Material change for
a better environment

Waste Minimisation in Construction

Material Logistics Plan
Good Practice Guidance

Guidance for Clients, Design Teams, Construction Contractors and Sub-contractors on developing and implementing an effective Material Logistics Plan.

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WRAP works in partnership to encourage and enable businesses and consumers to be more efficient in their use of materials and recycle more things more often. This helps to minimise landfill, reduce carbon emissions and improve our environment.

Front cover photograph: Construction and fit-out of Bow Bells House

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CONSTRUCTING EXCELLENCE in the built environment

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SKANSKA

The following organisations supported the development of the Material Logistics Plan by piloting the template at one or more of their active construction sites, for a short period of time.

Organisation	Project	Phase	Approximate Value
Bovis Lend Lease	Central St Giles project in London	Planning and Preconstruction Phase	£150m
SKANSKA	Barts Hospital project in London	Construction Phase	£400m
COSTAIN	A2/A282 project	Construction Phase	£550m
Riverside HOUSING	Balls Road Refurbishment project in Wirral	Construction Phase	£750,000
Crossrail	Maidenhead to Kent railway project	Planning Phase	£15bn

Appendix 4 details further information on the pilot sites and the key findings.

This Good Practice Guidance Document is endorsed by the Chartered Institute of Waste Management (CIWM).

The Chartered Institution of Wastes Management

Acronyms and Glossary

Collaborative Working

Collaborative working involves clients and integrated supply chains working closely together often under long-term framework arrangements using non-adversarial approaches and contract conditions to meet the project or programme objectives. A wide range of approaches can be adopted in collaborative working such as using project accounts, project-wide insurance, two-stage tendering, combined planning, joint risk assessments, early contractor involvement and integrated project teams.

Construction Consolidation Centre - CCC

A distribution facility that receives materials, equipment and plant and delivers it to local construction sites in consolidated loads.

Information and Communication Technology – ICT

ICT systems are generally computer-based information systems that are used to track materials through a process e.g. manufacture, distribution, assembly and installation.

Inventory Management Optimisation - IMO

IMO software systems are tools to manage stock levels and model the demand and supply of materials for one or more sites.

Just In Time – JIT

Service of frequent deliveries in work packs, 'pulled' for delivery to the workplace in time for the trade to perform the next task and minimise on-site storage.

Key Performance Indicator – KPI

A KPI is a measurement of the performance of essential tasks, operations, or processes. A KPI will usually unambiguously reveal conditions or performance that are outside the norm and can help identify the need for managerial intervention. A KPI can be quantitative or qualitative, objective or subjective, although preferably quantitative, unambiguous, and reliable. KPI's can be set by the client, main contractor and/or sub-contractors to assess performance.

Logistics

Whilst often associated with transport 'Logistics' is a comprehensive business planning framework for the management of material, service, information and capital flows.

Material Logistic Plan - MLP

A MLP is a tool to assist the proactive management of material types and quantities to be used during construction. The MLP covers the management of materials from design to construction (including supply routes, handling, storage, security, use and reuse, recycling and disposal) through to project demobilisation and completion.

Market Place - MP

An onsite facility used to provide common materials and equipment for all contractors.

Materials

Physical resources used in the construction of a project, for example, bricks, windows, plasterboard, cement, nails and wood.

Offsite fabrication

A term for a modular building that is put together on-site from sub-structures (walls, floors, roof, etc.) that have been built off-site.

On-site Logistics Team

A service to receive deliveries and distribute materials, equipment and plant so that specialist operatives handle materials only when assembling or installing.

Partnering

A structured management approach designed to promote collaborative working between contracting parties. The objective is to align and unite all the parties with a shared goal of completing the scope of the work in a cost-effective manner which is mutually beneficial. It can apply to a single construction project (project partnering) or it can be used by clients working together with suppliers on a series of construction projects with the aim of promoting continuous improvement by deliberately applying the lessons from one project to the next (strategic partnering).

Pre-assembled

Delivery of products to a construction site that have been assembled before they arrive on-site.

Supply Chain

The supply chain comprises all parties from clients, contractors, consultants, suppliers and manufacturers that process the flow of project materials, information, and finances.

Site Waste Management Plan - SWMP

A SWMP identifies types and amounts of waste that will be produced by a project. Good Practice SWMP references the design and design changes and their impact on materials specifications or methods of working that seek to minimise this waste. A SWMP incorporates the re-use, recycle or recovery of wastes and is used as a tool to record quantities of waste produced to enable best practice to be incorporated in subsequent projects.

TAG

A label or tag which is attached to a material or item that contains data which is read by a scanner or similar device.

Work Pack

A collection or package of materials required to complete a specific task.

Overview

This document provides guidance on the development and use of Material Logistic Plans (MLPs) in the construction Sector. MLPs are tools to manage all materials from project conception through to demobilisation and completion. The MLP covers key aspects such as:

- the setting of objectives and key performance indicators for efficient material use;
- training;
- minimisation of materials through attention to:
    - material specifications;
    - delivery of materials;
    - storage of materials;
    - handling of materials;
    - use of materials;
    - disposal of materials; and
- identifying lessons to be learned and best practice.

Poor material management is commonly linked to the inaccurate or surplus ordering of materials, damage to materials, inadequate storage, rework due to errors, poor workmanship, defective site processes, and inefficient use of materials. Ordering materials that are not used on the project due to loss, wastage or being surplus to requirements has a cost which is often overlooked as it is built into the total project price and paid for by the client. This includes the cost of purchase and delivery, storage and handling, disposal, treatment or return to supplier, and labour to manage the unused materials.

Implementation of a comprehensive MLP will lead to economic, efficiency and sustainability benefits. A template MLP, checklist and a further information tool are provided in Appendix 1 and 2. The guidance document and templates were developed with technical input from the Project Advisory Group members and piloted at a number of construction projects (see Appendix 4 for details on the pilot sites). The pilots ensured the MLP template would be a practical; easy to use and maximise project benefits. The case studies (provided in Appendix 3) detail methods and techniques implemented at actual construction sites and the benefits and savings achieved.

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1.0 Introduction

1.1 Background

Typically 10 to 15%, but up to 45% for some materials (WRAPa, 2007) of the total materials ordered for construction projects are either unused or end-up as waste. A 35% reduction in material wastage could be achieved by adopting more efficient logistic practices and the key to achieving this is the development and implementation of a robust Material Logistic Plan (MLP). These plans are an important tool for the construction sector to help ensure the right materials are in the right place at the right time in the right quantity. This is achieved through rigorous attention to design, materials specification, estimating and ordering as well as preventing the generation of waste from damaged, lost or surplus materials e.g. from poor storage or resulting from multiple handling of materials.

This document provides guidance on the format of MLPs and their application within the construction industry. A useful MLP template and checklist are also provided which have been designed to ensure MLPs are practical, easy to use and develop on-site, and to enable them to deliver economic and environmental benefits. The template MLP provided in Appendix 1 was developed with technical input from the Project Advisory Group members and piloted at a number of construction projects (see Appendix 4 for details on the pilot sites).

1.2 What is Material Logistics Planning?

Material logistics planning is a practice designed to assist construction projects in proceeding smoothly whilst achieving programme certainty and cost predictability on complex building projects. Material logistics planning relates to the proactive management of the types and quantities of materials to be used, including supply routes, handling, storage, security, use and reuse, recycling and disposal of excess materials. As projects get larger, supply chains increase in complexity and planning controls get tougher so that logistics becomes progressively more important.

The use of logistics as a complementary approach to construction management is becoming more popular and logistics is now a key feature of pre-construction planning; not just on large complex schemes, but also in the planning and delivery of mainstream housing and fit-out contracts. MLPs are tools to formalise and implement the logistic planning process.

The key stages of material logistics planning are shown in relation to the construction process in figure 1.

Figure 1 Key Stages of a MLP within the Construction Process

Logistic planning should be initiated at the project outset to achieve the greatest material savings. Ideally the client should develop and maintain a clear strategy for best practice logistics planning based on their corporate goals and policies. The logistics strategy will define the approach to formulation of the MLP. However the development of a project specific MLP is often a designated, or implied, responsibility of the main contractor, whereas it should be used during the design stage to minimise material wastage through eliminating bespoke designs; for example, reducing the proportion of unique window sizes.

Once the design of the project has been agreed, the material types and quantities should be built into the MLP together with a programme specifying the project phase for which they are required. It is important to identify and understand how materials will be procured, delivered, stored and handled onsite and incorporate these procedures into the MLP so that they can be communicated to all relevant parties. The MLP will be implemented during site mobilisation and is a live document that changes as the project develops.

Site practices should be monitored for their conformance to the MLP. The plan should also be reviewed on a regular basis and updated as improvements or design changes are identified. The main causes of material wastage during the construction phase are:

- off cuts of materials such as tiles and plasterboard;
- inaccurate or surplus ordering of materials;
- damage to materials e.g. through inappropriate handling, inadequate storage;
- rework due to errors, poor workmanship or defective site processes; and
- inefficient use of materials e.g. use of temporary materials such as hordings.

Upon completion of the project the findings of the MLP including achievements and lessons learned should be communicated to all relevant parties involved in the project and key stakeholders so that the knowledge gained can be incorporated into future projects. It is particularly important to quantify and internally advertise efficiency and materials cost savings to promote take up of MLP in new projects.

1.3 Why is good practice material logistics important?

Logistics principles are not difficult in themselves, but putting them into practice takes commitment, effort and attention to detail, with an emphasis on manageability. There is a strong business case for implementing MLPs in construction projects using the good practice guidance laid out in this document. The MLP may assist in delivering financial, efficiency and sustainability benefits.

This section provides an overview of the main benefits of good practice material logistics that will contribute to improved project programming, best practice environmental performance and reductions in build cost. Appendix 3 details Case Studies demonstrating projects which have achieved a variety of the benefits detailed below.

1.3.1 Financial Benefits

Ordering materials that are not used on the project due to loss, wastage or being surplus to requirements has a cost which is often overlooked as it is built into the project price and paid for by the client. The total cost of poor material logistics includes the cost of:

- purchase and delivery;
- storage and handling;
- disposal, treatment or return to supplier; and
- labour to manage the materials.

A study into construction waste costs (Envirowise, 2007) estimated that the true cost of one skip of mixed construction waste was £1,343. The most significant cost element, at £1,095 of the total cost was attributed to unused material in the skip.

Case Study
Cost savings in the region of 2.5% of the project costs were achieved by implementing a robust logistics strategy at the BAA Terminal 5 Project

Case Study
Over £200,000 of materials were recovered using reverse logistic procedures during the refurbishment of Unilever House which might otherwise have ended up in a skip

Preventing the ordering of materials that will not be used on the project by implementing good practice logistics planning will:

- produce a total saving on the project and/or increased profit margins for main-contractors and sub-contractors;
- reduce the total cost of purchasing materials;
- avoid waste disposal charges through minimising the amount of materials that result in waste; and
- reduce labour resources through the reduced handling of materials, as well as having the right materials present to undertake a task.

Main contractors and sub-contractors can increase their chance of a bid being successful by demonstrating that their total bid price for a project has been reduced because of their good logistic practices and that clients will benefit from the savings made.

1.3.2 Labour Efficiency

The efficiency of the labour force on-site contributes to the project costs, duration and quality, as well as the client's perception of the construction organisation. Implementing efficient material logistic practices will reduce the number of times materials are handled and prevent skilled craftsmen being taken away from the core tasks to handle materials. Onsite personnel performance will increase by having the materials required for a task on-hand, at the right time and in the right quantities.

Case Study
The increased reliability and efficiency in the use of materials led to an increase in productivity levels of 25% (based on a typical construction site average of 55 – 60%) at the BAA Terminal 5 Project

1.3.3 Legislative and Policy Drivers

There is an increasing thrust of public policy (including waste strategy reviews, planning requirements, and industry targets) to achieve greater material resource efficiency. While there is currently no regulatory obligation to implement a formalised plan to minimise the purchase and use of materials that will result in waste, the following initiatives provide a clear indication of the direction in which policy is moving.

