TEMPLE

REPORT for

The South East Centre for the Built Environment (SECBE)

Waste Management Programme

Development of a Real-time Data System

Grow
North East South West INTERREG IIIC
PROJECT PART-FINANCED BY THE EUROPEAN UNION
SEEDA SOUTH EAST ENGLAND DEVELOPMENT AGENCY
Working for England's World Class Region

SECBE

Development of a Real-time Data System

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EXECUTIVE SUMMARY

The primary objective of the SECBE Real Time Data System (RTDS) was to minimise waste in the construction process through the accurate collection of waste data which would enable immediate action to be taken on-site and which ultimately would be used in designing out waste from the construction process.

SECBE, in association with Kier Partnership Home (KPH) and Thanet Waste ran a pilot trial to assess the effectiveness of the RTDS concept.

Although there was general support for the objectives of the RTDS concept, the pilot partners identified a number of concerns and shortcomings which included the time involved in inspecting and assessing waste, the absence of standardized reporting metrics, and the absence of any structured approach to providing feedback to the procurement managers and ultimately the design teams.

Temple was appointed by SECBE to review the RTDS pilot study to identify lessons learned, the technical and operational challenges encountered and to provide recommendations on how the RTDS concept could be improved.

The study included discussions with SECBE and personnel at KPH and Thanet Waste directly involved in the pilot trial to understand both the practical challenges encountered and their suggestions on how the system could be improved.

Our recommendations include a revised RTDS together with a revised definition of “real time” in the context of extended time horizons i.e. immediate, intermediate and strategic supplemented by a number of other initiatives. One such initiative was the need to move away from the “one size fits all” approach and manage by variance, adopting Expert Systems and processes including the use of segregated skips, which would allow the immediate segregation of waste on-site, which would better reflect the phase of the project.

We also provided a proposal for another pilot trial based on our revised RTDS.

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1 INTRODUCTION

This report has been funded by SEEDA and the GROW programme as part of a Pilot Project for Sustainable Construction.

The PPSC project aims to draw out existing and emerging sustainable construction methods, techniques, policies and activities in order to drive industry best practice across the regions of South East of England and Andalucía in Spain.

Temple Group (Temple) was instructed by the South East Centre for the Built Environment (SECBE) to undertake a review of the piloted SECBE Real-Time Data System (RTDS). The primary objective of the RTDS was to correlate in real time construction waste data from waste handling stations back to construction projects.

This data would enable site managers to improve their site waste management practices and would ultimately enable waste to be designed out of the construction process achieving cost savings in terms of reduced landfill disposal costs and raw material purchase costs. This waste analysis data would be of particular benefit in repeat type projects such as housing developments.

As of March 2007, SECBE had collected data on the types of waste generated on a number of construction sites, however the process of waste data collection was found to be very labour intensive and time intensive. Another problem encountered was that skips were being aggregated and therefore traceability back to the site of generation was not possible.

Other achievements of the RTDS at that time included:

- A review of available waste data collection systems to identify the most effective method of waste data collection,
- Identification of leading waste management companies and building contractors to form the basis of a RTDS pilot partner team;
- A brainstorming meeting with SECBE and the RTDS pilot partner team;
- Development of an outline RTDS technical specification, in discussion with the pilot partner team; and
- A pilot of the material data collection methodology with Kier Partnership Homes and Thanet Waste based on retrospective Saturday waste analysis.

A summary of the waste data collected was reported to the Temple study team by SECBE. The main conclusion of the SECBE report was that the RTDS methodology needed to be redefined and developed, in accordance with users' needs.

Temple was employed to provide additional waste management expertise to further develop the RTDS concept and methodology to meet the client / industry demands.

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1.1 Objectives

Our understanding of the original aims of the SECBE RTDS project were as follows:

1. To enable building contractors (large and small) to manage construction wastes more effectively by providing them with data on the types of waste generated during a construction project. It was hoped that contractors would take "remedial actions" on site through improved waste management practices and in the longer term "preventative action" for repeat work, designing out waste. Such "actions" would be based on fast, accurate analysis of materials generated on-site;
2. In partnership with leading building contractors and waste material handlers, identify and pilot a system that shares the waste data in real time with the project team including construction site workers and the design team to enable the industry to take both remedial and preventative actions;
3. To identify existing data collection systems and develop an understanding of criteria/ barriers to successful implementation;
4. To develop pilot partner teams and outline a RTDS technical specification;
5. To develop and trial a pilot RTDS; and
6. To promote the product to contractors and waste management contractors.

