaste^{TM} tool it can be seen that packaging at 25.9% represents the greatest amount of waste from construction sites followed by timber at 12.3% and plaster and cement at 11.5% and miscellaneous (office, canteen waste etc) at 9.6%. When packaging timber is included in the timber figure it is increased to 26%. Plastic stands at 3% but if plastic packaging is included these rises to 8%. This is based on a limited number of case studies of different sizes and types but the data is believed to be the most accurate and reliable data available for construction and demolition sites. Further implementation of SMARTWaste^{TM} on various sites is expected to provide a more accurate picture.

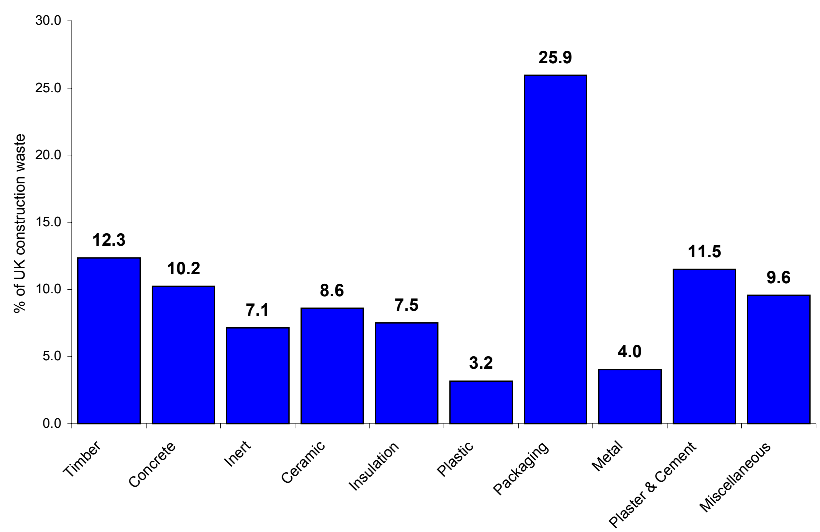

Figure 3: Composition of on site construction waste by SMARTWaste^{TM} data

BEST PRACTICABLE ENVIRONMENTAL OPTION

In order to develop Best Practicable Environmental Option (BPEO) guidance it is necessary to address the waste management activities involved and gain an appreciation of the range of waste streams and the processes generating these wastes. The England and Wales Waste Strategy emphasises that it is unlikely that one approach will represent the BPEO for all elements of the waste stream. C&D waste is a complex mixture of different materials, in differing proportions originating in differing locations. BPEO is defined in the 12th Report of the Royal Commission on Environmental Pollution as:

'the outcome of a systematic and consultative decision-making procedure which emphasises the protection and conversation of the environment across land, air and water. The BPEO procedure establishes, for a given set of objectives, the option that provides the most benefits or the least damage to the environment as a whole, at acceptable cost, in the long term as well as the short term' (3).

The concept of BPEO means that local environmental, social and economic preferences will be important in any decision. The BPEO may be different for the same type of waste originating from differing locations. Decisions will have to be made with regard to international obligations (e.g. Landfill Directive), national policy framework (such as the Waste Hierarchy) and policy guidance at regional and local levels (e.g. Waste Local Plans). For some waste streams, and in some circumstances, options nearer the bottom of the waste hierarchy may be the best and most practical BPEO. The assessment of BPEO for C&D waste is not straightforward with many factors to consider with an inherent lack of data and is evolving through ongoing research. Within a planning context, guidance advises that the BPEO should be site specific.

PROPOSED BPEO MODEL

For each waste management option the environmental impacts, including transport, need to be identified in broad terms. Legal constraints might rule out some options whilst technical and economic constraints make others less acceptable. An initial scoping matrix identifies those options, which are worth further consideration and more detailed work. After the scoping exercise has been carried out, detailed appraisal of the remaining options will be undertaken. At each stage the reasons for rejection or further consideration of each option will be set out. The outcome of the process might identify more than one option as being appropriate. The overall BPEO for a waste stream is likely to be a mix of different waste management options as different options will be environmentally beneficial and economically affordable

Baseline Information

Baseline information on waste types and characteristics is essential to determine the BPEO. A series of questions will be asked dependant upon the classification of the waste. Therefore the BPEO will be dependent upon the data that is entered regarding the waste in question. For example painted timber waste will most likely have a different BPEO then unpainted timber. The BPEO is dependent upon the initial classification of the timber waste. Examples of questions will include:

- Amount of waste?

