Demonstrating continuous improvement in reducing construction waste

**Key facts**

- **GRAHAM Construction** signed the HWTL Commitment in 2009, and set a target of a 10% reduction in waste to landfill by 2012.

- **GRAHAM Construction** is focused on continuous improvement – lessons learned from a previous project are being applied at PGSC.

- WRAP’s NWT was used to identify a potential saving of £274,000 (0.62% of construction value) in wasted materials by pursuing good practice wastage rates.

**Project background**

Inverclyde Council appointed GRAHAM Construction to design and build a new £44 million shared campus secondary school to replace the existing Port Glasgow High School and St Stephen’s High School (Figure 1). The project also includes a new additional support needs (ASN) school to replace the existing Lilybank and Glenburn schools. The new campus will accommodate 920 students.

The project began in October 2011 and is due to be completed in April 2013. The new shared campus will consist of a three-storey steel frame clad in a combination of curtain walling, facing brick and rainscreen panels, with single-membrane flat roofs and profiled...
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"Through careful planning and continual learning [GRAHAM Group] ensures that all possible opportunities are taken to minimise waste."

Lianne Rafferty, Environmental Manager (construction)

Figure 2 Port Glasgow Shared Campus, modelled output

metal-covered pitched roofs. The single-storey ASN school will be composed of a glulam timber structure clad in facing brick (Figure 2).

Corporate targets
GRAHAM Construction has a strong corporate objective to minimise waste. GRAHAM Construction recognises that attention must be directed to waste prevention as well as diversion and, as such, was one of the first companies to become a signatory of the HWTL Commitment in 2009, agreeing to reduce waste sent to landfill by 10% by 2012. In April 2012 GRAHAM Construction set targets to reduce waste sent to landfill by a further 5% by April 2013. Performance will be measured on the basis of tonnes of waste generated and tonnes of waste sent to landfill per £100k of turnover, with project performance being measured per £100k of construction value.

GRAHAM Construction recognised that the construction of PGSC was an ideal opportunity to implement the lessons learned from previous sites, specifically those from Barrhead Health and Social Care Centre, allowing the company to engage in a process of continuous improvement.

Barrhead Health and Social Care Centre in East Renfrewshire (Figure 3) was used as a test bed in 2009/10 to trial a range of approaches to waste reduction and site waste management as part of GRAHAM Construction’s commitment to HWTL. Initiatives included:

- motivating and educating the workforce to segregate waste through the use of toolbox talks and awareness sessions and charging subcontractors for cross-contamination of skips;
- reporting on achievement against waste reduction targets during quarterly reviews;
- creating a secure work area for steel fixers to allow controlled conditions for

Figure 3 Barrhead Health and Social Care Centre, East Renfrewshire
prefabrication, which in turn facilitated waste reduction; and

- just-in-time (JIT) site deliveries to prevent damage/wastage of materials and to reduce unnecessary site traffic.

The Barrhead trial was a resounding success, with efforts to reduce and recover waste saving over £77,000 in wasted material and disposal costs. The trial was published by WRAP in 2011 as an exemplar case study (more information can be found here). Following the Barrhead project, further initiatives were identified for trial on future projects. These included:

- asking designers, where applicable, to identify opportunities to prevent waste through design;
- using WRAP’s NWT on selected projects at the detailed design stage to develop a forecast with which to compare performance and identify waste reduction opportunities;
- consulting the supply chain as early as possible to receive each member’s input on recycled content, packaging and take-back strategies;
- involving subcontractors as early as possible to receive their input on reducing wastage rates and improving on the forecast; and
- holding post-completion reviews of site waste management plans (SWMPs), focusing specifically on project waste arisings and recovery rates, to identify areas for improvement and reasons for waste generation.

**Designing out waste**

The design team for PGSC held in-house seminars with its Sustainable Futures group to discuss the impact of the chosen design on waste. Upon winning the contract, both GRAHAM Construction and the design team attended seminars with Zero Waste Scotland (the trading name for WRAP in Scotland) to inform the design development with a view to reducing waste from design.

As a result of the design team’s ongoing consideration of the impacts of design on waste, the following initiatives have been implemented to minimise waste generation:

- Prefabrication helped to make work on site a process of assembly rather than traditional construction, thereby reducing potential for wastage from off-cuts and reworking. Prefabricated elements included the following:
  - The ASN building is a timber kit design which has been prefabricated off site for erection in panel form (Figure 4).
  - The roof-lights to the ASN will be prefabricated off site and lifted into place.
  - The brick-faced concrete lintels will be precast off site and erected on site, instead of on site hanging.
  - Brick slips will be preformed in lengths with a glass fibre-reinforced plastic backing off site for fixing to steel lintels to reduce time and waste on site.
  - The concrete stairs will be prefabricated off site.
- Materials optimisation enabled the rationalisation and coordination of the build, reducing construction time and wastage rates.
  - The design has been coordinated to minimise excess cutting and joining, reducing both time on site and potential wastage.