1.2 Study Scope

As discussed the original vision for the project was to develop and pilot a system that immediately correlates in real time construction waste analysis data (by waste handling stations) back to the corresponding construction projects/programmes to improve their site practices and design out waste, especially for repeat projects.

This Study was carried out to help understand why this pilot did not achieve the original goals of the RTDS (as outlined in Section 2.2 above). The original brief of our study was as follows:

1. Carry out a strategic review of the SECBE RTDS project;
2. Identify key regulatory drivers at the National and EU level and identify future policy trends;
3. Review SECBE RTDS work to-date to identify information gaps, positives, negatives and practical lessons learned;
4. Review RTDS best practice internationally and identify lessons learned and understand how these lessons can be applied to the SECBE RTDS project;
5. Consult pilot project partners to identify barriers to successful implementation of the system and identify system improvements;
6. Develop 3 alternative Real Time Data Systems;
7. Review critically all three RTDS options and develop a RTDS Business Development Plan for the preferred option;
8. Prepare a report detailing key findings, recommendations and conclusions;

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9. Prepare a Business Development Plan robust enough to attract SEEDA or commercial investment to mainstream the service.

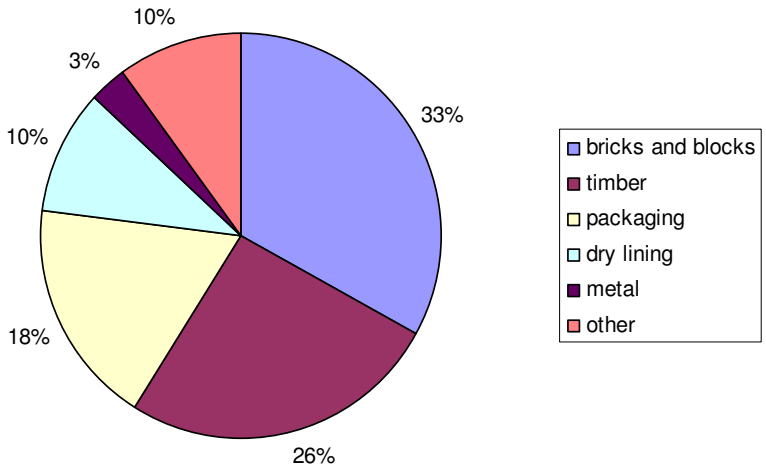
In carrying out this research it was evident that it would be difficult to define three "distinct" alternative RTDS schemes. Therefore it was agreed with SECBE that the report would focus on Objectives 1 through 5 and would develop, building upon the original RTDS scheme, a modified RTDS which would address those conceptual and practical lessons learned during the RTDS pilot test.

1.3 Context - Overview of the UK Construction Waste Sector

Every year in the UK 106 million tonnes of waste is disposed of by the construction and demolition industry, representing approximately 1/3 of all waste[1] and making construction and demolition waste the single largest waste stream.

Of this, 34% is sent to landfill, 50% is reused (mainly as aggregate) and 16% is recycled. The total material composition of this waste is illustrated in Figure 2.1

Figure 1.1 - Total Composition of Waste from Construction and Demolition Industries[2]



It is estimated that at current rates of disposal the 10,000 landfill sites in the UK will reach capacity within 6 - 15 years[3].

According to the UK Environment Agency the amount of construction and demolition waste (C&DW) going to landfill more than halved in the period 1997-2003[4].

[1] Wates Group (2006). Target:Zero.

[2] Wates Group (2006). Target:Zero.

[3] Wates Group (2006). Target:Zero.

