

Waste minimisation in construction

# Reducing material wastage in construction



Guidance for clients, contractors and sub contractors on how to deliver good practice in materials procurement and usage.

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#### **Overview**

All participants to the construction process have an important role to play in the drive to reduce waste from construction sites. This document provides useful guidance on how to actively reduce waste on projects by focusing on the role of contractors and subcontractors who procure and use materials.

Achieving good waste minimisation and management (WMM) on construction projects helps reduce the quantities of construction waste sent to landfill and makes a substantial contribution to sustainable development. This guidance forms part of a suite of documents on waste minimisation and management developed by the Waste and Resource Action Programme (WRAP). This document provides guidance on the efficient use of materials by contractors and sub contractors, focusing on:

- effective estimating of waste
- developing and implementing waste reduction solutions, and
- producing accurate records of waste

## 1.0 This guide and how to use it

This guide is intended to raise awareness about the possibilities to reduce waste in construction by engaging sub contractors in the site waste management planning process. Construction generates large quantities of waste and sub contractors have a key role to play in reducing this waste stream.

Significant volumes of waste result from activities such as inefficient design, inaccurate materials estimates and orders, design changes, poor logistics and storage, and a traditional low prioritisation of materials costs (as compared to labour costs). Sub contractors have an important role to play in eliminating or reducing wastage generated by these activities. Whilst main contractors can ensure that waste is recycled effectively (where possible) it is the sub contractors who have the ability to make real reductions in the total volume of waste generated. The main opportunity to achieve this is in producing accurate and realistic estimates of materials requirements and their associated waste and actively looking for ways to reduce waste.

This guide therefore helps sub contractors play an integral and useful part in the drive to reduce waste on projects. In addition, the guide identifies the important roles that can be played by clients and main contractors in support of the sub contractor.

The guidance is structured in two parts:

#### Section 1 includes:

- an explanation of what construction waste is and how it can be reduced,
- the business case for taking action, and
- a brief description on the roles of clients, main contractors and sub contractors in reducing waste.

#### Section 2 includes:

- **a** Best Practice approach to reducing waste in a step by step approach, and
- proformas to support the implantation of waste reduction actions (as appendices).

Users of the guide are encouraged to select, adapt and develop the most useful check-lists and proformas as 'pull-out' documents so that they can be integrated into the clients' / main contractors' / sub contractors own standard procedures, thus supporting a drive for greater materials efficiency. They should not be followed rigidly but rather seen as simple tools that help to highlight the important areas where effort should be directed.



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## Section 1

## 1.1 What is construction waste?

Construction waste can be subdivided into two main categories

Construction waste			
Waste generated by construction activitiesWaste generated by construction activities			

#### 1.1.1 Waste generated as a result of design & specifications

Design and the specifications can contribute significantly to the amount of waste generated during the construction of a project particularly when uneconomical design solutions are selected or when unsuitable materials are specified. Design decisions impact on the level of waste arising, some examples of the type of waste involved are detailed below:

- Drylining: cutting of plasterboard sheets and metal studs to fit wall heights and openings
- Flooring : cuttings of floor tiles to fit room layouts
- Ceilings: cuttings of ceiling tiles and fixings to fit room layouts
- Insulation: cutting of insulation boards to fit openings
- Tiling: cutting of floor and wall tiles to suit design and room shapes
- Paving: cutting of paving slabs to fit layout
- Brickwork and blockwork: cuttings of bricks and blocks to suit building dimensions and building services

The best practice is to design this waste out as part of the design process, (further guidance on designing out waste can be found on www.wrap.org.uk/construction). However once the design is in place, the waste arising from the design can be estimated, controlled and reduced at tender stage, particularly for 'area based' packages such as flooring, walling and ceilings or when off site manufacture is used. For example, plasterboards may be ordered pre-cut to negate the need for so much site cutting; or flooring layouts may be re-arranged to fit the modular size of the flooring product.

#### 1.1.2 Waste generated by construction activities

The way construction activities are carried out during the construction process also impacts on the quantity of waste produced. This waste is usually 'accidental' and is generated by the following factors:

- Inaccurate or surplus ordering of materials that don't get used
- Damage through handling errors
- Damage through inadequate storage
- Damage generated by poor co-ordination with other trades
- Rework due to low quality of work
- Inefficient use of materials
- Temporary works materials (e.g. formwork, hoarding etc)

This waste is more difficult to estimate at tender stage as it is based upon events that occur during construction that are not foreseen at tender stage. This waste can and should be avoided wherever possible. By focusing upon the way waste is generated, the participants to the construction process will be able to understand what their wastage is and subsequently, be able to take action to reduce it.



# 1.1.3 The process of buying materials

The critical point at which contractors and sub-contractors can influence waste is when buying materials for a project, as this activity determines the materials that are to be supplied to site. Because materials are considered in-expensive when compared to labour, a 'waste allowance' is generally included within the order to account for design waste and construction process waste. These waste allowances are often generic and not project specific and as such run a risk of being inaccurate. This can lead to either the order of a surplus of materials (usually entering the waste stream) or a materials shortfall (resulting in additional costs to purchase more materials). Little evidence exists on the practice of reconciliation between materials ordered and materials used, therefore limiting the information available on sub contractors' knowledge of their own efficiency levels.

