THE GREEN CONSTRUCTION BOARD

REPORT 019

Precast Concrete Resource Efficiency Action Plan

October 2013

A contribution to delivering the targets in the joint government and industry Strategy for Sustainable Construction and the ambitions of the Green Construction Board

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mpa British Precast

Clay Bricks and Clay Blocks: a Resource Efficiency Action Plan

October 2013

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Executive summary

This Resource Efficiency Action Plan (REAP) for the clay bricks and clay blocks sector has been developed to assist the supply chain, which ranges from raw material extraction to the demolition/deconstruction of buildings, in identifying and creating an actionable strategy for improving resource efficiency. The plan identifies the key challenges and actions that the clay bricks sector and its associated supply chain need to address in order to make improvements in resource efficiency.

This REAP addresses a wider range of issues than previous REAPs. It tackles a much wider scope of resource efficiency and covers the main impact indicators of waste, water, carbon (energy usage and emissions), materials (primary raw materials and secondary/recycled materials) and biodiversity. It is in accordance with the current resource efficiency, low carbon and general sustainability themes being promoted by the Green Construction Board (GCB) and Construction 2025 Industry Strategy: government and industry partnership, and the Construction Products Association (CPA).

The plan has been developed in association with two other action plans, Precast Concrete and Ready Mix Concrete, sharing a Joint Project Management Team, and it underpins the approach these related heavyweight construction materials sectors are taking to address sustainability issues and the provision of resource efficient products and solutions to the construction sector in the UK.

It has been put together *by* the supply chain *for* the supply chain, and has benefited from the input from a stakeholder group formed of a wide range of professionals drawn from the clay bricks construction supply chain, including raw material suppliers, clay bricks and clay blocks manufacturers, logistics and packaging suppliers, designers and architects, builders' merchants, house builders and main contractors, and demolition and recycling contractors. In addition to providing the funding for this project, WRAP (Waste and Resources Action Programme) has supplied valuable links with other sectors and other REAPs and its contribution is duly acknowledged.

The UK clay bricks industry produced in the region of 1.5 billion bricks in 2012, consuming more than 4.5 million tonnes of materials from 60 brickworks in the UK, emitting on average 234kg CO_2e/tonne of fired brick in the process. The manufacturing end of the supply chain is well understood and the main resource efficiency impacts are managed by the manufacturers on a day-to-day basis. The benefit of this plan is that it extends the scope of the review of impacts throughout the supply chain, with the aim of setting objectives that will deliver improvements and thus create a more resource efficient clay bricks supply chain.

During the development of this REAP, more than 70 challenges and potential actions were identified by the stakeholder group, encompassing all aspects of the supply chain. These preliminary actions were subsequently reviewed and prioritised, resulting in the 35 'SMART' high priority actions presented here. When put into practice, it is believed that these actions will bring about measurable improvements in resource efficiency, not only when first instigated but continuing over time.

The actions generated provide a range of approaches to addressing continual improvement in the sector. These include the need to transfer knowledge in the form of formal Continual

Professional Development (CPD) programmes, guidance documents and training packages in order to change resource inefficient practices in the production, specification, distribution and use of clay bricks and clay blocks. Other actions relate to technical assessment and, where appropriate, investment in equipment and infrastructure that will deliver resource efficiency improvements.

The basic concept of the action plan is that this report is just the start of a journey towards continual improvement in the sector, resulting in resource efficiency improvements in the manufacture, supply, construction and reuse, or recycling, of clay bricks and clay blocks in the UK, thus contributing to the UK Government's requirements for a low carbon, sustainable construction sector.

Summary of actions

The following is a summary of actions within the report, including information regarding the lead on action delivery and the timescales proposed.

Proposed action	Deliverable action
Manufacturing	
SG1.1 Companies engaged with the extraction and use of brick making raw materials to review current planning conditions and to identify the potential for the use of overburden and inter-burden materials for other applications.	**A1.1a** Development of a resource efficiency impact report, identifying the benefits of use of all extracted materials, based on industry data of current mineral workings. **A1.1b** Engage with the Environment Agency regarding a position statement to determine future potential.
SG1.2 Development of a case for the permission to extract and then stockpile significantly important raw materials for long periods.	**A1.2a** Development of a strategy for engagement. Position paper to be written in support of changes to planning that will allow stockpiling.
SG1.3 Promotion of the benefits of recycled and alternative raw material usage in the overall production process by case studies.	**A1.3a** Preparation of case studies and sharing of best practice. **A1.3b** Liaison with the Environment Agency and local authorities regarding the issues involved in waste management and regulatory compliance.
SG1.4 Data quality has been identified as being the most important action because the amount and quality of data currently provided are variable. The Brick Development Association (BDA) has agreed to encourage its membership to reply to industry surveys completely and in a timely manner. Promotion of best practice for data collection through BDA membership. Gaps in the current resource efficiency data have been identified: • Water usage (measurement and reporting for key performance indicators (KPIs) – including guidance needed). • Renewable energy usage (split between non-renewable and renewable).	**A1.4a** Collaboration between the BDA, the British Ceramic Confederation (BCC) and Ceram in the collection of industry data and the setting of industry targets and reporting of performance against KPIs. **A1.4b** Demonstrate the increase in data completeness by annual declaration of the percentage of production reported; to be declared in each survey with immediate effect. **A1.4c** The BDA to report annual level of returns (percentage based on production) with a view to including a requirement for reporting as part of membership of the BDA and thus aim to have 100% reporting. **A1.4d** Development of associated guidance notes for annual questionnaires to be completed, ready for data collection in 2014, relating to the 2013 data, and to include renewable energy splits. **A1.4e** Development of a brick manufacturing sector water strategy and guidance notes on best practice in association with the Construction Products Association (CPA) and linked to ISO 14046.
SG1.5 Development of a target of zero process waste to landfill and diversion of general waste from landfill.	**A1.5a** The BDA to promote zero production process waste to landfill with a target of 100% compliance. **A1.5b** Set a target of 95% of all manufacturing site waste generated diverted from landfill and to alternative uses.
SG1.6 Brick manufacturing is a water consuming process; however, much of this water could be, and in some cases is, sourced from non-mains supplies.	**A1.6a** The BDA to develop, publish and promote case studies of water management and water recycling and rainwater harvesting (linked to A1.4e). **A1.6b** Development of an assessment tool, in the form of a rainfall calculator, to give indication of the area of the site and local rainfall to assess total available rainfall harvested water.
Logistics and packaging	
SG4.1 To increase the efficient utilisation of the logistics fleet for clay bricks and assess the benefits of extending the pick-up and delivery to site periods within the day.	**A4.1a** The Chartered Institute of Logistics and Transport **(**CILT) with member companies to develop and undertake a study programme to identify the potential efficiencies in extending the delivery to site periods to later in the afternoon.

Proposed action	Deliverable action
SG4.2 Undertake an industry study to evaluate whether 'brand miles' are a real issue and identify the scale of additional mileage incurred as a result of the use of branded vehicles for specific deliveries.	**A4.2a** The CILT, BDA and British Precast Concrete Federation (BPCF) to devise and seek support to undertake a survey of members on the issues relating to brand miles. The aim is to quantify the scale of the problem and identify any additional inefficiencies it imposes on the supply chain – and then work to remove them.
SG4.3 Continue to undertake driver awareness training and promote fuel efficient driving techniques.	**A4.3a** The CILT and its member companies to continue to promote driver awareness and training in relation to fuel efficient driving techniques.
SG4.4 Pallets have long offered a potential opportunity for increased efficiency within the logistics and packaging sector, through pallet return and reuse schemes. However, there is a wide range of pallets currently in use, not all of which are regarded as being fit for purpose in the context of reuse.	**A4.4a** Assessment of the merits of the CPA Pallets Group being resurrected. If the assessment recommends the resurrection of the Pallets Group, a first meeting is to be held. **A4.4b** Establishment of a small working party to review the merits of developing the specifications for a small range of standardised pallets with agreed minimum specifications.
SG4.5 Brick pack sizes currently range from around 360 bricks to 500 for the standard UK format brick (215 x 102 x 65mm). The sub-group identified that there may be benefits in standardising packs to 500 bricks.	**A4.5a** The BDA and member companies to form a small working party to investigate the merits of standardising a 500 brick pack, the implications on vehicle load and benefits for standardising packaging equipment at brickworks.
Design for use and reuse	
SG5.1 Development of a standardised Building Information Modelling (BIM) compliant resource efficiency data set, including how to incorporate the six key elements of Environmental Product Declaration (EPD) data.	**A5.1a** The BDA to promote the use of the standard formats for resource efficiency BIM data (and, where appropriate, EPD data sets) through guidance notes to members.
SG5.2 There is a need to manage client expectations better in respect of the aesthetics of products. Continual Professional Development (CPD) training to improve the education of the client base through CPD content for designers and architects, supported by the Royal Institute of British Architects (RIBA). Redrafting and promotion of the contents of PAS (Publically Available Specification) 70 to architects and the design community.	**A5.2a** The BDA to develop CPD presentations, and general practical guidance notes, to promote good workmanship and manage customer expectations. **A5.2b** The BDA to produce a guidance document, based on the current content of PAS 70, to promote good workmanship and manage customer expectations.
SG5.3 Technical guidance is needed to help designers design and build to standard brick dimensions. The aim is to help inform choices regarding the possible implications of matching products used in building with these standard dimensions.	**A5.3a** The BDA to develop CPD and general guidance on designing buildings based on standard brick dimensions, including the development of supporting material e.g. case studies and design guides.
SG5.4 Promotion of responsible sourcing, aims and objectives, through engagement with the customer base via CPD activities, and guidance on how to maximise the benefits of applying BES 6001 to the supply chain and links with the UK Contractors Group (UKCG) and its register of BES 6001 certificated products and suppliers.	**A5.4a** Responsible sourcing guidance document to be developed by the BDA, including it within CPD. The document is to contain guidance to manufacturers of how to maximise the benefits of having BES 6001 in respect to BREEAM and the Code for Sustainable Homes (CSH). The document will also link with the UKCG and signpost links to BES 6001 certificates.
Construction process	
SG6.1 Development of better awareness of the actual value of the materials and how site management and best practice can be used to minimise wastage of materials on site.	**A6.1a** Identification of the training and guidance needed for different target audiences in relation to waste minimisation through on site actions. **A6.1b** Development of CPD and other training package content by the BDA to promote best practice on site in relation to clay bricks, especially when bringing innovative products to market. Links to be established with other interested parties such as the RIBA, UKCG, the Royal Institution of Chartered Surveyors (RICS) and Construction Skills.