[4] Environment Agency website – www.environment-agency.gov.uk/

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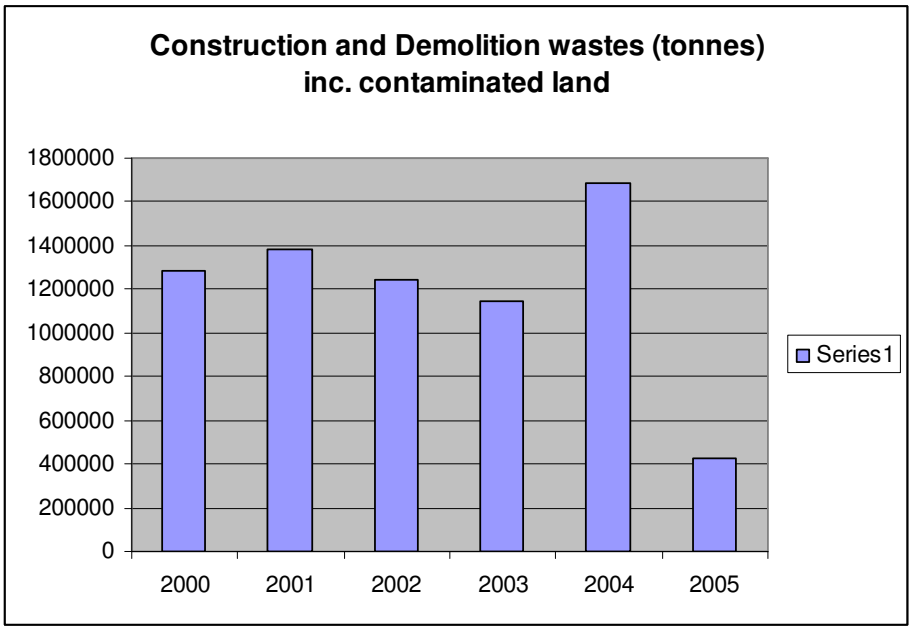
A recent conference on "Special / hazardous waste data trends" by the Hazardous Waste Forum, on 8th May 2006 demonstrates the falling C&D waste volumes to 2005. There was an increase of CDW in 2004, which was likely due to the enactment of the Landfill (Scheme Year and Maximum Amount) Regulation 2004 which came into force in July 2004.



However, a commonly held view is that the construction industry can do more to avoid waste generation, as it is likely much of waste generated is soil and aggregates.

For instance, WRAP estimates that 13 million tonnes of material that becomes construction and demolition waste (C&DW) are discarded without being used and that by eliminating the over-order, "Just-in-case" (JIC) culture in the construction and demolition sector this would save 5 landfill sites a year.

The potential business benefits of more effective waste management on site include:

- savings in disposal and transport costs;
- revenue from reuse and recycling;
- reduced costs of purchasing construction materials; and
- Improved environmental performance/credentials.

It has been estimated that waste typically costs businesses up to 4% of turnover[5]. For example AMEC, an engineering consultancy, estimates that for an 8 cu yd skip the actual costs are £1,343, which is made up as follows:

- Skip hire £ 85

[5] Envirowise website (http://www.envirowise.gov.uk/page.aspx?o=168830)

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- Labour to fill skip £ 163
- Cost of materials put in skip £1095

1.4 Barriers to Construction and Demolition Waste Minimisation

Whilst there has been a reduction in waste production from the construction sector[6], there are a number of perceived barriers to more effective waste management processes, including the:

- Perception that un-used materials are disposable;
- Expectation that un-used materials are damaged beyond use;
- Perception that recycling will ultimately result in additional costs;
- Lack of involvement in the design process – more accurately specifying material quantities/requirements at the design phase thereby designing out waste;
- Difficulties with contract specification /green specification;
- Lack of client understanding of the potential advantages of C&DW minimisation;
- Perception of recycled material being of poor quality;
- Lack of a quality assurance system (quality marks) to help give confidence of quality;
- Use of subcontractors with lack of knowledge/understanding of efficient use of materials;
- Over-ordering and under-explored supply channels (think about sale or return as a solution);
- Under-explored markets for recyclates;
- Lack of distribution systems for assessing and redeploying reusable materials;
- Lack of understanding of the importance and uses of a waste measurement processes;
- Greater use of off site construction techniques;
- Lack of guidance/training for staff in developing a better understanding;
- Lack of motivation to overcome barriers (lack of support from middle and top management, some resistance to change); and

[6] Target Zero 2006, Wates Group

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- Lack of incentives to change, particularly at the 'front line'.

The RTDS was an approach to respond to some of the barriers as listed above by providing value feedback into the system in real-time and helping improve project performance and financial return.

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2 LEGISLATIVE AND OTHER DRIVERS