- SWMPs are scheduled to become a mandatory requirement for all projects above a certain threshold value in England and Wales (threshold value to be determined) with Scotland and Ireland currently implementing similar requirements. The development of a SWMP requires a thorough assessment of waste types, including how much will be produced and when, so that appropriate waste handling and storage is planned for. Good practice SWMP also requires that the reuse of materials be assessed.
- The draft Strategy for Sustainable Construction, 2007 and The Waste Strategy for England 2007 propose to aim for a 50% reduction of construction, demolition and excavation waste going to landfill by 2012 (compared to 2005) and zero net waste production at construction site level[1] by 2015[2] with zero waste going to landfill by 2020. The strategy will assist in obtaining specific commitments from Government Departments, the construction industry and its clients, to deliver on the sustainability targets.
- Landfill Tax was introduced in 1996 to encourage all organisations to reduce the amount of waste disposed to landfill. The standard rate of £24 per tonne for active waste will increase by £8 per tonne per annum until 2010/11 and the inert materials rate will increase from £2 to £2.50 per tonne in 2008. The proposed increases therefore provide a strong financial incentive to prevent materials being disposed as waste.
- In October 2007 the requirement to pre-treat all non-hazardous wastes prior to landfill was introduced under the Landfill Directive. Pre-treatment of wastes prior to landfill aims to ensure that the maximum proportion can be recycled and also that the residual waste has a minimal impact when landfilled. Organisations can meet the requirements of pre-treatment by separately collecting wastes as individual waste streams and recycling one of the separated streams. Alternatively a third party can undertake the treatment on an organisation's behalf via sorting facilities at a transfer station or through treatment facilities such as mechanical biological treatment, thermal treatment or anaerobic digestion.
- The Government introduced measures to reduce CO_2 emissions in 2005 and the stringency of these is measures is set to increase. This will require many organisations to take additional and sustained action to reduce the CO_2 emissions from their activities. Notwithstanding any regulatory requirements, it is generally considered socially responsible for organisations to identify methods to reduce their carbon footprint through efficient material use, good building design and reducing transport where feasible.

Organisations that anticipate and pre-empt policy drivers will be in an advantageous position in comparison to those that wait until they are compelled to act by legislation.

[1] The concept of 'Zero Net Waste' is explained in: http://www.wrap.org.uk/construction/index.html
[2] http://defraweb/environment/waste/strategy/index.htm

1.3.4 Environmental Benefits

Improving project environmental performance helps clients and contractors demonstrate their commitment to reducing their impact on the environment. Projects using efficient material logistics will reduce:

- the tonnage of waste sent to landfill or for treatment;
- raw material requirements and the need to manage re-use and recycle excess materials; and
- their carbon footprint from CO2 emissions associated with extracting, processing/manufacturing and transporting material.

Case Study
The fit out of the Willis Tower produced 500 tonnes of waste in 7 months of which 70% was recycled as part of their logistics plan

The use of a MLP will enable organisations to produce quantifiable achievements and undertake benchmarking activities against similar projects (see section 2.5.1 for information on KPIs).

2.0 Guide to Formulating a Material Logistic Plan

2.1 Key Stages of a MLP

Stage 1 – Identify who is **responsible** for producing the MLP and ensuring that it is implemented. Different individuals may be responsible over the project lifetime, from the pre-design to the post construction stages. Each responsible person must know that they are responsible and what they are responsible for.

Stage 2 – To maximise the benefits of the MLP a **training and communications** plan should be developed which details the level of training required by all persons with responsibility for developing or implementing the MLP. Attention should be paid to programming the training in advance of when it is needed.

Stage 3 – Identify the project's **material requirements** i.e. the types and quantities of materials to be used throughout the project and how and when these will be delivered to the site including any constraints. The percentage, weight or units of materials that are anticipated to be ordered as design waste (i.e. off cuts) and construction process waste (i.e. from damage, reworking and similar) should be identified and justified for all key materials. KPIs should be set for procurement of all key materials.

Stage 4 - Identify the requirements for the **Receipt and Storage** of materials which will include the identification of the locations for receiving and storing materials as well their handling procedures. Any requirements which may restrict or limit the receipt or storage of materials, such as planning conditions, should be identified and mitigating measures put in place.

Stage 5 – Sub-contractors should be effectively prepared, managed and monitored so that they are aware of their responsibilities under the MLP and are able to supply the required information and adhere to the plan. Where feasible, contracts should include a specification that requires sub-contractors to implement the relevant aspects of the MLP. Their capability to do this can be assessed through their tender response where material usage and supply has been identified as a selection criteria.

Stage 6 – The MLP should identify any changes occurring during **Site Mobilisation and Construction** which impact on the MLP and the plan should be amended accordingly. Changes which affect working practices should be communicated to the relevant personnel.

Stage 7 – A planned approach to **project demobilisation and completion** should be implemented to ensure that materials, equipment, plant, personnel and wastes are removed from site in a managed and timely manner. An effective demobilisation plan will minimise costs through off hiring equipment and plant when it is no longer required onsite as well as planning for excess materials management.

Stage 8 – Review how the MLP worked at the end of the project and identify learning points for the next project. Share any lessons learned with other parties involved in the project so that they can benefit from the experiences. Determine unit costs of processes which showed the best improvement from implementation of the MLP.

The generic phasing of the Key Stages is shown diagrammatically in Fig 1. The development and implementation of the SWMP occurs in tandem with these Key Stages as discussed in section 2.2.

2.2 Site Waste Management Plans

Many elements of the MLP will be mirrored in the completion of the SWMP. Figure 2 shows where the key stages of the SWMP link with the MLP. To prevent duplication of efforts both plans should be implemented in tandem, for example, when undertaking the training programme for the MLP it would be an efficient use of time to carry out the SWMP training.

When identifying the roles and responsibilities of key staff it is important that the MLP references the persons responsible for completing the SWMP as a number of areas will overlap, such as in estimating the amount of materials to be ordered to cover design waste (i.e. off cuts) and construction process waste (i.e. from damage, reworking and similar).

The MLP will identify the types and quantities of materials to be used throughout the duration of the project. The main contractor and sub-contractors should estimate the % or quantity of the materials to be ordered that will end-up as waste and justify its production. This data should then feed into the SWMP. This data will also be needed to inform the SWMP particularly in the provision of appropriate waste containers which promotes waste segregation and thus facilitates recycling of clean separated material types.

During site mobilisation the procedures detailed in the MLP to manage materials will be implemented. Contractors and sub-contractors will be tasked with conforming to these procedures and be monitored throughout the project. The MLP and SWMP both require waste quantities to be recorded and reported on and a single system for doing this should be implemented with the resultant data being shared between all relevant parties. Furthermore, good logistic practices such as JIT delivery and co-ordinated material ordering will reduce the amount of materials that end up as waste. It would be beneficial for the person (s) responsible for monitoring conformance to the SWMP, such as viewing storage areas for appropriateness and ensuring waste containers are appropriately used, to be knowledgeable about logistic methods and waste management to reduce duplication of efforts.

At the project completion and demobilisation stage is vitally important to prevent any excess materials being ordered as it is unlikely they will be able to be redeployed to activities elsewhere on-site. The demobilisation process should implement a robust reverse logistics strategy to capture all unused materials for either return to supplier or reuse elsewhere to prevent valuable resources being disposed.

During the review of the MLP the data on the quantities and types of wastes generated from the project will assist in the evaluation of material types and quantities ordered and how they were managed. For example, if a high proportion of plasterboard waste was identified this could have been as a result of poor storage or handling of the material resulting in damaged plasterboard being disposed of as waste. The review process should then identify measures to minimise this occurring in future projects.

Further information and resources on construction waste minimisation and management is available on the WRAP website.www.wrap.org.uk/construction and in Section 4 Further Information and Tools.

Figure 2 Links between the MLP and SWMP

2.3 Contracting Methods and their Impacts

Best practice is about partnering, collaborative working and stripping out, at the earliest possible stage, those costs which add no value. To achieve that, it is vital to involve the whole supply chain. Ideally partnering should be between the client, main contractor and specialist contractors and consultants. The persons responsible for material logistics and the contracting teams should be integrated from the earliest conceptual design stage, to ensure that the client's requirements are understood through an effective and iterative briefing process and that all are committed to the whole project. Therefore, organisations need to use the most appropriate procurement and contracting strategies which requires the use of contracts that support collaborative working. Where partnering type contracts are not in place the MLP will need to be pushed by the client through the supply chain and tendering process. Alternatively skilled logistics specialist can be employed by the client or main contractor to co-ordinate the various contractors and ensure all parties are communicated with.

Most traditional main contract forms should still recognise logistics and could leave it to the individual sub-contractors to provide their own logistics as part of their sub-contract works. However, management forms of contract, i.e. the Construction Management Contract, do refer to 'site wide logistics' as a service and this is normally where specialist logistics organisations are brought into a project. Where this occurs there is an obligation on the other trades to provide the specialist organisations with information regarding material

quantities, deliveries etc. This information is generally sought during project meetings rather than being detailed in their contracts.

Clients and main contractors should cost the provision of logistic services such as a Tag system and then potentially recover all or a proportion of these costs from the trade contractors; by including within their contracts a mandatory clause to use the service. Where the service can provide quantifiable savings the client and/or main contractor may expect to see a reduction in price where savings are significantly greater than the cost of the service. Logistic services can also be procured direct by a main contractor or sub-contractor, see section 3.1 for further information.

2.4 Roles and Responsibilities

All parties to a construction project can contribute to the efficient management of materials. The roles and responsibility on a construction project can be divided into three main groups:

1) Clients
2) Main contractors
3) Sub-contractors

Those clients regularly engaged in construction projects will have the experience and knowledge to understand how and where they can influence a main contractor's method of work. However few clients have involvement with major construction projects and it is often the responsibility of the main contractor to inform the client of the benefits of implementing initiatives such as the use of MLPs. Whilst the preference is for client led initiation of MLP this is not currently the norm; this should be taken into account when reviewing the following sections detailing responsibilities.

2.4.1 Clients

The client's main role in the development of the MLP is in demonstrating leadership by setting the structure and requirements of the MLP and communicating these requirements to the project team. Generic material efficiency requirements should be part of the clients overarching business strategy, independent of particular projects. These requirements will then form the framework which all projects should conform to. The requirements within the client's business strategy will relate to the organisation's overall drivers such as project costs and environmental credentials.

The client's policy requirements for a particular project should be communicated during the tendering process with the aim of obtaining a main contractor that will meet the requirements and communicate the importance of best practice material logistics to the whole supply chain. Including a high level requirement for a MLP can ensure that good practice material management is included in all aspects of a project and the use of targets / requirements in contracts can help make contractors accountable for their performance.

As the design develops, opportunities to improve the management of materials should be identified and pursued. This is best done by a small team of staff which includes representation from the client, design team and main contractor to pool knowledge and experience in identifying where materials are being wasted through e.g. design, project programming and damage. Clients are also responsible for leading the project review process at the conclusion of the construction project and ensuring that any 'lessons learned' are communicated to the appropriate stakeholders.

2.4.2 Main Contractor

Main contractors should deliver the clients requirements by developing a robust MLP (or in the absence of client requirements devise the MLP themselves) which implements clear procedures to manage materials through the supply chain. The procedures should also be aimed at gathering estimated material quantities and comparing these to the actual quantities used. All sub-contractors will need to produce accurate material quantities for their trades and supply these to the logistics manager.

A logistics manager for the project should be appointed. For large projects this might be a dedicated, full time role. For smaller projects it can be combined with wider project management responsibilities. In either case however, the role should be given authority and support from senior management and the person should be appropriately skilled in logistic methods and techniques. The logistics manager should be appointed as early as possible in the project life cycle so that logistics can be considered at the design stage whilst it is still possible to make changes to accommodate good practice.