Proposed action	Deliverable action
SG6.2 Investigate the benefits of using site-based pallets for off-loading and site handling of void packs and storage.	**A6.2a** Development of a case study to look at the potential benefits and reduction in site-sourced waste generation and losses of materials through storage and handling of void packs on site-based pallets.
SG6.3 Investigate the cost and benefits of pre-blending brick colours within packs before leaving the brickworks, with an aim to minimise brick wastage on site and post-build remedial works.	**A6.3a** Brick manufacturers to undertake a study to evaluate the cost and practicality of pre-blending packs for colour before leaving the brickworks.
SG6.4 Agree the actual wastage rates and reasons why clay bricks and blocks are wasted on construction sites in order to be able to set appropriate targets for waste reduction.	**A6.4a** To agree wastage rates of products listed in the WRAP wastage rates report to enable the publication and dissemination of the report and the use of the data set in tools and guidance.
Demolition	
SG7.1 Development of mortar specification and use guidance to allow for brick recovery, while maintaining structural performance during service. Better understanding of the cost implications of brick recovery from sites and potential value of end product.	**A7.1a** The BDA to develop CPD and general guidance. Development of supporting material, following consultation with the Mortar Industry Association (MIA). **A7.1b** Liaison with the National Building Specification (NBS), structural engineers, the National House Building Council (NHBC) and MIA in order to develop support, if appropriate, for the redrafting of European Standards for Masonry Mortars. **A7.1c** Case study to develop a better understanding of the practicality, processes and cost implications of the recovery of bricks for reuse from demolition sites.
SG7.2 There is a need for the brick sector to work with the National Federation of Demolition Contractors (NFDC) in the development and updating of the Demolition Refurbishment Information Data Sheets (DRIDS). General lack of understanding of what is fit for purpose and what is appropriate when selecting recyclable or reusable materials.	**A7.2a** The BDA to provide practical support and technical information in support of the updating of the DRIDS.
SG7.3 Development of appropriate best practice guidance based on the experiences of reuse and recycling of clay bricks in Europe.	**A7.3a** The BDA to liaise with European sector bodies to identify best practice across Europe, and potentially adopt the best ideas in the UK sectors. Initial survey and report to be completed.

Content

1 Introduction

This Resource Efficiency Action Plan (REAP) for the clay bricks and clay blocks industry (the clay bricks industry) and its supply chain identifies a set of actions that will result in a significant improvement of the sector's resource efficiency. In this report, resource efficiency covers aspects of operational impacts other than just the generation of waste, as has been the focus of previous REAPs for other sectors. In the context of this report, resource efficiency covers the following main areas:

- Water
- Waste
- Carbon (energy and greenhouse gas emissions)
- Materials
- Biodiversity

The primary purpose of the REAP is to promote collaboration within the supply chain, resulting in a beneficial outcome.

In doing so, the report presents the actions the clay bricks sector and the associated downstream supply chain are taking in response to the UK Government's July 2013 'Construction 2025: industrial strategy for construction – government and industry in partnership'[1], and to the 'greening the industry' approach being developed by the Green Construction Board[2].

The original impetus for the action plan came from liaison between the Brick Development Association (BDA), the Construction Products Association (CPA) and the Waste and Resources Action Programme (WRAP) following the successful publication of REAPs for other parts of the construction materials sector – flooring[3], joinery[4], windows[5], plasterboard[6], insulation foam[7], and mineral wool ceiling tiles[8]. The BDA identified, through its Sustainability Working Party, a need for a better understanding of the potential benefits of improved resource efficiency, other than those already within the existing annual KPIs, and thus better alignment with the wider UK construction sector's goals in achieving a more sustainable construction sector.

The BDA represents the United Kingdom and Ireland's clay brick and paver industries. Its role is to ensure clay bricks and pavers are recognised as the material of choice by

[1] Construction 2025: industrial strategy for construction – government and industry in partnership https://www.gov.uk/government/publications/construction-2025-strategy
[2] Green Construction Board http://www.greenconstructionboard.org/index.php/working-groups/greening-the-industry
[3] http://www.wrap.org.uk/sites/files/wrap/Flooring_REAP.pdf
[4] http://www.wrap.org.uk/sites/files/wrap/REAP_Joinery_Final.pdf
[5] http://archive.defra.gov.uk/environment/business/products/roadmaps/documents/windows101019.pdf
[6] http://archive.defra.gov.uk/environment/business/products/roadmaps/documents/plasterboard101019.pdf
[7] http://www.wrap.org.uk/sites/files/wrap/BIF.pdf
[8] http://members.ais-interiors.org.uk/assets/Uploads/Mineral-Wool-Ceiling-Tiles-A-Resource-Efficiency-Action-Plan.pdf

architects, engineers, planners, specifiers, developers, landscapers, builders and property owners.

The clay bricks sector in the UK produces around 1,554 million bricks per annum (2012) from 60 operational sites and is dominated by four major manufacturers, Hanson Building Products Ltd, Ibstock Brick Ltd, Michelmersh Group and Wienerberger Ltd. With the exception of Michelmersh, these companies are all part of major multinational groups with wider construction materials interests.

Resource efficiency for the clay bricks sector is therefore directly relevant to the consumption of raw materials, including energy and water, as well as the generation of emissions from combustion processes and the decomposition of the raw materials during the firing process. It also relates to providing biodiversity and new habitats as part of the decommissioning process and the restoration of quarries and operational sites.

1.1 The Clay Bricks and Clay Blocks supply chain

The supply chain is represented by the following sub-groups (Table 1) that form the stakeholder group for the clay bricks and clay blocks REAP:

Table 1: Sub-group structure of the supply chain for the Resource Efficiency Action Plan for clay bricks and clay blocks

Sub-group	Supply chain segment served
SG1	Clay Bricks and Clay Blocks manufacturing and raw materials
SG2	Precast Concrete manufacturing and raw materials (not included in this report)
SG3	Ready Mix Concrete manufacturing and raw materials (not included in this report)
SG4	Logistics and packaging (including builders' merchants)
SG5	Design for use and reuse
SG6	Construction
SG7	Demolition

For the purpose of this report, the clay bricks supply chain was mapped out in order to create the basis for forming the stakeholder group. The main features of the supply chain

are shown in Figure 1, which outlines the primary routes to market for clay bricks and where some of the resource efficiency opportunities lie.

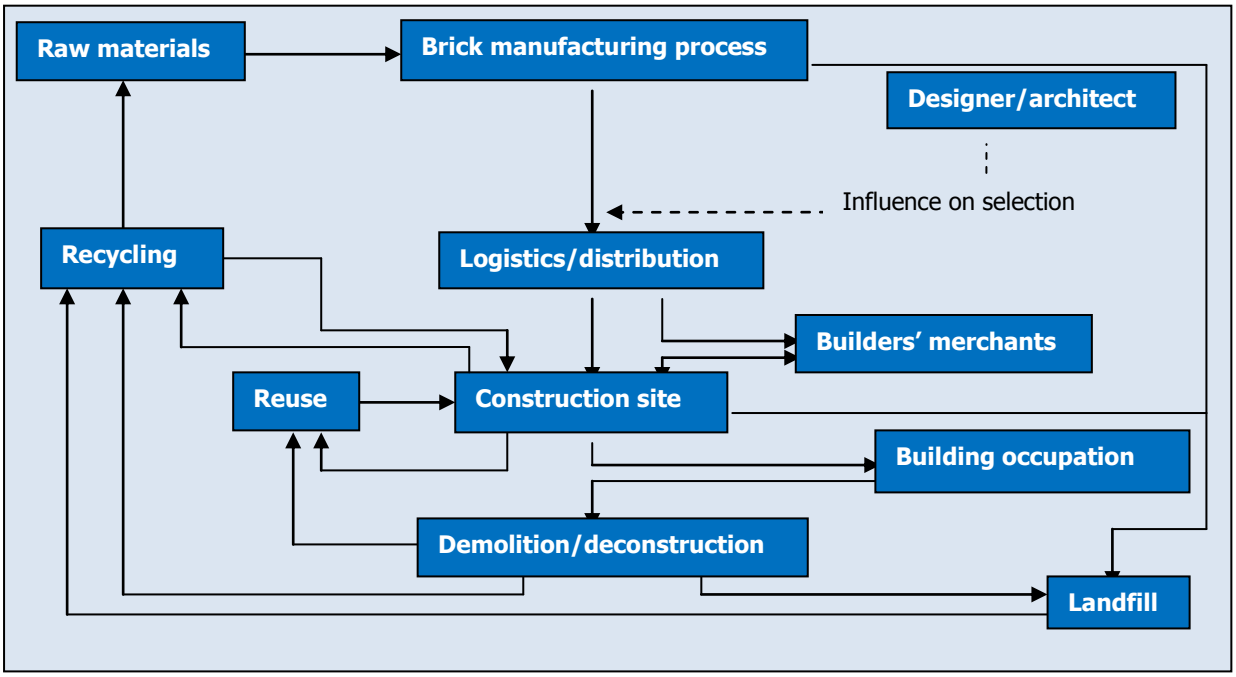

Figure 1: Schematic for the supply chain of clay bricks and clay blocks

After the manufacturing process, the supply chain for clay bricks and clay blocks is relatively simple. However, several routes to the end customer have evolved. As shown in Figure 1, bricks are not only supplied direct to the customer from the brickworks but can be sold via builders' merchants or via brick factors. In the case of builders' merchants, bricks can either be sold by the merchant and delivered directly from the brickworks or via a merchant's yard. Brick factors on the whole act as agents and bricks are delivered from the brickworks to the site without intermediary storage at the brick factor's facilities.

1.2 Resource efficiency impact indicators

Following the publication of Environmental Product Declaration standard BS EN 15804 2012[9], there is a standardised assessment methodology for the measurement of resource efficiency and environmental impact indicators for construction products. Where possible, the resource efficiency indicators and principles of BS EN 15804 have been used in identifying relevant factors in assessing the resource efficiency and measurement

[9] BS EN 15804 2012 Sustainability of construction works — Environmental product declarations — Core rules for the product category of construction products

methodologies adopted in this REAP. This is specifically the case in the development of targets and the assessment of progress towards them.

Throughout the supply chain, the principal resource impact areas fall within the following:

- **Materials** – including recycled materials used in the manufacturing process.
- **Carbon (energy and greenhouse gas (GHG) emissions)** – covering both direct and indirect energy consumption associated with the manufacture, transportation and installation of the products, as well as natural gas, electricity and other fuel oils and gas. In addition, the GHG emissions associated with the use of fuels is a particular area of interest because the clay bricks and clay blocks sector falls within the Energy Intensive Users Group in the UK and is thus required to report annually on GHG emissions through the EU ETS (European Union Emissions Trading Scheme) or the UK Small Emitters Scheme, and additionally through the Climate Change Agreement (CCA) process.
- **Water** – consumption of water within the process, either through the use of mains (potable) water or, in the case of the manufacturing process, via abstraction from lagoons or boreholes on site as well.
- **Waste** – covers waste generation through the manufacturing process, waste as a result of the transportation and storing of products before use, handling and storage of materials on the construction site, pallets and packaging wastes, and waste either recovered or recycled through recycling schemes (typically, the packaging wastes) and materials sent to landfill.
- **Biodiversity** – mineral workings, including quarries, lagoons and decommissioned production facilities can provide the opportunity to develop and enhance the biodiversity of a site following its restoration. Such actions are usually identified within the restoration plans for all the brick industry's extractive and production operations.

Within the raw materials supply and manufacturing segments of the supply chain, the UK brick industry has sustainability related KPIs (since 2001) that are measured and reported on annually through the BDA's Sustainability Working Party. One of the actions already achieved as a result of the development of the REAP is the review and refinement of the actual sustainability KPIs being measured. The structure of the questionnaire and the scope of the data requested have been modified to be more specific, allowing for better reporting against resource efficiency targets in future. Also, steps are being taken by the BDA to ensure that the data is representative of the entire BDA membership from 2014.

There are no specific actions directly related to the reduction in energy consumption (including carbon and GHG emissions). While energy is of great importance within the sector, and is a major resource, the industry is committed to legally binding national and European targets through the EU ETS and CCA. As such, any suggested actions would be subservient to these agreements, and thus are unlikely to provide any additional reductions or improvements in resource efficiency.