## 1.1.4 The solution

The solution is the adoption of a robust system that enables the production of accurate estimates of material requirements at the start of a project that then links to real waste figures on completion. Only by focusing upon these material quantities will sub contractors be able to understand what their wastage rates are and subsequently, be able to take action to reduce them.

This guidance therefore sets out how a project can ensure that materials are used as efficiently as possible.



## 1.2 Why should construction waste be reduced – The Business Case

## 1.3 Financial benefits

Waste has a cost. This simple relationship has historically been overlooked as commonly the cost of waste is usually included in the project tender price and paid for by clients. Main contractors have the responsibility for waste disposal although in most cases waste is generated by sub contractors. Clients, main contractors and sub contractors have now started to focus upon this issue from both an environmental and a cost perspective. This is partly due to fact that the cost of waste disposal has increased significantly due to the escalation applied to landfill tax.

The true cost of waste is not just the cost of paying a waste contractor to remove a skip from site, but a combination of costs that are generally paid for by the client, including material and labour costs (see Figure 1). Contractors often underestimate the real cost of waste on a project as this is not an explicit cost, but a cost built into every trade package that covers traditional wastage rates. Because of this, clients often end up paying for new materials that simply get thrown away.

Figure 1: The true cost of waste



There are also some additional costs (not covered in the above diagram) that contribute to increasingly higher true costs of waste. Some examples are:

- The labour cost of handling waste
- Poor packing or overfilling of skips leading to extra skip costs
- Reputation cost
- Higher disposal costs due to poor waste segregation and management practices

The true cost of filling and disposing of one skip with mixed construction waste in one study was found to be £1,343.

Although the skip hire was only £85, the labour cost to fill it was £163 whilst the cost of unused material in the skip was the most significant at £1,095.

AMEC – Darlington Survey (http://envirowise.gov.uk/media/attachments/202895/BRE-Construction-resourceefficiency.pdf)

Benefits to sub contractors

Reducing the wastage of materials should result in either a total saving to the project or an increase in profit for sub contractors. The former would be realised through a drop in tender prices and a resultant commercial, competitive advantage being achieved. The latter by maintaining tender prices with reduced materials costs. Either way, the sub contractors stand to benefit from using their materials more efficiently.

In addition, if sub contractors can demonstrate a willingness to support and engage in waste reduction measures and demonstrate that these have an effect on their waste, then they improve their chances of being identified as preferred bidders as they could help main contractors meet their waste targets. Sub contractors therefore have the opportunity to be pro-active and in doing so, reap the benefits from growing pressure for reduced material waste.

#### Benefits to clients and contractors

The cost of waste is usually built into project tenders and therefore clients end up paying for material wastage. By reducing the total volume of waste generated, a reduced cost for the project can be achieved. This cost saving may be shared by main contractors, sub contractors and clients. This already happens in partnering arrangements and it could be introduced in other forms of procurement as well.



## 1.3.1 Environmental benefits

There are two important aspects of materials efficiency: product selection and waste management. Each of these can then be broken down into constituent parts which themselves have an impact on both:

- Minimising environmental damage: Reduced waste means less quantity of landfill space used and reduced environmental impacts (e.g. embodied CO<sub>2</sub>) associated with extracting, transporting, and manufacturing / processing the raw materials of construction products<sup>1</sup>.
- Conserving natural resources: Recycled packaging and waste results in a reduced demand for virgin materials thereby stimulating demand for recycled materials amongst product manufacturers and thereby encouraging higher levels of recycling throughout the economy.

(Anderson, J., Shiers, D. and Sinclair, M., The Green Guide to Specification, 3<sup>rd</sup> Edition, 2004)

By minimising the amount of waste generated during construction, the construction sector can make a major contribution to achieving these goals.

At corporate level, reducing waste can bring the following benefits for clients, main contractors and sub contractors:

- Demonstrates commitment to sustainability
- Reduces the organisation's carbon footprint
- Engenders a culture of material efficiency in all project activities
- Provides evidence of environmental policies being put into place

## 1.3.2 Policy and legislation

There is an increasing thrust of public policy (including waste strategy reviews, planning requirements, industry targets etc) to achieve greater resource efficiency and reduce waste sent to landfill in the construction industry. While there is currently no regulatory obligation to reduce and manage waste to good practice standards, the following initiatives provide a clear indication of the direction in which policy is moving.

#### Landfill Tax

The Landfill Tax was introduced in 1996 to encourage all organisations, including those in the construction industry, to reduce the amount of waste disposed to landfill. There are two rates of tax: currently a standard rate of £24 per tonne for active waste (substances that either decay or contaminate land); and a lower rate of £2 per tonne for inert materials (including rocks, soils, ceramics and concrete). The standard rate is due to increase by a rate of £8 per tonne per annum until 2010/11 and the lower rate will increase from £2 to £2.50 per tonne in 2008. The proposed increases therefore provide a strong financial incentive to reduce waste with immediate effect.

#### Mandatory requirement for Site Waste Management Plans (SWMPs)

It is expected that the use of SWMPs will become a mandatory requirement for many construction projects throughout the UK in the near future, the current position being summarised below.

