Construction case study

Woolwich Single Living Accommodation Modernisation (SLAM) Regeneration

Examining the cost savings and environmental benefits achievable by following WRAP's approach to improving materials resource efficiency on the Woolwich SLAM regeneration programme, London.

Project code: WAS061
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WRAP helps individuals, businesses and local authorities to reduce waste and recycle more, making better use of resources and helping to tackle climate change.

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Executive summary

This case study outlines how Bovis Lend Lease and Debut Services have employed the WRAP (Waste & Resources Action Programme) Regeneration Guide methods to inform and influence the feasibility, planning and delivery stages of work related to the demolition, excavation and construction works associated with the regeneration of the Woolwich barracks in the east end of London, as part of the SLAM (Single Living Accommodation Modernisation) project.

Key outcomes of the case study were:

- Overall cost savings of between £26,250 (£7.50/tonne) and £42,000 (£12.00/tonne) could be achieved by retaining and reprocessing 3,500 of the 12,000 tonnes of demolition arisings – to be used as a recycled aggregate and instead of hauling this material off site and importing aggregates, subject to compatibility with the Contract Specifications.
- A Demolition Recovery Index (DRI) of 95% was set as the target for recovering material from site.
- The Retained Material KPI was 29%, indicating that although there was a limited demand for aggregates within the footprint of the modular build (3,500 tonnes) there was still a significant opportunity to improve the sustainability of the project in terms of the approach to materials resource efficiency.
- The target for recycled content of bulk materials in the new build was 100%.
- Analysing recycled content levels using WRAP’s Net Waste Tool on the modular build design determined a current standard project performance of 16% recycled content by value. Through closer inspection of the specification this could be improved to a good practice (Quick Win) level of 20% and a potential to achieve a ‘best’ practice level of 23%.
- Besides a carbon reduction, additional environmental benefits were identified in relation to 350 reduced vehicle trips and their associated nuisance (noise, vibration and dust) impacts – the result of retaining demolition arisings on-site for reprocessing.
- In terms of climate change potential impacts, the carbon footprint of the development was improved by approximately 11 tonnes of carbon dioxide, as a result of the reduced number of vehicle movements.
- The use of recovered materials would reduce the extraction of virgin aggregate materials, improving the longevity and sustainability of this industry moving into the future.
## Contents

1.0 **Introduction** ................................................................................................................................. 3  
   1.1 The WRAP Regeneration Guide ..................................................................................................... 3  
   1.2 SLAM Woolwich - Description of the Development ..................................................................... 3  

2.0 **The scope of work and activities** .................................................................................................... 5  
   2.1 Scope of works ............................................................................................................................. 5  
   2.2 Activities forming part of the case study ..................................................................................... 5  

3.0 **Designing for Materials Resource Efficiency (MRE)** .................................................................... 6  

4.0 **Outputs** ........................................................................................................................................ 7  
   4.1 Pre-demolition audit and new build bulk material requirements ............................................. 7  
   4.2 Key Performance Indicators (KPIs) for bulk materials ............................................................. 7  
   4.3 Key Performance Indicators (KPIs) – Recycled content for modular build components .......... 8  
   4.4 Waste arisings from the manufacturing process ...................................................................... 8  

5.0 **Benefits of linking demolition and new build** ............................................................................. 9  
   5.1 Description of assumptions and underpinning data .................................................................. 9  
   5.2 Cost and environmental benefits model for using reprocessed demolition arisings on-site ........ 9  
      5.2.1 Cost benefits ......................................................................................................................... 9  
      5.2.2 Environmental savings (transportation only) ................................................................. 10  

6.0 **Material Resource Efficiency context** .......................................................................................... 10  

7.0 **Conclusions** ................................................................................................................................ 11  

8.0 **Recommendations** ........................................................................................................................ 11  

9.0 **References** .................................................................................................................................. 12  

Appendix A Overview of the WRAP Regeneration Guide ........................................................................ 13  
Appendix B Demolition award letter - reference to the WRAP Regeneration Guide requirement ......... 14  
Appendix C WRAP Net Waste Tool report on the Caledonian Modular Build ...................................... 15  
Appendix D Reclamation survey report ................................................................................................. 16
1.0 Introduction

This case study is one of a number developed across the UK, involving implementation of the WRAP Regeneration Guide on a range of projects (the Guide is described in Appendix A).

1.1 The WRAP Regeneration Guide

This case study describes the implementation of the principles contained within the WRAP publication ‘The efficient use of materials in regeneration projects’ at the Woolwich barracks site in the east end of London. Referred to as the “Regeneration Guide” for brevity in this document, it describes how Materials Resource Efficiency (MRE) practices can provide more environmentally sustainable outcomes as well as cost benefits. The Guide draws upon the ICE Demolition Protocol, Site Waste Management Plans and the WRAP Recycled Content Quick Wins approach and integrates them into a clear and structured framework.

This guide is a resource for all parties interested in implementing requirements for the efficient use of materials in regeneration projects. A brief overview of the Guide can be found in Appendix A, with the full document available for free download from WRAP’s website www.wrap.org.uk/construction.

1.2 SLAM Woolwich - Description of the Development

SLAM Woolwich is one project from the SLAM (Single Living Accommodation Modernisation) programme, forming part of the MOD’s (Ministry Of Defence) objective to improve its military accommodation to aid recruitment and retention. In 2006/07 the MOD spent £700m on housing and other living accommodation, anticipated spending £870m in 2007/08 and more than £5bn over the next decade.¹

The new build element of the SLAM project at Woolwich Barracks mostly encompassed the provision of new Single Living Accommodation (SLA) procured under the Defence Estates SLAM Prime Contract. The SLAM approach was based on a Model Standard Specification, which defines the materials, space standards and construction approach. The aim was to provide high quality accommodation efficiently while achieving value for money. The Woolwich development involved bringing in modular building units, pre-assembled by Caledonian Building Systems, based near Newark. Caledonian are a primary provider of permanent accommodation buildings for the Ministry of Defence, using offshore modular construction. Caledonian Building Systems are described as being compliant designs conversant with MOD standards. The company has a dedicated manufacturing facility at Newark co-located with other MOD supply chain partners.

Primarily the SLA for Phase 1 of the Woolwich project was for Junior (military) ranks with 422 ensuite rooms and personal store. This included six new blocks, consisting of a mix of 32, 56 and 88 man-blocks at 4 storeys and a single block of 70 at 5 storeys. All of these blocks would be contained within the area presently taken up by the existing accommodation blocks providing a combined total of 13,392m² GIA (Gross Internal Area) of new accommodation to Phase 1.

Figure 1 shows the site and the area/buildings covered by Phase 1 of the project. Discussions and consideration of the site indicated that there should be sufficient area to store demolition arisings from the buildings and infrastructure to meet the demand for bulk materials (2,000m³) in the new build. This would be confirmed through development of a site logistics drawing. The Grade 2 listed buildings would be retained, with balance of buildings within the development area demolished. The mass concrete strip foundations (1.2 metres deep) would be excavated completely. Other non accommodation buildings would be maintained, refurbished or rebuilt by the Regional Prime contractor responsible for the ongoing maintenance of the site.

¹ Data from Ministry of Defence News (Estates and Environment), 13th September 2007: http://www.mod.uk
The total value of Phase 1 of the SLAM Woolwich project was circa £25 - £30 million.