While energy, specifically carbon, is not addressed in this report in any detail, it remains of critical importance to the resource efficiency of the sector, not least because some of the current legislation and regulation can inadvertently work against the primary objectives of

resource efficiency. An example of such unintended consequences could relate to inflexible future allocations of carbon allowances under the EU ETS.

The brick industry is an extractive industry; by its nature, when clay pits are exhausted, the associated factory will close. The industry is also cyclical, being tied to fluctuations within housing and the wider construction markets. It requires a flexible approach from Government to increase or decrease capacity in existing factories, and the facility to take carbon allowances (emission allowances within EU ETS) to new factories with fresh reserves of clay. Without this flexibility, the industry can only decline, with a consequential danger of the reliance on importing bricks in the future. The current situation of mothballed factories being restarted for production and having to reapply for carbon allowances from the New Entrant Reserve is an example. This lack of flexibility and clarity makes long-term capital investment unsure and speculative, which could have a direct and negative impact upon the resource efficiency of a production site and the sector.

2 The action plan

The development of the REAP for clay bricks has been undertaken in consultation with a wide range of interested parties from within the supply chain, from raw material suppliers to demolition contractors. The establishment of the stakeholder group has enabled an open and wide-ranging discussion and analysis of each stage in the supply chain, the current effects on resource efficiency, and the actions that could be taken to improve the overall resource efficiency of the supply chain.

Following the initial stakeholder group meeting, it was clear that, to engage with all members and particularly to capture all the salient information to enable the development of the REAP, it would be more efficient to create specialist interest sub-groups. These sub-groups were also given the task of helping with the REAP for precast concrete products being developed in parallel.

The primary aim of the action plan is to identify, clarify and define actions that will improve the resource efficiency of each of the segments in the clay bricks supply chain. These actions need to be defined in such a way as to make things happen. To this end, the actions have been developed as 'SMART actions' – specific, measurable, achievable, realistic and time-bound to enable periodic review and refinement of performance.

This allows actions to be developed and managed with clear and meaningful outcomes, which in turn will have a beneficial impact on resource efficiency throughout the supply chain.

2.1 Manufacturing

Sub-group SG1 included representatives of the raw materials suppliers and the clay bricks and clay blocks manufacturers. The breakpoint in the supply chain was identified as the point at which the bricks or blocks leave the brickworks.

The sub-group identified five areas that were evaluated and ranked as being of high priority:

- **SG1.1 Regulatory barrier** – Currently, planning consent related to mineral extraction is often only granted to extract and transport off site specific materials. All other materials are required to be used as landscaping or restoration. Where such 'non-consented' materials occur and are of technical and economic value, a revision of planning consent to allow extraction and use would have significant environmental benefits.

- **SG1.2 Regulatory barrier** – Protection of strategically important brick making raw materials through the extraction and stockpiling of 'important' raw materials that would otherwise be sterilised as a result of other developments.

- **SG1.3 Recycled and alternative materials** – Promotion of the use of these materials across the industry. Currently, some brick production sites use recycled or alternative materials and some don't. Therefore, a better understanding is required of why uptake of these materials is variable.

- **SG1.4 Data collection** – Improvement in the quality of industry based data surveys is required. Data is typically collected annually and is regarded as good in some areas but poor in others. There is an agreed need to improve data quality and completeness, not least by collecting from the whole industry and not just the main manufacturers.

- **SG1.5 Waste generation** – Promotion of an industry-wide policy to reduce waste to landfill produced on the site of manufacture.

- **SG1.6 Water management** – Development of a better understanding of how water is used within the manufacturing process and how water from sources other than mains supply can be maximised to reduce the need to use potable water.

Table 2 shows the SMART actions developed to address these areas of resource efficiency. Actions **A1.1a, b and A1.2a** relate to the resource efficient extraction and utilisation of primary raw materials at the point of extraction or allowing for long-term storage in stockpiles to avoid sterilisation of strategically important brick making materials.

The current practice is to extract the minerals required for the brick making operation, with the remaining overburden and inter-burden used for landscaping and restoration. Allowing the use of all materials with a technical and economic viability would enable the extraction

process to be optimised, resulting in reduced energy, emissions, land change and waste generation.

Table 2: Actions identified relating to the supply of raw materials and the manufacturing process for clay bricks and clay blocks

Proposed action	Lead	Deliverable actions
SG1.1 Companies engaged with the extraction and use of brick making raw materials to review current planning conditions and to identify the potential for utilisation of overburden and inter-burden materials for other applications. Development of a case in support of resource efficient extraction through planning consents. Requires liaison with the Environment Agency and local authorities.	British Ceramic Confederation Land Property and Minerals Committee	**A1.1a** Development of a resource efficiency impact report, identifying the benefits of use of all extracted materials, based on industry data of current mineral workings. **By Mar 2014** (work started). **A1.1b** Engage with the Environment Agency regarding a position statement to determine future potential. **By Sep 2014** (engagement process started).
SG1.2 Development of a case for the permission to extract and then stockpile significantly important raw materials for long periods. There is a need to understand the upfront financial implications of such an operation and whether or not in the foreseeable future such an investment is likely.	British Ceramic Confederation Land Property and Minerals Committee	**A1.2a** Development of a strategy for engagement. Position paper to be written in support of changes to planning that will allow stockpiling. This would enable engagement with the Environment Agency and the CBI Minerals Committee. **By Sep 2014** (completed).
SG1.3 Promotion by case studies of the benefits of recycled and alternative raw material usage in the overall production process. Need to understand the difference between *active materials* (with a firing benefit/technical benefit) and *filler materials* (inerts which just displace primary clay).	Brick Development Association Sustainability Working Party	**A1.3a** Preparation of case studies and sharing of best practice and identification of issues related to regulatory compliance. **By Sep 2014** (completed). **A1.3b** Liaison with the Environment Agency and local authorities regarding the issues over waste management and regulatory compliance. **By Dec 2014** (engagement process started).
SG1.4 Data quality has been identified as being the most important action because of the variability of the amount and quality of data currently provided. The BDA has agreed to encourage its membership to reply to industry surveys completely and in a timely manner. Promotion of best practice for data collection through BDA membership. Gaps in the current resource efficiency data have been identified: • Water usage (measurement and reporting for KPIs – including guidance needed) • Renewable energy usage (split between non-renewable and renewable).	Brick Development Association Sustainability Working Party	**A1.4a** Collaboration between the BDA, BCC and Ceram in the collection of industry data and the setting of industry targets and reporting of performance against KPIs. **By** (actioned already). **A1.4b** Demonstrate the increase in data completeness by annual declaration of the percentage of production reported. Report in each survey with immediate effect. **By** (actioned already). **A1.4c** The BDA to report annual level of returns (percentage based on production) with a view to including a requirement for reporting as part of membership of the BDA and thus having 100% reporting. **By 2015** (completed). **A1.4d** Development of associated guidance notes for annual questionnaires to be completed, ready for data collection in 2014, relating to the 2013 data, and to include renewable energy splits. **By Jan 2014** (completed). **A1.4e** Development of a brick manufacturing sector water strategy and guidance notes on best practice in association with the CPA and linked to ISO 14046 and the outcomes of Sustain's Embodied Water Project[10] for manufactured products. **By Dec 2014** (completed).

[10] Sustain Embodied Water Project – http://www.sustain.co.uk/water-footprinting/ (under development)

Proposed action	Lead	Deliverable actions
SG1.5 Development of a target of zero process waste to landfill and diversion of general waste from landfill.	Brick Development Association Sustainability Working Party	**A1.5a** The BDA to promote zero production process waste to landfill with a target of 100% compliance. **By 2016** (completed). **A1.5b** Set a target of 95% of all manufacturing site waste generated diverted from landfill and to alternative uses. **By 2016** (completed).
SG1.6 Brick manufacturing is a water consuming process; however, much of this water could be, and in some cases is, sourced from non-mains supplies. The aim is therefore to maximise the use of recovered, harvested and recycled water, thus minimising the need to take water from the mains supply by better understanding of water 'flow' within the manufacturing process.	Brick Development Association	**A1.6a** The BDA to develop, publish and promote case studies of water management and water recycling and rainwater harvesting (linked to A1.4e). **By Mar 2014** (started). **A1.6b** Development of an assessment tool, in the form of a rainfall calculator, to give indication of the area of the site and local rainfall to assess total available rainfall harvested water. **By Dec 2014** (started).

Actions **A1.3a and b** relate to the promotion and encouragement of the use of recycled and alternative raw materials in the brick making process. Currently, around 9% of the brick making materials are sourced from 'alternative, recycled and secondary sources' and are reported on annually in the Ceram MARSS report (unpublished). These alternative materials are grouped into five categories:

- Ash products
- Hydrocarbon products
- Industrial mineral products
- Mineral products
- Organic products.

The recycled mineral products category is the highest contributor to the MARSS usage, and it covers mineral based materials from extraction processes other than for brick making, including secondary fireclays recovered from open cast coal operations. Such materials are classed as recycled based on the WRAP 'Rules of Thumb' guidance[11], and typically are dominated by overburden and inter-burden from other extractive processes, in a way similar to that being promoted in actions **A1.1a and b**.

Actions **A1.4a-e** refer to the need to improve the quality and completeness of the data collected through industry surveys and questionnaires. Currently, data is mostly provided by the four large brick manufacturers dominating the sector. Obtaining data from the smaller single site manufacturers is less successful, usually as a result of limited resources and lack of centralised data collection systems. The aim therefore is for the main data gathering agencies, BDA, BCC and Ceram, to work together to create a uniform approach to data gathering, including the development of guidance as to what data can be collected and reported through surveys and questionnaires and how it should be done.

In terms of specific types of data, actions **A1.4d and e** concern the development of data collection on 'renewable energy consumption' and 'water usage' respectively. At present,

[11] Guide for product manufacturers. Calculating and declaring recycled content in construction products: 'Rules of Thumb' guide (http://www.wrap.org.uk/sites/files/wrap/Rules_of_Thumb1.pdf)

significant amounts of data are gathered for energy consumption, not least because the sector is part of the UK's Energy Intensive Industries sector and is thus required to report annually on energy usage relating to emissions of GHGs through EU ETS and CCA reporting. One area not yet measured or reported on is the sector's use of renewables. The manufacturers have therefore identified a need to collect this data and to publish it as a KPI following the establishment of a baseline and future targeting.

Water usage is an existing KPI within the brick manufacturing sector and has been reported for over 10 years. However, the quality of the data, and specifically how it fits in with the ISO 14046[12] on water footprinting, is not currently available. The current KPI measures the amount of water consumed from the mains supply against that from non-mains sources. The sector recognises that this is a very crude water KPI, so the aim of this action is to provide a methodology to capture accurate water usage data in accordance with ISO 14046, reporting on mains and non-mains sources with more detail and accuracy.

Actions **A1.5a and b** have been jointly developed with the Precast Concrete sector and relate to the reduction of waste – in the case of **A1.5a**, the reduction of process waste to landfill to zero; and for **A1.5b**, the diversion of 95% of all waste to landfill from brick production sites.

The sector has recognised that some waste will be generated as a result of production processes. But the emphasis of these actions is to reduce the waste being generated and to lessen the impact by recovery and recycling within the operation or by the collection and recycling of materials through external recycling schemes for commercial waste streams.