England and Wales	A requirement for regulatory measures was included in the Clean Neighbourhoods and Environment Act 2005. Following separate consultations in England and Wales, it is expected that a basic SWMP will be a mandatory requirement for projects with a value in excess of £250,000 and a detailed SWMP for projects in excess of £500,000 from April 2008.
Scotland	The 2006 public consultation on the proposed Scottish Planning Policy 10: Planning for Waste Management, included provision for SWMPs to form part of the planning conditions for new developments with a value in excess of £200,000.
Northern Ireland	The Waste Management Strategy 2006 – 2020 indicated that detailed proposals for a statutory requirement to prepare SWMPs will follow through a public consultation.
Code for Sustainable Homes	The new Code for Sustainable Homes has a specific requirement for a SWMP to be adopted.



#### 1.4 Who should take action to reduce construction waste?

Waste is a shared responsibility between all parties of the supply chain, from the client down to the waste contractor. This guidance focuses on the role of contractors and sub contractors, taking into account the fact that they cannot work in isolation to reduce and manage waste. In order to ensure that everybody works towards a common goal leadership is required from clients together with effective interaction between main contractors and sub contractors.

In this context, the roles of clients, main contractors and sub contractors are:

## 1.4.1 Clients

The clients' role is to:

- demonstrate leadership by setting requirements for the efficient use of materials,
- communicate requirements on waste to the project team;
- ensure that waste issues are considered and addressed;
- ensure that all parties fulfilling their roles in the effort to reduce waste.

#### 1.4.2 Main contractors

The main contractors'role is to:

 deliver the clients requirements by developing a site waste management plan which:

 has clear estimates and targets of waste that will be generated, has a clear strategy to reduce the waste has a clear strategy to ensure the recycling of residual waste is maximised.

 monitor waste data and ensure continuous improvement via:

 gathering site waste data comparing against estimates and targets collating sub contractors' quantitative records on actual waste performance

#### 1.4.3 Sub contractors

The sub contractors' role is to therefore support the main contractor in delivering the client's requirements. This includes:

- producing accurate waste estimates for their trade and supplying this information to the main contractor for the SWMP
- developing actions to reduce waste and supply this information to the main contractor so that it can be recorded in the SWMP (Note these mitigating actions may include site wide solutions which could radically affect the performance of the site i.e. Just in time delivery strategy)
- using materials in an efficient manner during construction and wherever possible, ensure that waste is minimised, and
- on completion, providing accurate data on the actual level of wastage and feedback on why wastage was generated and how it could be reduced.



#### 2.0 Section 2

#### 2.0 A best practice approach to waste reduction

The driver for reducing waste needs to come from the client. As part of the project brief, the client needs to establish waste as an important issue, and challenge the project team to deliver a project that uses materials efficiently. This can be achieved through the following actions:

- require the design team to identify and reduce waste wherever possible
- require the main contractor to develop and implement a Site Waste Management Plan, and
- require that the main contractors and sub contractors to estimate, reduce and report on their waste performance.

This section sets out how sub contractors can reduce waste by taking action in four stages:

- 1. Planning
- 2. Implementation
- 3. Review
- 4. Improvement.

At each stage sub contractors can do something to reduce the waste they generate. Below is a detailed guidance on what can be done at each of these stages.



#### 2.1 Planning

This stage involves the development of the Site Waste Management Plan by the main contractor, and also the development of waste estimates by sub contractors. By bringing the sub-contractors into the site waste management planning exercise, real reductions in waste can be realised, rather than merely planning to manage the waste streams that will arise.

The main contractor should develop a waste management plan which contains the following key features:

The main contractor should develop a waste management plan which contains the following key features:

- waste targets as set by client,
  an estimate of the waste to be generated on site,
  actions to reduce waste, and
- actions to avoid waste going to landfill



The DTI Site Waste Management Plan, 'Guidance for Construction Contractors and Clients' and subsequent guidance from WRAP contains proformas and checklists to support this. Linking procurement of sub contract packages to the Site Waste Management Plan ensures that specialist trade input is obtained and accurate figures are used in the waste estimates for the project. Main contractors must therefore ensure that, where possible, sub contractors are engaged and challenged on the waste they are likely to generate (see quantitative estimates below).

By producing accurate estimates of the quantities of materials required and the waste likely to be generated, contractors and sub contractors will be able to manage a process of waste reduction that will enable them to meet the waste targets set for the project.

The following actions can help the sub contractor reduce waste by producing more accurate estimates of the waste that will be generated:

- Use accurate information When pricing projects or placing orders for materials ensure that the information used is up to date, accurate and in the correct format. Too often sub-contractors are given insufficient or inaccurate data from which they need to either price or order materials. The following checklist could help assess the quality of the information available:
  - Are the design and specifications complete and up to date?
  - Are the drawings provided the latest issue?
  - Is there any further information required?
  - Are the drawings available in a format that enables accurate scaling and printing?
- Use CAD drawings When measuring the quantities of materials required (taking off), ensure that the drawings are available in digital format so that the information extracted is accurate and to scale. By doing so, contractors, sub contractors and suppliers can have access to the same information and errors are avoided. This also allows sub contractors to use electronic take off software (see below)
- Use digital estimating software When carrying out measurements, use software designed specifically for each particular trade (if available). By doing so, accurate waste estimates and more economical solutions can be achieved (i.e. it can suggest how to lay carpet in the least wasteful way, how much plasterboard is need for a particular type of space etc)