Phase 2 of the SLAM project started in December 2007. This is a 5-year programme with Defence Estates worth more than £300 million, which could potentially double. Phase 1, which Woolwich is a part of, has a 2003 - 2009 programme, worth circa £600 million.

The project team working on this case study was as follows:

- Debut Services Ltd\(^2\) - Principal Contractor – Project SLAM
- H Smith (Engineers) Ltd – preferred demolition contractors
- HLM Architects - design
- Scott Wilson Group Plc - engineering contractors
- Hulley and Kirkwood - M&E Services Engineers
- W. Long & Co Ltd – groundworks contractor
- Caledonian Building Systems (CBS) Ltd - manufacture and construction of new build- off-site modular construction
- Lorne Stewart - M&E contractors
- Irvine Whitlock - External Cladding contractor
- Crendon Roofing Services - Roof contractor
- EnviroCentre - managing the implementation of the Regeneration Guide
- Bovis Lend Lease - facilitating implementation of the Regeneration Guide
- White Design - implementing/supporting the use of the Net Waste Tool, forming part of the Regeneration Guide.

\(^2\) Debut Services Ltd is a joint venture between Bovis Lend Lease Limited and Babcock International Group PLC. To manage the delivery of the first phase of the SLAM programme (worth £600 million between 2003 and 2009).
The contractual approach to the project was that it is delivered as a Maximum Price Target Cost (MPTC), which has a Pain/Gain Mechanism and shared savings structure to incentivise and unite the Design and Contracting Supply Chains.

The programme and activities shown in Section 2 describe the key milestones for the project, requirements for stakeholder engagement and incorporation of the Regeneration Guide in the project specifications, tenders and contracts.

2.0 The scope of work and activities

2.1 Scope of works

The scope of works for the support in implementing the Regeneration Guide included the following:

- Incorporate the requirements of the WRAP Regeneration Guide into the tender/contract documentation for the demolition and construction activities associated with the regeneration of the Woolwich barracks. This work would lead to an assessment of the quantity and type of demolition arisings, the preferred approaches to managing this material, from cost and environmental perspectives.
- An assessment of the quantity of recycled materials to be procured for the civils work, with the potential for reprocessed demolition arisings to supply this demand.
- Establish the potential for the modular build, being constructed by CBS, to incorporate an increased level of recycled materials in the various building components. The case study focuses on the four storey T shaped block design which will serve up to 72 personnel, has a construction value of between £4 - £5 million and is due for completion by September 2009.

2.2 Activities forming part of the case study

The Regeneration Guide implementation support in 2007 and to March 2008 involved the activities outlined below.

**October - December 2007**

A meeting was held at Woolwich between EnviroCentre, Debut Services and H Smith (preferred demolition contractor). Agreement was reached for the requirement to implement the Regeneration Guide to be built into the contract, and discussions were held on the potential to segregate materials (e.g. concrete from the foundations), with a view to delivering maximum reuse potential in the new build.

Discussions between EnviroCentre, Caledonian and White Design resulted in agreement of the scope of works and requirements for delivering the recycled content Quick Wins using the Net Waste Tool (NWT) as part of the Regeneration Guide. A meeting with Caledonian in December 2007 discussed the initial run of the Toolkit and its outputs. A walk through the process identified that one of the key opportunities for influencing material specifications could be with regards to plasterboard, which was, after the structural steelwork, the most significant volume/tonnage of material used. Caledonian commented that changes to the design for Woolwich could be incorporated into the modules supplied, if decisions were made early in 2008.

At the December 2007 meeting it was agreed that the Woolwich design would be used as the basis for further runs of the Net Waste Tool (outputs shown in Appendix C), to incorporate the proposed roofing design and ground works. This would allow a recycled content value specifically for this project to be given (in terms of the baseline and potential). Modular builds are typically delivered by Caledonian to site where the ground works have been managed by the main contractor. This will often mean that the roof design is different, and the site preparation, is also different.

**January 2008**

There was a project meeting on site at Woolwich where clauses for inclusion in the demolition and construction contracts (Box 1) were provided and discussed. A letter could be included within the contract documents for the demolition works, to be incorporated within the Works Order (see Appendix B). The groundwork contractor (W.
Long & Co Ltd) was operating under a framework contract with Debut Services Ltd. A letter incorporating the relevant clauses would be sent requesting that they incorporate the approach identified in Box 1 within their works.

Discussions were held about cost benefits associated with implementation of the guide and its approaches. A template of the reporting needs was provided to simplify the process. The meeting had highlighted that there may be an opportunity for reclamation activities to be undertaken onsite. The project team were given the contact details for BioRegional (London based environmental organisation) to establish the potential for a reclamation audit.

**Box 1. Draft Clauses For Inclusion in the SLAM Woolwich Project**

**Demolition**

"Demolition works should be carried out in accordance with the WRAP Regeneration Guide. This describes how demolition should be carried out in line with the principles of the ICE Demolition Protocol, with the following requirements:

- A pre-demolition audit to establish the quantity of materials which will arise from demolition;
- Recovery targets to be set and agreed with the Client; and
- Verification approaches to be established and agreed with the Client"

**Construction**

"Construction works will be carried out in accordance with the WRAP Regeneration Guide. This describes how (i) these works should use demolition arisings recovered from site where possible and (ii) imported materials with high recycled content where recovered demolition materials cannot be used. The requirements are as follows:

- A target should be set and agreed with the Client for the use of recovered demolition materials;
- A target should be set and agreed with the Client for the recycled content of imported materials; and
- Verification approaches to be established and agreed with the Client"

**February – March 2008**

It was established that a reclamation audit could be carried out on the site free of charge by BioRegional. A subsequent report identified a number of items which would have reclamation value, some of which had already been identified and targeted by the Demolition Contractor. A copy of this report is shown in Appendix D.

A Demolition Bill of Quantities (D-BOQ) was produced, and an estimate of the demand for aggregates in the new build civil engineering works programme was made.

**Forward Programme (post case study)**

The forward programme, shown below, summarises the work which would be undertaken at Woolwich in the period after March 2008:

- Demolition programme - March 2008 start, with groundworks projected to begin in May.
- Some of the Caledonian SLA modules scheduled to start arriving in April - to be stored at the site until groundworks / foundations complete and ready.
- New Build Design: View from Caledonian on the potential to make specification changes.
- Measurements/verification of performance against targets. e.g. Measurement of material recovered (on-site and off-site) versus KPI targets.
- Measurement of materials retained for use in construction works.

**3.0 Designing for Materials Resource Efficiency (MRE)**

Opportunities for the delivery of Materials Resource Efficiency (MRE) on demolition and regeneration projects are heavily influenced by the following factors.

- A policy/development framework that is supportive to MRE concepts.
- The way in which tenders and contracts are devised to allow ownership of the materials.
- The practicalities of the recovery process on site (availability of land, proximity of sensitive receptors to noise / dust).
- Adequate timescales are allowed at each of the stages to ensure MRE principles can be implemented.
- Perceived availability of virgin materials / quality of recycled materials.
- Availability of end use for recovered materials on site or identifiable market off site.
4.0 Outputs

4.1 Pre-demolition audit and new build bulk material requirements

The Demolition Bill Of Quantity (D-BOQ) in Table 1 shows that the arisings from demolition and excavations were significantly more than the demand for materials for groundworks and development platforms.