Seeking early logistics advice can create many efficiencies and cost benefits. Working with the supply chain on material consolidation and JIT delivery, combined with a multi-skilled site logistics team can make a real difference to the productivity of trade contractors.

The main contractor is responsible for linking with the design team to identify potential material savings from the design of the project and for providing a site wide SWMP and monitoring conformance of sub-contractors to the plan.

2.4.3 Sub-contractors

Sub-contractors are responsible for ordering, and managing most of the materials for the project. Therefore the sub-contractors buy-in to the MLP should be sought as early as feasible in the project planning process. Sub-contractors should be engaged at an early stage to identify where material wastage is likely to arise and contribute to identifying methods to prevent it.

Sub-contractors will also need to buy-in to the on-site logistics practices such as a Tag system and may need to be trained in the relevant procedures and reporting mechanisms. Sub-contractors are responsible for providing accurate material data including quantities against project timescales and load / delivery details.

Once each person's role and responsibility in developing and implementing the plan has been agreed it is vital to communicate this to all parties, especially sub-contractors. Meetings should be held with staff and contractors, clearly describing the importance of the MLP and their roles within it.

2.5 Training and Communication

A training and communications programme should be developed by the Main Contractor to ensure all parties understand how they are to report the quantities and types of materials they will use throughout the duration of the project. The training should include making sure that everyone is aware of any site specific issues and logistic strategies e.g. the use of a CCC or on-site MP. Training can be delivered via bespoke courses or incorporated into existing training sessions such as induction and tool box training.

Figure 3 Roles and Responsibilities

* In the absence of the Client leading the implementation of the MLP the Main Contractor should implement the client's roles and responsibilities.

2.6 Obtaining Material Types and Quantities

The main contractor and all sub-contractors will need to prepare a Bill of Quantities or similar as part of the MLP which will require input from the manufactures, suppliers and distributors of the materials. It is important to set strict guidelines on the process to estimate material quantities and their phased purchase throughout the project. Sub-contractors will need to make an allowance for wastage as it may be unavoidable where designs require materials to be cut. However, if the MLP provides good material management on-site such as JIT deliveries and designated, adequate storage areas to reduce damage to materials, the contingency allowance should be reduced to reflect these procedures.

Prior to ordering, materials should be requisitioned in such a way that highlights the immediate area and programme for their intended use. This information should then be provided to the logistics manager to ensure that only those materials intended for a particular area at a particular time are allowed onto the site.
Equally the rationale behind quantification should be apparent and highlight any global or rule of thumb allowances rather than absolute quantities. Where such allowances are made they should be agreed with the client before ordering and delivery.

2.6.1 KPIs

Measurement provides the basis for improved forecasting of activities, scheduling, and risk management. It can contribute to certainty in a construction programme in relation to project timing and the ability of personnel to keep working to plan. Setting and monitoring specific and relevant Key Performance Indicators (KPIs) for both the main and sub-contractors will indicate current performance and trends, and show where action needs to be directed. In addition to project KPIs, the client should set overall company/project policy requirements such as zero net waste production at construction site level by 2015 and zero waste to landfill by 2020 (as currently provided within the draft Strategy for Sustainable Construction, 2007). The KPIs can then be used to monitor the project's performance against the overarching aims and provide a standard measure to assess performance.

KPIs will be different for every project or even part of a project to be measured. However, understanding the flow and quantities of materials in detail allows the effect of change to be measured and the benefits to be quantified. The following KPIs have been based on current research and stakeholder engagement. For each project it is necessary to establish robust baseline data based on past performance to develop meaningful KPIs that ensure continuous improvement.

An example strategic KPIs to be set by the Client is:

- material wastage to be below 10% [or other specified amount] of total material quantities ordered.

Strategic KPIs to be set by the main contractor could include:

- labour productivity levels to be greater than 75% [or other specified amount]; and
- take up of logistics service for greater than 90% [or other specified amount] of materials by type.

Site Specific KPIs normally set by the main contractor and implemented by relevant sub-contractors could include:

- quantity of each material to include a contingency allowance (including design waste and construction process waste) of less than 5% [or other specified amount];
- completeness of material order delivered to be accurate for greater than 95% [or other specified amount] of delivery receipts; and
- level of damaged product received to be less than 3% [or other specified amount] of total quantity ordered.

For projects using CCCs typical KPIs to be included for their service provisions are:

- quantity of material call offs to be delivered to site within 24hrs to be greater than 98% [or other specified amount];
- number of full loads delivered to be greater than 95% [or other specified amount] of total number of deliveries;
- quantity of materials returned to be less than 1% [or other specified amount] of total quantity ordered;
- number of pallets returned and collected by the original supplier to be greater than 85% [or other specified amount]; and

- length of time materials are held at the CCC to be less than 11 [or other specified amount] days at any given time.

Main contractors and sub-contractors should ensure that the project KPIs are implemented and monitored regularly during periodic project reviews. At each project review reports on achievement against KPIs, e.g. material quantities used against estimated quantities (as identified by sub-contractors during the tendering process), should be produced to enable the identification of opportunities for improvement or areas of concern. The following figure details the development and use of KPIs throughout the duration of a construction project.

Figure 4 KPI Timeline

2.7 Managing the Receipt and Storage of Materials

During the design stage material laydown and storage areas will have been identified. These should be clearly demarcated at the start of the project and managed to prevent the areas becoming overfilled and ensure that they are suitable for the materials e.g. a dry area for plasterboard. Good site security such as perimeter fencing and security personnel will minimise materials lost due to theft or vandalism.

Based on the information supplied by all parties on the material types and quantities to be used, and the project phase/date that they will be required, the receipt and storage process can be devised. Suitable plant and equipment to unload and handle the materials at the identified storage or point of use area should be available. Ideally, similar materials should be stored together to prevent wastage of part utilised items.

To prevent the double handling of materials it is best practice to ensure a suitable labour team is available to unload and distribute materials to their point of use; this will also decrease the costs of specialist personnel such as craftsmen being taken away from their core tasks to collect materials.

Upon delivery of materials to their point of use the appropriate contractors should confirm receipt of the materials using either a manual paper based system or an electronic system (such as Tagging).

2.8 Managing Sub-Contractors

Each sub-contractor should conform to standards agreed with the main contractor. These standards should be itemised and included where possible as KPIs (see section 2.5.1) as part of any formal agreement between the

main contractor and sub-contractors. In addition, sub-contractors will need to supply data on material quantities and evidence of their purchase, use and disposal route. Examples of mandatory information are:

- quantities of each material type and when and where it will be delivered;
- material quantities factored in for contingency (design waste and construction process waste) or similar;
- copies of purchase orders;
- material delivery times, access, delivery points and documentation;
- material load units – crates, pallets etc and any specific handling equipment/plant requirements;
- details on material packaging and if it is returnable;
- material labelling procedures and use of any Tag type systems;
- material storage and security procedures; and
- material collection and returns procedures (including transfer/consignment notes if handled by sub-contractors).

The report Reducing Material Wastage in Construction (WRAP, 2007) provides guidance on how to actively reduce waste on projects by focusing on the role of contractors and sub-contractors who procure and use materials.

2.9 Materials Management from Site Mobilisation to Demobilisation

During the site mobilisation stage all the processes defined in the MLP will be implemented. The effectiveness of implementation and the communication of the MLP to all parties will directly affect the success of the MLP. Regular project reviews should be scheduled to enable the conformance to agreed procedures to be assessed and identify opportunities for improvement. As the project progresses, close-out reviews with each sub-contractor should be undertaken.

It is important to ensure that appropriate material handling plant and equipment is available to minimise damage to materials on-site. All equipment that is used to handle materials should be monitored for utilisation rates. Use of hoists and cranes, for example, should be planned to ensure that such equipment is kept well-utilised; with no more used than is necessary. Suppliers requiring the use of such assets should be required to pre-book their use. In some instances suppliers could be charged for the use of the asset to demonstrate its value to the project. With centralised control of resources there will be a need to balance the conflicting demands of the users.

The development and implementation of an efficient demobilisation strategy will ensure the effective removal of excess materials, wastes, plant, equipment, labour and facilities. To facilitate a controlled approach, the plan should identify how material usage, towards the end of the project, will be managed to prevent excess material being delivered that may result in waste. It should also ensure that any excess materials can be redeployed to another project, sold back to the supplier or donated to a charitable project to minimise waste quantities.

2.10 Reviewing the MLP and Reporting on Findings

The MLP will have been reviewed throughout the project at key stages or when a significant change in the project occurred e.g. project timescale. In addition, periodic reviews of the KPIs should be completed to allow for early identification of areas for improvement or of concern. At the end of the construction project the MLP and periodic reviews will be able to provide an accurate record of how effectively materials were managed on the site and how well the project preformed against the KPIs. The review should seek to answer the following questions:

- Were KPI targets exceeded and if not why not?
- Is there an opportunity to improve performance of the KPIs for future projects?
- Did the setting of objectives/KPIs have any negative impacts on the project, and, if so, how could these be minimised whilst still retaining the principles behind the objectives/KPIs?
- What could be amended to make the MLP easier to use or more effective for future projects?
- Did all sub-contractors participate in the MLP?
- How could the participation of sub-contractors be increased in future projects?
- What additional information was required for the MLP, and should this have been requested earlier?
- Could the project have further reduced the total amount of materials that resulted in waste and, if yes, how could this be achieved on future projects?

- Could the projects have further reduced the total amount of surplus materials that were returned to suppliers or distributed to other projects and, if yes, how could this be achieved on future projects?

This information will be of great value in the design and delivery of future construction projects. Preferably a summary or findings report should be written and distributed to all parties that contributed to the project. This summary report should identify a list of recommendations and identify the benefits of the MLP, its impact on the cost of the project and its benefit to the environment.

3.0 Logistics Services and Techniques

3.1 Logistic Services

Dedicated, trained logistics specialists can provide valuable experience and knowledge to a construction project. Logistics specialists can either be employed internally by the client or main contractor or can be hired from specialist external organisations for either a key task or for the entire duration of the project. Logistic services can generally be grouped into the following services:

- On-site logistics specialist - the on-site team receive all material deliveries and distribute materials, equipment and plant so that operatives handle materials only when assembling or installing. This team may also plan the infrastructure processes needed to deliver the project including site planning, welfare of the workforce, traffic management and health and safety.
- Full supply chain logistics planning – main contractors employ (either directly or indirectly) professionally trained logisticians who can plan across the range of, procurement, storage, distribution and back loading activities.
- 4th party logistics – an overarching service to co-ordinate other logistics providers where there is more than one supply chain.

See case studies in Appendix 3 which detail the roles of logistic co-ordinators and specialists on different construction projects.

3.2 Logistic Techniques

3.2.1 Just-In-Time Delivery (JIT)

JIT delivery is a service of frequent deliveries in work packs or task loads, 'pulled' just in time for the trade to perform the next task without incurring any delays. This can be done either through a CCC or individually by suppliers. JIT deliveries reduce or even eliminate the need for on-site storage of materials. Not only does this improve the site logistics but it reduces the risk of damage or loss of materials stored on-site as well as reducing congestion and the associated risks such as safety incidents. See case study 'BAA Terminal 5s Just-in-Time Logistics Strategy' in Appendix 3 for further information.

3.2.2 Demand Smoothing

Demand smoothing enables the peaks and troughs in the demand of materials to be evened out over a period of time or duration of the project. Demand smoothing is a means of looking at the programme of project activities in the entire value chain and identifying how the activities can be balanced or 'smoothed' to reduce the amount of transport resources, materials and labour needed to carry out the task or activity. Demand smoothing can be done at any level in the supply chain by clients and / or contractors.

3.2.3 On-site Marketplaces (MP)

A MP is a temporary storage area for consumable materials, fixings and small tools that are widely used and shared between a number of trade contractors working on-site. Typically this will include metal channel, threaded rod, anchor fixings, nuts, bolts, screws, raw plugs, small drill bits and similar.