- Carry out site measurements More accurate estimates can sometimes be produced if site measurements can be carried out. These are particularly useful when drawn information is limited.
- Identify causes of waste Ensure that all the causes of waste are identified at tender stage and develop mitigating actions.
- The following checklist could help assess what the causes of waste are. If the answer is 'No' to any of these questions, an action for improvement should be set:
  - Is the tender documentation complete?
  - Is the design fixed and agreed?
  - Is the information provided clear?
  - Is adequate and safe storage available on site?
  - Is the workforce trained in waste reduction and management?
  - Does the programme allow for the work to be carried out with no interference with other trades?

## 2.1.1 Quantitative Estimate and Qualitative Checklist 1

The Quantitative Estimate and the Qualitative Checklist 1 below are designed to feed directly into the site waste management plan such that there is a visible cause and effect relationship between sub contractors estimates and main contractors' actions.

#### **Quantitative Estimate**

When each sub contract trade develops a price and/or orders materials, an allowance for waste is made. Often this allowance is inaccurate or based upon qualitative not quantitative data. By accurately estimating the waste likely to be generated from each of the key trades, sub contractors can take measures to reduce waste.

Appendix A contains a simple proforma which should be completed by all trades on the project that generate waste. This should be compiled when preparing a firm price for the project so that cost savings (or increases) can be reflected in the package tender / negotiated sum. Below is an example of a table that could be used to capture data.

	Estimate	Actual	Difference	Unit
Net Quantity material required (no				
wastage)				
Wastage allowance				
of which design waste				
of which construction process waste				
Quantity ordered				
Wastage rate				%
Wastage mass				t

Completing this table requires the sub contractor to think in more detail about what and why wastes will be generated. To support this, an additional qualitative questionnaire is included, embedded with guidance. Both the quantitative and the qualitative checklist should be completed in parallel as one should be used to inform the other.

#### **Qualitative Checklist 1**

A qualitative checklist should be completed by the sub contactor in conjunction with the quantitative estimate above. This checklist contains questions on:



- How estimates have been generated,
- Why they are the level stated (i.e. reasons for the waste arising),
- What could be done to reduce waste?

To reduce waste the sub contractor should consider the following:

- Develop a logistics strategy that minimises waste
- Use suitable, safe and secure storage
- Consider mechanical systems and machinery for moving materials
- Consider off site manufacture / construction
- Programme and monitor construction activities
- Use packaging in an efficient way
- Train/educate people on how to reduce waste

The checklist (as illustrated in Appendix B) encourages sub contractors to think in detail about why waste is generated and what they can do to reduce it and it enables the main contractor to respond to feedback from sub contractors – resulting in reduced project waste.

#### 2.2 Implementation

The implementation of the waste reductions strategy relates directly to the construction phase of the project. At this stage the practical measures to reduce waste on site agreed at planning stage can be implemented.

During construction waste reduction and waste management measures must be implemented. Contractors and subcontractors must ensure that the waste management solutions proposed are put into action and their effect monitored regularly through project reviews.

At each project review, reports on waste should be produced to enable the team to check performance and look for opportunities to reduce waste. As the project progresses, when each trade package is complete, reviews of their individual performance should be carried out and feedback provided so that:



- Sub contractors have a chance to identify exactly how efficient they were on the project in turn enabling them to understand how wasteful they were;
- Main contractors can see which of the trades contributed what quantity of materials to the waste stream and why – enabling them to prepare better waste estimates in the future, and
- Lessons can be learned both by sub contractors and main contractors, enabling both to improve on reducing waste on subsequent projects.

Construction activities play a very important role in the way waste is generated on site at construction stage. By working together at this stage of the project, sub contractors and main contractors can remove obstacles to materials efficiency. This can be achieved by taking the following actions:

Implement a Waste Minimisation strategy for the project as part of the a Site Waste

**Management Plan (SWMP).** SWMPs will become a mandatory requirement for many projects throughout the UK very soon. As a minimum, the SWMP should contain detailed measures to comply with relevant waste legislation but should also include good practice guidance and objectives in order to maximise the reduction, re-use and recovery of construction waste, with disposal to landfill as the least preferred option.



For further guidance on site waste management, please refer to DTI's 'Site Waste Management Plans, Guidance for Construction Contractors and Clients' document and supplementary guidance available from WRAP (www.wrap.org.uk/construction)