2.1 Context

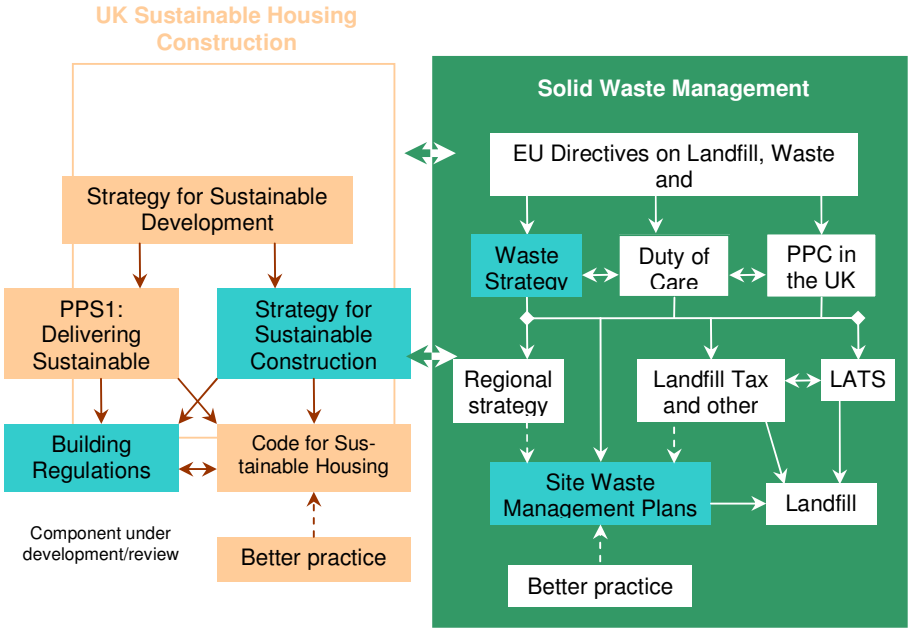
The framework for management of waste includes a variety of specialised statutory and non-statutory instruments at the international, national and regional levels, with ultimate responsibility for waste management devolved to the appropriate local government authority and the individual (generator of waste). Much of this framework applies to specific waste streams, particularly C&DW.

Over the next few years, programmes such as the Code for Sustainable Homes (See Section 2.4.3) are to be enforced through Building Regulations for Sustainable Homes (See Section 2.4.89).

However there remains a significant opportunity for proactive developers and contractors to reduce the impact of such regulations by adopting the Code for Sustainable Homes as early and as fully as possible.

The following sections outline key components of the framework for the minimisation and disposal of C&DW in the UK. The main drivers such as the Code for Sustainable Homes and PPS1, Building Regulations, Site Waste Management Plans and others as shown are all increasing the requirements to reduce waste. **Figure 2.1** illustrates the national policy context – UK Sustainable Housing Construction and the practical, site based mechanisms required to achieve policy objectives. This regulatory framework will provide the necessary economic incentives to reduce waste to landfill.

Figure 2.1 - Key Components of the C&DW Management Framework for the Housing Sector



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2.2 EU Waste Directives

2.2.1 Directive on Landfill of Waste[7]

The European Directive on Landfill of Waste ("the Landfill Directive") came in to force in 1999 and requires member states to *"prevent or reduce the adverse effects of the landfill of waste on the environment, in particular on surface water, groundwater, soil, air and human health".* It specifies that waste is divided into three types of landfill sites: hazardous waste; non-hazardous and municipal waste; and, inert waste.

2.2.2 Directive on Waste[8]

The European Directive on Waste ("the Waste Directive") came into force in 2006. It requires that:

"Member States must prohibit the abandonment, dumping or uncontrolled disposal of waste". They shall promote waste prevention, recycling and processing for reuse".

In particular, it requires that:

"the recovery of waste and the use of recovered materials as raw materials should be encouraged in order to conserve natural resources", and

"in addition to taking responsible action to ensure the disposal and recovery of waste, member states take measures to restrict the production of waste particularly by promoting clean technologies and products which can be recycled and re-used, taking into consideration existing or potential market opportunities for recovered waste".

2.2.3 Directive on Pollution Prevention and Control[9]

The European Directive on Integrated Pollution Prevention and Control ("the IPPC Directive", as amended), requires Member States to regulate industrial sites, including landfill and waste management operations. It has no direct relationship with housing construction, but does impact on landfill operations and therefore influences disposal of Construction and Demolition Waste (C&DW). This is discussed further in the UK drivers section.

2.3 UK Legislation

2.3.1 Landfill (England and Wales) Regulations 2002 SI 1559

In addition to wider requirements and those already in place, the current approach to non-hazardous waste is changing in October 2007, so that it will now need to be treated before disposed of in a landfill. Many of these changes are now in place, however two more important changes will happen from 30 October 30 2007, in particular, these requirements:

[7] EU Council Directive 99/31/EC (1999) Landfill of Waste

[8] EU Council Directive 2006/12/EC (2006) On Waste

[9] EU Council Directive EC/96/61 (1996) Integrated Pollution Prevention and Control

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- ban the landfilling of non hazardous liquid waste, and
- require non hazardous waste to be **treated** before landfilling.