On the basis of a Demolition Recovery Index (DRI) of 95% there would be 10,739 tonnes of recycled aggregate available from the site. With the modular build approach the quantity of material required within the footprint of the buildings was described by the project team as minimal. The requirement for crushed material in the new build was estimated at 2,000m³, or 3,500 tonnes, which would be used in the formation layers of the paths, and hard standings.

The reclamation audit shown in Appendix D was undertaken by BioRegional. This identified a number of items which had reclamation potential; a number of which the demolition contractor had planned to take advantage of prior to demolition commencing, but with a view to benefiting from scrap metal value rather than reclamation value. In the end, the reclamation of items from the site were not anticipated to form a significant part of the demolition works due to time constraints.

<table>
<thead>
<tr>
<th>Recovery Items</th>
<th>Recovery potential</th>
<th>In-situ quantity</th>
<th>Unit</th>
<th>Quantity (tonnes)</th>
<th>Demolition Recovery Index</th>
<th>Demolition recovered material potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bricks</td>
<td>Recycling</td>
<td>2,168</td>
<td>m³</td>
<td>3,951</td>
<td>95%</td>
<td>3,753</td>
</tr>
<tr>
<td>Concrete Roof tiles</td>
<td>Recycling</td>
<td>49</td>
<td>m³</td>
<td>59</td>
<td>95%</td>
<td>56</td>
</tr>
<tr>
<td>Concrete</td>
<td>Recycling</td>
<td>2,218</td>
<td>m³</td>
<td>4,083</td>
<td>95%</td>
<td>3,879</td>
</tr>
<tr>
<td>Aggregates (hardcore)</td>
<td>Recycling</td>
<td>1,413</td>
<td>m³</td>
<td>2,489</td>
<td>95%</td>
<td>2,365</td>
</tr>
<tr>
<td>Asphalt</td>
<td>Recycling</td>
<td>392</td>
<td>m³</td>
<td>723</td>
<td>95%</td>
<td>686</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>11,304</strong></td>
<td></td>
<td><strong>10,739</strong></td>
</tr>
<tr>
<td>Timber Doors</td>
<td>Re-use</td>
<td>290</td>
<td>No</td>
<td>290</td>
<td>100%</td>
<td>290</td>
</tr>
<tr>
<td>Timber (roof trusses)</td>
<td>Recycling</td>
<td>41</td>
<td>m³</td>
<td>33</td>
<td>70%</td>
<td>23</td>
</tr>
<tr>
<td>Metal Windows</td>
<td>Recycling</td>
<td>480</td>
<td>No</td>
<td>480</td>
<td>100%</td>
<td>480</td>
</tr>
<tr>
<td><strong>Total £</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>12,107</strong></td>
<td></td>
<td><strong>11,532</strong></td>
</tr>
<tr>
<td>DRI %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>95.25</strong></td>
</tr>
</tbody>
</table>

4.2 Key Performance Indicators (KPIs) for bulk materials

Key performance indicators (KPIs) provide information and data which can be measured, providing targets and a focus for the various actions that need to be taken during the programme of works. As a result progress and effectiveness of the programme of works can be monitored and reported transparently. Without transparency there can be little confidence that what has been set out to be achieved has actually been achieved. In terms of the WRAP Regeneration Guide, there are 3 main KPIs used at various stages of a project.

- Demolition Recovery Index (DRI). This describes the efficiency of material recovery from demolition (as defined through the use of the Demolition Protocol).
- Retained Material (RM). This is a measure of the extent of the reuse of demolition materials on site.
- Recycled (and reclaimed) Content (RC). This measures the proportion of the recycled (and reclaimed) materials in the new build (based on the value of the material).
The KPIs for the Woolwich project were as summarised below:

- DRI: 95%
- RM: 29% (quantity of recovered material retained for use on site / total quantity of demolition material)
- RC: 100% (to be confirmed, on the basis of the grading certificates achieved from demolition arisings)

The above represents a significant and highly sustainable approach to the demolition and new build works at Woolwich i.e. the hard arisings available from demolition can provide the full demand for aggregates through on-site storage and reprocessing. This target of 100% procurement of aggregates was still to be confirmed at the time of writing.

4.3 Key Performance Indicators (KPIs) – Recycled content for modular build components

Appendix C provides the detailed WRAP Net Waste Tool\(^3\) outputs produced to demonstrate the following:

- The standard recycled content – this was the likely recycled content percentage of modular builds as designed by Caledonian for the SLAM project on the basis of using Bills of Quantities and through understanding the typical recycled content of such materials.
- The Quick Win increase in the standard recycled content, through the procurement of materials which have the highest monetary value and are procured in the highest quantities (focussed on the top ten materials).

At the detailed design phase, the Net Waste Tool was used to analyse the whole modular building construction, including the roof, sub-structure, super-structure and adjoining features, such as the stairwells. A current standard project performance of 16% recycled content by value was determined, exceeding the 10% minimum set by the client. This could be improved to a good practice (Quick Win) performance of 20% and best practice performance of 22.9%. These improved performances could be achieved through closer inspection of the specification.

The overall percentage mirrors advice that all projects should achieve a minimum of 10% recycled content target as a matter of course.

It was an aim of this case study that the SLAM project team and CBS would adopt specifications for the modular build which included a higher recycled content. This could be achieved by replacing materials currently specified with the ‘Quick Win’ opportunities identified by the Net Waste Tool, for example by using plasterboard with a higher recycled content.

4.4 Waste arisings from the manufacturing process

WRAP studies have shown that modular build can reduce on-site waste by up to 90%. Anecdotal evidence suggests the waste that does arise is dominated by plasterboard. A number of aspects of the current process could be evaluated with a view to reducing level of waste arisings:

- Investigate opportunities for the plasterboard supplier to take back plasterboard offcuts for recycling back into the plasterboard manufacturing process.
- Modular designers to consider the opportunities to rationalise layouts in terms of plasterboard dimensions, and in turn reduce cutting with the associated reduction in offcuts.
- Consider time implications for fabricators to use off cuts to surround window and door openings in order to avoid the current practice of covering window and door openings and cutting out.

\(^3\) More information on the WRAP Net Waste Tool can be found at: www.wrap.org.uk/nwtool
5.0 Benefits of linking demolition and new build

The potential benefits of MRE practices can be described by comparing their costs and environmental impacts with more traditional approaches. This section does so using a transparent approach which can be modified to reflect varying circumstances, changing pricing structures etc.

5.1 Description of assumptions and underpinning data

The following pricing structure (derived from an aggregates processor) was used to indicate the extent of cost savings to be realised through the ownership, reprocessing and retention of materials on site.

- Recycled aggregates (RA): reprocessing cost on site £3 / tonne
- Imported aggregates: including haulage £8 / tonne

Estimates of cost savings and environmental benefits were made on the basis of the above costs and the quantities mentioned in previous sections. By retaining materials on site, avoided vehicle movements would be realised. The haulage and use of dredged sands by boat would also provide significantly reduced movements of vehicles by road.

Avoided road vehicle movements were calculated from the scenario where 20 tonne payload vehicles would be used, with the assumption that a round trip of 20 miles would be avoided (an average of 10 miles to a landfill and/or aggregate supplier/depot). More than 12,000 tonnes of hard materials would become available from the demolition process, with the potential for 3,500 of this to be reprocessed and stored on the site for use as recycled aggregates in the new build works. By retaining this material on site, this equated to 350 avoided vehicle movements.