Actions **A1.6a and b** cover the development of a better understanding of, and case studies relating to, water consumption and management in the manufacturing process and the identification and evaluation of potential alternative sources of usable water, other than through the potable mains water supply network.

[12] ISO 14046 – Water Footprint – Principles, requirements and guidelines (under development)

2.2 Logistics and packaging (including merchants)

Sub-group SG4 contained representatives from the logistics and packaging part of the supply chain. Their role in the supply chain relates to the packaging and transportation of the bricks and blocks either to a construction site or in some cases to a builders' merchant, DIY chain or similar.

The sub-group identified a number of opportunities to undertake actions that would result in resource efficiencies (Table 3). These predominantly relate to energy conservation in the logistics sector and to the reduction of damage from handling through the distribution process or on site, with the use of appropriate packaging and/or palletisation of products.

- **SG4.1 Extended pick-up and drop-off times** – The group identified that the working day for most sites is from 7am to 5pm. But scheduling of deliveries is dominated by morning requests, and deliveries after 3pm are very limited. In addition, brickworks usually only operate a limited loading period, again foreshortened in the late afternoon. Extending pick-up and drop-off times by a couple of hours per day would, it is thought, increase the efficiency of the logistics fleet significantly.

- **SG4.2 Brand miles** – The sub-group identified an activity that significantly affects the fuel consumption and thus the energy efficiency of the delivery of certain branded products to the client. Some manufacturers or merchants will only deliver products on similarly branded delivery vehicles, even if this increases the distance travelled to make the delivery. It would therefore appear that non-branded vehicles or interchangeable branding for delivery vehicles would provide the best solution and offer more flexible fleet utilisation.

- **SG4.3 Driver awareness/training and fuel efficiency** – Many of the logistics operators already work with a fuel efficient fleet. However, there are perceived to be significant benefits to continued driver awareness and training in order to optimise fuel efficiencies. Some companies, in addition to training, offer financial rewards to drivers for achieving defined targets.

- **SG4.4 Pallets** – The use and type of pallets in the construction and retail sector has been a topic of debate for many years. In addition to the opportunities in respect of limiting pallets to a small number of standard sizes and specifications, opportunities for resource efficiency have been identified, including the use of site-based pallets (see SG6.2) for product storage and handling.

- **SG4.5 Brick pack size** – There is a wide variety of standard pack sizes (based on numbers of bricks) within the UK brick manufacturing sector. The sub-group found that there was merit in linking with brick manufacturers to investigate the standardisation of a 500 brick pack (standard UK format brick: 215 x 102 x 65mm), so that any new or refurbished packing equipment could be standardised to this configuration.

Table 3: Actions identified relating to the logistics and packaging aspects of the supply chain for clay bricks and clay blocks

Proposed action	Lead	Deliverable actions
SG4.1 To increase the efficient use of the logistics fleet for clay bricks to assess the benefits of extending the pick-up and delivery to site periods within the day.	Chartered Institute of Logistics and Transport and member companies	**A4.1a** Work with the CILT and its member companies to develop and undertake a study programme with site operators to identify the potential efficiencies in extending the delivery to site period to later in the afternoon (to 5pm or 5.30pm). **By Dec 2014** (study to be completed).
SG4.2 Undertake an industry study to evaluate whether 'brand miles' are a real issue and identify the scale of additional mileage incurred as a result of the use of branded vehicles for specific deliveries.	Chartered Institute of Logistics and Transport with the Brick Development Association and British Precast Concrete Federation	**A4.2a** The CILT, BDA and BPCF to devise, and seek support for, a survey of members on the issues relating to brand miles. The aim is to quantify the scale of the problem and identify any additional inefficiencies it imposes on the supply chain – and then work to remove them. **By Dec 2014** (study to be started).
SG4.3 Continue to undertake driver awareness training and promote fuel efficient driving techniques.	Chartered Institute of Logistics and Transport and member companies	**A4.3a.** The CILT and its member companies to continue to promote driver awareness and training in relation to fuel efficient driving techniques. **By** (ongoing).
SG4.4 Pallets have long offered a potential opportunity for increased efficiency within the logistics and packaging sector, through pallet return and reuse schemes. However, there is a wide range of pallets currently in use, not all of which are regarded as being fit for purpose in the context of reuse. The aim is to establish whether the pallet sector, manufacturers of pallets and users, should reform the CPA Pallets Group and reinvestigate a number of possible resource efficiency opportunities, either by modifications to site practice or by pallet specification and standards.	Chartered Institute of Logistics and Transport, manufacturers and pallet manufacturers	**A4.4a** Assessment of the merits of the CPA Pallets Group being resurrected. If the assessment recommends the resurrection of the Pallets Group, a first meeting is to be held. **By Mar 2014** (CPA to review if Pallets Group is to be re-established). **A4.4b** Establishment of a small working party to review the merits of developing the specifications for a small range of standardised pallets with agreed minimum specifications, and to circulate and promote the outcomes. **By Mar 2014** (working group to be established).
SG4.5 Brick pack sizes currently range from around 360 bricks to 500 for the standard UK format brick (215 x 102 x 65mm). The sub-group identified that there could be benefits in standardising packs to 500 bricks rather than based on pack dimensions or pack weight.	Chartered Institute of Logistics and Transport and brick manufacturers and merchants.	**A4.5a** The BDA and member companies to form a small working party to investigate the merits of standardising a 500 brick pack, the implications on vehicle load and the benefits of standardising packaging equipment at brickworks. **By Jun 2014** (establishment of a working party).

Sub-group SG6, which focused on the construction process segment of the supply chain, identified that the assessment of the use of appropriate packaging and the potential application of site-based palletised storage of 'void packs' of bricks and blocks (see SG6.2) represented a key action. Packaging therefore has a role in optimising the protection of the product during transportation, handling and storage, and thus in minimising the potential for damage or rejection of bricks and blocks as a result of contamination during storage.

Packaging also has a significant role in the health and safety implications of the supply chain logistics and safe handling of the packs. Although this issue is very important, the sub-group concluded that current guidance and requirements for safe handling were robust and would not warrant further consideration in this REAP.

Action **A4.1a** relates to extending the period when the logistics fleet can pick up and drop off products during the working week, subject to a review and guidance from the Health and Safety Executive. The sub-group highlighted that construction sites often request drop-offs between 7am and 3pm or at the latest 3.30pm, while the site usually remains manned and operational up to 5pm or 5.30pm. The additional two hours at the end of the day for dropping off products would increase the efficient use of the logistics fleet. The sub-group also identified that extended pick-up (loading) times at the brickworks would help, so overnight shipments for long haul could be utilised. Ideally, the logistics fleet would benefit from a 6am to 6pm loading time from brickworks.

Action **A4.2a** focuses on a known issue relating to the use of branded vehicles to carry same brand products or to deliver to certain customers. Many logistics companies have national relationships with the brick manufacturers but may work for more than one. Therefore, it is possible that products may be transported on competitors' branded vehicles. The key issue to be researched relates to specific delivery requirements and thus whether branded vehicles can be used to deliver competitor brand products to certain customers. A requirement to use same brand vehicles often increases the distance products are transported, if same brand vehicles are not available, adding to the road miles. It is thus seen as a potentially significant inefficiency.

Action **A4.3a** reflects the support for driver awareness and training in respect of fuel efficient driving techniques. Most logistics companies already promote this and the action is intended to add additional support to this process.

Pallets are a regular topic for debate in the packaging sector. However, the sector has arrived at its current position by evolutionary processes and has become very diverse, both in products and the recycling schemes available and used.

Action **A4.4a** relates to assessing if there is merit in the resurrection of the CPA Pallets Group, which worked on similar issues in the past and brought together a wide range of interested parties from across the whole construction sector.

Action **A4.4b**, which could be dealt with by the Pallets Group, concerns the investigation into the benefits of a smaller number of standardised pallets with minimum quality specifications. The aim is to maximise the recovery of pallets within recycling schemes, and to promote pallets that are fit for purpose in terms of quality, so they can be reused an extended number of times.

Action **A4.5a** highlights the potential to develop a standard pack based on the number of bricks – that is, 500 bricks (UK standard format) – rather than on the pack weight or dimensions. Bricks and blocks are sold on a number basis rather than by weight, so

standardising across the manufacturing sector to a defined pack size would allow for standardised packing equipment and for easier load allocation.

2.3 Design for use and reuse

Sub-group SG5 group represented the interests of the designers of buildings and structures, and the specifiers who use clay bricks. This segment of the supply chain can have a significant influence, not only on the decision making process to use bricks but also in the design of buildings that are 'brick dimension' compatible.

Bricks of all sizes are a very versatile construction medium and can be used in both traditional and contemporary architectural designs. However, there were some action points developed by the sub-group on potential improvements to resource efficiency at the design stage.

- **SG5.1 Building Information Modelling** – The use of BIM with the latest generation of building design software is aimed at better development of a bill of quantities, and thus more accurate pricing for projects. BIM also allows for the inclusion of specific information relating to the environmental impact of the building materials in the database. Accordingly, there is a need for the sector to provide data in a BIM compliant form with complete resource efficiency and Environmental Product Declaration (EPD) data sets.

- **SG5.2 Customer expectations** – A significant amount of site waste stems from issues, normally involving the client and the main contractor, regarding the aesthetics of completed brickwork. The issues can stem from poor workmanship or the client's unrealistic expectations of the materials being used and the tolerances of brickwork. Occasionally, this results in significant waste being generated because elements are taken down and the products disposed of in skips or used as 'low grade hard core' on site.

- **SG5.3 Designing to brickwork coordination** – Waste is generated on site during construction as a result of brickwork not being designed in a way that is compatible with the selected brick's dimensions. This results in cutting or 'snapping' of bricks to bespoke lengths and commonly the disposal of the remaining portion of the brick. Typically, windows and doors are designed and manufactured on a modular basis; therefore, if brickwork were designed in modular form, this source of waste would be eliminated from the construction site.

- **SG5.4 Responsible sourcing** – Within the brick manufacturing sector, there has been a significant adoption of responsible sourcing policies through reporting and certification schemes such as BES 6001[13]. This, however, has only fed through into the Green Guide[14] and Code for Sustainable Homes[15] assessment schemes and is not

[13] BES 6001 Responsible Sourcing of Construction Products
http://www.bsigroup.co.uk/en-GB/bes-6001-responsible-sourcing-of-construction-products/
[14] The Green Guide to Specification
http://www.bre.co.uk/greenguide/podpage.jsp?id=2126
[15] Code for Sustainable Homes
http://www.breeam.org/page.jsp?id=86

widely acknowledged outside these schemes. So there is a potential benefit in an education programme for the client base as to the merits and benefits of using building materials that are responsibly sourced and certificated, as well as guidance on how manufacturers can maximise the benefits of having BES 6001 within the construction sector via links with the UK Contractors Group (UKCG). Table 4 shows the resulting actions developed from the sub-group discussions.