Each trade contractor will deliver their supplies to the market place for common storage and distribution by a store-man when required, or they can agree to make a common contribution to the store for these materials to be provided by the store-man. When stocks become low they are replenished by the individual trade contractor or through the store-man who will order on their behalf.

The major benefit is the assurance of available materials in a known and secure location when required and removes the need for individual trades to set up their own small materials storage areas and controls on-site. This leads to productivity benefits and cost reduction.

3.2.4 Pre-assembled and offsite fabrication

It is generally considered good practice that, where possible, materials should be obtained configured as far as possible to their final use. For example, this might include electrical components made into partial wiring looms, or plasterboard pre-cut to the size needed. The next step might be for component materials which could be prepared in packages appropriate to a room, a floor or other designated area. A key objective is to reduce the amount of thinking time whilst the job is in progress. By taking a logistics view it is possible to do most of the thinking during the planning stages. Similar to pre-assembly, offsite fabricated materials are generally preferable to those constructed on-site, since wastage can be more efficiently controlled and transport requirements are usually reduced.

Figure 5 Offsite Fabricated House being Constructed

3.2.5 Information and Communication Technology (ICT) Systems

ICT Systems are used to tag and track materials through manufacture, distribution, assembly and installation. Commonly referred to as Tag systems they help to manage material flows by using various forms of information technology. Radio frequency identification allows a rapid and accurate reading of tags on the site. This can be done from a distance and through many materials without a direct line of site being required. The Tag system allows the tracking of materials to the point of use and can provide considerable detail about what actually happens on-site. Suitable IT systems are relatively low cost and are becoming more widespread on construction sites.

3.2.6 Inventory Management Optimisation (IMO)

IMO software systems are proactive planning tools to optimise inventory levels and the utilisation of site / warehouse space and transport facilities. The software is designed to distribute materials to the right place at the right time, with supply measured against actual and forecast demand for each individual supply centre.
IMP software can model demand and supply scenarios, assess areas like lead time variability and undertake this analysis for multiple sites at the same time. IMO is more commonly used in the automotive industry but is becoming increasingly popular within the construction sector. See case study 'BAA Terminal 5s Just-in-Time Logistics Strategy' in Appendix 3 for further information.

3.2.7 Construction Consolidation Centres

Construction Consolidation Centres (CCC) are distribution centres used to supply materials in the required quantities to one or more construction projects. They are an effective supply chain management solution enabling the safe and efficient flow of construction materials and equipment from supplier to project. The concept of CCC was developed to serve the materials handling needs of construction sites in busy and challenging environments such as inner city areas. The CCC does not store materials in the conventional sense (not more than 7 days is the ideal). It distributes materials 'just in time' to meet the daily needs of construction sites. Goods are 'consolidated', which means that multiple part-loads are combined into single shipments. This process maximises the efficiency of distribution vehicles and leads to a substantial reduction in overall vehicle numbers delivering into a congested environment.

The key feature of the centre is that goods are delivered not just to a site entrance - but to specified locations as close as is practicable to the workface, by material handling operatives. They are specialists in their field and use an extensive range of vehicles and mechanical handling equipment necessary to complete distributions safely, efficiently and without damage. Trade contractors are left free to concentrate on their core tasks, without worrying about the co-ordination of and supply of goods to site, nor the need for their specialist trade operatives, who are often working in short time windows, to be diverted away from production to assist with material handling. The main benefits of a CCC are the potential to:

- improve certainty of supply;
- reduce site deliveries;
- reduce site stock holding; and
- reduce waste and losses.

Figure 6 Construction Consolidation Centre Model

See case study 'Management of Materials through Construction Consolidation Centres in Appendix 3 for further information on CCC.

4.0 Further Information and Tools

4.1 WRAP

WRAP (Waste & Resources Action Programme)

The WRAP construction programme is helping the construction industry cut costs and increase efficiency through the better use of materials. The WRAP website provides tools and guidance to help identify opportunities for waste minimisation and management, recycled content and support to find suppliers, understand specifications and regulations and identify business funding opportunities. www.wrap.org.uk/construction.

WRAP resources include:

- Publications on both standards and benchmarks of good practice and guidance on both procurement and implementation of waste minimisation & management and recycled content.
- Exemplar wording for pre-qualification questionnaires, briefs and contracts.
- SWMP templates covering housing, general construction and civil engineering.
- On-line recycled content toolkit for calculating performance and opportunities.
- Reference guide identifying specific products with higher levels of recycled content.
- Case studies covering all types of construction.

4.2 Other Sources of Information and Tools

Building Research Establishment (BRE)

BRE has developed the SMARTWaste suite of tools, designed specifically for the construction and demolition industries. These include waste monitoring software, a benchmarking tool, and a locator for waste management facilities (BREMAP).
www.smartwaste.co.uk

The Chartered Institute of Logistics and Transport (CILT)

CILT (UK) exists to be the pre-eminent independent professional body for individuals associated with logistics, supply chains and transport. The CILT Knowledge Centre houses one of the largest specialist collections of logistics, supply chain and transport information in the world.

Chartered Institute of Waste Management (CIWM)

CIWM provide guidance on technical queries relating to waste production and management including recycling reuse and waste prevention. In addition, CIWM and the Environmental Services Association (ESA) have joined together to provide training for the industry by the industry, such as the Construction Waste Awareness Certificate Course.
http://www.ciwm.co.uk/pm/389

Constructing Excellence (CE)

CE aims to deliver improved industry performance by bridging the gap between industry, clients, government and the research community. The CE website provides information on training, benchmarking and research in the construction sector and a Logistics Zone which provides a point of reference for the growing interest in this topic.
www.constructingexcellence.org.uk

Envirowise

Envirowise delivers a government-funded programme of free, confidential advice to UK businesses. This assistance is designed to support companies in reducing their environmental impact. Envirowise can provide independent advice and guidance via a free Advice Line, on-site visits and through their website which details guidance, case studies and best practice guides.
www.envirowise.gov.uk

Transport for London (TFL)

The TFL website provides information on construction projects in London and an overview of the environmental and economic benefits achieved by the London construction consolidation centre, the freight strategy and driver recognition scheme.
http://www.tfl.gov.uk/businessandpartners/freight/1294.aspx

Waste Aware Construction (WAC)
WAC provides information on the National Colour Coding scheme for the source segregation of recyclates on construction and demolition sites and guidance on techniques for the construction sector to reduce, reuse and recycle wastes.
www.wasteawareconstruction.org.uk

5.0 References

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WRAPa, 2007. *Achieving Effective Waste Minimisation*. Waste and Resources Action Programme: Banbury.

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WRAPc, 2007. *Reducing Material Wastage in Construction*. Waste and Resources Action Programme: Banbury.

Appendix 1 Material Logistic Plan

Material logistics Plan

This template has been developed to enable you to prepare, implement and continuously update a Material Logistics Plan (MLP). The template has been designed to be used from project conception through to project close. The main purpose of the plan is to achieve savings in materials use and reduce the production of wastes.

The template provides tasks to complete the seven key steps of the MLP. The template provides space to record progress against each task in note form. Each step is supported by the 'Questions to Consider and Further Information' document. The table below displays the contents of the MLP and the corresponding section(s) in the 'Questions to Consider and Further Information' document.

Good site waste management practices will reduce the amount of materials that will end up as waste. Therefore, the project's SWMP should link into the MLP to prevent duplication of effort. Guidance on SWMPs has been issued by WRAP, DTI, Envirowise and the Environment Agency and is available from the respective websites.

Contents

Step	Title	Supporting Section in the 'Questions to Consider and Further Information' document
1	Responsible Persons, Training and Communication	1 Project Conception 2 Project Location Selection Pre-Defined Sites 5 Tender Process 7 Construction
2	Training and Communication Plan	1 Project Conception 6 Site Mobilisation
3	Material Requirements	1 Project Conception 2 Project Location Selection Pre-Defined Sites 3 Planning Permission 4 Outline Design
4	Materials Receipt and Storage	2 Project Location Selection Pre-Defined Sites 3 Planning Permission 6 Site Mobilisation 8 Site Waste Management
5	Management of Sub-contractors	5 Tender Process 7 Construction
6	Site Mobilisation and Construction	6 Site Mobilisation 7 Construction 8 Site Waste Management
7	Project Demobilisation and Completion	9 Demobilisation, Commissioning and Completion
8	Review	10 Review and Auditing

Material Logistics Plan

Project Name, address and location:

_____
_____
_____
_____

Main Contractor: _____

SECTION 1 RESPONSIBLE PERSONS, TRAINING AND COMMUNICATION

Identify who is responsible for producing and implementing the MLP. Different individuals may be responsible during the various work stages. They must know that they are responsible, what they are responsible for and receive appropriate training or instruction. They must have sufficient authority and senior management support to ensure that others comply with the MLP. See sections 1, 2, 5 and 7 in the Questions to Consider and Further Information document.

1.1. Name and contact details of the nominated logistics coordinator.

1.2. Identify responsible persons for developing and implementing the MLP. Details should include the name, company and contact details of each key person responsible for project timescales, material types and quantities, MLP training or dissemination and waste management at project setup and during design, construction and completion stages.

Name	Company	Contact Details	Responsibility

1.3. Detail when the MLP and subsequent revisions will be disseminated to the responsible persons.

SECTION 2 TRAINING AND COMMUNICATIONS PLAN

Identify key staff that need to be trained in material logistics and the completion / management of the plan and how all trade contractors will be either trained or instructed in the requirements of the MLP. See sections 1 and 6 in the Questions to Consider and Further Information document.

2.1. Describe how key site staff have been/will be trained on the implementation of the MLP.

2.2. Detail the timescales for the training of site staff

2.3. Detail how sub-contractors are to be trained and informed of the procedures for material delivery scheduling. Include details of the mechanism in place for monitoring sub contractor logistics and any training that takes place.

2.4. Provide evidence of key staff training on MLP e.g. site tool box talks.

SECTION 3 MATERIAL REQUIREMENTS

Identify the types and quantities of materials which will be required at all stages of the work programme and how they will be delivered. The information generated to complete section 2 should be linked to the Site Waste Management Plan (SWMP). The SWMP should detail the procedures for segregating wastes and moving them up the waste hierarchy as well as for their collection and end-use/disposal. See sections 1, 2, 3 and 4 in the Questions to Consider and Further Information document.

3.1. Each responsible person should complete the relevant sections of the following table based on the materials used in the project. The method of delivering the materials impacts on the three key reasons for generation of design waste (i.e. off cuts), construction process waste and wastage i.e. over-ordering, design and programme change, and damage. Justifications for contingency/wastage should include expected levels of wastage through actual use, accidental damage etc . Please duplicate the table for each person/work programme stage as required.

Completed By:									
Project Stage	**Expected Construction Period**	**Material**	**Quantity**	**Delivery Method**	**Delivery Timings**	**Design Waste (i.e. off cuts) %**	**Construction Process Wastage %[3]**	**Justification of Design & Process wastage**	**Supply Route**
Example Erection of Structure	*Example Jun 09 – Sept 09*	*Example Steel Frame*	*Example 732kg*	*Example Phased delivery to meet project programme. Open flat bed-lorry, crane needed to unload.*	*Example 3 call-off loads 4 May 09 6 Jun 09 4 Aug 09*	*Example 5%*	*Example 5%*	*Example Based on last project of similar design and size where design and construction process waste was between 5 – 10%*	*Example Direct from Manufacturers - Robinson Construction*

[3] *Quantities and types of materials that will end up as waste will be identified as part of the SWMP. This information will be gathered and managed by the site waste manager or waste champion for the project. It is important to ensure that the data obtained in the development of the SWMP feeds into the MLP.*

3.2. Key Performance Indicators (KPIs) are derived from baseline project data and are required to monitor the programme performance of material wastage, against the information supplied in Q 2.1. In the table below, KPIs are listed for key materials and their respective performance area and the baseline value of the KPI. An example is included.