You can define 'treatment' by using the following 'three-point test'. All three criteria must be satisfied for all of the waste to have been treated:

1. It must be a physical, thermal, chemical or biological process including sorting;
2. It must change the characteristics of the waste;
3. It must do so in order to:

    (a) reduce its volume; or

    (b) reduce its hazardous nature; or

    (c) facilitate its handling; or

    (d) enhance recovery.

One of the simplest ways to pre-treat your non hazardous waste is to separately collect your waste as individual waste streams and recycle one of the separated streams. Alternatively your waste management company can treat the waste for you before it is sent to landfill. This can include simply sorting your waste at a transfer station and recycling part of this waste.

Mixed Construction and Demolition Waste Guidance[10]

Construction waste typically contains materials such as bricks, concrete, plasterboard, timber, plastic film, packaging and surplus materials. It may contain site clearance waste such as soil and vegetation. Demolition waste may also include the contents of buildings and the residues from the provision of services.

Mixed waste can either be separated or the whole waste stream treated. The latter will not usually be appropriate because of the high content of material such as bricks and concrete, and the low content of readily combustible or biodegradable material.

Government policy, supported by research and guidance, strongly favours the minimisation and recycling of C&D wastes. Separation is therefore the normal option. Separation and the role that Site Waste Management Plans have in encouraging the recovery of construction and demolition waste are described in the guidance.

WDFDL (Waste Destined for Disposal in Landfills) sets out the Environment Agency's views on the source segregation of mixed wastes. If producers segregate waste at source, segregation should be optimised to remove as much recyclable material as possible.

[10] Treatment of non-hazardous wastes for landfill. EA Feb 2007

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Principles

It is for waste producers to satisfy landfill operators that waste has been treated and this means meeting the 3-point test. All three need to be satisfied. The following principles should help in applying the test.

1. All of the waste must have been pre-treated. Collection services that mix treated and untreated waste are not meeting the new requirement and all the waste will need further treatment before landfill. In many cases it will be easier and more economic to pre-treat the waste before collection or undertake separate collection rounds. If the treatment option is to separate out certain recyclable material, one could reasonably expect all of that material to have been removed, not just one or two items.

2. Sorting is an acceptable form of treatment – because if it is carried out properly it will change the characteristics of the waste and meet one of the four elements of the aforementioned criteria, No.3. Source segregation meets the same criteria and is acceptable treatment. Compaction is not an acceptable form of treatment as it does not change the characteristics of the waste which will therefore have the same impact on the environment as un-compacted waste.

3. Waste that was already being treated prior to October 2007 does not need further treatment. Although the legal requirement to pre-treat is new, it is not intended to require additional measures provided the treatment option satisfies the 3 point test. It is not intended to penalise forward thinking companies.

2.4 Drivers for Waste Minimisation in the United Kingdom

In the UK the regulation of housing construction and C&DW are coordinated by the Department of Environment, Food and Rural Affairs (DEFRA), the Department of Communities and Local Government (CLG) and the Department of Trade and Industry (DTI) through a variety of regulatory instruments and programmes. The following components of this framework are briefly described in this section:

- Strategic framework;
- Duty of Care (Environmental Protection Act 1990);
- Financial incentives - Landfill Tax Escalator, Aggregates Levy;
- Code for Sustainable Homes(note BREEAM/Eco Homes will still be in effect and Code level 4 is Eco Homes Excellent, so they are comparable);
- Building Regulations (to come into force in 2008);
- Site Waste Management Plans (SWMPs) (to come into force in April 2008, but already are in use by many housebuilders);
- Built Environment Sustainable procurement Network (BESPN).

Of these, the SWMP will be a key driver to improve practice in this area; and

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- Supplementary Planning Documents and policy e.g. many Local Authorities have a construction or demolition SPD that developments have to meet before planning consent is given. This can assist with Waste minimisation at the design stage but one of the problems is that individual LAs may all be working to slightly different SPDs.

2.4.1 Strategic Framework

Strategy for Sustainable Development (2005)

Released in 2005, the Strategy for Sustainable Development identifies four priorities "that have strong resonance within the sustainable construction agenda"[11]:

- Sustainable consumption and production;
- Climate change and energy;
- Natural resource protection and environmental enhancement; and
- Sustainable communities.