Cost and environmental benefits, from retaining material on-site, are encouraged by the WRAP Regeneration Guide and the following section summarises these benefits – doing so by describing the use of reprocessed demolition arisings on-site versus hauling demolition material off-site and importing aggregates.

Environmental savings through avoided transportation were calculated as CO₂ savings using DEFRA data (Guidelines for Company Reporting on Greenhouse Gas Emissions). WRAP’s CO₂ Estimator Tool could equally be used, as well for calculating a wider range of impacts beyond transportation. The approach used determined the impacts of vehicle movements on CO₂ gas production for different options. It was assumed that 20 tonne payload vehicles could be expected to deliver a performance of around 8 miles per gallon of diesel or 1.7 miles per litre. With 2.63 kg of CO₂ produced per litre of diesel, this then translated to 1.55 kg CO₂ emissions per mile travelled.

5.2 Cost and environmental benefits model for using reprocessed demolition arisings on-site

5.2.1 Cost benefits

A summary of indicative cost savings associated with this use is presented below in Table 2, on the basis that 3,500 tonnes of reprocessed material could be used on-site.
Table 2  Summary of cost savings

<table>
<thead>
<tr>
<th>Description</th>
<th>Use of site-won aggregates</th>
<th>Haulage, landfill &amp; use of imported aggregate</th>
<th>Haulage &amp; use of imported aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landfill cost</td>
<td>None</td>
<td>*£4.50/tonne, therefore £15,750</td>
<td>None</td>
</tr>
<tr>
<td>Haulage cost from site</td>
<td>None</td>
<td>£2.50/tonne, therefore £8,750</td>
<td>£2.50/tonne, therefore £8,750</td>
</tr>
<tr>
<td>Cost of producing/buying aggregate</td>
<td>£3/tonne, therefore £10,500</td>
<td>**£8.00/tonne, therefore £28,000</td>
<td>**£8.00/tonne, therefore £28,000</td>
</tr>
<tr>
<td><strong>Total cost</strong></td>
<td><strong>£10,500</strong></td>
<td><strong>£52,500</strong></td>
<td><strong>£36,750</strong></td>
</tr>
</tbody>
</table>

*Landfill Tax of £2.50 and waste gate fee of £40/load or £2/tonne.  TOTAL = £4.50/tonne
**Assumption: ex quarry/reprocessor price £5.50/tonne; haul (20 mile round trip) £2.50.  TOTAL = £8.00/tonne.

Table 2 shows that an overall cost saving of between £26,250 (£7.50/tonne) and £42,000 (£12.00/tonne) could be achieved by using recycled aggregates instead of hauling material off site and importing aggregates.

5.2.2  Environmental savings (transportation only)

Using site won recycled aggregate or recycled concrete aggregate instead of imported primary aggregate results in less CO₂ emissions being generated. A summary of the scale of the emissions saved is highlighted in Table 3.

This results in an overall CO₂ saving of 10.85 tonnes.

Table 3  Summary of CO₂ emissions

<table>
<thead>
<tr>
<th>Description</th>
<th>Use of site-won aggregates</th>
<th>Demolition material exported &amp; aggregates imported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haulage from site</td>
<td>N/A</td>
<td>5,425</td>
</tr>
<tr>
<td>Haulage of aggregates to site</td>
<td>N/A</td>
<td>5,425</td>
</tr>
<tr>
<td><strong>Total emissions</strong></td>
<td>0</td>
<td>10,850</td>
</tr>
</tbody>
</table>

6.0  Material Resource Efficiency context

The increases in Landfill Tax and the aggregates levy are driving greater consideration of more sustainable approaches to managing demolition contracts, in particular with respect to how material ownership models can lead to cost savings for clients, as well as environmental benefits.

As well as impacting on the demand for aggregate, the Landfill Tax increases the cost of disposal considerably, particularly if demolition and construction waste is mixed (both inert and non-inert). The Landfill Tax for non-inert waste was £32/tonne in 2008/09 (an increase of £8/tonne over 2007/08) with inert Landfill Tax set at £2.50/tonne (an increase of £0.50 over the previous year). The increase in tax for non-inert waste provides additional incentives for the segregation of demolition arisings. With the increase in the aggregates levy from £1.60/tonne to £1.95 in 2008, the benefits of additional segregation activities are compounded by making recycled aggregates an even more attractive material stream than primary/virgin materials.

In common with many parts of the UK there is also an increasingly limited amount of landfill space available, and in some areas no space remaining. This will also continue to drive costs higher in time.
7.0 Conclusions

This case study highlighted the cost savings and environmental benefits achievable by improving materials resource efficiency on the Woolwich SLAM project.

The key outcomes were:

- Overall cost savings of between £26,250 (£7.50/tonne) and £42,000 (£12.00/tonne) could be achieved by retaining and reprocessing 3,500 of the 12,000 tonnes of demolition arisings – to be used as a recycled aggregate and instead of hauling this material off site and importing aggregates, subject to compatibility with the Contract Specifications.

- A Demolition Recovery Index (DRI) of 95% was set as the target for recovering material from site.

- The Retained Material KPI was 29%, indicating that although there was a limited demand for aggregates within the footprint of the modular build (3,500 tonnes) there was still a significant opportunity to improve the sustainability of the project in terms of the approach to materials resource efficiency.

- The target for recycled content of bulk materials in the new build was 100%.

- Analysing recycled content levels using WRAP’s Net Waste Tool on the modular build design determined a current standard project performance of 16% recycled content by value. Through closer inspection of the specification this could be improved to a good practice (Quick Win) level of 20% and a potential to achieve a ‘best’ practice level of 23%.

- Besides a carbon reduction, additional environmental benefits were identified in relation to 350 reduced vehicle trips and their associated nuisance (noise, vibration and dust) impacts – the result of retaining demolition arisings on-site for reprocessing.

- In terms of climate change potential impacts, the carbon footprint of the development was improved by approximately 11 tonnes of carbon dioxide, as a result of the reduced number of vehicle movements.

- The use of recovered materials would reduce the extraction of virgin aggregate materials, improving the longevity and sustainability of this industry moving into the future.

8.0 Recommendations

- Confirmation/verification of the quantity of material to be retained and used in the new build as recycled aggregates. The design to assess and state the suitability of the demolition arisings for use as aggregate under paths and as hard-standing.

- Consideration should be given to alternative approaches for the assembly of the modular building components to minimise waste production, in particular with respect to plasterboard.

- Specifications for the modular build components of SLAM should be reviewed with the objective of moving beyond the current 16% recycled content to a Quick Win of 20%. The review should identify the materials most likely to be suitable to the project with inclusion of these in the building specification.

- Caledonian Building Services to provide feedback on materials selected, why they selected them and the practical impacts they had on the specification and construction of the project.

- The volume/tonnage of materials recovered from demolition should be verified, with stockpile locations recorded and waste transfer notes easily available to support this. This information can then be used to inform and influence approaches to future projects.

