Case Study: Material Logistics Planning

Barts Hospital, London

A comprehensive logistics strategy at Barts Hospital in central London successfully reduces waste, site traffic and carbon emissions.
Our vision is a world without waste, where resources are used sustainably.

We work with businesses and individuals to help them reap the benefits of reducing waste, develop sustainable products and use resources in an efficient way.

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Executive summary

Barts and The London NHS Trust is redeveloping two hospitals under one of the largest Public Private Partnerships in Europe with a construction value exceeding £1 billion. The main contractor is the international group Skanska. Skanska was one of the companies engaged with WRAP (Waste & Resources Action Programme) when the Material Logistics Plan (MLP) guidance document and template was first drawn up. Barts, in the centre of London, was a pilot project in this process and its use of a Construction Consolidation Centre (CCC) is of particular interest in this study. The London is the larger of the two projects but in a less constrained location, and the CCC is not used.

This study focuses on Barts but includes some comments, data and comparisons with The London. Some logistics strategies are employed at both projects.

Key achievements

- 95% waste diverted from landfill on both projects.
- 2,229 fewer delivery vehicle journeys into central London between March 2008 and July 2009 as a result of consolidation at Barts – a 74% reduction.
- A 18 tonne reduction in carbon emissions resulting from journey reduction.
- A vehicle delivery accuracy to Barts consistently between 95% and 100% measured as arriving within ±15 minutes thereby avoiding congestion and waiting time.
- Plasterboard waste at Barts, using CCC, minimised to less than the ‘allowance’ of 15%.

Key elements of logistics strategy

- Engaging suppliers in developing zero waste packaging solutions. A reusable box pallet has been developed and is used by the lighting contractor. There is no packaging waste, the materials are protected against damage and handling is efficient.
- Off Site Manufacturing (OSM). Particularly successful examples of OSM are the modules with pre-installed services (water, wiring, power etc.) for installation in corridor ceiling-space. This generates no waste on site and drastically cuts installation time.
- Use of Construction Consolidation Centre. The CCC made possible operation without congestion at the extremely restricted site in central London. The use of the CCC directly led to substantial vehicle traffic reductions and carbon reductions.
- Just-in-time deliveries. Materials are ordered and delivered from the CCC on a 48-hour cycle and material volumes kept on site are minimised.
- Use of on site logistics specialists. At Barts an on site logistics specialist company is used – the same company that operates the CCC. This results in smooth material flow all the way to the work face – trade contractors don’t need to do any material handling. Waste bins are handled by the same company who are also responsible for traffic management, security and cleaning.

This comprehensive logistics strategy leads to the quantified achievements above. It also leads to further qualitative improvements such as creating:
- a clean uncluttered working environment;
- a safer working environment;
- an efficient working environment; and
- a construction site that is a good neighbour with minimum interruption to the life of the city and the ongoing activities of the old parts of the hospital - in full operation throughout.
1.0  **Skanska**  

1.1  **In brief**  

Skanska is a large international project development and construction company. With headquarters in Stockholm, Sweden, Skanska is active in a number of markets in Europe, the US, and Latin America. The company employs some 60,000 people, and at any one time has perhaps four times as many subcontractors working on 12,000 projects across all its markets. The turnover in 2008 was £11.2 billion.  

In the UK Skanska employs 5,500 people and is oriented towards building and civils construction. A section of the UK business focuses on Public Private Partnerships (PPP) - also referred to as Private Finance Initiatives (PFI) - the largest of which is Barts and The London NHS Trust.  

1.2  **Sustainability**  

Skanska has a well-developed sustainability strategy. The environmental part of this strategy identifies four priorities: energy & climate, materials, ecosystems, and local impacts. The materials priority targets high level action on:  

- resource efficiency - which is about doing more with less. Skanska adopts the “waste hierarchy” principles of: reduce, reuse, recycle, extract energy, and dispose responsibly; and  
- intelligent selection - by which Skanska means 1) avoiding materials that in the future may be less favoured than today due to new-found risks or hazards and 2) taking into account long-term considerations relating to eco-design and life-cycle analysis/costing.  

Skanska targets each of its business units to send less than 10% of its construction waste to landfill by 2010.  

2.0  **Barts and The London redevelopment project**  

Barts is part of Barts and The London NHS Trust and the hospital redevelopment is one of the largest PPPs in Europe with a construction value exceeding £1 billion.  