- Is the waste clean?
- Is the waste preserved?
- Is the waste mixed?
- Can it be segregated on site?
- What is the waste mixed with?
- Is the waste an off-cut?
- Is the waste treated?
- Is the waste softwood?
- Is it a standard size?
- Is it damaged?
- Does it have any metal fixings?

Criteria

Criteria are an essential part in the BPEO assessment and include:

- Technical: new echnologies, current and future management routes, innovation, specifications
- Environmental: transportation, impacts on water, air, lands, global and local
- Social: health, community, employment, transport
- Legislative: landfill tax, landfill directive, packaging regulations, European waste catalogue, etc
- Economic: markets, supply, financial cost, environmental cost, viability, proximity

Information for these criteria will have to be available for the BPEO assessment. Verification of the information will be undertaken where possible. A key issue is how these criteria will interact with each other and if necessary how the criteria will be weighted. Weighting will only occur if a consensus of opinion can be obtained from the waste processors, users, producers and other interested parties. At this stage, the user of the guidance will weight the decision using cost and environmental impact data.

DATABASES

The databases lie behind the BPEO assessment. Databases have been created for the legislative, technical, economic and social criteria. These are divided into the type of process, which can be generic i.e. 'recycling' or material specific such as the recycling of 'plasterboard', inert etc. Re-use, recycling, recovery (including combustion) and landfill have data attached. Data sources are clearly indicated on the database and these form the basis of the scenarios. Quantitative data has been applied for the economic criteria (e.g. capital cost, gate fee, haulage cost, collection cost, revenue for recyclate, aggregates tax, landfill tax, Packaging Recovery Note etc) and also for environmental criteria based on the waste management options. Various sources have now been identified that provide data for the environmental impacts including global warming potential (CO_2), acidification (SO_X), transportation (NO_X), particulate emission (PM10), dioxins, VOCs/odours, resource displacement, euthrophication (N). These have been established from the WISARD model for municipal solid waste management (MSW) produced by the Environment Agency (EA) (4) and the IWM2 model, also for MSW produced by Procter and Gamble (5). This data is limited in use for the purposes of construction and demolition waste as the waste stream is generally more mixed and organic but is adequate for this study.

There is a separate database for legislative criteria as this criterion is applied at the scoping stage of the BPEO model and not at the assessment level. A waste management route is therefore discounted early on, if it does not meet legislative requirements. There is also a separate database for transportation impacts from transporting the waste by road, rail and water. This is of course dependant upon the type of waste being hauled, aggregates will vary considerably in price compared to packaging for instance. Data is also available for potential casualties from the mode of transport, noise, structural damage, road congestion, fuel consumption (litres/km), cost and employment for road transport. These databases from the basis of each scenario and the scenario data-entry form.

2 questionnaires have been designed, one for construction and demolition waste managers and the other for construction and demolition waste producers. The main reason for this is due to the inherent lack of data for the BPEO assessment levels, including 'threshold' values, e.g. minimum tonnage, cost, maximum distance etc. The questionnaire is being combined with a construction timber waste management and production questionnaire and has been sent out to over 1500 companies. Press releases will also be sent to appropriate magazines and journals. It is anticipated that detailed information for waste producers will be on:

- Distribution of size of companies generating the waste
- Regional variation and distribution of waste producers
- Types of businesses
- Overall volume/cubic metres of C&D waste produced
- Cost of waste disposal
- Percentage composition of waste
- Percentage segregation of waste
- Amount of waste reprocessed
- Percentage composition of types of C&D waste
- Opportunities for increased sustainable waste management
- Barriers for increased sustainable waste management

For waste managers detailed information will be on:

- Distribution of size of companies generating the waste
- Regional variation and distribution of waste producers
- Types of businesses
- Total volume of waste
- Percentage managed by different waste management methods
- Markets for the recyclate and also for reuse
- Percentage composition of types of C&D waste
- Opportunities for increased sustainable waste management
- Barriers for increased sustainable waste management

METHODOLOGY

The BPEO methodology is currently under development. It will be based on scenarios (e.g. urban/rural) developed from case studies in a flow chart basis. The BPEO methodology is summarised in Figure 4.