- Clear linkages should be made in any future redevelopment tenders/contracts to how Materials Resource Efficiency approaches should be implemented.
9.0 References

1. WRAP: The efficient use of materials in regeneration projects - a step by step guide. 
   www.wrap.org.uk/construction/construction_waste_minimisation_and_management/mre_guide.html

2. Institution of Civil Engineers (ICE): Demolition Protocol. 
   www.ice.org.uk/knowledge/specialist_waste.asp

3. The WRAP Net Waste Tool (formerly the Recycled Content Toolkit) 
   www.wrap.org.uk/nwtool
Appendix A
Overview of the WRAP Regeneration Guide

Introduction

This guide is a resource for all parties interested in implementing requirements for the efficient use of materials in regeneration projects. It incorporates good practice:

- in demolition – through the use of the ICE Demolition Protocol and Site waste Management Plans;
- in new build construction – through WRAP’s recycled content, waste minimisation and site waste management guidance; and
- between the demolition and new build phases – through on site reclamation and recycling of materials.

Efficient use of materials in regeneration

Regeneration projects, in the context of this guide, are those where existing buildings and infrastructure contribute materials to the new build stage.

The efficient use of materials can lead to time and cost savings, reductions in material sent to landfill and extraction of primary resources and reduce carbon emissions.

Introducing good practice in the efficient use of materials involves:

- effective design;
- efficient procurement, and
- recycling of site arisings

Figure A1 Overview of materials resource efficiency in regeneration
Appendix B
Demolition award letter - reference to the WRAP Regeneration Guide requirement
Our Ref: [Redacted]

12th February, 2008.

Mr. Keith Rosher,
H. Smith Demolition Engineers Limited
Fordcroft Place, Fordcroft Road,
Orpington, Kent.
BR5 2DB

Dear Sirs,

Project SLAM
A8201 Woolwich Barracks
Demolition

Thank-you for your letter ref: [Redacted] DSL respond as follows:-

1. DSL acknowledges receipt of H. Smith's revised quotation of £179,000 plus inflation of 5% totalling £187,950. We note no allowance has been made for the discount of £10,000 on your tender included with H. Smith's letter dated 16th May, 2007. It was only after this discount that H. Smith became the most competitive tenderer for the demolition work at Woolwich. On this basis DSL included a value of £169,000 within our Maximum Price Target Cost (MPTC) submission to Defence Estates. The MPTC does make due allowance for inflation at 5%. Therefore DSL propose a revised order value of £169,000 plus 5% inflation at £1,8450 making a Sub-Contract order value of £177,450. Please review the above and confirm your acceptance of this total (£177,450) as your Sub-Contract order value.

2. The addition of the words, "as far as is practicable" is a fair and reasonable change to the phrase, "All metal, glass and plastic would be re-cycled." DSL are pleased to accept this.

3. With regard to the segregation of

4. Bioregional (contact Nicole Lazarus 0207 404 4267) would be invited to attend site to see if any of the materials (e.g. radiators, doors, sinks, baths, light fittings etc) would be of use. Any discussions with bioregional would have to include how material would be salvaged, stored and removed from site.

5. DSL confirmed they would also contact a supplier of biomass timber fuel to see if the timber from the buildings to be demolished could be used for fuel.

6. H. Smith requested a list of hazardous material be issued to include Man Made Fibre (note a site walk revealed fibre insulation within the loft spaces of the building) H. Smith were to supply some men and plant to form investigation holes within some of the external brick walls of the buildings to be demolished. This would determine whether the walls have cavity wall insulation that must be treated as hazardous material.

7. H. Smith and DSL noted that if extensive segregation of demolition materials was required this could have a cost impact. DSL and H. Smith to review following meetings with Bioregional.

8. DSL agreed to send plan drawings of the buildings to be demolished to H. Smith.

9. DSL agreed to issue a tender enquiry for any asbestos / hazardous materials to be removed to H. Smith.

10. The following wording proposed by Envirotech will be used to describe how the demolition process will be carried out.
Demolition works should be carried out in accordance with the WRAP Regeneration Guide. This describes how demolition should be carried out in line with the principles of the ICE Demolition Protocol, with the following requirements:
- A pre-demolition audit to establish the quantity of materials which will arise from demolition
- Recovery targets to be set and agreed with the client
- Verification approaches to be established and agreed with the client"

H. Smith confirmed that the demolition would be carried out in accordance with the above wording.

H. Smith confirmed they have a copy of the Wrap Regeneration Guide.

Yours faithfully

P. N. W. Dunn
Commercial Manager
Appendix C
WRAP Net Waste Tool report on the Caledonian Modular Build
WRAP Case Study: Caledonian, Project Slam

Introduction
Caledonian specialises in the design, manufacture and construction of permanent, multi-storey buildings using off-site modular construction (generally termed “Modern Methods of Construction”). The company operates as both Principle Contractor and Modular Sub-Contractor, constructing projects with values between £1M and £50M. Caledonian is the largest off-site constructor of permanent buildings in the UK, with a turnover in excess of £130M.

Caledonian is a primary provider of permanent accommodation buildings for the Ministry of Defence (MoD). With a long history of design and construction of single living accommodation, Caledonian’s design teams are fully conversant with all MoD standards and are able to develop compliant building designs which achieve the user needs within any specific regime or establishment.

Caledonian have long experience of Prime Contracting and Integrated Project Teams. Within the SLAM (Single Living Accommodation Modernisation) programme several supply chain partners are co-located at Caledonian’s base in Newark, Notts. and dedicated manufacturing facilities are aligned to the construction of service accommodation across a wide number of MoD establishments in the UK. Woolwich is just such an MoD site. This is just entering into the construction phase of the project, it is a residential site in London. The materials case study focuses on one four-storey T-shaped block at the Woolwich site which will serve up to 72 personnel. This has a construction value of £4.5 million and is aimed to be completed by September 2009. This case study will look at the opportunities for the use of materials with recycled content using the WRAP RC toolkit.

Feasibility
The project has adopted the standard WRAP advised minimum requirement of 10% recycled content by value of materials used within the construction. The Client has set this requirement as the initial benchmark of achievable practice with the hope to significantly exceed this figure and to improve steadily over time.

Outline Design
Using the RC toolkit and the design team’s estimates, an initial analysis of the current materials specified for use on this project resulted in a current standard project performance of 23.27%, with a suggestion that a good practice performance of 31.01% and total potential content value from use of ‘best’ products of 34.84% could be achieved. In this first analysis, the minimum had been achieved and so the expectations of the design team were greatly increased. This analysis was however based on a singular module component and did not include the substructure, external cladding or roof.

Detailed Design
Subsequently, at the detailed design stage, the RC toolkit was then used to explore the whole building, including the roof, sub-structure, super-structure and adjoining features, such as the stairwells. Much more information was available at this stage, some of which superseded previous details and with a whole building to now consider, a second analysis revealed that the materials specified for use on this project resulted in a current standard project performance of 15.99%, with a suggestion that a good practice performance of 20.24% and total potential content value from use of ‘best’ products of 22.88% could be achieved through closer inspection of the specification.

1 Waste & Resources Action Programme, Recycled Content Toolkit (WRAP RC Toolkit)
It is an aim of this case study that the SLAM project team and their consultants, will adopt a suggested target of 20% recycled content. This could be achieved by replacing materials currently specified with the ‘Quick Win’ opportunities identified by the RC toolkit. The ‘Quick Wins’ identify the hierarchy of products with the most monetary value, quantity and recycled content potential.

Package Procurement
Table 1, below, indicates the Quick Wins identified by the toolkit, it was apparent that they could all be incorporated to some extent.