Barts Hospital, which first opened in 1123, will become a Cancer and Cardiac Centre of Excellence. The Royal London Hospital dates back to 1740 and will be largely rebuilt to include London’s leading trauma and emergency care centre, the capital’s second largest children’s hospital, and one of Europe’s largest renal units, with London’s Air Ambulance operating from the top of the new building. In addition to the two new hospitals’ 1,248 patient beds, Barts will have eight operating theatres and the Royal London 22.  

The project started in 2006 and is scheduled for completion in February 2016. The new Cancer Centre at Barts (Phase 1) is due to be ready by early 2010.  

**Figure 1** Old Royal London Hospital with the new development rising behind and (right) the narrow access road to Barts with no queuing allowed in the street.
3.0 Logistics approach and planning

While the two hospitals are part of the same project and share many features they are separate entities with many differences. The logistics approach is one such difference. At Barts the space constraints on the site were such that the project was forced to consider external material storage and consolidation. As a consequence the London Construction Consolidation Centre (LCCC) is used in combination with on site logistics specialists taking responsibility for all materials handling to the point of use. The London, which is a much larger site, is run in a conventional way. Contractors are responsible for their own material supply including delivery to site, site storage, handling, and waste removal.

This study will focus on Barts as an example of good practice. However, where appropriate some comparison with The London will be made, highlighting the different strategies and their impact on waste and environment.

3.1 Involving suppliers

Skanska has encouraged suppliers to examine their processes and introduce reusable pallets in order to eliminate packaging waste – the most common waste category during the fit out stage. This has proved very successful with the lighting supplier (at both Barts and The London) who has introduced a box pallet, or crate. While the supplier had to carry the initial cost it has now become clear that the pallets bring such benefits and cost savings in the operation that they pay for themselves. The pallets:

- eliminate packaging waste;
- reduce damage to the materials;
- improve security as they are fully enclosed;
- improve efficiency in installation; and
- reduce cost by providing a zero packaging process.

This initiative has been so successful with the lighting supplier that Skanska has decided to encourage as many suppliers as possible to adopt a similar method. Suppliers who introduce this kind of solution are likely to have a competitive advantage when bidding for future work with Skanska and any other major contractor.

Figure 2 Reusable box pallets at the LCCC and (right) collapsed empty pallets stacked for return to supplier.

3.2 Off Site Manufacturing (OSM)

OSM is logistically efficient. Instead of carrying each material category to site separately, complete pre-assembled modules are brought to site. It reduces both the transport intensity and the material stockholding on site. OSM speeds up the installation programme and is one of the most efficient waste reduction strategies. Read more about OSM at: http://www.wrap.org.uk/construction

In hospitals, installation of services such as water, power, communications, and signal wiring is highly labour intensive and potentially generates a substantial amount of waste. At both Barts and The London the Mechanical & Electrical is pre-fabricated, off site, in steel frame sections of about 3-6m in length. These are delivered in complete sections to site and simply lifted into place and connected. No waste is generated on site and in the controlled manufacturing environment waste can be minimised.
3.3 The material flow

The LCCC is the key to the logistics operation at Barts. Contractors are asked to instruct their suppliers to deliver to the LCCC. This mainly concerns materials in the fit out stage; large loads that require specialist handling such as steelwork and heavy plant are delivered directly. From arrival at the LCCC responsibility for the materials supply to the workface is taken over by the logistics contractor Wilson James (WJ).

The controller at the LCCC is in contact with the site and assembles consolidated loads. Thus regular deliveries to site can be made yet with many fewer vehicle arrivals to site than if suppliers delivered directly. The regular deliveries also mean that minimum quantities of materials are held on the site thereby reducing risk of damage, obstructions, and health and safety incidents caused by congestion. The resulting reduction in CO₂ can be seen in the data analysis.

At the site WJ’s operatives control traffic, receive and offload the vehicles, and deliver each load to the precise location where the materials are needed by the contractors.

Figure 4 The principles of the material flow when using a Construction Consolidation Centre.
3.4 The LCCC operation

3.4.1 The warehouse

The LCCC, operated by WJ, is located in Silvertown close to City of London Airport. It is housed in a standard warehouse unit of 60,000ft² - about a quarter of which is laid out with pallet racking. The rest of the space is used for floor storage, with designated areas for assembling deliveries and loading.

![Figure 5](image1.jpg) One of the LCCC’s range of forklifts and a delivery vehicle being loaded by the racked area.

3.4.2 Loads and pallets

The LCCC encourages suppliers to use pallets, cages, or stillages that allow mechanical handling so that manual lifting can be avoided. Good quality pallets also protect the goods and reduce damage and waste. Poor pallets and packaging often go in the skip and can contribute substantially to the waste generated on a building site, whereas good quality pallets or other load carriers can be returned to the supplier and reused many times, vastly reducing packaging waste.