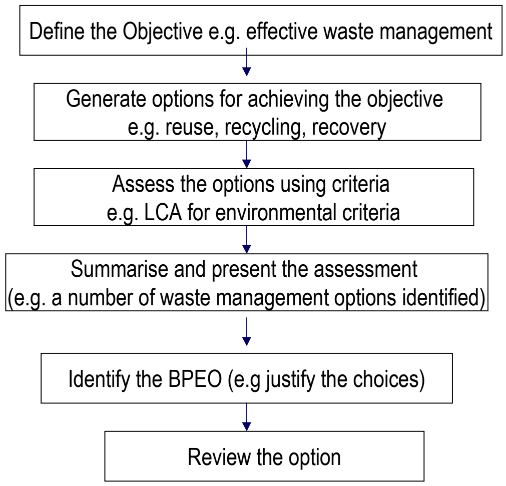

Figure 4 - BPEO methodology

Examples of the BPEO in practice
The following scenarios are being analysed:

Construction: New build	**Deconstruction, demolition and refurbishment**
Housing: timber frame; brick and block	Traditional methods: e.g. by hand, pulling Explosive e.g. charges Newer methods e.g. heating
Offices	Selective demolition e.g. deconstruction
Retail	Refurbishment e.g. internal fit-out
Roads/Civil Engineering	

The 12 SMARTWaste product groups are being tested for each of these scenarios and where applicable the scenario will be presented as rural and urban. It is important to relate the waste product back to the waste production process as this will affect the level of contamination, quality, size, amount etc of the waste product in question. At this stage a number of baseline questions are asked to help the user to distinguish what type of waste they are dealing with and this will then determine the BPEO for their waste. As the data can only be established for waste management options in general terms, the level of questions to determine the characteristics of the waste are limited. The rural and urban scenarios are based on the proximity of waste management facilities. Mixed waste will also be analysed coming off site by analysing component percentages of inert waste. As the waste coming off site is mixed the analysis will take place as the waste transfer station stage. A number of waste transfer stations are providing information on the economic and environmental impacts of their waste management procedures and have been visited as case studies.

It must be emphasised that the BPEO system is still under review. It is anticipated that this will continue to develop as the project advances over the coming year and application of the system to the real world through case studies, site visits and questionnaires. Figure's 5 and 6 provides an example of how the BPEO will be undertaken. All scenarios will go through an initial scoping matrix which will identify which waste management options need analysing in further detail. Options are ranked in terms on environmental impacts and cost in three categories: low significance, medium significance and high significance. Options, which are of high significance in terms of cost and environmental impacts, will be discounted at this stage with reasons attributed to this. As the waste product groups have been matched to the European Waste Catalogue, the scoping matrix will eliminate options that do not meet the legislative criteria. Figure 7 shows the level of information required for each scenario.

BARRIERS

Barriers include a lack of reliable and accurate data for the criteria to enable the BPEO to be identified and a lack of case studies whereby the scenarios for the BPEO can be generated from all relevant waste management sectors. The ownership and uptake of the guidance is key if the BPEO is to make any difference to waste management practices in the future. Translating the BPEO into practice could be difficult if the choices are unsuitable for the producer and the end-user; therefore the BPEO will generate a range of choices to minimise this risk.