Selected Quick Wins

<table>
<thead>
<tr>
<th>Option</th>
<th>Standard %</th>
<th>Good %</th>
<th>Best %</th>
<th>Selected QW %</th>
<th>QW added %</th>
<th>Qualifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal drainage flats</td>
<td>0%</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
<td>0.59%</td>
<td></td>
</tr>
<tr>
<td>12.5mm plasterboard, paint finish</td>
<td>36%</td>
<td>84%</td>
<td>98%</td>
<td>84%</td>
<td>0.56%</td>
<td></td>
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<tr>
<td>Expanded polystyrene (EPS) zero</td>
<td>0%</td>
<td>25%</td>
<td>25%</td>
<td>25%</td>
<td>0.44%</td>
<td></td>
</tr>
<tr>
<td>ODP 100mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expanded polystyrene (EPS) zero</td>
<td>0%</td>
<td>25%</td>
<td>25%</td>
<td>25%</td>
<td>0.48%</td>
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<td>ODP 60mm</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation to module ceilings</td>
<td>30%</td>
<td>50%</td>
<td>80%</td>
<td>50%</td>
<td>0.22%</td>
<td></td>
</tr>
<tr>
<td>Glass wool insulation 100mm</td>
<td>30%</td>
<td>50%</td>
<td>80%</td>
<td>50%</td>
<td>0.18%</td>
<td></td>
</tr>
<tr>
<td>Glass wool insulation 100mm</td>
<td>30%</td>
<td>50%</td>
<td>80%</td>
<td>50%</td>
<td>0.18%</td>
<td></td>
</tr>
<tr>
<td>Glass wool insulation 100mm</td>
<td>30%</td>
<td>50%</td>
<td>80%</td>
<td>50%</td>
<td>0.18%</td>
<td></td>
</tr>
<tr>
<td>Facing bricks £250 / 1000</td>
<td>0%</td>
<td>9%</td>
<td>35%</td>
<td>9%</td>
<td>0.12%</td>
<td></td>
</tr>
<tr>
<td>Carpet (generally)</td>
<td>0%</td>
<td>25%</td>
<td>25%</td>
<td>25%</td>
<td>0.11%</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Quick Wins identified by the RC Toolkit, for use on Project Slam, Woolwich

Graph 1: Quick Wins identified by the RC Toolkit, for use on Project Slam, Woolwich

Quick Win Product Suggestions

All the suggestions made in the table below are products that are ISO 14021 compliant. The materials list is not exhaustive and this information can be found online in the ‘Construction Product Guide’ on the WRAP website (www.wrap.org.uk).
<table>
<thead>
<tr>
<th>Option</th>
<th>Standard</th>
<th>Good</th>
<th>Best</th>
<th>Qualifier</th>
<th>Option</th>
<th>Standard</th>
<th>Good</th>
<th>Best</th>
<th>Qualifier</th>
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</thead>
<tbody>
<tr>
<td>Internal drainage flats</td>
<td>0%</td>
<td>10%</td>
<td>10%</td>
<td>0.059%</td>
<td>Europipe (RC: 70%)</td>
<td>Corripipe (RC: 100%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.5mm plasterboard, paint finish</td>
<td>36%</td>
<td>84%</td>
<td>98%</td>
<td>0.056%</td>
<td>British Gypsum - Gyproc Wallboard (RC: 84%)</td>
<td>British Gypsum - Gyproc Moisture Resistant (RC: 84%)</td>
<td>British Gypsum - Gyproc Duraline (RC: 84%)</td>
<td>Knauf Drywall - Moistureshield (RC: 87%)</td>
<td>Knauf Drywall - Wallboard (RC: 87%)</td>
</tr>
<tr>
<td>Expanded polystyrene (EPS) zero ODP 100mm</td>
<td>0%</td>
<td>25%</td>
<td>25%</td>
<td>0.044%</td>
<td>Celotex, Tuft - R Zero GA 3000 Z (RC: 10%)</td>
<td>Rockwool - Beamclad (RC: 20%)</td>
<td>Rockwool - Rockfloor (RC: 20%/22%)</td>
<td>Rockwool - Cavity Batts (RC: 20%/22%)</td>
<td>Rockwool - Cladding Roll (RC: 20%)</td>
</tr>
<tr>
<td>Expanded polystyrene (EPS) zero ODP 60mm</td>
<td>0%</td>
<td>25%</td>
<td>25%</td>
<td>0.028%</td>
<td>Celotex, Tuft - R Zero GA 3000 Z (RC: 10%)</td>
<td>Rockwool - Beamclad (RC: 20%)</td>
<td>Rockwool - Rockfloor (RC: 20%/22%)</td>
<td>Rockwool - Cavity Batts (RC: 20%/22%)</td>
<td>Rockwool - Cladding Roll (RC: 20%)</td>
</tr>
<tr>
<td>Insulation to module ceiling</td>
<td>30%</td>
<td>50%</td>
<td>80%</td>
<td>0.022%</td>
<td>Rockwool - Duorock (RC: 20%)</td>
<td>Rockwool - Rockfloor (RC: 20%/22%)</td>
<td>Wall and floor insulation: Isowool - Hi-Therm (RC: 70%); Isowool - Saint Gobain/BPB - Spacesaver (RC: 70%); Pittsburgh Corning (UK) - FOAMGLASS® Floorboard (RC: 66%); Superglass - Superwall (RC: 80%); Superglass Insulations Ltd. - Timber &amp; Rafter Batt, Multi Purpose Slab, Cladding Mat, Multipurpose Acoustic Roll, Multi Acoustic Roll, Timber Roll Sound, Deadening Mat, Multi Roll, Superglass Mat/Floor Slab. (RC: 89%); Vencel Resil (jablite) - jabfloor 70 (RC: 20%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass wool insulation 100mm</td>
<td>30%</td>
<td>50%</td>
<td>80%</td>
<td>0.018%</td>
<td>Isowool - Hi-Therm (RC: 70%); Isowool - Saint Gobain/BPB - Spacesaver (RC: 70%); Pittsburgh Corning (UK) - FOAMGLASS® Floorboard (RC: 66%); Superglass - Superwall (RC: 80%); Superglass Insulations Ltd. - Timber &amp; Rafter Batt, Multi Purpose Slab, Cladding Mat, Multipurpose Acoustic Roll, Multi Acoustic Roll, Timber Roll Sound, Deadening Mat, Multi Roll, Superglass Mat/Floor Slab. (RC: 89%); Vencel Resil (jablite) - jabfloor 70 (RC: 20%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Facing bricks £25/1000</td>
<td>0%</td>
<td>9%</td>
<td>35%</td>
<td>0.012%</td>
<td>Akristolos - Terrainova eco-bricks (RC: 20%); Baggerridge Brick PLC - Red, Sea Sand and Yellow Multi Rudgwick stock (RC: 11%); Hanson Brick UK - Marlow Red Multi (RC: 14%); Ibstock - Tudor Brown Smooth Blend, Parham Red Stock, Harwich Minster Cream Blend (RC: 5%); Ibstock Brick Ltd. - Arden Weathered Red - Red Multi (RC: 5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpet (generally)</td>
<td>0%</td>
<td>25%</td>
<td>25%</td>
<td>0.011%</td>
<td>Green Concept Ltd. - Green Concept Carpet Tiles, Carpet Tiles (RC: 65%); Interface Europe - Transformation (RC: 80%); Milliken Carpet - Omni Collection (RC: 30-40%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2: Quick Win product suggestions for Project Slam, Woolwich.
Further Recommendations
From a site visit to the Newark offsite prefabrication factory it was stated that the product generating the most waste was plasterboard. Several recommendations were discussed to reduce this wastage and these were identified as:-

- Investigate opportunities for plasterboard supplier to take waste and re-use in plasterboard manufacturing process
- Module designers to consider opportunities to rationalise layouts to use plasterboard dimensions and in turn reduce cutting and the production of off-cuts.
- Re-consider time implications for fabricators to use off cuts to surround window and door openings in order to avoid the current practice of covering window and door openings and cutting out.