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**Figure 4 Additional support needs schoold**
Where feasible the building has been designed to conform to standard material dimensions, eliminating off-cuts.

- Cut and fill – design consideration enabled the retention of demolition and excavation material that will be used to build up the sports pitches and landscaping areas (Figure 5). This was feasible because of the large site area, which enabled on site storage. Material that cannot be utilised on site will be sent to Thompson’s Landfill where it has been confirmed that it will be used for restoration purposes, and thus will be 100% re-used.

Supply chain partnership
GRAHAM Construction is committed to involving subcontractors and suppliers as early as possible to receive their input on how to reduce construction and packaging waste and to ensure that take-back schemes are pursued.

With support from Zero Waste Scotland, GRAHAM Construction undertook a 12-week supply chain partnership (SCP) initiative with key suppliers, subcontractors and waste management contractors. The SCP aimed to:

- identify opportunities to reduce waste arisings on site;
- identify opportunities to recycle more of the waste produced;
- share good site practices between trades; and
- realise financial savings.

The SCP launch event (in November 2011) gave suppliers an opportunity to discuss waste performance and identify potential improvements to both processes and products to enable lower waste generation and higher recycling and re-use. At the launch event priority waste streams were discussed, and waste minimisation strategies were suggested through the facilitated workshop, relating to design coordination, procurement, and planning and communication.

Supply chain waste minimisation strategies

Design coordination
- Ensure that designers identify, investigate and implement where practical the five key principles identified by Zero Waste Scotland to reduce waste through the design process:
  - design for re-use and recovery;
  - design for off site construction;
  - design for materials optimisation;
  - design for waste-efficient procurement; and
  - design for deconstruction and flexibility.

Procurement
- Closer working with the quantity surveyor to improve the accuracy of material ordering and wastage predictions.
- Get suppliers on board to reduce quantities of packaging used or use re-usable packaging where possible.
- Order materials when required, rather than storing surplus materials on site.
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Table 1 Port Glasgow Shared Campus Net Waste Tool wastage outputs

<table>
<thead>
<tr>
<th></th>
<th>Waste arising (tonnes)</th>
<th>Waste produced (tonnes per £100k)</th>
<th>Wasted materials (£)</th>
<th>Cost of waste disposal (£)</th>
<th>Total cost of waste (£)</th>
<th>% construction cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline practice</td>
<td>4,250</td>
<td>9.66</td>
<td>360,955</td>
<td>205,390</td>
<td>566,345</td>
<td>1.29</td>
</tr>
<tr>
<td>Good practice</td>
<td>2,186</td>
<td>4.97</td>
<td>87,010</td>
<td>87,010</td>
<td>271,200</td>
<td>0.62</td>
</tr>
<tr>
<td>Potential saving</td>
<td>2,064</td>
<td>4.69</td>
<td>273,945</td>
<td>118,380</td>
<td>295,145</td>
<td>0.67</td>
</tr>
</tbody>
</table>

- Ensure that the site is ready to receive the materials; for example, in the case of more easily damaged materials, is the site wind- and water-tight?

Planning and communication
- Improve communication between the client and subcontractors. Involve subcontractors as early in the process as possible. Subcontractors will be given specific waste targets which will be set to the ‘good practice’ levels or better provided by the NWT.
- Ensure the correct phasing of works to eliminate wastage through rectification works.
- Improve planning and coordination between sites to re-use soil and excavation wastes.

Use the Zero Waste Scotland Construction Materials Exchange Tool to identify ways to re-use waste materials on other sites.

Waste forecasting
Following the Barrhead project in 2010, GRAHAM Construction made it a requirement for all construction projects to employ the principles of WRAP’s NWT by ensuring that a waste forecast was calculated before construction to provide a benchmark. The NWT applies ‘baseline’ (industry typical practice) and ‘good practice’ (industry good practice) wastage rates to the project specification in order to estimate the project waste forecast and identify project-specific waste reduction opportunities, including the specification of increased recycled content.

The tool generates waste forecasts and estimates the potential saving in waste arisings, the value of wasted materials and the cost of waste disposal.

The results for PGSC (Table 1) show the potential to halve the mass of construction waste generated, saving £274,000 in the value of potentially wasted materials and £118,000 in the cost of waste disposal, based on the difference between the theoretical ‘baseline’ and ‘good practice’ wastage rates for the materials in the project specification.

The NWT identified a list of potential opportunities to reduce project expenditure through lowered wastage costs, to be implemented through procurement practices and on-site initiatives. Examples included:
- setting waste allowances at ‘good practice’ levels or better for subcontractors;
- setting off-cut and surplus targets for priority waste streams;
- utilising take-back schemes;
- specifying re-usable packaging; and
- JIT delivery.