KPI	Project element affected	Baseline KPI value (current or expected value)	Comments
Example *Level of wastage of aggregates*	*Example* *All build stages*	*Example* *5% of total ordered*	*Example* *Develop and implement methods to accurately monitor actual wastage*
Insert more rows as necessary			

3.3. When available, evaluate the detailed design to confirm that the materials requirements described in section 2.1 are accurate. Has this been completed?

Yes / No if Yes Date: _____

3.4. Develop and detail a demobilisation plan for individual trade contractors and how the plan will minimise residual material arisings and equipment downtime. When completed, record the location and owner of each demobilisation plan below.

SECTION 4 MATERIALS RECEIPT, STORAGE AND MANAGEMENT

Identify the locations for receiving, storing and management of materials. See sections 2, 3, 6 and 8 in Questions to Consider and Further Information document.

4.1. The Logistics Coordinator is to review the design of the site and confirm that sufficient space and resources have been allocated for the receipt and storage of materials. For each material, identify any requirement for a Market Place and/or Consolidation Centre (CCC) if required. Planning supply routes, the reception and storage of materials requires the development of guidelines for the safe, secure and appropriate storage of materials. Details of these guidelines should be recorded in the following table. Where required, the Logistics Coordinator should suggest amendments to the procedures for the receipt, storage and handling of materials.

Material / Resource	Receiving Location (inc CCC)	Storage Location (inc Market Place)	Guidelines for reception and storage of materials	Procedures for materials handling (inc equipment)	Comments
Example Fluorescent Light Tubes	*Example Site office*	*Example Site office*	*Example Material management guidelines stored in site office which detail the lamp laydown area and security controls.*	*Example Lamps to be delivered in protective packaging unloaded manually and immediately distributed to point of use.*	*Example There is insufficient space to store the tubes in the site office and they should be delivered in consolidated loads, 'Just in Time' and moved to their point of use.*

4.2. Identify any restrictions or implications for the management of materials from the Planning Permission, EIA and Constructability Review and/or noted by third party bodies and/or individuals (e.g. which may be affected by the choice of receipt/storage locations and supply routes). If appropriate, describe how the restrictions are to be mitigated.

Restriction / Implication	Planning Permission (PP)	EIA	Constructability Review (CR)	Third Party Body or Individual	Mitigation Process
Example Vehicle Movements	*Example No vehicle movements such as the delivery of materials or removal of wastes will take place outside of the hours of 09:00 and 16:00 hrs to minimise disruption to local residents*				*Example Deliveries of materials and removal of wastes to be co-ordinated through the on-site Logistics Coordinator to ensure conformance to the PP restrictions.*

SECTION 5. MANAGEMENT OF SUB-CONTRACTORS

Implement and/or review the procedures in place for the management of sub-contractors. See sections 5 and 7 in Questions to Consider and Further Information document.

5.1. Supply details of the tender specification requirements that mandate attention to waste minimisation and the sub-contractors responsible.

5.2. Incorporate material usage and supply criteria into the tender selection criteria for the assessment of sub-contractors. Detail the criteria and weightings below.

5.3. Supply details of contractual requirements to adhere to, support and implement relevant aspects of the MLP.

SECTION 6. SITE MOBILISATION AND CONSTRUCTION

See sections 6, 7 and 8 in the Questions to Consider and Further Information document.

6.1. Provide evidence that appropriate site staff, plant and equipment is available for materials management including handling.

Material	Site Staff Required	Site Plant Required	Site Equipment Required	Availability
Insert more rows as necessary				

6.2. Describe how changes in the design or construction activities are to be incorporated into the MLP. Provide details of the key management involved for amending and approving the MLP.

6.3. Describe how unforeseen activities which may cause a change to the programme are to be incorporated into the MLP. Provide details of the key management personnel involved for amending and approving the MLP. Examples of unforeseen activities are project slippage and broken machinery.

SECTION 7 PROJECT DEMOBILISATION AND COMPLETION

The main contractor should have compiled a demobilisation plan. The demobilisation plan is a continual phased process and includes the removal of plant, equipment, wastes and materials from site. See section 9 in Questions to Consider and Further Information document.

The project Demobilisation Plan (developed as part of Q 2.4) should now be implemented and monitored to ensure that residual materials and equipment downtime and timescales are minimised.

7.1. Assess the supply routes for the reverse logistics of surplus materials and provide details below.

7.2. Describe how excess materials and site facilities that are not waste, are to be recovered and removed from the site. Provide details and reasoning for the disposal of any excess materials as waste.

SECTION 8. REVIEW

See section 10 in the Questions to Consider and Further Information document.

8.1. Provide information on how the MLPs performance is to be reviewed e.g. during project close-out meeting, who is consulted and how the outcomes are used.

8.2. Describe the process in which lessons learnt and potential improvements are to be recorded and made available for future projects.

8.2. Detail the retention period for information on past MLP performances and the location of this information.

8.4. Use the existing information and knowledge base from this and past MLPs to establish accurate KPIs for future projects. Detail how this will be managed.

8.5. Disseminate the findings of this MLP review to all relevant parties including sub-contractors. Provide the details of this dissemination process and parties below.

Appendix 2 MLP Detailed Information and Checklist

Project Stages	Ref	Questions to Consider	Tick if 'Yes'	Further Information
1 Project Conception	**Material logistics planning is increasingly recognised as an aid to successful projects. It is important to consider logistical implications at the conception of any project to add certainty of delivery.**			
	1.1	Has logistics been considered amongst the project's key drivers?		Ensure that the logistics elements associated with each of your key drivers is considered at this stage to enable a coordinated and consistent approach throughout the life of the project.
	1.2	Have key logistics interfaces been identified?		Interfaces can include but are not limited to the project's end user (if known at this time), the developer, designer, planning supervisor, CDM coordinator and contractor. It is important to bring these groups together at the earliest opportunity to ensure the concept is clear to all interfaces regarding material logistics.
	1.3	Does your company have policy/processes in place for material delivery?		Where existing company policies and processes are in place they are to be reviewed to ensure they suit the project at this time. Any early indication that they may need re-issuing to be flagged at this point. If there is not a set policy or process then one should be established to enable a clear understanding of who is responsible for the quantifying, procurement and physical delivery of materials.
	1.4	Do you have a nominated person accountable for construction materials?		At project conception, a company representative should be nominated for all material logistics issues - a logistics coordinator. This will include identification of roles and responsibilities in relation to logistics and liaison with all interfaces (both internal and external) to ensure parties have a coordinated approach. This role will monitor the logistics requirements throughout the entire pre-construction stage. During construction this role may be transferred to another suitable person responsible for the delivery of the project's logistics i.e. lead contractor.
	1.5	Do you have data on material usage from similar previous projects?		Data capture is a valuable tool for informing future projects. If data from previous projects is available then it should be reviewed at this time as a 'lessons learned' exercise, identifying areas that can be improved on. Data may include previous supply routes, material purchasing, quantities and types of material used. The plant, equipment and other material related resources used previously can be assessed against proposed project costs as a cross check (providing confidence in project viability).
2 Project Location Selection / Pre-Defined Sites	**It is important to take account of material logistics when choosing site locations. This could include existing infrastructure for material delivery supply routes both local and long range. Some construction projects will be assigned to pre-defined sites; where this is the situation, consider questions 2.2 to 2.4 only.**			

	2.1	Is the person accountable for the MLP involved with the site selection?		It is advisable that the logistics coordinator is involved in the site selection process to ensure the locale is suited to material delivery whilst coordinating and liaising with interfaces. At this point you may be able to identify additional interfaces such as neighbours (public/private offices, schools, churches, residential areas) whose needs must be considered during site selection and logistic planning process.
	2.2	Are the logistics requirements of the project identified?		During site selection you should have identified the known logistics requirements to ensure they meet with the sites location e.g. is there a demolition or soft strip phase prior to construction/refurbishment. Requirements include material supply routes, personnel access routes, transport and parking, pedestrian access to site, welfare and office accommodation, temporary power supply, temporary water supply, drainage, wheel wash facilities, material laydown and distribution routes, security.
	2.3	Has a site MLP been created?		This should be prepared as a live document based on known requirements but flexible enough to be amended as circumstances change.
	2.4	Has material supply been considered during site selection?		Based on the project concept materials sources should, where possible, be included in the location assessment. This may be particularly important where materials are sourced from overseas.
3 Planning Permission	**The majority of projects will require Planning Permission from the relevant Local Authority (LA). For larger projects you may need to undertake an Environmental Impact Assessment (EIA) to determine all aspects, direct and indirect, of the project's effect on the environment. The EIA is a process, the findings of which are transferred into an Environmental Statement (ES). The ES may contain logistics related issues. Note: The design of the building (Section 4) will have commenced for this stage but may need amendment to comply with the ES.**			
	3.1	Has construction material usage been considered in the EIA?		Based on the building design the material types and quantities (although not exact) should be entered in the EIA. This covers all materials including earthworks and demolition spoil arisings, through to fixtures and fittings and site waste.
	3.2	Does the completed ES get passed on for tendering process?		Once the results of the EIA are entered into the ES it is important that the logistics coordinator retains this information and ensures it is referred to at tender, mobilisation and construction stages.
	3.3	Have you, or will you, undertake a Constructability Review?		As mentioned previously, the design will be underway concurrently. The logistics coordinator should be involved with the construction management department to ensure that a Constructability Review is undertaken. This is a high level process to determine how the designed structure can be built on the site selected. It is at this point that the design and logistics interface becomes key to ensuring there is space and resources within the project boundaries to deliver the logistics requirements to enable the build process.
	3.4	Has a programme for logistics been created?		Prior to this point a construction programme should have been created. The logistics coordinator should overlay the construction programme with a logistics programme which will be the basis for review and update throughout the project. This will include the logistics requirements and material usage. Although still not exact, it will be included in the EIA.

4 Design	**The design of a construction project is a process to create a description of a new facility that is typically represented by detailed plans and specifications and identifying the activities and resources required to make the design a physical reality.**			
4.1 Outline Design	The outline design will involve the preparation of a schedule of works, specification and/or construction drawings. A Bill of Quantities is used as a form of cost planning and mapping to monitor and control the construction cost during the execution or post-contract period of construction.			
	4.1.1	Does the design interface with the logistics requirements?		Assess the design against the logistics requirements within the constructability review. This gives opportunities to identify potential barriers that may arise and appropriate mitigation measures.
	4.1.2	Has a programme for logistics been created?		The logistics coordinator should overlay the construction programme with a logistics programme which will be the basis for review and update throughout the project. This will include the logistics requirements and material usage.
	4.1.3	Do you consider material logistics during design?		Ensure that the design actually allows for the physical delivery of materials. This can involve reviewing the location of common user plant and equipment such as hoists and tower cranes to be used and early identification of material distribution routes and on-site laydown areas.
	4.1.4	Will material quantities be estimated during design?		Direct interface with the design and EIA is important to ensure the outline material quantities comply with Planning Permission. This includes all construction materials.
4.2 Detailed Design	The object of the detailed design is for the designers to develop the project concept and schematic design phases into a detailed design package to such a level that the information produced can then be transformed into documentation suitable for tender.			
	4.2.1	Have you, or will you, undertake a Constructability Review?		The logistics coordinator should be involved with the construction management department to ensure that a Constructability Review is undertaken. This is a high level process to determine how the designed structure can be built on the site selected. It is at this point that the design and logistics interface becomes key to ensuring there is space and resources within the project boundaries to deliver the logistics requirements to enable the build process.
	4.2.2	Are the logistics requirements facilitated?		Once the detailed design is completed you will be able to calculate more precisely the material quantities and confirm that the right material quantities have been identified for the project.
	4.2.3	Have modern methods of construction been considered?		If during design allowance is made for off-site fabrication then this will reduce the material usage on-site and reduce overall waste. If the design utilises additional modern methods of construction (MMC) such as build on-site opportunities then this may result in fewer individual deliveries and also reduce waste.
	4.2.4	Has the build process/logistics interface been considered?		Further to the constructability review it is important to review this against the detailed design. Over and above previous findings this will give early indication of internal material distribution, laydown and storage requirements.