These priorities provide an overarching framework for work within the construction sector, with clear direction to reduce and manage waste more effectively. There are two key policies that support this Strategy in relation to planning that are relevant to the construction sector:

- Planning Policy Statement 1: Delivering Sustainable Development (PPS1)
- Planning Policy Statement: Planning and Climate Change (Supplement to PPS1)

Strategy for Sustainable Construction (due 2007)

The Department of Trade & Industry (DTI) is coordinating preparation of a Government Strategy for Sustainable Construction. It will set a vision and targets[12] for Sustainable Construction for the period to 2015, building on key existing mechanisms such as the Code for Sustainable Homes, see Section 2.4.7 and future mechanisms like new Building Regulations, see Section 2.4.9.

Waste Strategy (2000)

The Waste Strategy (England and Wales) set out two clear aims:

- tackling the amount of waste produced, by breaking the link between economic growth; and

[11] DTI (2006) Review of Sustainable Construction 2006 – A Summary

[12] Draft targets are set out in DTI (2006) Review of Sustainable Construction 2006 – A Summary

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- waste production, putting waste which is produced to good use – through substantial increases in re-use, recycling, composting, and recovery of energy.

In 2006, the Waste Strategy was under review and a new Waste Strategy is due during 2007. It will address how waste management will help to meet the Government's strategic priority of sustainable consumption and production[13].

2.4.2 Duty of Care

In the UK, Section 34 of the *Environmental Protection Act 1990* "imposes a duty of care on persons concerned with controlled waste. The duty applies to any person who produces, imports, carries, keeps, treats or disposes of controlled waste"[14]. Within the definition of this Act and the *Controlled Waste Regulations 1992*, waste from construction and demolition activities is classified as controlled household waste, unless it consists of hazardous materials such as asbestos. It requires that all reasonable measures are taken to:

- Ensure that waste is only transferred to appropriately licensed receivers;
- Stop materials escaping from your control or the control of anyone else by packaging it appropriately and robustly;
- Ensure that waste is only transferred to a person authorised to handle that type of waste; and
- Ensure that the waste being transferred is accompanied by a written description that will enable anyone receiving it to dispose of it or handle it in accordance with his or her own Duty of Care.

In particular, the identification and description of waste is a critical step in processes to prevent and reduce waste disposal. This information is to be recorded on a Transfer Note, as required by *The Environmental Protection (Duty of Care) Regulations 1991*. The *Landfill (England and Wales) Regulations 2002* also require that reference be made to the European Waste Catalogue[15], which provides specific classification of all waste streams (this now adopted as the List of Wastes (LOW) in the UK).

2.4.3 Pollution Prevention Guidelines

UK Environment Agency publishes these and one is particularly relevant to this report: Pollution Prevention Guidelines – Working at Construction and Demolition Sites PPG6, particularly Section 7 on Waste Management. The key points from PPG6 are:

- The correct handling, storage and disposal of waste materials is vital if environmental harm and public complaint are to be avoided. Schemes which aim

[13] DEFRA Review of England's Waste Strategy website (http://www.DEFRA.gov.uk/environment/waste/strategy/review/index.htm)

[14] DEFRA Waste Management Duty of Care Code of Practice

[15] EU Commission Decision 2000/532/EC (As amended)

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to minimise waste and increase recycling are not only beneficial to the environment but can also reduce costs.

- The Duty of Care (Reference 1) requires waste producers to ensure that waste does not escape from their control and is passed only to an authorised person accompanied by a full written description.

a) Waste minimisation - Waste minimisation involves reducing the volume of waste produced, reusing the material again (without reprocessing) or recycling (which involves an element of reprocessing). All of these can bring benefits to the environment and significant savings in terms of management time, wasted materials, transport and disposal charges and landfill tax.

b). Waste treatment and storage - All wastes must be stored in designated areas which are isolated from surface drains. Under some circumstances, for example if storing or treating material from a contaminated site, a waste management licence may be required. Skips should be covered to prevent dust and litter being blown out and rainwater accumulation and should be regularly inspected and replaced when full. Where possible, separate skips should be provided so that wastes can be segregated for recycling or to prevent cross contamination. Used chemical containers may need special handling and the manufacturer's instructions should be followed. If plant maintenance is carried out on site, used oil should be stored in a bunded area for collection. Oil and fuel filters should also be stored in a designated bin in a bunded area for separate collection and recycling (PPG8-Reference 10). Used oil and filters are considered a 'special waste'.

c). Waste disposal - Under the Duty of Care, the waste producer has a duty to ensure that the waste contractor who removes the waste is registered with the Agency. A written description of the waste must be given to the contractor. Certain hazardous wastes are defined as being "special wastes" and a more rigorous consignment note system applies. If there is any doubt, the Agency should be contacted for advice.