Construction
The project will shortly be entering into the construction phase, the following Quick Wins have been selected for use and will be completed after consultation with Caledonian.

The evidence to support the selection and use of these Quick Win materials by the client, contractor and sub-contractor can be found on pages 2 of 4 and 3 of 4, in the form of delivery notes for material used at construction stage.

Next Steps...
The are two streams of work that will need to be completed. The first is the consideration of the identified Quick Wins and their associated material suggestions by Caledonian, the Client. Caledonian should review which of these materials are most likely to be suitable to their project and endeavour to include these into their building specification. The second stream of work directly relates to this case study. Both EnviroCentre, the lead partner in this case study, and Caledonian, will need to review the information in this study and provide feedback to White Design. Caledonian will also need to provide feedback on the materials they choose to select, why they selected them and what practical impacts they had on the specification and construction of the project. The full case study will need further work to be completed by all parties involved.

Considerations
There are a number of considerations that are associated with this case study, the most important and crucial is that the specification inputted by the WRAP Advocacy Consultant is correct. This can be addressed by a thorough review by Caledonian of the specification inputted into the RC toolkit. This review should include both selection of material, unit cost and quantities. The current rates used are those supplied by the WRAP RC Toolkit.
Appendix D
Reclamation survey report
Report to Bovis Lend Lease on the Potential for Reclamation and Reuse at the Royal Artillery Barracks Site, London

1.1. Overview

This document is the result of a reclamation survey\(^1\) carried out on behalf of Bovis Lend Lease of the Royal Artillery Barracks site at Repository Road, Woolwich, London SE18. The site contains five three storey brick buildings (approximately fifty years old) that will be demolished and replaced with new residential accommodation for military personnel. The survey was undertaken by BioRegional Reclaimed on the 31 January 2008 and for the purposes of this report the site will be referred to as the RA Barracks.

The redevelopment of the RA Barracks offers some good opportunities for reclamation and reuse. Opportunities of particular note include the cast iron radiators, the eight galvanised steel fire escapes and the brick paving sets to the perimeter of the blocks. In addition, there are a good quantity of heritage Royal Doulton Vitreous low volume cisterns, toilet pans, wash basins and Butler sinks all of which have potential value on the salvage market.

Although we do not believe the bricks can be re-used in their original form because of the cement bonding, there is the additional opportunity to recycle the non-reusable brick into aggregate for reuse on and off-site. Whilst not the focus of this report, the recycling of these materials presents additional economic and environmental savings, and the extent of this should be estimated within a full pre-demolition audit.

There is a clear case for the onsite reuse of the galvanised fire escapes, stainless steel staircase treads and brick paving sets. Additional reclamation of the cast-iron radiators and Royal Doulton Vitreous sanitary ware may generate some additional revenue. Established markets exist for the majority of the materials listed in this report.

Reclamation presents an opportunity to recover valuable materials and reduce disposal costs. Such reclamation would also result in significant environmental benefits including embodied carbon savings and diversion of waste from landfill. This is summarised in Table 1 overleaf.

\(^1\) A non-invasive site inspection to identify key reclaimable building materials: those that can be salvaged from the waste stream and reused in their original form, with minimal reprocessing.
<table>
<thead>
<tr>
<th>Materials</th>
<th>Quantity</th>
<th>Embodied CO₂</th>
<th>Estimated value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cast Iron</td>
<td>29 tonnes</td>
<td>53 tonnes</td>
<td>£3000+</td>
</tr>
<tr>
<td>Galvanised Steel</td>
<td>7 tonnes</td>
<td>12 tonnes</td>
<td>£8000+</td>
</tr>
<tr>
<td>Steel Treads</td>
<td>9 tonnes</td>
<td>16 tonnes</td>
<td>n/a</td>
</tr>
<tr>
<td>Ceramic ware</td>
<td>1 tonne</td>
<td>1 tonne</td>
<td>Cost neutral</td>
</tr>
<tr>
<td>Bricks sets</td>
<td>1 tonne</td>
<td>878 kg</td>
<td>£8,000-£11,000</td>
</tr>
</tbody>
</table>

Table 1: Estimated values for the reclaimable materials arising from demolition activities at the RA Barracks.

More detailed quantities of materials (whether reclaimable, recyclable or for disposal) are provided by a pre-demolition audit, with figures presented in a “Bill of Quantity” format (D-BOQ) as set out in the ICE Demolition Protocol\(^2\).

To reclaim the materials identified in this report, the following key issues should be addressed when planning the demolition processes:

- time – the predicted programme should allow sufficient time;
- space – salvaged materials require suitable storage space on and/or off-site;
- safe access – to support a safe environment for operatives and the general public during demolition and reclamation activities; and
- asbestos and health and safety – it is advisable that all Asbestos Containing Materials are removed in advance of demolition and reclamation activities.

A complete assessment of the health and safety risks and requirements under the CDM Regulations should be considered by Bovis Lend Lease whilst planning, designing and undertaking any reclamation work recommended in this document.

\(^2\) A Report on the Demolition Protocol, produced by EnviroCentre for the Institution of Civil Engineers (ICE) and London Remade.
1.2. Case for Reclamation

1.2.1. Overall Justification

Construction materials have a significant impact on UK sustainability. In the UK, the construction and demolition industries annually account for:

- 420 million tonnes of material consumption (7 tonnes per person);
- 19% of the total national ecological footprint;
- 23% of the total national greenhouse gas emissions; and
- 30% of all road freight on UK roads.


The environmental impacts of these significant quantities of material are generated during:

- extraction of raw materials;
- processing and manufacture;
- transportation; and
- pressure on landfill sites.

The construction and demolition industries can reduce their environmental impact at the same time as realising cost savings through resource efficiency. This can be addressed by taking a reclamation-led approach that:

- not only diverts waste materials from landfill but also retains greater value by reclaiming them intact at the demolition stage;
- re-uses materials either on the project where they arise or elsewhere;
- replaces the need for new materials;
- reduces the embodied impact of the new construction works; and that
- maximises resource efficiency.

1.2.2. Reclamation at the RA Barracks site.

This report identifies the types and estimated quantities of valuable reusable construction materials at the RA Barracks site. A reclamation-led approach to demolition will:

- enable Bovis Lend Lease to realise the economic value of these materials;
The Potential for Reclamation and Reuse at the RA Barracks Site
5 February 2008

- recover valuable materials whose on-site reuse supports the retention of desirable architectural features,
- increase the overall sustainability of the demolition activities, and new development project as a whole if the identified materials can be reused on site; and
- be supported through the segregation of demolition arisings. Such segregation is required by the Demolition Protocol and is an integral part of a Site Waste Management Plan which is scheduled to become mandatory in early 2008.

Materials

This section identifies the materials that can and should be reclaimed during demolition activities at the RA Barracks Site. It discusses potential extraction methodology as well as the relative economic and environmental benefits resulting from their reclamation and is summarised in the table in Appendix 1.