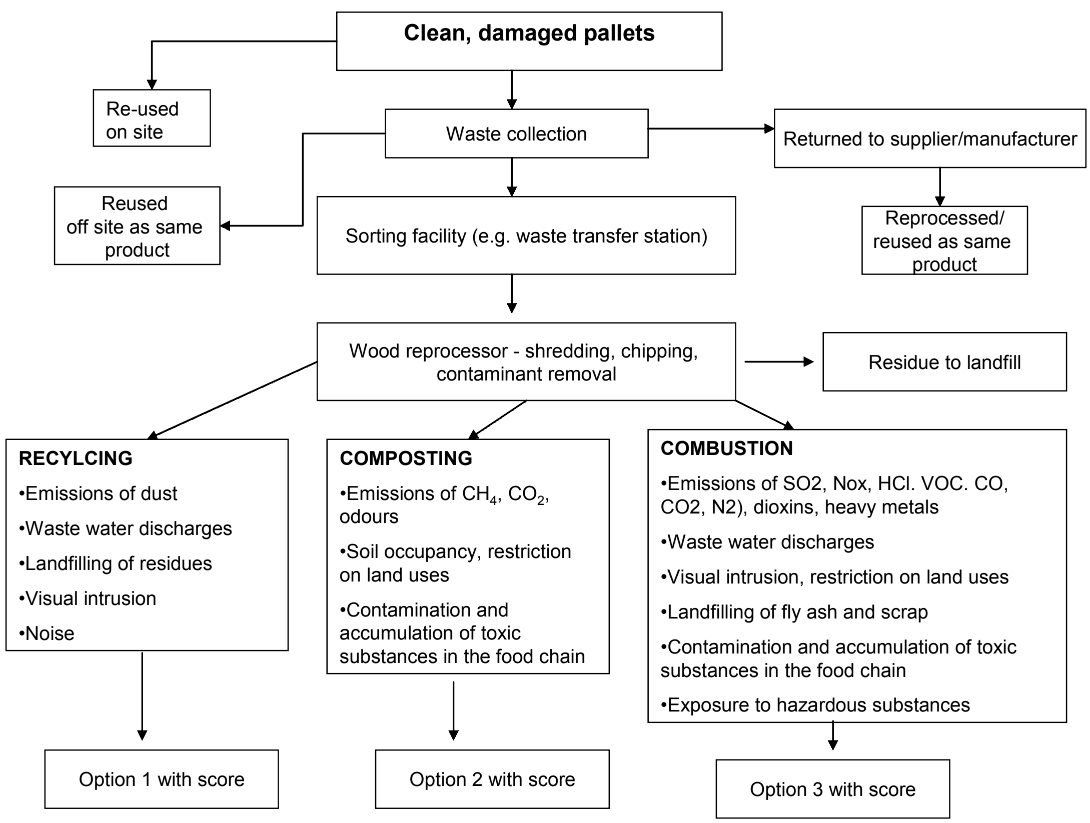

Figure 5: Scenario using the BPEO Methodology

CASE STUDY VI
Activity Area – Demolition (Nationwide)
Company Size: 11 – 49 employees