2.4.4 Pollution Prevention and Control

Pollution Prevention and Control (PPC) is a regulatory regime for controlling pollution from certain industrial activities enacted through the *Pollution Prevention and Control Act 1999* and the *Pollution Prevention and Control (England and Wales) Regulations 2000*. It implements the European Directive on Integrated Pollution Prevention and Control, see Section 2.2.3. Chapter 5 of the Regulations deals with waste management, including disposal and recovery of waste. This affects the relationship between housing C&DW and landfill operations, as well as disposal of waste by incineration and the recovery of waste materials.

Best Available Techniques

PPC requires that the 'Best Available Techniques' (BAT) are used to balance the cost to the operator against benefits to the environment. Regulators are required to set permit conditions for pollution to air, land, water, energy efficiency, site restoration, noise,

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odour, waste minimisation, accident prevention and heat and vibrations. The EU provides sector specific guidance on BAT[16].

The concepts inherent in BAT and resource efficiency are driving key improvements in industry leading to "Design for the Environment" (DfE) changes from the concept to the reuse of all materials.

2.4.5 Landfill Allowance Trading Scheme

The Landfill Allowance Trading Scheme (LATS) was launched in 2005 and aims to help waste disposal authorities to reduce the amount of biodegradable municipal waste (BMW) sent to landfill. The LATS is enacted through the *Waste and Emissions Trading Act 2003* and *Landfill Allowances and Trading Scheme (England) Regulations 2004*. The Act places a duty on waste disposal authorities to reduce the amount of Biodegradable Municipal Waste disposed of to landfill but also provides the legal framework for the trading scheme. The scheme allocates tradable landfill allowances to each authority in England, with allowances set at a level that will allow England to meet its contribution to the UK targets under the Landfill Directive.

The LATS directly influences the nature of materials going into landfill and promotes processes to avoid landfill in favour of waste minimisation programmes at the site level. It therefore affects relationships between landfill operations and the management of C&DW.

2.4.6 Financial Incentives

Landfill Tax Escalator

In order to reduce the amount of waste being disposed to landfill and promote waste avoidance, reuse and recycling, the Landfill Tax was introduced in 1996 at £2 per tonne for inert waste, escalating at £1 per tonne per year. The tax was subject to an escalator of £3 per tonne each year so that from April 2007 it became £24 per tonne, but from April 2008 this increases by an increase of £8 per tonne, to £32, then £40 in 2009 and £48 in 2010. This significant increase will be key in driving initiatives such as considered in this report.

Aggregates Levy

The Aggregates Levy[17] introduced in 2002 was to reduce demand for primary aggregates by increasing their cost and thereby make the use of recycled and secondary materials more viable. The Aggregates Levy Sustainability Fund aims to reduce the environmental impacts per tonne of aggregates extraction and helps to stimulate the market for recycled and secondary materials.

[16] EU Guidance on BAT for Waste Treatment (http://ec.europa.eu/environment/ippc/brefs/wt_bref_0806.pdf)

[17] DEFRA – Aggregates levy (http://www.DEFRA.gov.uk/environment/waste/aggregates/index.htm)

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Climate Change Levy

The Climate Change Levy[18] is a tax on the use of energy in industry, commerce and the public sector, with offsetting cuts in employers' National Insurance Contributions - NICs - and additional support for energy efficiency schemes and renewable sources of energy. It is of relevance to the construction industry as it promotes more energy efficient practices, of which unnecessary handling of materials would be a prime target for reductions to be made.

2.4.7 Code for Sustainable Homes

The Code for Sustainable Homes came into operation in December 2006 to provide a single national standard for the design and construction of sustainable homes. The voluntary Code introduced a system for rating the overall performance of homes in relation to the design categories set out in **Table 2.1**. .

Table 2.1 - Design Categories set out in the Code for Sustainable Homes

Energy/CO_2	Pollution	Health & Wellbeing
Water	Surface Water Run-off	Management
Materials	Waste	Ecology

The Code affects not only the design of the building, but the quality of construction and materials used in the construction process, with points awarded for the minimisation, sorting, reuse and recycling of waste, as well as other construction site operations that relate to the above categories.

The release of the Code is accompanied by a consultation paper on future revisions to the Building Regulations.

An online sustainability checklist[19] has been prepared by the South East England Development Agency (SEEDA), World Wide Fund for Nature (WWF) and BRE to assist with application of the Code.