![Figure 6](image2.jpg) Various loads and pallet types at the LCCC and (right) plasterboard with no pallet.

Some types of goods can be handled efficiently without a pallet - yet create only a minimum amount of waste. Plasterboard for instance is sometimes supplied stretch-wrapped with only wooden space bars underneath for forklift entry. The waste consists of one sheet of plastic and the wood-chip runners – both recyclable.
3.4.3 Receiving

Trade contractors advise the LCCC of intended deliveries. This should be done a minimum of 24 hours before delivery. The LCCC checks: which project the consignment is for; the trade contractor; whether there are space and resources available at the LCCC; and if they can receive the load at the requested time. If everything is ok the trade contractor is notified that delivery can proceed.

3.4.4 Put away and storage

On arrival, deliveries to the LCCC are off-loaded and identified to the Warehouse Management System (WMS). A certain level of inspection is undertaken:

- what has been delivered;
- whether it agrees with what was notified;
- quantity (e.g., number of pallets); and
- a check of the load for any external damage.

Boxes and packages are not however opened for detailed inspection of the goods. A label (see WMS section, 3.4.7) is produced and attached to each load, and the load is put away in the warehouse and its location recorded in the WMS. Loads are stored in pallet racking or stacked on the floor as appropriate, depending on the physical characteristics of the load and the packaging.

3.4.5 Pick and deliver

For delivery to site, contractors are required to call off materials 48 hours before they are needed at the workface. Call off is by email from the site, often complemented by telephone instructions. The LCCC picks the materials for a number of contractors and makes up consolidated vehicle loads for delivery to site. Whole pallets, crates, stillages etc are picked. The LCCC will also pick individual boxes from pallets to match precise quantity requirements; they will not however break open boxes to count out individual items.

3.4.6 Kitting

Sometimes the quantity in one box or container is too large for direct delivery to site, and often there is a mixture of components needed at one workface. This means there is a need to make up a work package for a specific task i.e. kitting. In these cases the trade contractors are welcome to come to the LCCC and make up kits in advance of delivery to site.

Figure 7 A kit made up at the LCCC in the required quantity of eight long panels and four short ones.
Kitting means that you only have the required materials at the workface and you avoid double handling on site. This reduces the risk of both damage to goods and congestion on site. Obviously there is also an important productivity benefit as no time is spent on site moving goods from one work area to another.

Excess materials on site, with the associated congestion and extra handling, also significantly increase the risks to health and safety.

If the mixed load does not require individual boxes to be broken up the LCCC will prepare kits without the need for the trade contractor to visit the LCCC.

The picture to the right shows one such load in a ward at Barts.

### 3.4.7 Warehouse management

On arrival to the LCCC each load is identified and entered on the Warehouse Management System (WMS).

The data entered is as follows:

- project
- contractor/customer
- supplier
- goods
- quantity
- date received

When the goods are registered the WMS allocates a Received Voucher (RV) number to the load; this is used for tracking until the entire load has been delivered to site. A label is attached to the load.

### 3.4.8 Traffic management

Figure 9 Map screen indicating site, vehicle locations and live information on areas of traffic congestion.
The LCCC uses a GPS-based traffic management system. The system provides:

- GPS navigation support for the drivers;
- real-time information to the controller at the LCCC on the exact location of the vehicles at any time;
- forecast ETA;
- real time traffic information allowing drivers to avoid congested areas;
- communication using messaging between controller and drivers; and
- data logging of all aspects of the journeys: arrival/departure times, distance travelled, average speed, excessive speed (speeding) etc.

3.5 On site handling

There are two small yard areas at Barts; both are used for receiving materials and one is also used for waste removal. Careful traffic management is of the essence as it is impossible for instance to receive an incoming load at the same time as waste is being removed from the same yard.

**Figure 10** Incoming load of plasterboard to Barts and (right) four vehicles at The London.

By contrast at The London there is room to handle more than one vehicle at a time although congestion and waiting time is not unusual.

At Barts off-loading and all internal handling is done by Wilson James – the same company that operates the LCCC. Materials are ordered to specific floors and zones, and labels on the pallets ensure that operators put the right pallet directly in the right zone, avoiding double handling on site.