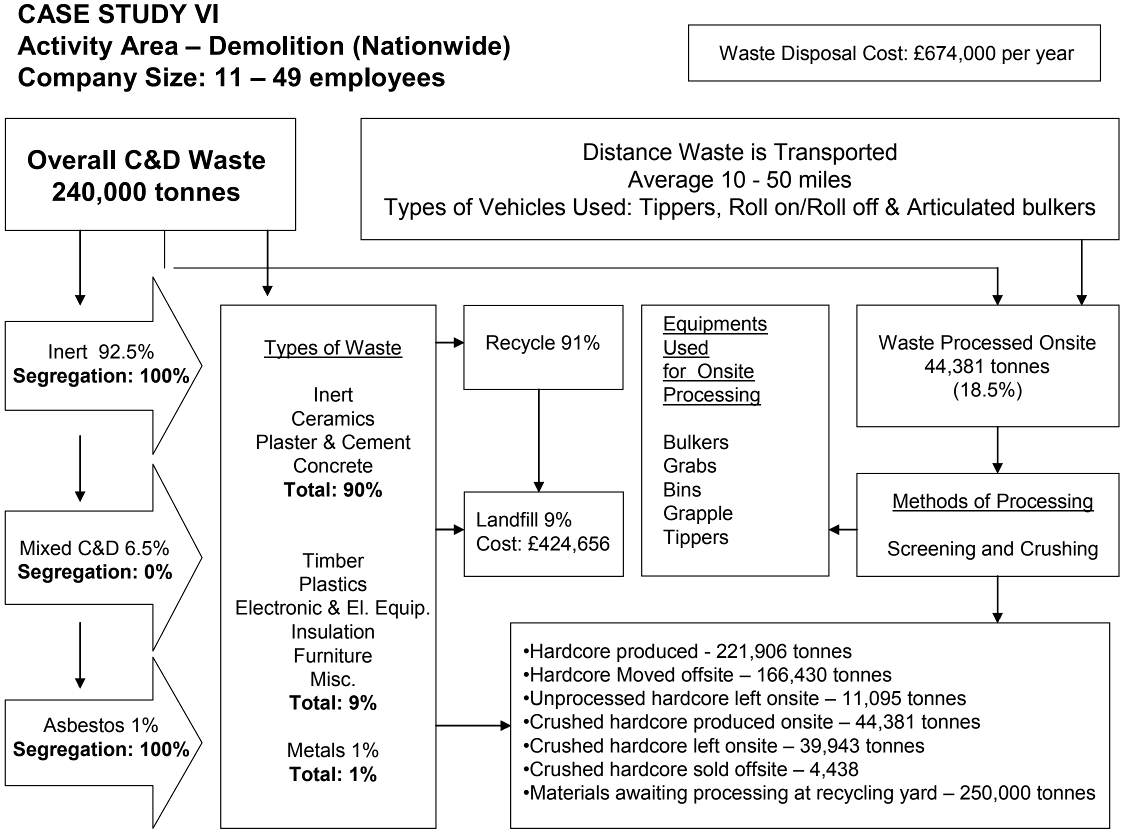

Figure 6: Scenario for a Demolition Company

THE FUTURE

It is anticipated that the BPEO tool will eventually become a web-based application, which will be linked into a Geographical Information System (GIS). This will have spatial datasets on waste facilities, waste producers and other relevant information. This would allow the BPEO to be a location specific tool whereby decisions could be made on the entering of a postcode, still using the same criteria. Other approaches could be effectively combined with the BPEO including cost benefit analysis, multi-criteria analysis and social impact analysis to enhance the tools application.

The project has so far identified a number of policy implications for local, regional and national bodies to consider. Firstly that there is little information actually available with regard to the type, composition, waste management routes and associated impacts for C&D wastes. The main body of information is for the inert fraction, though studies have shown that increasingly non-traditional C&D wastes are becoming more commonplace e.g. packaging, especially with the rise of prefabrication. By undertaking site visits and a questionnaire study, some of the missing data will be obtained but there is a great need for a formalised system to gather data, as to the allow the industry to plan for the high grade recovery of the waste materials.

The main findings emerging that when it is economically viable to re-use, recycle and recover C&D waste, it is already occurring. However, contamination levels are a key barrier to the reprocessing of some types of waste e.g. softwood timber mixed with chipboard. When the volumes produced are low which is apparent for the majority of the construction industry with over 90% being small and medium sized enterprises or the production of the waste is slow then the majority of the waste will be placed into skips, usually mixed ones and only the hardcore fraction will be separated out at waste transfer stations for recovery, usually for low-grade applications e.g. fill, sub-base materials. The barriers include contamination, commercially viable thresholds, financial investment, geographical location, commodity price and the volume of waste. It is therefore becoming increasingly important to identify all construction and demolition waste producers so that high quality C&D waste can be separated earlier on or easier within the process to make better use of these wastes.

BRE Scenario Data Sheet- Inert Waste from Demolition of Housing

				Notes/ Data Source
Description	Specification Details	Name		Name and description
		Description		
	Process	Process		Briefly descibe the waste generation process
		Location		Identify Location
		Location details		Describe the location needs, how much space is needed
BPEO Information				
Baseline Assessment	Type of waste			General information on the raw material used - cullet, colour, flat glass and the generation of the raw material waste
	Quantity of waste			For each process, per year (tonnes)
	Quality of waste			Requirements for quailty and contamination levels of cullet
	Source of waste	Geographical source		Source of glass - local, regional, national
		Transportation impacts		Mode and distance of transportation
Scoping Exercise	Current technology for waste management	Type of technology		Scoping matrix
		Cost		Scoping matrix
		Feasibility		Scoping matrix
		Location		Scoping matrix

Figure 7: Data entry sheet for each scenario produced

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ACKNOWLEDGEMENTS

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