Table 4: Actions identified relating to the design for use and reuse of clay bricks and clay blocks

Proposed action	Lead	Deliverable actions
SG5.1 Development of a standardised BIM compliant resource efficiency data set covering how to include the six key elements of Environmental Product Declaration data.	Brick Development Association	**A5.1a** The BDA to promote the use of the standard formats for resource efficiency BIM data (and where appropriate EPD data sets) through guidance notes to its membership. **By Jun 2014** (work to start).
SG5.2 There is a need to manage client expectations better in respect of the aesthetics of products. CPD training to educate the client base through RIBA supported CPD content for designers and architects. The BDA to create a workmanship guide. Redrafting and promotion of the contents of PAS 70 to architects and the design community, as a BDA guidance document.	Brick Development Association's Brick Mortars Pavers Standards Working Party	**A5.2a** The BDA to develop CPD presentations and general practical guidance notes in order to promote good workmanship and manage customer expectations. **By Sep 2014** (work to start). **A5.2b** The BDA to produce a guidance document, based on the current content of PAS 70, to promote good workmanship and manage customer expectations. **By Dec 2014** (completed).
SG5.3 Technical guidance is needed to help designers design and build to standard brick dimensions. The aim is to help inform choices regarding the possible implications of matching products used in building with these standard dimensions. Promotion of modularising – general modular systems to sync with certain products.	Brick Development Association	**A5.3a** The BDA to develop CPD and general guidance on designing buildings based on standard brick dimensions, including the development of supporting material e.g. case studies and design guides. The BDA is to host these on its website for download. **By Dec 2014** (work to start).
SG5.4 Promotion of responsible sourcing, aims and objectives through engagement with the customer base via CPD activities, and guidance on how to maximise the benefits of having BES 6001 for the supply chain and links with UKCG and its register of BES 6001 certificated products and suppliers.	Brick Development Association in association with the GCB, BPCF, CPA and BRE	**A5.4a** A responsible sourcing guidance document to be developed by the BDA, with inclusion in CPD. The document is to incorporate guidance to manufacturers on how to maximise the benefits of having BES 6001 in respect to BREEAM and CSH. The document will also link with the UKCG and signpost links to BES 6001 certificates. **By Dec 2014** (work to be completed).

Action **A5.1a** identifies the need to develop guidance for UK brick manufacturers so they can supply BIM compliant data sets for inclusion, incorporating the sustainability information. This will allow designers and architects to use 'real' rather than 'generic' data for their BIM building designs and thus enable better management of the specification and procurement processes. It will also minimise inefficiencies in this part of the supply chain, mainly over ordering or incorrect specification of bricks and blocks.

Action **A5.2a** relates to the development of guidance in the form of 'guidance notes' and content of CPD presentations, promoting good workmanship on site, specifically when using clay bricks. The aim is to minimise the generation of waste from poor site construction practice.

Action **A5.2b** defines the need to redraft the current content of PAS (Publically Available Specification) 70[16] as a BDA Technical Guidance Note, the better to manage client and customer expectations of the aesthetic qualities of bricks and brickwork. Often, inspection of brickwork and or bricks from close quarters results in aesthetic 'blemishes' being regarded as unacceptable. This can lead to sections of brickwork needing taking down and rebuilding or to the client requesting extensive remedial work. The new BDA Technical Guidance Note will provide robust guidance on what is deemed acceptable and what is not on such aesthetic issues, and how they should be assessed on site, including sample panels and colour blending.

Action **A5.3a** covers the development of guidance and CPD training content for architects and designers on coordinating brickwork design with the dimensions of the bricks specified. The aim is to minimise the amount of brick cutting needed, and thus waste generation on site, through a better understanding of gauged brickwork and potentially modularisation of brickwork designs to fit in with the existing modular openings for doors and windows. The guidance will comprise case studies and presentation slides for CPD training packages presented by the BDA and brick manufacturers.

Action **A5.4a** is based on the development of information and guidance in the promotion of 'responsible sourcing', and specifically BES 6001 certification, to architects and designers. The clay bricks and clay blocks sector has been at the forefront of this development. However, based on feedback from the sub-group discussion, it is not widely known by specifiers and main contractors. This guidance and information will be provided via CPD content development and through guidance documents for the wider construction community, along with links to the UKCG and its register of BES 6001 compliant products and producers.

[16] PAS 70 2003 HD clay bricks. Guide to appearance and site measured dimensions and tolerance. http://shop.bsigroup.com/en/ProductDetail/?pid=000000000030102669

2.4 Construction process

Sub-group SG6, led by the UK Contractors Group, was a collection of representatives interested in the construction process itself. Their primary interest concerns the actual construction process and thus entails a significant amount of coordination of both materials and human resources.

There have been several studies on site waste management and the avoidance of waste generation[17] on construction sites, most of which came about from the introduction of the need to have operational Site Waste Management Plans brought in as a regulation in 2008[18].

Since 2008, site waste management has improved significantly. But, as a result of the development of the clay bricks and clay blocks REAP, four outstanding issues relating to waste generation were identified as requiring more development:

- **SG6.1 Perceived value of the products** – There is a general perception within the construction sector that the actual value of construction products is not appreciated or understood by the construction workforce. As a result, the level of care and attention when it comes to protection in storage and the appropriate use of the materials on site contributes to site-based waste generation. So there is a need for better guidance for the site-based workforce, both main contractors and sub-contractors, on the value of clay bricks and the appropriate handling and storage on site.

- **SG6.2 Storage of void packs on site-based pallets** – Clay bricks and clay blocks are delivered to site in void packs - that is, packs which are not palletised but have 'fork' voids formed within the pack so they can be lifted using forklifts or cranes from the back of delivery vehicles. At the point of delivery, these bricks and blocks are often lifted from the vehicles and stored on the ground, and they can be moved a number of times while on the construction site. This results in mechanical damage to, and contamination of, the lower rows of bricks if stored in mud or on damp ground. SG6 identified that, by transferring the void packs on to suitable site-based pallets (slave pallets) on site at the point of off-loading, they could be handled and stored on site in a way that would reduce waste generation.

- **SG6.3 Brick pack colour blending –** Current guidance from the BDA and brick manufacturers states that bricks should be mixed from at least three packs in order to reduce the risk of colour banding and patchy brickwork. It has been suggested by the SME House Builders Group at the Federation of Master Builders that, because of restricted access on many sites, mixing from packs is not practical or in some cases possible. So pre-blending of colours at the brickworks would aid in reducing the

[17] Understanding and Predicting Construction Waste' 2008 (WR0111) WRAP
http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14677
[18] The Site Waste Management Plans Regulation 2008
http://www.legislation.gov.uk/uksi/2008/314/contents/made

wastage from brickwork taken down after building for colour correction. If the bricks were left in place, pre-blending would reduce the amount of remedial tinting work required before handover.

- **SG6.4 Site wastage rates of bricks and blocks** – A better understanding is needed of the real wastage rates on construction sites in order to evaluate why clay bricks and clay blocks are being wasted. Then appropriate targets can be set.

Table 5 shows the resulting actions developed by the sub-group in order to address these site-based issues.

Table 5: Actions identified relating to the construction process, storage and use of clay bricks and clay blocks on construction sites

Proposed action	Lead	Deliverable actions
SG6.1 Development of better awareness of the actual value of the materials and how site management and best practice can be used to minimise wastage of materials on site. General support of existing actions in other sectors for the promotion of best practice in terms of site management and education of the workforce.	Brick Development Association	**A6.1a** Identification of the training and guidance needed for different target audiences in relation to waste minimisation through on site actions. **By Dec 2014** (compilation of suitable resources completed). **A6.1b** Development of CPD and other training package content by BDA to promote best practice on site in relation to clay bricks, especially when bringing innovative products to market. Links to be established with other interested parties such as the RIBA, UKCG, RICS and Construction Skills. **By Dec 2014** (project team to be established and project started).
SG6.2 Investigate the benefits of using site-based pallets for off-loading and site handling of void packs and storage.	Pallet manufacturers and main contractors	**A6.2a** Development of a case study to look at the potential benefits and reduction in site-sourced waste generation and losses of materials through storage and handling of void packs on site-based pallets. **By Dec 2014** (establish a project team and start study).
SG6.3 Investigate the cost and benefits of pre-blending brick colours within packs before leaving the brickworks, with an aim to minimise brick wastage on site and post-build remedial works.	BDA and brick manufacturers	**A6.3a** Brick manufacturers to undertake a study to evaluate the cost and practicality of pre-blending packs for colour before leaving the brickworks. **By Dec 2014** (establish a project team and start the study).
SG6.4 Agree the actual wastage rates and reasons why clay bricks and clay blocks are wasted on construction sites so that appropriate targets for waste reduction can be set.	WRAP	**A6.4a** To agree wastage rates of products listed in the WRAP wastage rates report to enable the publication and dissemination of the report and the use of the data set in tools and guidance. **By Mar 2014** (completed).

Actions **A6.1a and b** relate to the need to develop and present guidance and training packages to the site-based workforce in relation to waste minimisation and avoidance in the handling, storage and use of bricks.

The aim is to develop an awareness of the actual value of the products, both financially and in terms of the resource efficiency implications associated with the poor handling, contamination in storage and inappropriate use of clay bricks.

Action **A6.2a** identifies a need for a better understanding of the potential benefits of using site-based pallets (slave pallets) for the storage and handling of void packs, particularly clay brick and clay block packs. This would be best achieved by undertaking a number of case studies on different types of construction site to evaluate, on a like-for-like basis, whether the use of site-based pallets reduces the amount of damage or contamination of the bricks and blocks through handling and storage.

Action **A6.3a** concerns the SME house builders and main contractors who operate on restricted sites where the colour blending from three packs, as recommended in the current guidance from the BDA and brick manufacturers, is either not practical or not possible. The aim is to investigate the potential for colour blending to be undertaken as a routine operation at the brickworks and what on-cost this would put on the bricks.

Action **A6.4a** highlights the need for representative site-based data for the current wastage rates of clay bricks and clay blocks, and for an understanding of the underlying reasons why this wastage occurs. WRAP has already collected data for a number of other construction materials and the inclusion of bricks would enable realistic waste reduction targets to be set.

2.5 Demolition

SG7 focused on the demolition process and the recovery of clay bricks for reuse rather than the common practice of recycling construction and demolition waste by using it as secondary aggregates.

The sub-group was led by the National Federation of Demolition Contractors (NFDC), which represents the majority of the UK's demolition contractors. Most of the suggested actions developed to address the resource efficiency aspects of the REAP were based on the recovery and reuse of the clay bricks, rather than crushing them to generate secondary aggregates or fill materials.

- **SG7.1 Recovery of bricks and blocks for reuse** – While there is a market for the recovery and reuse of clay bricks within the salvage sector, widespread recovery and reuse are not yet a common process within the demolition sector. One of the main factors is the ability to remove mortar from the bricks to enable reuse. The use of 'strong' mortars, i.e. those with a high cement content, increases the time and labour required in the dressing of the bricks in order to remove the mortar, thus increasing the cost of the recovered bricks.

- **SG7.2 Brick sector support of the DRIDS** – The NFDC has developed practical guidance in the form of Demolition Refurbishment Information Data Sheets (DRIDS). The bricks sector has indicated an interest in the DRIDS and a willingness to provide technical guidance, specifically in the assessment of technical properties of recovered bricks ready for reuse.

- **SG7.3 Review of European practice of reuse of clay bricks and clay blocks** – Within continental Europe, there are a number of approaches to the promotion of recovery and reuse of construction materials from the demolition and deconstruction process. A comprehensive review of these practices could be used to inform the development of best practice in the UK for the recovery and reuse of clay bricks.

Table 6 presents the actions resulting from the development of the action plan within the demolition sub-group.

Actions **A7.1a-c** relate to the practical aspects of the recovery and processing of bricks and blocks from the demolition or deconstruction process, in order that the bricks and blocks can be reused.