	4.2.5	Is the weather considered when designating material marshalling areas?		Some materials and plant may become broken or damaged when subjected to rain, wind etc.Bad weather may hinder plant operation e.g. cranes
	4.2.6	Has the need for a Market Place, Construction Consolidation Centre (CCC) or similar been considered?		Upon completion of the design a decision is required as to whether a CCC or Market Place is required. The Market Place is a centralised store for the smaller, common use material items such as nuts, bolts, tapes and mastics. It can ease material delivery quantities and permit accurate stock taking to aid productivity and reduce waste. The use of CCC will rationalise material delivery via 'just in time' consolidated loads to meet planned productivity. The location of the CCC is dependent on many factors e.g. the journey time from the CCC to the site.
5 Tender Process	**If you are intending to sub-contract any element of the works then this will most likely be via a competitive tender process. Logistics must play a major role during the tender process as sub-contractors will become the key logistics interface during the construction programme (note: If the works are to be undertaken direct then this section, in part(s), can be used as an internal reference). The report Reducing Material Wastage in Construction 2007 (available via www.wrap.org.uk/construction) provides useful guidance on how to actively reduce waste on projects by focusing on the role of contractors and sub-contractors who procure and use materials.**			
5.1 Pre-qualification and Tender	**5.1.1**	Do you have a Pre-Qualification process and does it include a logistics requirement?		In order to ascertain suitable sub-contractors prior to invitation to tender do you have a process that gives you confidence in their ability in terms of quality, safety, financial stability, industrial relations. These are the core elements of most PQQ's however you should consider the logistical support elements of their business to give confidence in their ability to deliver the sub-contract.
	5.1.2	Is the person accountable for the MLP involved with sub-contractor selection?		The person responsible for the MLP should have access to all companies that will impact upon the plan through the procurement, use, handling, storage and/or disposal of materials to enable accurate and robust data to be gathered.
	5.1.3	Is material usage/supply a criterion for sub contractor selection?		Material usage and supply must be assessed to ensure it meets commitments of the EIA and MLP.
	5.1.4	Have material usage performance targets been set?		Material usage and performance should be measured against commitments made in the EIA and MLP.
	5.1.5	Is material usage information requested at tender stage?		Proposed material suppliers and manufacturers to be assessed to measure their previous performance in the delivery of materials and confirm they have the capability to supply bespoke material sizes in order to reduce waste.
	5.1.6	Are material quantities calculated at this stage?		During the tendering process the potential sub-contractor should be asked to provide details of the estimated material usage in line with the design to ensure all materials are accounted for in the contract. The logistics coordinator should collate this information from each tenderer.

	5.1.7	What logistics methods are used? e.g. off site pre-fabrication/pre-assembly		Ensure that short listed sub-contractors are given opportunities to influence the amount of potential waste coming to site.
5.2 Materials Procurement	**5.2.1**	Do you have a material procurement strategy?		Potential suppliers to be assessed on whether they have a material procurement strategy and if this can be integrated as part of the project's MLP.
	5.2.2	Are materials procured directly from site?		Within the material procurement strategy potential sub-contractors are to identify how they purchase materials. If the responsibility for ordering materials is not onsite then the site based sub-contractor's knowledge or input may be challenged.
	5.2.3	Are materials called off in line with productivity?		It is important that the materials are purchased to arrive on-site to meet planned productivity. However note that on occasions it may be beneficial to 'load out' some areas in advance to permit the release of plant or equipment or to progress the design. This will have been identified at the design stage.
5.3 Transport	**5.3.1**	Do you have a material transportation strategy?		It is advisable to establish whether potential sub-contractors have a transport strategy which can be adapted to suit/become part of the MLP. Identification of out sourced hauliers is to be taken into consideration as, if appointed, they become a key interface with the sub-contractor and logistics coordinator.
5.4 Material Delivery	**5.4.1**	Will you use a material delivery booking/ scheduling tool?		The MLP will adopt a material delivery scheduling tool. This will either be a paper based system or detailed electronic/web system depending on the type of project. It is important that sub-contractors/material suppliers/hauliers have the ability to access and use whatever system is used
	5.4.2	Do you have a planned material delivery regime?		Potential sub-contractors should be assessed on whether a material delivery regime or process is in place which can be integrated into the MLP.
6. Site Mobilisation	**During site mobilisation it is important that all physical aspects of the MLP to date are implemented so that the project is prepared for planned operational implementation. This includes the instalment of plant and equipment and ensuring the human resources are in place. Many sub-contractor's representatives active during tender process are no longer involved during mobilisation or the construction activity, therefore the logistics coordinator should also set up material logistics workshops to be delivered to sub-contractors prior to site works.**			
6.1 Materials Plan and Matrix	**6.1.1**	Has a detailed material matrix been compiled?		Compile a matrix of material usage per sub-contract and cross check against the logistics requirements and programme.
	6.1.2	Has a material delivery programme been created?		Create a long term material delivery programme to ensure resources are available to meet needs.
	6.1.3	Has suitable plant and equipment been provided for unloading?		This is part of the logistics requirements however check that the material matrix does not contain materials types/quantities that cannot be unloaded/distributed. Specialist plant may be required on a 'one off' basis on occasions.
	6.1.4	Are opportunities to utilise plant and equipment explored?		In line with the design, opportunities may arise to utilise equipment such as lifts prior to completion to facilitate the logistics requirements.

	6.1.5	Have sub-contractors been issued with the MLP?		Post Tender (in addition to key interfaces) sub-contractors should be issued with the MLP to ensure guidance on and compliance to procedures. This can be done via workshops.
6.2 Transport	**6.2.1**	Has reference been made to the site EIA and planning conditions?		Ensure transport routes comply with the EIA.
	6.2.2	Are road/rail/river routes re-assessed during mobilisation?		Transport routes may change, e.g. check that traffic systems have not been altered by Local Authorities.
	6.2.3	Has a Traffic Management Plan been prepared?		Prepare a Traffic Management plan and issue to all users and stakeholders.
6.3 Material Unloading and Distribution	**6.3.1**	Is plant and equipment provided?		Provision of plant and equipment must be in place at this time. Note: a centralised supply will reduce costs, congestion and carbon emissions.
	6.3.2	Is the material distributed to the point of use?		Provision of labour to distribute the material to point of use will reduce double handling, potential for damage, accidents, and costs for craftsmen taken away from core task. This in turn will increase productivity.
	6.3.3	Are there materials acceptance 'sign off' controls?		Upon material arriving at the point of use, controls should be in place to ensure the sub-contractors have confirmation of receipt. This can be either a paper based system requiring a physical signature or an electronic bar coding system depending on the size of project.
6.4 Storage and Use	**6.4.1**	Have material laydown/ marshalling areas been provided?		During design, opportunities will have arisen to identify material laydown/ marshalling areas. These should be created and designated at this stage.
	6.4.2	Has a programme of on-site storage been developed?		Materials should be programmed for the amount of time they can be held on-site prior to actual usage. As a rule of thumb the preference is generally for 'just in time' delivery. A programme must be in place to ensure material laydown area usage does not extend beyond planned use in case it impacts on planned productivity. This should be created in relation to the construction programme.
	6.4.3	What security controls do you implement?		Over and above perimeter security, measures should be in place to monitor materials on-site to ensure their secure storage. This can permit the use of secured material laydown areas using temporary barriers/fencing and mobile (wheeled) containers.
6.5 Personnel	**6.5.1**	Does the labour requirement allow for material management?		You should allow for a bespoke team, either full or part time role(s) to manage the materials once on-site. This is more effective than if it is a part of everybody's role but nobody's hands on accountability.

	6.5.2	Will this labour receive specific training?		The labour designated for the management of materials should be suitably qualified and experienced to undertake the material management role. Furthermore they should receive training on plant usage to current approved industry standard prior to the start of works. If not, do you need to implement training at this stage before material deliveries arrive on the project? Training can include manual handling, safety awareness, logistics NVQ, plant operation and traffic marshalling - all to industry standards.
	6.5.3	Has the labour requirement been sourced internally?		If you internally resource then are they always available for redeployment and do you sometimes need to recruit additional staff for material management?
	6.5.4	Are mechanisms in place to ensure availability of labour?		The project should have a resourcing team to support the MLP throughout the life of the project. The labour market is prone to change; contingency is required to ensure demand is fulfilled throughout the works.
7 Construction	**At the point of construction, interfaces are more dependent on project management and sub-contractors. The logistics coordinator's role may involve a change of personnel; therefore the person undertaking logistics management of the project should be suitably qualified and experienced in direct construction related activities. With functions identified and process and resources in place, the logistics role should now centre on operational implementation, to include detailed short term planning and live data capture.**			
7.1 Control of Contractors	**7.1.1**	Are sub-contractors regularly updated with logistics requirements?		The MLP may be subject to change due to unforeseen events, such as ground conditions this may include changes to the design and construction programme which may in turn have an effect on the logistics requirements. At this stage the project manager and sub-contractors become the key interface and must be kept informed at the earliest opportunity to enable any amendments to their functions or procedures.
	7.1.2	How are logistics change control processes managed?		Many projects have change control procedures in place for design, construction activity, etc. These processes may not always consider the impact on the material logistics strategy. It is important for the logistics coordinator to be part of any change approval process.
8 Site Waste Management	**For construction projects costing more than £250,000 a Site Waste Management Plan (SWMP) must be developed and implemented. SWMPs aim to reduce the amount of waste produced on construction sites and to prevent fly-tipping.**			
	8.1	Do you have a SWMP in place?		A SWMP should be drafted at the pre-planning stage and take account of design and waste minimisation issues. The developer/ client/ architect's representative should be responsible for developing the SWMP. If the SWMP is not written until tender stage it is likely that the contractor will be responsible for developing and implementing the plan.

	8.2	Does the SWMP consider optimising material supplies and procurement and feed into the MLP?		The amount of waste generated on-site can be reduced significantly by looking at the way in which materials are procured and supplied to site. Wastage rates for materials can be reduced through better ordering systems, less packaging and take-back schemes. Initiatives include: ● specifying products that create less waste and are not hazardous wastes if they enter the waste stream; ● greater use of off-site prefabrication and modular construction; ● setting up agreements with suppliers to take back excess materials and packaging, e.g. plasterboard and insulation off-cuts; ● adopting systems such as 'just-in-time' delivery and procurement; ● specifying re-usable and recyclable packaging; re-using waste generated on-site, e.g. demolition waste; ● using materials and products with a high recycled content; ● on-site batching of materials; and ● good quality control systems to inspect materials delivered to site for damage before acceptance.
	8.3	Does the SWMP include a review and report activity?		Upon handover of the of the construction project to the occupant, a full review of the quantities and types of wastes generated and their end-use/disposal route should be conducted. The findings of this review should be reported into the MLP review to identify potential improvements in materials management to prevent wastage.
9 Demobilisation, Commissioning and Completion	**During construction it is important that the project is prepared for planned operational demobilisation. This includes the removal of plant, equipment, wastes and materials.**			
9.1 Demobilisation	**9.1.1**	Is demobilisation planned?		The demobilisation strategy should be pre-planned to include the programmed removal of plant and equipment, labour and facilities.
	9.1.2	Is the strategy subject to regular review?		The MLP may be subject to change due to unplanned events which may have an effect on the demobilisation time scales or procedures.
	9.1.3	Has a demobilisation programme been created?		In order to facilitate a controlled approach to demobilisation a separate programme should be created for material delivery and waste estimates to ensure the project does not either retain unnecessary equipment or labour. This will also ensure that resources are not removed which may still be required at a later date.
9.2 Commissioning and Completion	**9.2.1**	Is there a strategy for material usage during this period?		Towards the end of the project it is particularly important to manage material usage to ensure excess material (which may result in waste) does not come on-site. Controlling measures may include daily communication to facilitate short term material planning requirements and daily stock checks of materials currently on-site. This, on occasions, can be difficult to plan as much of the material requirement is controlled by snagging requirements.