- Develop a logistics strategy that minimises waste Poor logistics is a major contributor to waste. Solutions such as a just in time delivery help reduce damage to materials and products by minimising the amount of time they are stored on site. This can be achieved by using a centralised site materials database that provides information on overall project requirements for materials. In this way, excess call offs can be eliminated. Planning and co-ordinating the materials ordering processes on site prevents cumulative overordering.
- Use suitable, safe and secure storage For trades or materials where 'just in time' deliveries cannot be set up, suitable, safe and secure storage should be provided so that damage during storage and moves is avoided.
- Consider mechanical systems and machinery for moving materials This is particular useful for trades where materials are delivered in large quantities (drylining, brickwork, blockwork). By using mechanical handling of materials damage and loss during materials movement on site is minimised.
- Consider off site manufacture / construction Off site manufacture of elements is becoming a popular method to improve efficiency and quality. For example, the off site manufacture of wiring looms for domestic housing enables expensive electrical cabling to be used with minimal waste. Off site manufacture minimises the amount of work required on site and in particular off cuts.
- Programme and monitor construction activities- This can be achieved by creating metrics which allow monitoring of performance and control of the construction process. Project management activities should also include regular reviews of the materials management process. Planning work in a way that avoids the overlap of incompatible trades working in the same area (wet and dry trades) helps reduce damage and rework.
- Use packaging in an efficient way Packaging is one of the largest waste streams in construction. There are situations where too much packaging (and sometimes too little packaging) is provided. Contractors and sub contractors should investigate ways of eliminating or reducing packaging. Where possible, take back schemes for packaging and unused materials with suppliers or alternatively recycling the materials at a central depot should be put in place. The selection of suppliers should take into account whether they have measures in place either to reduce or re-use packaging.
- Train/educate people on how to reduce waste This can be achieved by:
  - Raising awareness of the relationship between design, waste and impact on the environment;
  - Allocating personal responsibility on site for waste reduction (e.g. appoint a Waste Manager);
  - Incentivising people to reduce waste;
  - Sharing experience of good practice;
  - Using training/tool box talks on waste minimisation and management; and
  - Enabling more interaction between estimators, buyers, site managers and operatives.

The process of monitoring performance during construction should also incorporate the following best practice activities:

- Main contractors should appoint a Site Waste Manager responsible for reducing waste on site (at project level). The designation of a Site Waste Manager does not need to be a full time task. However it is vital that a designated individual has clearly defined responsibilities in this role and sufficient time to fulfil the role.
- The Site Waste Manager should co-ordinate with sub contractors to ensure that appropriate storage conditions are available
- The Site Waste Manager should keep a record of all materials brought to site to enable a reconciliation against what was used
- Sub contractors should appoint a Trade Waste Manager (at trade package level)
- Sub contractors should liaise with the Site Waste Manager to ensure materials are supplied in an appropriate manner, and in the correct quantity (where not supplied direct by sub contractor)
- Site Waste Manager should monitor costs/volumes of disposal
- The Site Waste Manager to determine KPI's on this basis

Appendix C provides a useful checklist for the type of activities required at implementation stage.

#### 2.3 Review

A review of waste performance should take place when each work package is completed (particularly for long term projects) and also at the end of projects, as part of the final account and post project review.

When each subcontractor completes their work, a review of its waste performance should be carried out. Just a small amount of time reviewing data and providing feedback can have real benefits, such as:

- Assess whether the waste minimisation and management strategy was effective
- Learn what works and doesn't work in reducing waste
- Identify exactly how efficient main contractors and sub contractors were on the project – in turn enabling them to understand how wasteful they were
- Main contractors can see which of the trades contributed what quantity of materials to the waste stream and why – enabling them to prepare better waste estimates in the future
- Capture any relevant data for future reference and use, and
- Sub contractors and main contractors can learn lessons, thus enabling both to improve the waste performance on subsequent projects.



Specific actions that can be taken at the end of projects are:

- Post completion reconciliation Comparing the net quantity of materials used with the quantity ordered and the quantity of materials un-used provides a simple measure of how efficient materials usage has been. The reasons behind any waste should be investigated and recorded.
- Carry-out reviews of performance against targets– 'All party' workshops should be carried out at regular intervals as part of project reviews to assess performance on waste minimisation and management. Good practice requires the clients and contractor to establish and agree targets using Key Performance Indicators (KPIs) for maximising material resource efficiency. Meeting these targets and KPIs should become a contractual obligation for the main contractor and sub-contractor and will enable the performance of the project to be monitored during the construction phase. For further information please refer to WRAP's 'Achieving Good Practice Waste Minimisation and Management' document.



Record data - Continuously capturing waste data across different project types will allow clients, contractors and sub contractors to build up a clear picture of how efficient their materials usage is and what effect this had on profit and on overall project cost. Recording data on a material by material basis will enable more robust information to be collected on wastage in different material types/groups. This can then be used to identify areas where improvements can be made.

# 2.3.1 Quantitative Record and Qualitative Checklist 2

To support this process, a quantitative and a qualitative proforma have been developed (see Appendices D & E).

#### **Quantitative Record**

This is the same form as the Quantitative Estimate used at the planning stage but with the opportunity to record the actual performance of the project. This requires the sub contractor to provide information on the actual quantities of materials used for the project and compare this against original estimates. Completing this form effectively is likely to require a good degree of data management during the project to ensure that records are sufficiently robust to identify actual material usage. Additional guidance on completing the form is included in Appendix D.

#### Qualitative checklist 2

This is a very simple checklist that explores why the wastage rate is above or below the estimate. It therefore questions what the main causes of waste were on the project and also, what could have been done to reduce these. This is important information that enables the main contractor to build a picture of how to reduce waste on subsequent projects. In addition, it also enables the sub contractor to understand and document what their wastage rates are, with the intention that they can be reduced. The checklist and guidance on completing it is included in Appendix E.