1.2.3. Steel

A number of steel elements were identified as suitable for reuse. These include the eight galvanised steel fire escapes, three hundred and twelve cast iron radiators and thirty two stainless steel insert stair treads.

Fire Escapes

The eight galvanised fire escapes will be easy to dismantle as they are bolted into the brick side elevations of four of the five buildings. They are apparently newly fitted and in very good condition. The Work at Height Regulations 2005 must be referred to prior to deconstruction to ensure that adequate risk assessments and safety measures are in place. The staircases embody approximately 12 tonnes of carbon and reuse on site would produce significant environmental savings.

Options for re-use include:

- Incorporation within the new development
- Re-use on existing structures at the RA Barracks

To optimise the potential for on-site reuse we recommend that the possible staircase dimensions are provided to the project architect and designers. Should their onsite reuse not be possible, an end-user can be sought through the list of contacts provided in appendix 2. BioRegional are to assist with this if requested.

Cast Iron Radiators

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3 A Report on the Demolition Protocol, produced by EnviroCentre for the Institution of Civil Engineers (ICE) and London Remade.
There are three hundred and twelve cast iron radiators within four of the five buildings. These are estimated to have a combined mass of 29 tonnes, representing an embodied 53 tonnes of CO2. The radiators are wall mounted and do not have feet stands; the market value of the radiators reflects this. BioRegional has identified an end-user willing to purchase these, and provide a removal service if required.

Care should be taken in their reclamation as cast iron can be a brittle material.

**Stainless Steel Stair treads**

Each of the five buildings has thirty two screw fixed stainless steel stair treads. These can be easily removed and could be reused in the construction phase on site wherever internal staircases are present.

Reuse will be particularly applicable where concrete staircases are proposed as the treads will provide excellent long term protection from heavy foot traffic.

An estimated 16 tonnes of carbon could saved by on-site reuse, in addition to considerable costs. It is therefore recommend that the dimensions of the treads are conveyed to the design team to optimise the potential for inclusion in the redevelopment.

**1.2.4. Brick Setts**

The RA Barracks has a significant quantity of new composite brick effect paving setts. We calculate that the setts cover approximately 380 m² with an associated 14 tonnes of embodied CO₂. The setts can be easily lifted and reused in the new development so providing both cost and carbon savings.

Assuming thirty bricks per square metre, we estimate 11,000 brick setts on site. Current market prices for new bricks range from 75p to £1, suggesting a total market value of between £8,000 and £11,000.

To achieve cost and carbon savings at the RA Barracks, the quantity and sett specification should be provided to the project architects with a client instruction to reuse where possible in the landscape design.

**1.2.5. Ceramic Ware**

The buildings contain roughly one tonne of ceramic sanitary ware with an associated embodied carbon of 1.3 tonnes. The sanitary ware is of varying ages. The Royal Doulton Vitreous China in Block F has the

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4 Research on www.salvo.com (material exchange website) indicates a retail value of in excess of £20/radiator is achievable. The interested buyer has offered to pay £10 per radiator including a removal service.

5 A specialist supplier quoted £5000 per unit for equivalent new fire escapes (Nick at www.completestairsystems.co.uk contacted by telephone). This report assumes a very conservative estimated value of £1000 per unit for the existing escapes.
highest market value and the new sanitary ware in Blocks I and D having the greatest on site reuse potential.

New Sanitary Ware
Blocks I and D contain sixty almost new washbasins and taps that embody over 0.3 tonnes of CO₂. It would be straightforward to re-use these in the new development provided dimensions and washbasin specifications are forwarded to the project architects at the earliest opportunity.

Assuming an average cost of £50 per new washbasin re-use could generate a cost saving to the project of around £3,000.

The Royal Doulton Vitreous China
There are a number of interesting fittings that would have some salvage value. Of particular note are the Royal Doulton marked wc pans and twenty eight wash basins. Subject to a formal instruction from Bovis Lend Lease, BioRegional could also find buyers for these items.

Butler Sinks
The buildings contain thirty Butler sinks with a total embodied carbon of approximately 0.3 tonnes. It is understood that these will be taken off site prior to demolition.

1.2.6. Other Items

The above sections have identified the materials whose reclamation offers the biggest benefits both from an environmental and financial perspective. However, other reusable materials are present on-site for which it may be possible to find end uses. These include:

- 84 identical double glazed UPVC windows in reasonable condition
- 12 fixed UPVC windows
- External Ansell IP65 Floodlights

1.3. Storage

Reclaimed materials require storage space prior to their reuse. The process of identifying suitable areas should be carried out in close consultation with the local planning authority. Key issues to consider will include:

- sufficient area – to store the predicted arisings;
- suitable location – on-site vs off-site;
- clear security arrangements – to reduce loss, damage or health and safety issues; and
- suitable storage facilities – perishable items must be kept under cover.
The most sustainable re-use of the materials is in the future redevelopment of the site. This would significantly reduce the costs and impacts of transport and handling whilst maximising the embodied CO₂ savings and character retention. This would require the allocation of suitable storage space on or near to the site. It is particularly anticipated that it would be possible to re-use the galvanised steel staircases onsite. The other items should be removed from site directly to end users for re-use.

Potential on-site storage areas include:

- open areas within the original geographic footprint of the RA Barracks Site; and/or
- the temporary use of existing buildings to provide covered shelter.

Additional storage facilities could be sought from the neighbouring areas, where available, or through the local authority.
1.4. Sequencing

Sequencing is critical to maximising reclamation through effective use of space and time. Demolition activities should plan for reclamation and the flexibility to allow the demolition contractor to minimise costs. It is envisage that this shall include:

- Clearing suitable covered storage space to facilitate reclamation activities and storage of perishable reclaimed materials;
- Clearing and delineating external space to facilitate reclamation activities and storage of non-perishable reclaimed materials;
- a rolling schedule of demolition to maximise the cleared/covered space available to reclamation activities e.g. starting demolition activities at the westernmost entrance point of the site and progressing southeast then northeast, northwest and finally southwest.

1.5. Contracts

Where possible, the above elements should be included in tender documents to ensure that bids and preferred contractors for demolition set out:

- how they propose to carry out reclamation; and
- the extent of the materials that they propose to reclaim and reuse.

For onsite reuse; specialist contractors will need to assess the quality and suitability of the reclaimed material and include this in the certification or guarantee that they provide for their work.

1.6. Building Insurance

The use of reclaimed materials within new build houses is recognised and permitted by insurance guidance for both Zurich Municipal\(^6\) and the National House Building Council\(^7\). There are specific requirements relating to suitability and integrity of the elements used and achieving design guidance requirements\(^8\). These can be determined through an inspection by a suitably qualified professional or testing where necessary. NHBC require prior agreement for use of reclaimed materials. Steel can be certified by visual inspection and shot blast processed where necessary\(^9\).

Appendix 1:

[accompanied pdf spreadsheet of materials data]

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\(^6\) Telephone conversation with Alan Cairns, 07710 038 346 from www.zurich.co.uk/Municipal/.

\(^7\) Conversation with Technical department of the NHBC - www.nhcbbuilder.co.uk.

\(^8\) Available in chapter 7.2, M6 of the NHBC Standards Book.

\(^9\) Structural Steel can be certified by Ellis & Moore Consulting Engineers see http://www.bioregional-reclaimed.com/Steel%20Certification.htm.
Appendix 2:

[accompanied spreadsheet of reclaimed materials end-user contacts]