Actions **A7.1a and b** refer to the types and specification of mortars for masonry construction as governed by European masonry mortar standards and UK and European building codes (building regulations). One potential solution to the ability to recover greater numbers of bricks from demolition processes would be to have mortars that have 'weaker' bonding to the bricks, and thus are easier to remove. The implications are wide-ranging and there is therefore a need to seek expert opinion from the mortar industry, via the Mortar

Industry Association and masonry structural engineers, to clarify what is possible and what the lower permissible boundaries are for the bond strength of brickwork in practice.

Table 6: Actions identified relating to the demolition of clay brick and clay block structures and the reuse of recovered clay brick and clay block units

Proposed action	Lead	Deliverable actions
SG7.1 Development of mortar specification and use guidance to allow for brick recovery, while maintaining structural performance during service. Better understanding of the cost implications of brick recovery from sites and the potential value of the end product.	Brick Development Association's Brickwork Working Party NFDC (A7.1c)	**A7.1a** The BDA to develop CPD and general guidance. Development of supporting material, following consultation with the Mortar Industry Association (MIA). **By Dec 2014** (work to be started). **A7.1b** Liaison with the NBS, structural engineers, the NHBC and MIA to develop support, if appropriate, for the redrafting of European Standards for Masonry Mortars. **By Mar 2015** (work to be started). **A7.1c** Case study to develop a better understanding of the practicality, processes and cost implications of the recovery of bricks for reuse from demolition sites. **By Aug 2014** (work to be started).
SG7.2 There is a need for the brick sector to work with the NFDC in the development and updating of the DRIDS. The DRIDS were launched in June 2013 but should be linked in with the REAP actions. Links to the construction education package from the sub-group. General lack of understanding of what is fit for purpose and what is appropriate when selecting recyclable or reusable materials. Design for reuse to be included as well as link into the Green Construction Board objectives.	National Federation of Demolition Contractors with support from the Brick Development Association	**A7.2a** The BDA to provide practical support and technical information for the updating of the DRIDS. **By Dec 2013** (work to be started).
SG7.3 Development of appropriate best practice guidance based on the experiences of reuse and recycling of clay bricks in Europe.	Brick Development Association	**A7.3a** The BDA to liaise with European sector bodies to identify best practice across Europe and potentially adopt best ideas in the UK sectors. Initial survey and report to be completed. **By Jun 2014** (work to be started).

Action **A7.2a** relates directly to the clay bricks and clay blocks manufacturing sector supporting the aims of the NFDC in the development of the DRIDS. This comes in the form of the promotion of the DRIDS principles and the development of complementary guidance documents on the practical assessment methodology for the quality and physical properties of recovered bricks ready for reuse, and thus for how the bricks could best be utilised in new build. In the past, the BDA has provided guidance but such guidance is not always heeded and has resulted in some significant failures. These usually relate to failure of brick structures through frost action resulting from inappropriate selection of bricks without understanding the properties of the bricks at the time of selection or procurement.

Action **A7.3a** concerns the development of best practice and the approach taken by different continental European countries in the recovery and reuse of clay bricks from

demolition. The ultimate aim is to promote the recovery and reuse of the clay bricks and clay blocks from the demolition process. This needs to be done in an appropriate way that is compatible with current building codes and regulations and maintains the embodied value of the products by extending the service life of the individual units. It is possible that the clay bricks and clay blocks may re-enter the supply chain a number of times and thus the service life of the units may be in excess of that of the buildings themselves.

3 Next steps

To maintain a focus on the development and delivery of the actions identified within this report, the Joint CBB, PCC and RMC Management Team has agreed to meet formally twice yearly, in association with the BDA's Sustainability Working Party.

The underpinning objective of the development of this Resource Efficiency Action Plan for the clay bricks sector is based on the premise that, by delivering the actions identified, improvements and thus benefits will be achieved in supply chain segments and in the overall resource efficiency of the supply chain. For this to happen, there is a need periodically to review and report progress against the actions. It is the intention of the Joint Management Team to undertake this annually for all three REAPs, with an interim six-monthly review for each of the actions.

For the three REAPs, each action will have a 'champion' who will be the Joint Management Team's representative with responsibility for the action and the reporting back of progress in achieving the targeted action, and for liaison with the lead delivery organisation.

Annually or as appropriate once the Joint Management Team has reviewed progress, it is the intention to publish updates on the actions identified within this REAP and make them available through the BDA, BPCF and Concrete Centre websites, as well as via links to the GCB's 'Greening the Industry' portal.

Appendices

A1 Project management and stakeholder group

This Resource Efficiency Action Plan (REAP) has been developed from the Clay Bricks and Clay Blocks REAP Stakeholder Group, which represents the segments of the supply chain ranging from raw material suppliers to the demolition contractors and recyclers.

The development of this REAP has been managed by a Joint Project Management Team (Table A1), which has worked on the Clay Bricks and Clay Blocks REAP, the Precast Concrete REAP and the Ready Mix Concrete REAP. The rationale lies in the fact that, after manufacturing, the supply chain has a significant amount of commonality. So, to maximise the efficiency of data collection and feedback from the stakeholder group's sub-groups, the project was managed jointly.

The Clay Bricks and Clay Blocks REAP is chaired by John Sandford, Sustainability Director, Wienerberger Ltd, with the administrative secretariat provided by Richard Sawyer of AMEC; the technical specialist and project lead is Dr Andrew Smith, Head of Sustainability and Construction Materials at Ceram. The production of this REAP was funded by WRAP.

Table A1: Joint Clay Bricks and Clay Blocks, Precast Concrete, and Ready Mix Concrete Project Management Team

Name		Company	Sector
Richard	Sawyer	AMEC	Administrative secretariat
Simon	Hay	Brick Development Association (BDA)	Trade association
Andrew	Smith	Ceram	Technical specialist
David	Manley	Hanson; PCC REAP Chair	Manufacturer
Emma	Hines	Lafarge Tarmac; RMC REAP Chair	Manufacturer
Guy	Thompson	Mineral Products Association (Concrete Centre)	Trade association
Mike	Leonard	Modern Masonry Alliance	Trade association
Hafiz	Elhag	The British Precast Concrete Federation	Trade association
John	Sandford	Wienerberger; CCB REAP Chair	Manufacturer
Gareth	Brown	WRAP	WRAP
Malcolm	Waddell	WRAP	WRAP

The Joint Project Management Team gratefully acknowledges the contribution of members of the stakeholder group who have given freely of their time to offer feedback and support to the sub-groups in the development of this action plan. Members of the group are listed in Table A2.

Table A2: Clay Bricks and Clay Blocks Stakeholder Group

Name		Affiliation
Gareth	Brown	WRAP
Howard	Button	National Federation of Demolition Contractors (NFDC)
Barry	Chambers	Taylor Wimpey
Luke	Chilcott	Roe Group
Graham	Clark	UK Contractors Group (UKCG); Lendlease
Chris	Clear	British Ready Mix Concrete Association (BRMCA)
Colin	Cook	H+H UK Limited
Steve	Cook	Willmott Dixon (& UKCG)
Carl	Cuthbert	Hanson Building Products Ltd
Lauren	Darby	British Ceramic Confederation (BCC)
Gary	Dawber	Reclaimed Bricks Ltd
Andrew	Dixon	Federation of Master Builders (FMB)
Eamonn	Duggan	Flahive Brickwork
Hafiz	Elhag	The British Precast Concrete Federation (BPCF)
Stephen	Fox	Fox Plant
Paul	Freeman	Michelmersh Group
Samantha	Hanks	Scott ELM
Simon	Hay	Brick Development Association (BDA)
Ian	Heasman	Taylor Wimpey
David	Hills	Ibstock
Emma	Hines	Lafarge Tarmac; Chair RMC REAP
Karen	Hunter	Scott Pallets
James	Hurley	Built4Life (and NFDC)
Peter	Johnson	Kier Group
Charlie	Jones	Hanson
Mark	Kershaw	Crest Nicholson
David	Khana	BPI
Charlie	Law	BAM Construct (& UKCG)
John	Leader	Travis Perkins
Rod	Leigh	Jewson

Name		Affiliation
Mike	Leonard	Modern Masonry Alliance
Greger	Lundesjo	Chartered Institute of Logistics and Transport (CILT)
David	Manley	Hanson; Chair of the PCC REAP
Peter	Matthews	Builders Merchants Federation (BMF)
Michael	McGowan	Ibstock Brick
Francis	Morrall	British Ceramic Confederation (for HSE contact)
James	Newton	Mott MacDonald
Michael	Noble	Scott ELM
Barry	Proctor	Barry Proctor Services
Chris	Rhodes	Castle Clay Sales
Norman	Richards	NR Richards Associates Ltd
David	Riley	Anglian Water
Geraint	Rowland	Costain
John	Sandford	Wienerberger; Chair CCB REAP
Richard	Sawyer	AMEC (Administrative secretariat)
Ben	Shaw	Costain
Ian	Smart	HSE contact
Andrew	Smith	Ceram (REAP technical lead and author)
James	Stanfield	Wincanton
Keith	Stark	Wastepack
Andrew	Swain	Lafarge Tarmac
Guy	Thompson	The Concrete Centre (MPA)
Jane	Thornback	Construction Products Association (CPA)
Mike	Turner	Wincanton
James	Vance	Travis Perkins
Malcolm	Waddell	WRAP
Graham	Winter	Environment Agency

A2 The Brick Development Association

The Brick Development Association (BDA) represents the United Kingdom and Ireland's clay brick and paver industries. Its role is to ensure clay bricks and pavers are recognised as the material of choice by architects, engineers, planners, specifiers, developers, landscapers, builders and property owners.

The BDA conducts lectures and CPDs with students and practising architects and engineers and through its marketing arm, Think Brick, communicates the benefits of brick to a wider audience online, through advertising and PR and through the annual Brick Awards.

Brick has been a reliable construction material for centuries and has long been a favourite among architects, developers and the public. Not only is it beautiful to look at, but it has excellent sustainability credentials and affordability.

Made from an abundant natural material, clay bricks have a close visual connection with their raw constituents. Bricks blend easily and naturally with their environment and complement other building materials. Furthermore, brickwork can be adapted as a building changes use.

In terms of sustainability credentials, the BRE's Green Guide to Specification has assigned the highest possible accreditation (A+) to every external wall it rated containing brick. This is positive proof that brick has a key role in meeting the Code for Sustainable Homes (CSH) targets, and the wider aspects of sustainable construction in the UK.

Further information about the BDA can be obtained through the BDA's website: www.brick.org.uk

A3 About clay bricks and clay blocks

The use of clay bricks in construction in the UK has a very long and wide-ranging history, dating back to Roman times, when clay bricks, floor and roof tiles in construction and the skills to make them were introduced from the rest of the Roman Empire. General use of brick in UK construction has developed since the Tudor period. Though originally only for the costly and prestigious buildings, brick was widely used to rebuild much of London following the Great Fire of London in 1666.

The UK clay bricks industry expanded dramatically during the Industrial Revolution, supplying the main construction component of many of the iconic buildings and structures, including both infrastructure buildings and domestic dwellings, and continued into the latter half of the 20th century.

Production output

Sales since the 1980s have declined significantly, with brick deliveries falling by nearly 70% since 1989, reflecting delivery of around 4,559 million bricks. More recently, in 1995 deliveries peaked at 3,292 million bricks, but over the following 10 years (1996-2005) deliveries have hovered around 2,800 million bricks per annum and the delivery figures for 2012 show 1,551 million bricks[19].