#### 2.4 Improvement

By improving performance, a company can demonstrate best practice and a company-wide commitment to waste minimisation and management for an improved reputation with clients. The main benefit of improving performance in waste minimisation is the ability to deliver projects for a lower cost.



Specific actions that can be taken are:

- Share lessons learned One of the best ways to improve performance is to learn from experience. The issues relating to minimising and managing waste in construction are relatively new and any experiences (good or bad) should be shared across the industry. Sharing lessons learned via publications can act as powerful promotion for organisations and should not be perceived as conceding an advantage to competitors.
- Promote innovation By championing new ideas in the field of waste management and minimisation, clients, contractors and sub contractors can be at the forefront of the industry and contribute to increasing government led requirements for reducing construction environmental impact.



- Raise awareness By raising awareness within their own organisations and across the industry, all participants to the construction process can improve their performance on reducing waste, increase profits and promote a more sustainable image of the industry.
- Demonstrate better financial and environmental results Contractors and sub contractors can demonstrate through example for future tenders and this can provide competitive advantage.



# Appendix A - Quantitative Estimate

	Estimate	Actual	Difference	Unit
Quantity material				
required (no				
wastage)				
Wastage				
allowance				
of which design &				
specification waste				
of which				
construction process				
waste				
Quantity ordered				
<b>,</b>			'	
Wastage rate				%
g				
Wastage mass				t

Guidance
This is a measure of the net quantity of materials needed for the project, regardless of the dimensions of the materials to be used. This assumes that there will be no
wastage.
This is the allowance for waste for the sub contract package. This is a sum of both
design waste and construction process waste
This is an estimate of the waste generated by design and specifications and in
particular off cuts. On many trades this can be measured accurately (i.e. carpet
wastage). This forms first part of the wastage allowance.
This is an estimate of the waste likely to be caused by site activities such as damage,
defective materials, damage during transport, anticipated variations etc. This forms
the second part of the waste allowance.
This is an estimate of the quantity of materials that should be ordered and should be
the sum of the actual materials needed, plus the waste allowances. Sub contractors
should not (nor should they need to) order more than this.
This is the waste allowance as a percentage of the total material quantity required.
This is a simple calculation from the volume (using density) that identifies the
estimated mass of waste being generated.



# Appendix B - Qualitative Checklist 1

# **Qualitative Checklist 1**

This checklist is to be completed in conjunction with the Quantitative Estimate. It encourages the sub contractor to think about what the waste rates are and how they may be reduced. It is important to spend some extra time thinking about where waste will occur, how you will account for this waste, and importantly, what can be done to reduce this waste. Estimating material quantities Focus on: Producing an accurate estimate of the materials required for the project as this is the first step in avoiding unnecessary waste. Think about: Ways to ensure accurate estimates includes obtaining robust and reliable information and using this information to produce accurate measures. How was the material CAD take-off quantity calculated? Measure from printed drawings Cost plan / BQ quantity Site measurement Other (please specify) How accurate is this quantity High..... and why? Medium..... Low. Estimating waste allowances Focus on: The waste allowance can be split between design waste (i.e. off cuts) and construction process waste. By doing this, more accurate estimates can be made, resulting in tighter material ordering and more focused mitigating actions. Think about: Using accurate material estimates, what are the factors that generate waste and how they relate to design and/or the construction process. Has the waste allowance been Yes split between design and No..... construction process waste? If no, explain why. Design waste allowances Focus on: Design waste is the waste stream that is 'fixed' by the design. Think about: Using materials that avoid unnecessary cutting; order pre-cut materials; spend extra time thinking about the setting out. How was the allowance for Trade software package design waste developed? Based on historical data Personal experience Other (Please identify) Are there opportunities to Yes..... reduce this wastage through No..... design changes? If so, what are they? Are there opportunities to Yes..... reduce this wastage through No..... the construction / installation process? If so, what are they? **Construction Waste allowances** Focus on: Identifying the largest contributors to waste specific to this project and in identifying ways to reduce this waste with minimal effort. Think about: How opportunities to reduce waste can be achieved How was the allowance for Based on historical data construction process waste Personal experience developed? To what extent do the 1 - Material delivery ..... following factors influence the