	9.2.2	How are redundant materials managed?		Ideally there should be no excess material remaining on-site upon completion of the project. However, on occasions this is not the case. Rather than materials becoming waste, you should consider redeploying materials to another project where required, consolidating or storing until such a time as they are required, selling back to the supplier or donating to any charitable construction project if possible or recycle.
10 Review and Auditing	**The benefits of conducting a thorough audit and review of the effectiveness of the MLP are the good practice procedures which can be applied at other sites and lessons learned will enable the informed development of a revised, more effective MLP aiming for continuous improvement**.			
	10.1	Have you reviewed the project MLP?		Post project completion the logistics coordinator should review the MLP to identify good/poor practice and areas for improvement. This can be carried forward for the next project to improve your material logistics.
	10.2	Have you recorded the key logistics data?		It is important to collate data throughout the life of a project to benchmark forecasts against actuals. Key data includes material usage, delivery vehicles quantities, material delivery times/departures, where materials came from, waste quantities, plant and equipment usage/duration on-site, labour numbers. It is also important to investigate if there are any significant mitigation factors that have to be considered when compiling this data to ensure it reflects a true account of overall performance.
	10.3	Have you conducted interviews with project personnel?		As part of data collation you may wish to consider interviewing project representatives at various levels/responsibilities. This could vary from the project manager to labourer. Interviews should be consistent and cover appropriate aspects of the MLP. Results from these interviews are to be collated by the logistics coordinator and assessed against other data.
	10.4	Have you disseminated the findings of the review to key personnel?		The key findings of the review and lessons learnt should be disseminated to all relevant organisations (such as sub-contractors) so that relevant improvements can be implemented by all.

Appendix 3 Case Studies

Bow Bells House finds a solution to the restricted delivery of materials

The construction managers – Bovis Lend Lease engaged logistics specialist at an early project planning stage to formulate an integrated logistics plan for the site. All specialist trade contractors were required (as a conditional aspect of their contract) to support and implement the plan and make full use of the Construction Consolidation Centre.

Centrally located in the City of London, Bow Bells house is situated adjacent to the Church of St. Mary–Le-Bow in Cheapside.

The project commenced back in 2005 with the demolition of existing structures to form a new 8 storey, 180,000 square foot office building to category A fit-out standard.

Efficient material deliveries were identified as being key to the successful implementation of the project programme. Material deliveries were made increasingly challenging by the construction access point being shared by an adjacent project at 1 New Change.

To ensure strict compliance with the delivery arrangements set out in the logistics plan, a materials consolidation programme was implemented at the project outset. All construction materials except structural steel, cladding and capital M&E plant were routed to the site via The London Construction Consolidation Centre at South Bermondsey.

Materials located at point of use for the following days work activities	**Key facts** ▪ A £50 million, 8 storey Bow Bells House development; ▪ Project target to achieve a 30% reduction of construction waste by improved material management (based on a benchmark of less than 10 m3 per £100,000 spent); ▪ Reduction in material losses and breakages; and ▪ Reduced carbon emissions arising from the delivery of materials to the site by using a Construction Consolidation Centre.

Material work packs were formed at the Construction Consolidation Centre and transported to the site on dedicated delivery vehicles for off-loading by the site-wide materials handling team.

Many of the deliveries were scheduled for out-of-hours arrival and the site distribution team worked additional hours to ensure that materials were loaded out at night for the following day's activities.

Materials were delivered via the single point of access and, due to the basement loading restraints, all materials had to be off loaded by fork lift which required intense traffic management coordination. The materials were then transported directly to the various work faces for installation by the specialist trade contractors.

Material deliveries to the site were scheduled by an external logistics consultant. Part of the consultant's role was to provide full on-site logistical services and here the key was the interface between the trades and the Construction Consolidation Centre.

The consultants kept a constant dialogue going between the Construction Consolidation Centre and trade contractors to minimise the impact of late or un-scheduled material deliveries. In addition to prevent overstocking or incorrect delivery of materials to the site, the logistics team implemented strict logistic controls.

A key aspect of this approach was the engagement of the logistics specialist at a very early stage in the project planning and the formulation of an integrated logistics plan for the site. It was then made conditional that all specialist trade contractors equally engaged with the site processes to operate and support the plan for the site and this overcame what otherwise would have been restrictive and prohibitive material delivery constraints.

The project was completed on-time, having overcome severe congestion issues in the area and with neighbouring projects in Cheapside and New Change.

Studies undertaken by BSRIA in March 2007 that included the Bow Bells project compared the performance of projects employing full use of a Construction Consolidation Centre and on-site logistics services to those that did not.

In the main, the study concluded that their use greatly contributed to smooth and efficient project implementation, productivity enhancements, reduction in material losses and breakages and important environmental gains.

The Willis Tower implements a Fit-Out Material Strategy

Located in Lime Street, central London, opposite The Lloyds Building, the Willis Tower is the latest striking high-rise addition to London's sky-line.

Standing at 29 storeys the building is now undergoing a major >£40m fit-out for The Willis Corporation with occupation programmed for early 2008.

Since work commenced in April 2007, the supply of materials to the many work-points has been a key driver in the day-to-day logistics operations of the projects.

Delivery is via a single point of access to the loading ramp in Billiter Street and vertical transportation to each of its upper floors is by a single goods lift.

All deliveries are pre-arranged and scheduled by the logistics team to co-ordinate delivery access, timing and onward distribution to the floors.

Albeit 29 storeys, the actual floor footprints do not allow for bulk storage as this would hamper production targets and delay the construction process so the daily feeding of all work areas is paramount.

Materials handled by the site team include floor tiles, ceiling components, dry-lining, joinery sets, M&E equipment, carpets and internal partitions.

Materials in transport to point of use by the designated materials logistic team	**Key facts** ▪ 10 month programme for a >£40m project developing 491,000 sq ft; ▪ A designated logistics team co-ordinate materials distribution around the site ▪ Controlled delivery of materials to the sites single point of access; ▪ No on-site storage available resulting in the daily feeding of materials to all site work areas being required; ▪ Daily removal of waste to maintain a clear site. ▪ After 7 months approximately 500 tonnes of waste has arisen of which 70% has been recycled (up to 50% higher recycling rate than average rates at other construction sites).

A software based delivery booking in procedure has been implemented and closely controlled to achieve maximum capacity provision i.e. as many loads delivered as possible but not too many as to hinder the site.

The logistics contractor maintains a close working relationship with trade contractors and suppliers to assists the materials delivery and receipt programme and identify any delays in the process as early as possible.

As the site has limited storage at the entry point, all loads have to be delivered to the appropriate workplace on arrival.

All materials are delivered to the appropriate workplace through pre-defined materials access routes to ensure that no blockages or obstacles were caused within the building. Furthermore, materials had to be traversed to the upper floors via a goods lift which meant that the logistics plan had to provide timeslots of material deliveries effectively to prevent a backlog of materials.

Similarly, keeping areas clean and tidy and free from any build up of waste are key to achieving this fast-track project and a 'reverse logistics' methodology is employed to remove waste and excess materials on a daily basis.

The logistics contractor works closely with the trade contractors to minimise materials wastage by ensuring that the site production requirements control the flow of materials to the workplace and avoids any build up of materials stored on site that become liable to loss and damage.

This benefits the individual trades and the site as a whole by promoting enhanced productivity rates, improved quality and reducing the risk of injury to the workforce caused by materials congestion and handling inefficiencies.

BAA Terminal 5's Just-in-Time Logistics Strategy

Implementing a robust logistics strategy at Terminal 5 realised significant savings. The increased reliability and efficiency in the use of materials led to an increase in productivity levels compared to a traditional build from 55-60% to 80-85% with associated cost savings in the region of 2.5%.

The main terminal building comprised two satellite buildings, 60 aircraft stands, air traffic control tower, 4000 space multi storey car park, 600 bedroom hotel, all served by a new spur road from the M25. This £4.3 Billion project is widely hailed as the new benchmark for UK construction.

Terminal 5 under construction	**Key facts** ▪ A £4 billion construction project; ▪ Eliminated the need for lay down space for materials on a space constrained site; ▪ Offsite manufacturing reduced the waste that would have been created by using conventional practices; ▪ Cost savings are reported to be in the region of 2.5%; and ▪ 20-25% increase in productivity levels compared to a traditional build.

Despite being equivalent in size to London's Hyde Park, the T5 site itself is very heavily constrained and presents many logistical challenges. To the north and south of the site are two of the world's most heavily utilised runways.

With 36 work areas on site there is little or no room to store materials for any length of time. Project teams were required to plan their requirements for materials up to six weeks in advance.

Immediately after the initial planning stages of the project, BAA turned its attention to the site set up and logistics requirements to service the undertaking.

The Team were responsible for a variety of activities from erecting hoardings and partitions, providing the temporary accommodation, security, fire alarm and other systems. The next major step was to develop the materials delivery strategy.

The focal point for all construction material deliveries was the Colnbrook Logistics Centre.

Each of the various projects and contractors had access to a software booking system - Project Flow, a tool that has been structured especially for the construction industry.

Project Flow collates the team's demands and allocates a booking time into the Colnbrook Logistics Centre. It also identifies supplier, product, pallet weights and sizes for each delivery. These materials were then delivered either just before or on the day they were required.

Each afternoon a report was issued to security and the booking-in clerk for deliveries the following day.

Consolidated loads were called off by the project using the same software for cross referencing and the load was delivered to the work front to a pre-arranged schedule.

This process eliminated the need for extensive lay down areas for materials and the increased reliability and efficiency in the use of materials led to an increase in productivity levels and cost savings were reported to be in the region of 2.5% of the total project cost.

During the initial phases of construction T5 required a high volume of concrete and aggregate. Subsequently the variety of materials required such as steel, glass and the building services modules increased significantly while the volume of materials declined.

Terminal 5 Arial View

Refurbishment of Unilever House - Delivering Sustainability

Façade of Unilever House

Key facts

- £90 Million project;
- £200,000 of unused materials returned to the Construction Consolidation Centre from the project instead of being disposed;
- Consolidated day work packs of materials delivered direct to specialist work forces;
- Just in Time material delivery schedule;
- Waste materials were taken to the Construction Consolidation Centre for processing;
- 76% of waste materials were recycled; and
- Reduced traffic flow in the surrounding area and increased productivity on site.

The refurbishment of Unilever House was presented with the Best Site Facilities Award in 2006 (Building Magazine Health and Safety Awards). This award was achieved by the forward-thinking and innovative approach of Stanhope, Bovis Lend Lease and logistics provider Wilson James.

October 2004 saw the start of the 3 year redevelopment of the Unilever House, 8-storey, 400,000 square foot project located near Blackfriars Bridge in the City of London.

From the outset this project was designated by the Stanhope and Bovis Lend Lease Alliance as a demonstration project for material logistics and waste reduction.

The Unilever House project team shared the aspiration of delivering the most sustainable project possible. Three of the team's key targets were to:

1) Ensure key material deliveries to site were consolidated in South East London;
2) Source construction materials locally wherever possible; and
3) Maximise the reuse and recycle of materials and equipment.

To facilitate these aims, the project was one of the first to benefit from the use of the London Construction Consolidation Centre at Bermondsey where all materials for the project (except aggregates, structural steel, cladding and major plant) were initially delivered.

The use of the Centre enabled the main project barrier (a restricted delivery point in close proximity of the Crowne Plaza Hotel) to be overcome by ensuring deliveries were kept to a minimum, closely coordinated and timed.

The logistics team conducted on-site tool box talks to train contractors in the relevant logistics procedures. Information sessions for all site management were undertaken to ensure understanding of the Construction Consolidation Centre methodology. A Trade Contractor information pack was issued to all parties which contained the written logistics strategy and procedures.