**Figure 11** A box pallet with labels clearly identifying destination, detailed contents, and supplier reference.
Packaging is a major contributor to waste - a waste stream which the box pallet eliminates. The pallet size has been chosen to fit a wide range of sizes of items. The picture below shows both box pallets and light fittings too long to fit into them. The cardboard packaging, the plastic and the pallet will all add to the waste handling whereas for the material in the box pallet the only waste generated is one thin plastic sheet around each item. The box pallet also offers better protection against accidental damage.

**Figure 12** Box pallets and traditionally packed loads in a ward during fit out.

![Box pallets and traditionally packed loads in a ward during fit out.](image)

**Figure 13** Light fittings stacked with separating and protective sheets between each unit.

![Light fittings stacked with separating and protective sheets between each unit.](image)

The layout of the building - corridors and wards - means there is restricted space for creating material lay-down areas. Wherever possible, dedicated areas are provided for different contractors.
3.6 Waste segregation, reuse and recycling

The same waste segregation policy is observed on both sites. Bins are used and, at Barts, are handled by the logistics contractor Wilson James. At The London all the different trade contractors handle their own waste.

Waste is segregated in the following categories:

- timber
- metal
- cable off cuts
- cardboard
- inert
- polythene/shrink wrap
- plasterboard/gypsum
- waste only

At Barts the waste collection vehicles are subjected to the same ± 15 min delivery slot time as incoming material deliveries. This is necessary as they share the same gates and yards. At The London the waste area is large and the same restrictions do not apply.
3.6.1 Reuse and recycle

All floor areas are covered by protective Correx sheets. As Phase 1 of the Barts project will finish first, sheets will be removed from Barts and where possible reused at The London. Skansa’s Environmental Manager has also reached an agreement with the supplier of the Correx that they will take back the sheets at the end of the project for recycling.

Skansa has also made arrangements with the suppliers of the Vinyl flooring and the ceiling tiles that they will take back all off cuts for recycling. These are collected and returned to the LCCC on delivery return journeys. The LCCC accumulates the materials which are then available for collection by the suppliers/manufacturers.

All cable drums are also returned to the LCCC for supplier collection and reuse.

Figure 16 All floor areas are protected by Correx which will be reused and then recycled.

4.0 Data
4.1 Total waste

Waste analysis as per end of June 2009 at which date Barts was 80% complete and The London 35% complete.

<table>
<thead>
<tr>
<th>Waste</th>
<th>Barts</th>
<th>The London</th>
<th>Barts</th>
<th>The London</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total waste</td>
<td>48,019</td>
<td>100</td>
<td>206,155</td>
<td>100</td>
</tr>
<tr>
<td>Segregated on site</td>
<td>46,689</td>
<td>97</td>
<td>198,047</td>
<td>96</td>
</tr>
<tr>
<td>Reused</td>
<td>40,039</td>
<td>84</td>
<td>186,894</td>
<td>91</td>
</tr>
<tr>
<td>Recycled</td>
<td>5,463</td>
<td>11</td>
<td>8,511</td>
<td>4</td>
</tr>
<tr>
<td>Disposed volume (landfill)</td>
<td>2,517</td>
<td>5</td>
<td>10,750</td>
<td>5</td>
</tr>
<tr>
<td>Diverted from landfill</td>
<td>45,502</td>
<td>95</td>
<td>195,405</td>
<td>95</td>
</tr>
</tbody>
</table>

Note: The construction only phase includes the concrete frame construction as well as fit out. For comments on the data see Chapter 5 - Conclusions.
4.2 Plasterboard waste analysis

Plasterboard waste was monitored and analysed separately at both hospitals. A standard applied wastage allowance of 15% was agreed with the dry-lining contractors.

At Barts the actual waste tonnage was 14% on completion of the first phase of the project. At The London the waste tonnage was 28% at the same point in time, though with The London being a much larger project this was at 80% completion.

4.3 Transport related CO₂ analysis

At Barts the consolidation of incoming loads at the LCCC means that fewer vehicles arrive on site than would otherwise be the case.

Looking across this 17-month period 789 delivery vehicle journeys have been made to Barts. Without consolidation the number would have been 3,028 – the number of deliveries made to the LCCC. This is a reduction of 2,239 journeys or 74%.

This reduction is a conservative estimate because with direct deliveries to site it is likely loads would have had to be divided into smaller deliveries increasing the traffic flow even further. The LCCC is a distribution centre and as such equipped for efficient handling and fast turnaround of vehicles. Receiving the high number of deliveries (3,028 – the blue columns) at the LCCC is not a problem; in fact it handles materials for several sites simultaneously. The location of the LCCC outside central London means that hauliers’ journey time reduces significantly as the last leg of the journey into central London is the slowest.