waste allowance and wny?		
	2 - On site storage	
	3 - Co-ordination &	
	sequencing	••••••
	4 - Programme constraints	
	E Complexity of design	
	5 - complexity of design	
		••••••
	6 - Rework	
	7 Design shanges	
	7 - Design changes	••••••
	8 - Co-ordinated site	
	ordering processes	
	or doring proceeded	
	C Others (places list)	
	9 - Others (please list)	
	10	
Opportunities to improve		
Focus on: What are the most Think about: The lessons lea	important actions to take to red rned in the past and how they o	duce waste on this project could be applied to this project
For the top 3 waste	1	
contributors, what could be		
done to reduce the waste		
generated (and reduce the		
waste estimate)?		
	2	
	2	·····
	2	·····
	2	
	2	
	2	
	2	
	2 3	
Managing left over materials	2	
Managing left over materials	2 3	
Managing left over materials Focus on: How to minimise th	2     3     a quantity of materials sent to	landfill.
Managing left over materials Focus on: How to minimise th Think about: How to reuse o	2     3      a quantity of materials sent to r recycle materials that are left	landfill.
Managing left over materials Focus on: How to minimise th Think about: How to reuse o Can packaging be eliminated,	2     3      a quantity of materials sent to r recycle materials that are left	landfill.
Managing left over materials Focus on: How to minimise th Think about: How to reuse o Can packaging be eliminated, reduced, taken away or	2     3      a quantity of materials sent to r recycle materials that are left	landfill.
Managing left over materials Focus on: How to minimise th Think about: How to reuse o Can packaging be eliminated, reduced, taken away or recycled?	2     3      a quantity of materials sent to r recycle materials that are left	landfill. over after work is completed
Managing left over materials Focus on: How to minimise th Think about: How to reuse o Can packaging be eliminated, reduced, taken away or recycled? What will be done with	2     3      a quantity of materials sent to r recycle materials that are left      Returned to supplier	landfill. over after work is completed
Managing left over materials Focus on: How to minimise th Think about: How to reuse o Can packaging be eliminated, reduced, taken away or recycled? What will be done with unused materials?	2     3      a quantity of materials sent to     r recycle materials that are left      Returned to supplier     Taken away by set	landfill. over after work is completed Why & how?
Managing left over materials Focus on: How to minimise th Think about: How to reuse o Can packaging be eliminated, reduced, taken away or recycled? What will be done with unused materials? Please	2     3      a quantity of materials sent to     r recycle materials that are left      Returned to supplier     Taken away by sub	landfill. over after work is completed Why & how?
Managing left over materials Focus on: How to minimise th Think about: How to reuse o Can packaging be eliminated, reduced, taken away or recycled? What will be done with unused materials? Please explain why and how.	2     3      a quantity of materials sent to     r recycle materials that are left      Returned to supplier     Taken away by sub     contractor	landfill. over after work is completed Why & how?
Managing left over materials Focus on: How to minimise th Think about: How to reuse o Can packaging be eliminated, reduced, taken away or recycled? What will be done with unused materials? Please explain why and how.	2      3      a quantity of materials sent to r recycle materials that are left      Returned to supplier Taken away by sub contractor Given away	landfill. over after work is completed Why & how?
Managing left over materials Focus on: How to minimise th Think about: How to reuse o Can packaging be eliminated, reduced, taken away or recycled? What will be done with unused materials? Please explain why and how.	2 3 a guantity of materials sent to r recycle materials that are left Returned to supplier Taken away by sub contractor Given away Recycled	landfill. over after work is completed Why & how?
Managing left over materials Focus on: How to minimise th Think about: How to reuse o Can packaging be eliminated, reduced, taken away or recycled? What will be done with unused materials? Please explain why and how.	2 3 a quantity of materials sent to r recycle materials that are left Returned to supplier Taken away by sub contractor Given away Recycled Sent to landfill	landfill. over after work is completed Why & how?



	Other (Please advise)	
What will be done with damaged materials? Please explain why and how.	Recycled Sent to landfill Other (Please advise)	Why & how?



# Appendix C – Construction Activities Checklist

	Implementation stage checklist			
Subject	Questions to consider	Tick if 'Yes'	Comment: If 'Yes', what action have you taken / do you propose to take? If 'no', why not?	
Waste         Focus on: Understanding client's statement of intent that explains what levels o           targets and         expected for the project.		explains what levels of waste are		
	Think about: What can be done to achieve the	se targets.		
	Have the targets for maximum waste levels for the project been communicated to all parties involved in the project?			
	Have these targets been incorporated in the Site Waste Management Plan?			
	Have subcontractors signed up to the Site Waste Management Plan?			
	Have subcontractors been briefed on the Site Waste Management Plan requirements?			
	Have sub contractors completed and submitted the Quantitative Estimates forms?			
	Have sub contractors completed and submitted the Quantitative Estimates forms?			
	Has a Site Waste Manager been appointed?			
Programming	Waste Manager?	and rowo	nr.	
Frogramming			л к.	
	Think about: Who takes responsibility for reducing waste.			
	Is work programmed in a way that avoids damage and rework?			
	Does the programme include project reviews that require waste performance assessments?			
	Are procedures in place to record the causes of waste on site and prompt effective actions?			
	Is training in place to educate people on how to reduce waste?			
Materials Procurement	<b>Focus on:</b> Making sure that orders are placed only when materials are needed and that waste allowances are realistic.			
	<b>Think about:</b> How the estimates of the quantities of materials required are produced, what are the main factors that lead to ordering surplus of materials and what can be done to reduce waste for each trade			
	Has prefabrication/off site manufacture been considered?			
	Are take back schemes in place to remove materials and packaging from site?			
	Are recycling facilities set up on site?			

	Is an effective logistics strategy in place for delivering materials to site?		
Site activities	<b>Focus on:</b> How materials are used on site, including arrangements for maximizing efficiency in material storage, handling and distribution		ements for maximizing efficiency in
	Think about: Quality control, waste allowances and targets, logistics for material distribution a waste recovery		
	Are procedures in place to record the causes of waste on site?		
	Are materials delivered to site on a 'just in time basis'?		
	Is site storage suitable, safe and secure?		
	Are mechanical handling tools and machineries in place?		