By the end of 2012, there were only 60 operational brick manufacturing sites, compared with more than 200 in the mid-1980s, and UK production is dominated by four companies, Ibstock Brick, Hanson Building Products, Michelmersh and Wienerberger. With the exception of Michelmersh, these companies are all part of major multinational groups with wider construction materials interests.

Geographical distribution

The majority of the existing brickworks are located adjacent to the primary raw materials, brick clays and shales, and thus the historic brick making locations in the UK were dictated by the availability of the clay raw materials, as well as proximity to markets and transport links.

Most UK brickworks therefore are close to the main urban areas, in the North East and Yorkshire, North West, East and West Midlands, and the South East of England, as shown in Figure A1. Production in Scotland, Northern Ireland and Wales is almost non-existent now. Only one brickworks is still in operation in Scotland, and there are none in Wales or Northern Ireland.

The main raw materials for clay brick and clay block production in the UK vary depending upon geographic location and the underlying geological formations. The main raw materials include Mercia Mudstone (often still referred to as Keuper Marl in the industry),

[19] Monthly Statistics of Building Materials and Components April 2013 No 458 (BIS) https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/193222/13-313e-construction-building-materials-bulletin-april-2013.pdf

Carboniferous Shale, Mudstones, Etruria Marl and Fireclays associated with the Coal Measures of the Midlands and Northern England, and the Weald and Gault Clays of the South East of England, in Kent and Sussex. The once thriving London Brick or 'Fletton' brick industry, founded on the Lower Oxford Clay deposits of Buckinghamshire, Bedfordshire and Cambridgeshire, is now restricted to one site at Kings Dyke near Peterborough. During the post-war period from the 1950s to the 1970s, the Fletton brick industry provided the vast majority of bricks for the urban development of towns and cities south of the Midlands.

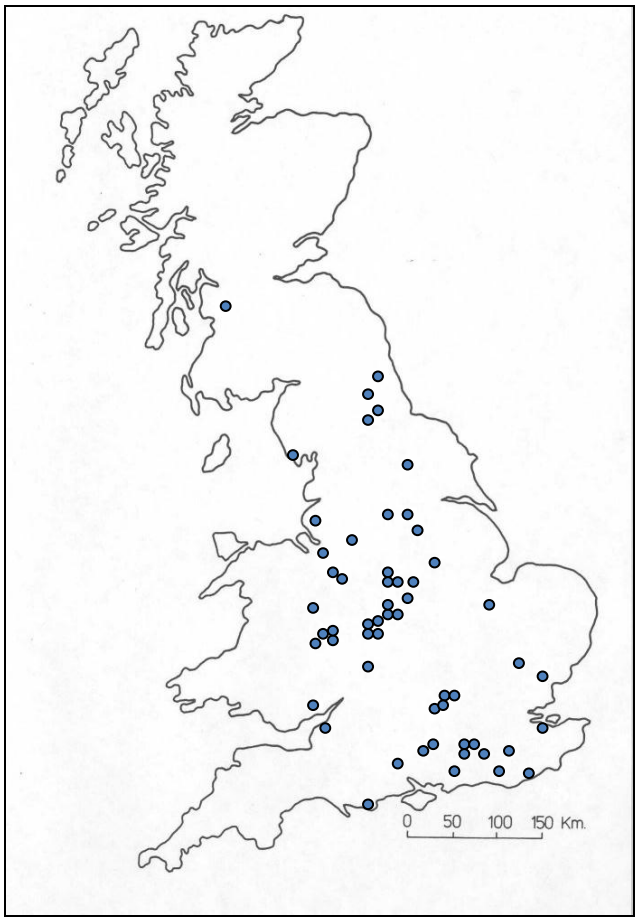

Figure A1: Location map of the UK brickworks in operation at the end of 2012

Manufacturing process

There are four main manufacturing processes for producing bricks in the UK:

- Extrusion
- Soft mud moulding
- Handmade moulding
- Semi-dry pressing.

Of these, the two dominant brick manufacturing processes in the UK remain the extrusion (Figure A2) and soft mud processes (Figure A3).

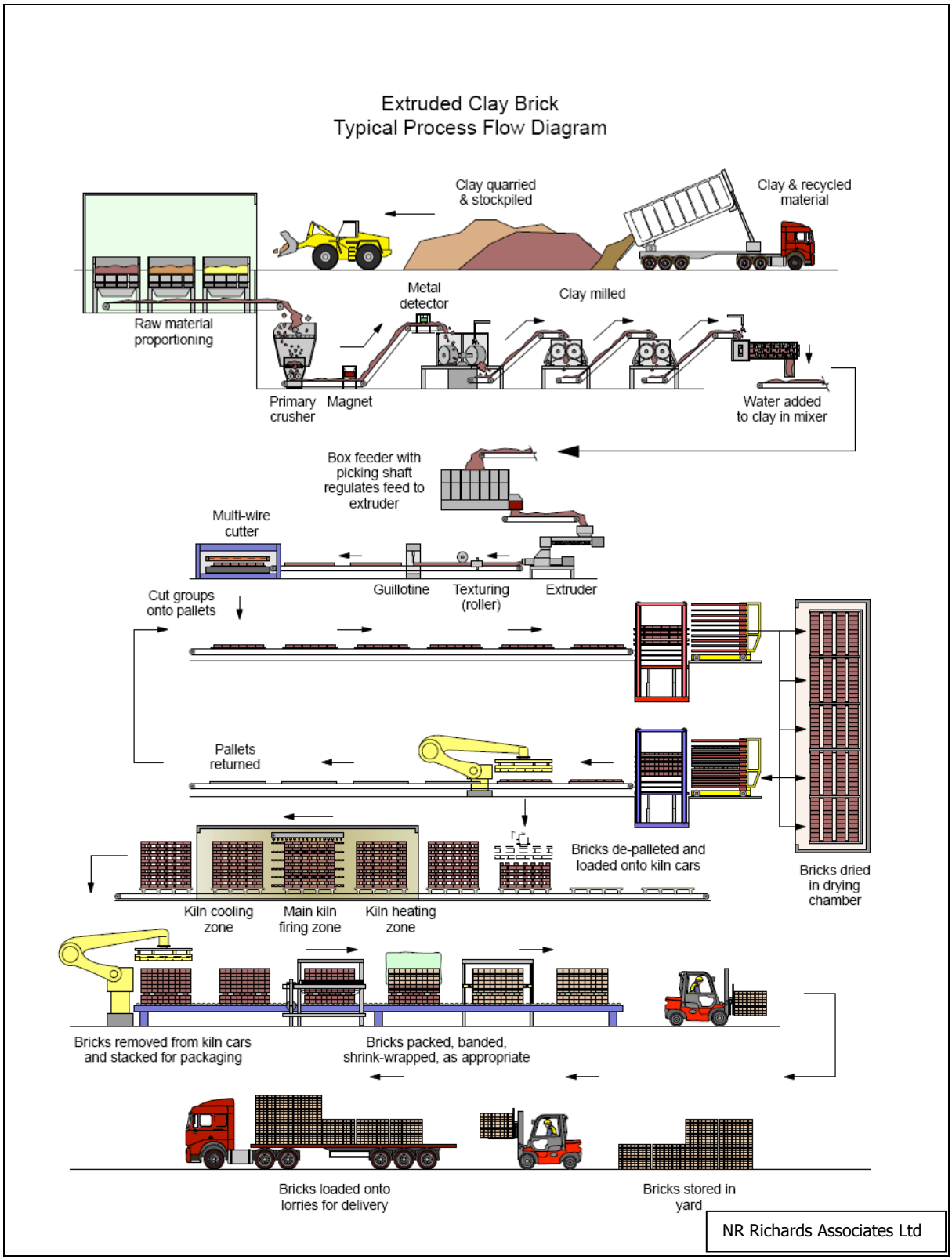

Figure A2: Typical process flow for the manufacture of extruded wire cut bricks

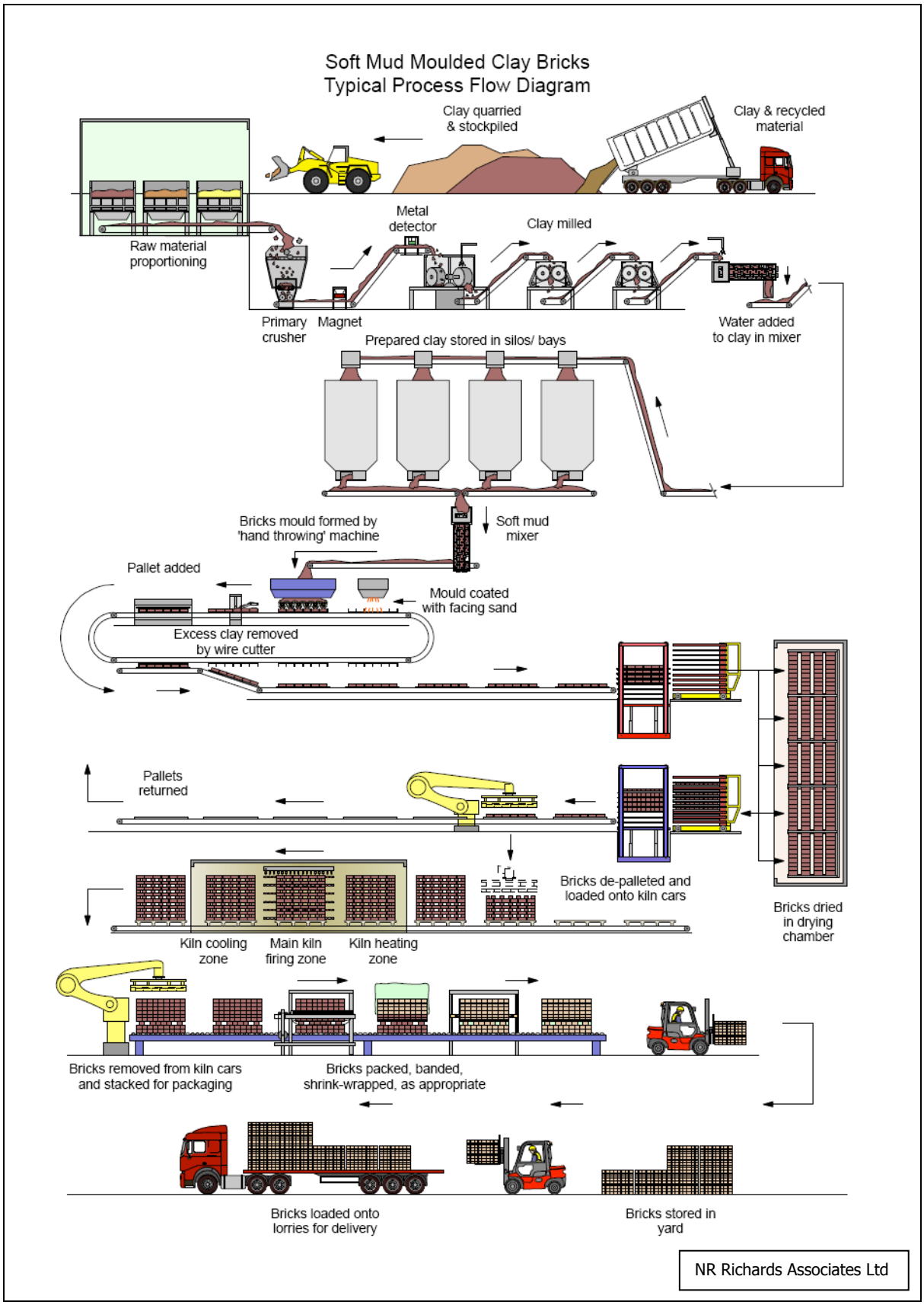

Figure A3: Typical process flow for the manufacture of moulded soft mud bricks

Most clay types in the UK can be used for either process. However, as the UK brick sector has evolved, the harder, less clay-rich shales and marls have tended to lend themselves more to extrusion than the soft mud process.