Trade Contractor's were required to order their work pack call offs and each order was recorded by the site Logistics Manager and forwarded to the Construction Consolidation Centre for picking and delivery.

At the Construction Consolidation Centre materials were re-packed into day work packs and forwarded to the site. Upon receipt at the site the day work packs were delivered directly to the individual work faces, thus reducing traffic flow and congestion in the surrounding areas and increasing productivity on-site. Individual contractor supply chains were established to focus on providing a robust just-in-time materials delivery schedule.

In all, some 13,200 pallets (or equivalent) were handled by the Construction Consolidation Centre over a 2 year construction period.

At project completion the extent of un-used materials, returned to the centre rather than ending up in waste skips, amounted to 38 full 26 tonne lorry loads, calculated at a value of approximately £200,000. Learning this lesson, the Centre now aims to work with Trade Contractors to minimise the extent of surplus materials delivered to the site by better understanding their materials scheduling procedures and site production requirements. In this way it is expected that even greater savings can be made and levels of waste reduced.

Waste generation was recorded on a monthly basis and, in total, the project generated 3,384 tonnes at an average of 140 tonnes per month, of which a minimum of 76% was reused or recycled.

In addition, 90% of all delivered pallets were returned to the Construction Consolidation Centre for collection by the individual suppliers.

Project Hal's 3 Day Material Limit

Material receipt and lift process	**Key facts** ▪ Project value of £190 million; ▪ Reduced material loss and damage by minimising materials on-site; ▪ Successful minimisation of material storage areas on a space constrained site; ▪ Reduction of stockpiled materials; ▪ Minimisation of double handling of materials on-site by delivering to the point of use first time; ▪ The use of a designated team to unload and move materials ensured that specialist contractors were not taken away from their main activities; and ▪ Performance levels were enhanced by having clear and safe working areas.

News International introduced a strict logistics strategy that was adhered to by the main contractor and all sub-contractors to enable the construction project to safely proceed on a severely space constrained site. Carillion has achieved a limit of a 3-day stock level of materials onsite. This target has been realised through the formulation of a robust logistics strategy that managed the flow of materials throughout the project.

From a brownfield site at the junction of the M25 and the A10, construction of the new £190M printing facility for News International is now entering the final stages of its 2 year construction programme.

Housing twelve state of the art printing presses, the 5 storey building also combines print plate production, automated storage, paper distribution and office accommodation with each area having its own demands for high volume equipment and services.

From the project outset a logistics plan was created to provide procedures for material delivery, distribution and offloading, elevation into the main building and work area control which was key to achieving the demanding programme deadlines for a series of phased handovers to the client. An external compound area was used to improve the marshalling of incoming deliveries and provide a temporary laydown space for off loaded materials.

All material deliveries were phased inline with the project build timeline and scheduled to arrive at pre-arranged times. The pre-scheduled delivery times were co-ordinated with the onward distribution to their intended point of use.

The project logistics strategy was based on any single trade having no more than 3-days-worth of materials on site to ensure that areas on-site did not become

congested with stockpiled equipment.

Large and/or heavy materials were elevated into the building using large tele-handling mobile equipment at key entry points and building levels.

Materials that arrived in smaller loads were off-loaded by use of electric pallet trucks instead of manually. The use of electric pallet trucks to offload materials dramatically improved the speed of unloading and lifting of materials into position which would otherwise have been impossible.

All sub-contractors were trained on the relevant aspects of the logistics plan via tool-box talks. In addition, daily meetings with trade contractor supervisors were undertaken to confirm the delivery and use requirements of materials for the forthcoming work activities.

These meetings helped identify any potential delays or disruptions to the programme resulting from project slippage or missed/late deliveries.

The production team controlled the supply of materials and performance levels were enhanced by having clear and safe working areas in which work was carried out.

The logistics team marshalled and co-ordinated on-site storage areas with the construction works to ensure materials were well organised and protected to minimise loss, damage and re-location.

Management of Materials through Construction Consolidated Centres

The London Construction Consolidation Centre (part funded by TFL) is widely accepted as one of the most recent demonstrations of how lessons learned from other industries can improve the performance of the construction industry.

The Construction Consolidation Centre approach demonstrates the key role supply logistics has to play in preventing construction waste by delivering materials to site when needed. By serving a large project or a number of different jobs, the centres are also able to reuse surplus materials, rather than disposing them to landfill.

Construction Consolidation Centre Model Approach	**Key facts** ▪ An approximate 15% reduction of material waste; ▪ Achievement of delivery performance of 95% of goods delivered, right first time; ▪ Increased productivity of the site labour force of up to 30 minutes per day; which equates to 25 workers working a 10 hours shift on a site employing 500 operatives; ▪ Recovery of re-usable materials (on one project the value of this was approximately £200,000); ▪ Reduction in supplier journey times by delivering to the LCCC rather than going direct to the site, of an average of 2 hours per journey ▪ 30% overall reduction in the number of construction vehicles entering the City of London and delivering to the sites being served by the LCCC; and ▪ 75% reduction in CO_2 emissions from reduction of vehicle movements.

The main purpose of the Construction Consolidation Centre was to promote the efficient flow of construction materials through the supply chain to the actual points of use on projects. It was not a warehouse.

The centre aimed to enhance construction sites performance and reduce the impact of environmental issues such as congestion, pollution and noise.

Construction goods, excluding steel frames, aggregates and major plant, were delivered to the Construction Consolidation Centre in relative bulk. From there, materials were called-off by the various trade contractors and formed into work packs for their immediate use on site, following a just-in-time approach.

Goods were checked on arrival at the centre for quality and condition, ensuring any problems were highlighted at an early stage.

The centre did not store goods in the conventional sense with an aim of a turnaround time of 7-10 days.

Materials were consolidated meaning that multiple part-loads were combined into single deliveries. This process maximised the efficiency of distribution vehicles leading to a reduction in overall vehicle movements delivering into a congested environment.

The site productivity benefits from having a steady supply of materials delivered right to their point of use by preventing the skilled workforce being called away from their workstations to help with materials handling.

Site housekeeping issues (quality, H&S, waste and dirt generation) are greatly improved by the arrival and on-site storage of only those materials intended for immediate incorporation. At the end of the shifts, un-used materials and packaging can be returned to the centre for recycling or reuse.

With its mission to deliver materials to site in the safest and most efficient manner, in active partnership with the trade contractors and project managers, the London Construction Consolidation Centre significantly benefited the various projects it serviced and greatly contributed to the achievement of the programme certainty demanded by the clients.

Several clients now view materials consolidation as an 'added insurance' in the delivery of their projects and openly recognise that leaving individual trade contractors to 'fend for themselves' is no longer the way forward.

Equally important, Materials Consolidation has a positive impact on good neighbour relations with the restricted flow of vehicle movements and associated emissions in any given location and time.

A recent study by BSRIA concluded that the Construction Consolidation Centre methodology can deliver clearly defined and well organised material benefits to projects and can do it consistently on time.

Main Benefits

- Goods are consolidated so that multiple part-loads are combined into single shipments.
- Substantial reduction in overall vehicle numbers delivering to a site, with resulting environmental benefits.
- Goods are delivered not just to a site entrance - but to specified locations as close as is practicable to the workface, by material handling operatives.
- Specialist operatives available with an extensive range of vehicles and mechanical handling equipment necessary to complete distributions efficiently and without damage to materials.
- Overall co-ordination of distributions (to avoid on-site clashes).
- 'Walking' of intended access routes, arranging road closures, lifting plans, ensuring that order is created in the distribution process.
- Trade contractors are left free to concentrate on their core tasks, without worrying about the co-ordination of and supply of goods to site,
- Trade contractors are not diverted away from production to assist with material handling.

Pilot of MLP at Construction Sites

The MLP template was piloted on six construction sites ranging in value from £750,000 to £15 billion. The pilots included projects at conception stage through to construction and nearing completion across a geographical region of Liverpool to Kent.

The concept of MLPs was well received and there is a positive attitude towards the need to develop a MLP for construction projects to proactively manage materials. The pilot sites were already undertaking a majority of the MLP requirements but were not necessarily linking tasks together or reviewing the performance of their controls/procedures.

Construction Site	**Key Benefits identified by pilots sites** ▪ Most of the sites already undertaking a majority of the requirements of the MLP; ▪ A useful tool to identify what information should be gathered and how its is used throughout the project; ▪ MLP viewed as a useful tool to formalise current practices; ▪ Immediate benefits were identified in developing and implementing the MLP; ▪ A potential significant reduction in material wastage was identified through the implementation of a robust approach to planning the demobilisation phase; ▪ Distribution of a lessons learnt document at the end of a project viewed as having the potential to greatly improve the use and benefits of MLP on future projects.

Over ordering of materials as a 'contingency' or 'just in case' measure was viewed as being an accepted common practice in the construction sector. Clients, and often main contractors, do not see the cost of this over ordering as the tendering process does not require trade contractors to separately identify actual materials to be used and those that will likely result as waste or surplus materials.

The completion and use of a material types and quantities table (as detailed in section 3 of the MLP) was identified as being the key to proactively minimising materials used onsite. Without obtaining the baseline or planned material quantities it would be impractical to expect to identify and quantify any material savings.

The use of KPI's to monitor the performance of trade contractors and the plan came under much discussion. It is generally believed that ideally the client should identify overarching strategic project KPI's or targets and local KPI's should be set by the main contractor in liaison with each trade contractor.

However it is likely that main contractors will become aware of MLP's and their importance in the industry in advance of clients. Therefore the industry can expect to see KPI's being initially driven by the main contractor.

Once construction works commence onsite the main benefit of the MLP tool would be that the material quantities and delivery methods and dates had been considered. Upon arrival at site the correct equipment and plant will have been identified to handle the materials to ensure their efficient relocation to the point of use or storage area. At some of the construction sites materials were found to be stored on floors in work areas where they were not required. The cause of this practice was the ordering of materials too far in advance of them being required onsite.

Furthermore personnel onsite were not aware of the procedure for receiving materials or being allocated a storage area so materials were being stored in any available space. It was noted that materials often get damaged when stored in work areas as they are not protected.

Another area where monies are lost is in having hired equipment such as cranes onsite when they are no longer required. The MLP tool will help to identify this in advance; ensuring equipment is removed at the earliest convenience.

During project demobilisation and completion the management of materials often becomes overlooked as the main drivers at this stage are ensuring the project is competed on time and budget. Unused materials can often be disposed as waste rather than transferring to another construction site or returning to the supplier (who can charge up to 50% of the material original value to receive unused materials). Planning the project demobilisation phase in advance will result in identifying potential surplus materials before they are ordered and rerouting unused materials to other projects or return to suppliers instead of disposing as waste.

Overall the use of the MLP tool was identified as being beneficial in reducing project costs and wastage of materials. The majority of the pilot sites are planning to trial the MLP tool on a future project to start realising the benefits identified.

Site	Location	Approximate Value	Project Details	Stage	Organisations	Project Duration
Central St Giles	London	£150mil	An Office Building at Central St Giles.	Planning and pre-construction phase.	Bovis and various trade contractors.	2007 – 2009
Barts Hospital, London	London	£400mil	A new construction and refurbishment.	Construction phase and is due to complete in approximately three years.	Skanska UK Construction and various trade contractors.	2006 – 2010
A2/A282	Thurrock	£100mil	Road improvement.	Due to complete in December 2007.	Jacobs, Highways Agency, Costain ltd various trade contractors.	2006 - 2007
Balls Road	Wirral	£750,000	A housing new build and refurbishment.	Construction phase.	Riverside housing and partners.	2007
Maidenhead to Kent	Maidenhead to Kent	£15bil	Construction of a railway from Maidenhead to Heathrow across the capital into Essex and Kent in the east.	Planning Phase.	Crossrail.	Enabling works in 2008 - first train running in 2017.

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