The advantages of reducing the number of deliveries to site:

- reduced traffic congestion in the city centre;
- reduced pollution and carbon emissions on the last leg of the journey to site;
- no waiting time at site delivery points;
- one vehicle at a time and fast turnaround (studies have shown that a significant amount of productive time can be lost queueing and waiting for materials at construction site receiving areas); and
- less congestion on site and well organised receiving of materials by the logistics specialists reduce H&S hazards and improve site productivity

The reduced number of journeys into site leads to a corresponding reduction in CO₂ as shown in graph 4.

**Graph 4** Barts, March 2008-July 2009, actual CO₂ emissions compared to estimated emissions had consolidation not been used.

![Graph 4](image-url)

Over this 17-month period carbon dioxide emissions from material deliveries reached six tonnes. Without consolidation the tonnage would have been 24. This is a reduction of 18 tonnes or 74%.

4.4 Note that the reduction relates to the last leg of the journey only, from the Consolidation Centre to the site, i.e. the 74% reduction does not relate to the total journey from supplier to site.
Delivery accuracy is important for a number of reasons. It removes the risk of congestion in the street, receiving area, and on site caused by overlapping deliveries. Site labour responsible for handling materials gets an even workload and trade contractors can plan, and trust that materials will be available on time.

**Graph 5** Barts - 2008 delivery accuracy.

![Comparison of Call Offs](image)

**Graph 6** Barts - 2009 delivery accuracy.

![Comparison of Call Offs](image)

The control project reflects typical industry delivery accuracy with only about 40% - 50% hitting a 30 minute slot.
5.0 Conclusions

5.1 Waste

Both Barts and The London achieve 96% waste diverted from landfill. The demolition and earthworks phases create a much higher tonnage. Of the total waste of 48,019 tonnes at Barts only 3,003 tonnes (6.3%) is generated in the construction phase. The biggest overall impact on landfill tonnage therefore is the high reuse rate in the demolition and earthworks phases of soil and stones and other inert material. One strategy that is the same on both sites and that has had a positive impact in all phases is the commitment to waste segregation on site – 97% and 96% achieved through the projects at Barts and The London respectively.

This has allowed both projects to maintain a high recycling rate even into the fit out when traditionally the rate falls as the number of contractors and waste streams increases. It is in this construction phase that effective logistics and waste management strategies can have most impact.

The analysis of plaster waste shows a much better performance at Barts compared to The London: 14% against 28%. This may in part be down to the logistics practices employed; low volumes on site and little or no damage in handling. With regard to the percentage of material lost in off-cuts it is reasonable to believe these volumes will be similar as the internal design is very similar.

When comparing the two sites it is important to bear in mind that The London is about 6 times larger than Barts and this scale factor probably contributes to there not being any difference in overall waste ratios even though there are significant differences in the plasterboard waste.

5.2 Vehicle movements and CO₂

Over the 17 months it has been in use, the consolidation centre has led to a 74% reduction in delivery vehicle traffic to site; that is 2,239 fewer journeys than would have had to be made without consolidation. The corresponding reduction in carbon emissions is 18 tonnes.

5.3 Key logistics strategies

A number of logistics strategies were employed at Barts - some also at The London.

- The reusable pallets used by the lighting supplier were very successful and were used at both sites. They virtually eliminate packaging waste for that material category and bring many other benefits besides, for example: the high level of protection minimises the risk of waste through product damage in handling and storage, and the fully enclosed pallet reduces risk of shrinkage.
- Off Site Manufacturing is used to some extent. The most effective example being the M&E services frames for installation in ceilings. Apart from reducing waste they drastically cut down installation time.
- The Construction Consolidation Centre used at Barts has resulted in the vehicle movement reduction and corresponding carbon reduction as identified in 5.2. It also made possible a just-in-time flow of materials.
- On-site logistics specialists used at Barts in combination with using the CCC has had a positive impact on waste as evidenced by the plasterboard analysis. The improved working environment in terms of cleanliness and less material on site has had a positive impact on health and safety. With the trade contractors not having to handle materials there are benefits in terms of productivity and programme certainty.
- Just-in-time deliveries are made possible by the use of the LCCC. This limited the amount of material stored on site and at risk of damage.
- The just-in-time strategy also allowed secondary handling to be minimised. Materials were off-loaded and taken directly to their point of use or to the lay down area of the relevant trade contractor. On sites without consolidation large volumes are often brought to site and as work progresses the material has to be moved several times with increased risk of damage.