Clays that are more clay mineral rich and thus can develop a greater degree of 'plasticity' lend themselves more to the soft mud process because the clay, when thrown or pressed into the mould, forms the shape and texture better than less plastic clays.

The extrusion process typically produces bricks with perforations within the body of the brick, ranging from highly perforated units through to the more traditional three and ten holes. The perforations help in the formation process of the bricks, allowing the clay to be compressed in the extrusion die. But the main benefits come from the drying and firing process, where the additional voids within the bricks not only reduce the amount of raw material in the brick but also increase the surface area, thus allowing more efficient drying and firing. An additional benefit is the reduction in the weight of the brick without loss of performance characteristics, so reducing the overall weight being transported.

Soft mud bricks are typically 'solid' or 'frogged' in appearance. The 'frog' is the name given to the indentation typically on the upper bedface of the brick. It reduces the amount of raw material in the brick and increases the surface area, thus aiding drying and firing. The frog also helps in the structural performance of the masonry when laid and filled with mortar.

The raw materials for clay brick and clay block production in the UK are usually located adjacent to the site of the brickworks, and consequently have limited transportation distances. The one main exception is the supply of fireclays, which are usually won as a by-product and are therefore predominantly a recycled raw material, sourced from opencast coal mining operations. Accordingly, fireclays tend to be transported the greatest distances of all the clay raw materials within this sector.

In addition to the primary raw materials, many secondary or alternative raw materials are utilised by a significant number of the UK production sites. Ceram annually reports the use of these types of materials, which within the sector are known as MARSS materials (Materials from Alternative, Recycled and Secondary Sources). Although the annual reports are not published outside the industry, a six-year review[20] of MARSS usage was published by Ceram in 2012 and presents an historical look at the trends in alternative materials consumption going back to 2005 within the brick manufacturing sector.

[20] Materials from Alternative, Recycled and Secondary Sources (MARSS) 2005-2010: A Review of the Use of Non-Primary Clay Raw Materials in the UK Brick Manufacturing Sector. (http://www.ceram.com/industries/construction/)

A4 Resource efficiency indicators

Using the Green Construction Board's primary indicators of waste, water, energy, materials and biodiversity, performance against these indicators was undertaken as part of the background scoping works for this report. The following sections identify the current performance of the UK clay brick industry against these indicators:

A4.1 Raw materials supply

Materials (primary raw) – The raw materials used in the brick/block manufacturing process include:

- Primary clay, shale and fireclays
- Sand
- Limestone
- MARSS materials (recycled materials)
- Pigments/additives.

The quantities (body mix) depend upon the type of brick/block being manufactured and the actual manufacturing process.

In 2010, the UK National Mineral Statistics[21] showed that 3,788,000 tonnes of clay, shale and fireclay were extracted for brick production. Based on UK construction materials production statistics for 2011[22], 1,554,000,000 bricks were produced. On the basis that the average weight of a brick is 2.8kg before firing, this equates to 4,351,200 tonnes of raw materials (of all types).

On this basis, the 4,351,200 tonnes (all materials) less the 375,263 tonnes of MARSS content gives approximately 3,976,000 tonnes of primary clay, shale and fireclay for 2011.

Waste – About four million tonnes of primary clays, shales and fireclays were extracted and, in addition, based on typical clay to overburden and inter-burden ratios, it is estimated that an extra 1-2.5 million tonnes of material were excavated but not used. Normally, these materials are placed back in the void for restoration purposes.

Although this value is an estimate, it does provide some potential scale to the materials that are extracted but not used outside the excavation site.

Recycled materials – The use of recycled materials in the raw material supply chain is detailed in the annual MARSS Report[23]. The 2012 report (reporting 2011 data) shows that the recycled content equates to 375,263 tonnes or 9.3% of material usage, based on the returns from 45/58 works operating during 2011. This, however, is a generic value for the sector and bricks/blocks individually range from zero percentage recycled content to 100% recycled content, depending on product type and manufacturing process.

[21] Minerals Produced In The United Kingdom 2010.
http://www.bgs.ac.uk/mineralsuk/statistics/downloads/MineralsProducedInTheUnitedKingdom.pdf
[22] UK construction materials production statistics,2011
http://www.bis.gov.uk/analysis/statistics/construction-statistics/building-materials
[23] MARSS 2012 (2011 data) Materials from Alternative, Recycled and Secondary Sources (MARSS); the use of none primary clay raw materials in the UK brick manufacturing sector.

Carbon (energy and GHG emissions) – The most up-to-date value for the embodied carbon content for bricks manufactured in the UK is in the study undertaken by Ceram in 2010[24], which established a generic carbon footprint for the UK bricks sector based on the weighted average of 13 brickworks, which represent the range of raw materials, manufacturing process and age/efficiency of facilities.

The Ceram carbon footprint for bricks shows that the raw materials component of the footprint (embodied carbon) is equivalent to 83kg CO_2e/tonne fired brick.

Water – As most of the raw materials used in the brick and block manufacturing process are typically from a primary source, the actual water content is dictated by two factors:

Free water content for clays, shales and fireclays is typically around 6-10% by weight. Based on the 2011 clay usage estimates, this equates to about 240,000m^3 to 400,000m^3 (tonnes) of water naturally embedded in the clay itself, which is lost through the drying, along with any additional water added to the atmosphere by evaporation.

The actions developed build upon current best practice and reflect the aims and objectives of the water footprinting methodologies developed for the reporting of water efficiencies.

A4.2 Manufacturing process

Materials – UK brick production[5] in 2011 was 1.554 billion bricks. This equates to approximately 3,418,800 tonnes of bricks/blocks based on an average fired unit weight of 2.2kg.

Waste – Waste to landfill is now below 4,000 tonnes per annum based on the reporting of the sector's KPIs[25]. This is broken down into the following:

- 0.09% non-hazardous (about 3,080 tonnes)
- 0.01% hazardous (about 340 tonnes)
- 0.10% total to landfill (3,420 tonnes).

Values are 'waste disposal to landfill expressed as percentage of production (fired product) by weight'.

Carbon (energy and GHG emissions) – The Ceram Carbon Footprint report for bricks shows that the manufacturing process component (including site office and head office contributions) of the footprint (embodied carbon) is equivalent to 151kg CO_2e/tonne fired brick.

Total embodied carbon therefore at the factory gate is 234kg CO_2e/tonne (process + materials).

Water – The BDA publishes an annual update to 'The Sustainability Strategy for the UK brick industry' and other environmental and business KPIs, in which water source and usage are reported. An update is available for 2011 (2010 data).

[24] Generic Carbon Footprint of the UK Clay Brick Industry 2010 (2008 baseline data)
[25] The Sustainability Strategy for the UK brick industry 2011 update.
http://www.brick.org.uk/wp-content/uploads/2012/05/KPI-sustainability-strategy.pdf

For the sites that responded to the survey, 375,208m^3 of water were used. Because this equates to approximately 90% of the production sites in the UK, it is estimated that the total UK water usage in brick manufacture is around 417,000m^3. Of this, currently 30.5% is recovered water (defined as 'not from mains supply').

Ceram has undertaken two site-specific water footprints. Neither study is published[26] but the values are included here for completeness:

- Soft mud brickworks – 22,826m^3 (4,850m^3 from water contained within the raw materials; 17,976m^3 added/used in the process).
- Extruded brickworks – 32,074m^3 (17,588m^3 from water contained within the raw materials; 14,486m^3 added/used in the process).

Converted to m^3 of consumed water per tonne of fired brick produced, this equates to:

- Soft mud = 0.563m^3/tonne
- Extruded = 0.217m^3/tonne.

A4.3 Logistics and packaging

Much of the available data for logistics and packaging waste is generic to the construction sector. However, there is limited specific information in respect of bricks and average delivery distance, and thus the resulting energy (carbon footprint).

Carbon (energy and GHG emissions) – The Generic Carbon Footprint for Clay Bricks for 2008 reported the average delivery mileage based on deliveries from each of the 13 brickworks included in the study.

The average delivery distance is 78 miles. Based on the DEFRA GHG conversion factors for 2008 for the type of fleet used for brick distribution, this equates to approximately 10kg CO_2e/tonne.

A4.4 Design, construction and demolition

For the remaining segments of the supply chain, the available current resource efficiency indicators are generic in the main and reflect the construction and demolition process as a whole, rather than with any specific focus upon the individual impact of any specific construction material.

Studies and reports have generally focused on waste generation in the construction process, and what factors have significant influence over the waste being generated. WRAP's report, Upper and Lower Wastage Ranges for Construction Products[27], indicates that wastage rates of bricks on site are typically in the range of 2% to 8%, depending upon the site practice and whether or not specialist bricklayers were employed. It appears that the main factors influencing the wastage rate on the construction site are:

[26] Confidential Reports – Water Footprint – Wienerberger Sandown, Ibstock – Ellistown.
[27] Upper and Lower Wastage Ranges for Construction Products 2011 (WAS908-001)

- Methods of work (workmanship)
- The need to cut bricks
- Design of structure being too complex
- Damage during transportation to site and handling on site
- Over ordering
- Brick properties themselves (brittleness).

Although these are averages based on a number of projects, significantly higher wastage rates were recorded for specific projects, the highest being 21.5% for a school project (363 tonnes of waste brick left the project).

The DEFRA 'Understanding and Predicting Construction Waste' (WR0111) report[28] published in 2008 identified that, for ceramic/bricks wastage, rates vary depending upon the type of building being constructed. The survey ranges from wastage rates (volume wastage in m^3 per $100m^2$ floor space) of $1.44m^3/100m^2$ (about $2.2t/100m^2$) for residential projects down to $0.1m^3/100m^2$ (about $0.2t/100m^2$) for leisure facilities.

A4.5 Biodiversity

Conserving the UK's biodiversity is an essential requirement for sustainable development. Stakeholders expect the brick manufacturing industry to reflect this in the way it carries out its business. At the same time, industry increasingly recognises the importance of its role in conserving biodiversity, with the brick/mineral industries being among the leaders in demonstrating how this can be done through the implementation of Biodiversity Action Plans (BAPs). The most exciting opportunities lie in quarry management and restoration, where there is great scope to recreate habitats and encourage species that were once more common in the wider countryside and are targeted in the UK BAP.

Built environment assessment schemes such as BREEAM and CEEQUAL are also helping to raise awareness with clients, architects and contractors and ensure that opportunities are taken to integrate biodiversity into the built environment.

Biodiversity is a developing area, in particular with the work being done on ecosystem services, which assign a financial benefit to natural resources. Also, there are future opportunities for a biodiversity credit scheme, where the impacts of development are offset at another location. Biodiversity will be revisited at the annual review stage, allowing progress of these developments to be monitored.

[28] Understanding and Predicting Construction Waste' (WR0111) http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=14677