# Appendix D - Quantitative Record

	Estimate	Actual	Difference	Unit
Quantity material required (no wastage)	ххх			
Wastage allowance	ххх			
of which design and specification waste	ххх			
of which construction process waste	ххх			
Quantity ordered	ххх			
Wastage rate	ххх			%
Wastage mass	ххх			t

Guidance
This enables a change in scope to be reflected. For example, if the floor area changed, then quantity of materials required would also change.
This is a fixed value
This is a fixed value
This is a fixed value
This is a record of the actual quantity of materials ordered for the project. This should be based upon invoice data such that a precise record is kept of what materials have been supplied to site.
This shows the difference between the quantity of materials needed and the actual quantity of materials ordered and delivered to site. This can be compared to the estimated wastage rate.
This is a simple calculation from the volume (using density) that identifies the actual mass of waste generated.



# Appendix E – Qualitative Checklist 2

## Qualitative Checklist 2

project review is that it captures the real reasons waste wast generated. This helps both contractors and sub contractors continuously improve their waste performance.         Wastage rates	This checklist is to be completed at package final account stage. The benefit of this post			
contractors and sub contractors continuously improve their waste performance.         Wastage rates          Focus on: What results were achieved          Think about: How do results compare to expectations       Is         Is the materials wastage rate          above or below the estimate?          Project review          Focus on: Undentifying the main factors that influenced waste on this project          Think about: Why these factors occurred       1         What 3 causes resulted in the increase / decrease in waste and why?       1         2          and why?       3         3          Opportunities to improve?          Focus on: Opportunities to improve          Think about: What would be the main benefits of improvement          List 3 areas where waste       1         performance could have been improved and why?       3         3           3           2           3           3           Is areas where waste       1          Improved and why?       3 <th colspan="3">project review is that it captures the real reasons waste was generated. This helps both</th>	project review is that it captures the real reasons waste was generated. This helps both			
Wastage rates       Focus on: What results were achieved         For think about: How do results compare to expectations       Inink about: How do results compare to expectations         Is the materials wastage rate above or below the estimate?       Project raview         Focus on: Identifying the main factors that influenced waste on this project       Think about: How do results compare to expectations         What 3 causes resulted in the increase / decrease in waste and why?       1       Init about: How do results are an above or below the estimate and why?         Qpportunities to improve?       2       Init above or portunities to improve         Think about: What would be the main benefits of improvement       Init above or portunities to improve         Think about: What would be the main benefits of improvement       Init above or good and why?         2       Init above or good and why?         3       Init above or good and why?	contractors and sub contractors continuously improve their waste performance.			
Focus on: What results were achieved         Think about: How do results compare to expectations         Is the materials wastage rate above or below the estimate?         Project review         Focus on: Identifying the main factors that influenced waste on this project         Think about: Why these factors occurred         What 3 causes resulted in the increase / decrease in waste and why?         2         2         Opportunities to improve?         Focus on: Opportunities to improve?         For some could have been improved and why?         2         2         3         2         2         3         3         2         3 <t< th=""><th colspan="4">Wastage rates</th></t<>	Wastage rates			
Think about: How do results compare to expectations         Is the materials wastage rate above or below the estimate?         Project review         Focus on: Identifying the main factors that influenced waste on this project         Think about: Why these factors occurred         What 3 causes resulted in the increase / decrease in waste and why?         2         3         3         Copportunities to improve?         Focus on: Opportunities to improve?         Think about: What would be the main benefits of improvement         List 3 areas where waste performance could have been improved and why?         2         3         3         3         3         3         3         4         3         3         4         3         4         4         5         6         6         7         7         8         9         9         9         9         9         9         9         9         9         9	Focus on: What results were achieved			
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above or below the estimate?	Is the materials wastage rate			
Project review       Focus on: Identifying the main factors that influenced waste on this project         Think about: Why these factors occurred         What 3 causes resulted in the increase / dccrease in waste and why?       1         2	above or below the estimate?			
Focus on: Identifying the main factors that influenced waste on this project         Think about: Why these factors occurred         What 3 causes resulted in the increase / decrease in waste and why?       1	Project review			
Think about: Why these factors occurred         What 3 causes resulted in the increase / decrease in waste and why?         2         2         3         3         Coportunities to improve?         Focus on: Opportunities to improve         Think about: What would be the main benefits of improvement         List 3 areas where waste performance could have been improved and why?         2         3 <td< td=""><td colspan="4">Focus on: Identifying the main factors that influenced waste on this project</td></td<>	Focus on: Identifying the main factors that influenced waste on this project			
What 3 causes resulted in the increase / decrease in waste and why?       1	Think about: Why these factors occurred			
increase / decrease in waste and why? 2	What 3 causes resulted in the	1		
and why?	increase / decrease in waste			
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Opportunities to improve?         Focus on: Opportunities to improve         Think about: What would be the main benefits of improvement         List 3 areas where waste performance could have been improved and why?         2         3		2		
Opportunities to improve?         Focus on: Opportunities to improve         Think about: What would be the main benefits of improvement         List 3 areas where waste performance could have been improved and why?         2         and				
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performance could have been	List 3 areas where waste	1		
improved and why?     2     3     3	performance could have been improved and why?			
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List bullet style is used for all bullet lists.





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