The tool is able to showcase the savings between baseline and good practice by identifying the best opportunities to reduce project costs by reducing wastage rates from baseline to good practice rates. The results for PGSC listed several components that may offer significant savings (Table 2).
Clear actions for waste minimisation will be recorded in the SWMP, with both individual and collective responsibilities and requirements detailed within project documentation and effectively communicated through all levels of the project team, ensuring sufficient awareness of waste minimisation including the following:

- A workshop to be held before work commences to review the outputs of the NWT (detailed below).
- Set targets for off-cuts and surplus materials (with involvement from subcontractors in this target setting).
- The utilisation of supplier take-back schemes where feasible, particularly for packaging and pallets.
- Utilise waste data collected to monitor and review performance against waste objectives and targets for the project.

The above proposals will be reinforced and supported by the clear roles and responsibilities set out in the SWMP for the site manager, environmental manager, procurement manager and waste champion, and their effective interaction with subcontractors and suppliers.

**Lessons learned**

Although it will not be clear until the end of the project which waste minimisation strategies were successful and which areas will require further work, it is already clear that the communication procedure implemented on the PGSC will benefit future projects. The SCP is already proving to be a useful process for improving communication with suppliers and subcontractors and setting expectations for performance requirements. The subcontractor workshop held for PGSC project demonstrates the benefits of early engagement with the supply chain and the discussion of project-specific issues.

Use of WRAP’s NWT proved helpful in the identification of potential waste reduction initiatives as well as materials selection to achieve the greatest savings at ‘good practice’ wastage rates. Subcontractors responded well to this information, with one subcontractor offering to provide quantified proof that it would achieve better wastage rates than the predicted forecast.

Procurement managers and quantity surveyors are crucial in ensuring that the correct quantities of materials are procured in a way that ensures unnecessary waste is not created. It is important that they understand which materials are likely to generate the

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**Table 2 Port Glasgow Shared Campus Net Waste Tool wastage minimising component suggestions**

<table>
<thead>
<tr>
<th>Component</th>
<th>Materials purchased (£)</th>
<th>Baseline wastage rate (%)</th>
<th>Good practice wastage rate (%)</th>
<th>Potential saving (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trenchfill foundation</td>
<td>913,295</td>
<td>20</td>
<td>10</td>
<td>91,300</td>
</tr>
<tr>
<td>Concrete strip foundation</td>
<td>223,699</td>
<td>10</td>
<td>5</td>
<td>16,400</td>
</tr>
<tr>
<td>Expanded polystyrene (substructure)</td>
<td>139,659</td>
<td>10</td>
<td>5</td>
<td>12,600</td>
</tr>
<tr>
<td>Reinforced PVC roofing on vapour control felt</td>
<td>147,698</td>
<td>10</td>
<td>6</td>
<td>8,900</td>
</tr>
<tr>
<td>Blockwork (internal walls)</td>
<td>275,478</td>
<td>4</td>
<td>2</td>
<td>5,900</td>
</tr>
<tr>
<td>In situ concrete slab</td>
<td>87,840</td>
<td>4</td>
<td>2</td>
<td>5,500</td>
</tr>
<tr>
<td>Marmoleum tiles</td>
<td>67,200</td>
<td>10</td>
<td>4</td>
<td>5,300</td>
</tr>
<tr>
<td>Hardwood flooring</td>
<td>71,056</td>
<td>10</td>
<td>5</td>
<td>4,400</td>
</tr>
</tbody>
</table>
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most waste, as this provides a focus for improving procurement and on site activities.

The subcontractors at the workshop raised some missed opportunities relating to the programming and sequencing of works which GRAHAM Construction has taken on board; however, some aspects were outwith their control.

- It may have been possible to re-use even more excavation waste had the cut and fill activities been arranged for the summer months as this would have reduced soil waterlogging.

- It may also have been possible to use more site-won materials in the construction of the surrounding roads had they been constructed earlier in the programme.

This suggests that it would be beneficial to consult with subcontractors at an earlier stage to ensure that re-use opportunities are built into the construction programme or to ask the design team to consider the impact of sequencing on resource efficiency.

The SCP follow-up event provided the opportunity to discuss and recognise success stories – not only from GRAHAM Construction projects – and identify barriers to and opportunities for further improvement. This resulted in, for example, a new approach to plasterboard procurement on some GRAHAM Construction projects, whereby material is ordered only when required, resulting in reduced material damage through limited site storage and fewer instances of overordering.

Furthermore, successful examples of off site manufacture were reported, including bathroom units and metal framing systems, which resulted in reduced wastage on site and reduced installation times.