2.4.8 Demand for Recycled Aggregates

Demand for primary aggregates has been steadily declining, balanced by steady growth in recycled and secondary aggregates sectors. In total, recycled aggregates made up around 24% of the total volume of aggregates sold in 2003, and it was estimated that 90% of all demolition material was recycled in that year[20].

The highest demand for recycled aggregates remains in the South East of England where primary aggregates are in short supply. It has been estimated that the region consumes 25-30% of all recycled aggregates used in Britain.

[18] DEFRA – Climate change levy (http://www.DEFRA.gov.uk/environment/ccl/intro.htm)

[19] SEEDA (2007) Sustainability Checklist (http://southeast.sustainability-checklist.co.uk/)

[20] Valuation Office Agency (2004) Property Market Report July 2004 for the Minerals and Waste Management Industries (http://www.voa.gov.uk/publications/property_market_report/july_2004/minerals.pdf)

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High quality aggregates are primarily used in the construction industry for the manufacture of Asphalt and Concrete Products, Unbound and Hydraulically Bound Materials, Armourstone and Railway Ballast.

2.4.9 Building Regulations for Sustainable Housing

In December 2006 the CLG released a consultation paper[21] on revisions to the Building Regulations in the UK, which would make the achievement of specified standards set out in the Code for Sustainable Housing compulsory. It proposes that the Regulations will be strengthened with stepped progression towards maximum performance levels for all new housing by 2016.

2.4.10 Site Waste Management Plans

The Department for Environment Food and Rural Affairs (Defra) has consulted (completed 9 July 2007) on proposed legislation that will require Site Waste Management Plans (SWMPs) for the construction industry[22]. It is due to be enforced from Spring 2008 and will apply to any construction projects over £250,000, with more detailed SWMPs required for projects over £500,000, subject to consultation. Suppliers and waste handlers to the construction industry will also be affected.

SWMPs are intended to change the construction industry's attitude to waste by raising the profile of waste planning with the goal of reducing the amount of waste produced on construction sites. In particular they aim to ensure:

- greater resource efficiency in the construction sector;
- improved re-use and recycling rates;
- a reduction in fly-tipping; and
- a reduction in site accidents.

It is intended that SWMPs will:

- identify the different types of waste that will be produced by the project, and note any changes in the design and materials specification that seek to minimise this waste;
- consider how to re-use, recycle or recover the different wastes produced by the project;
- require the construction company to demonstrate that it is complying with the duty of care regime; and
- record the quantities of waste produced.

[21] CLG (2006a). Building a Greener Future: Towards a Zero Carbon Development. Consultation.

[22] NetRegs (2006) Site Waste – It's Criminal. A Simple Guide to Site Waste Management Plans.

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During construction, the plans would be updated to record what actually happens to the waste, including the legitimate disposal of materials that cannot be reused or recycled.

One individual, usually the principal contractor, will be responsible for writing and implementing the SWMP. Building Regulation of the Local authorities or the Environment Agency will enforce SWMPs and they will impose penalties for failure to make, keep or produce a SWMP, again subject to consultation.

This work progresses a voluntary code of practice for SWMPs released by the DTI[23] in 2004.

2.5 Drivers for Waste Minimisation in the South East Region

2.5.1 The Regional Economic Strategy for the South East 2006-2016

The Framework within which every Regional Development Agency (RDA) works is the Regional Economic Strategy (RES). This Strategy is produced every three to four years in consultation with a wide range of stakeholders and defines the region's priorities and targets for the work of all the partners in its delivery – public, private and voluntary. It acts as the central point between national Public Service Agreements (PSA) targets and local objectives.

The South East England Development Agency (SEEDA) undertook a comprehensive consultation with stakeholders in business, local government and the voluntary sector to produce the third RES for South East England, 2006 – 2016.

SEEDA's vision for tackling the challenging issue of waste is to work with key partners to promote waste as a valuable resource. SEEDA has the lead role on waste for all the Regional Development Agencies in the UK.

SEEDA is focused on encouraging organisations to recognise opportunities for waste minimisation and to champion re-use and greater recycling.

The aims of the Waste Market Development Group in SEEDA are to:

- build capacity in the materials efficiency/re-use supply chains;
- stimulate demand for recycled materials and products;
- co-ordination of materials efficiency activities in the South East;
- promotion of business opportunities to help implement the regional Waste Management Strategy; and
- influence Government policy to enable effective implementation of waste directives and regulations.

[23] DTI (2004) Site Waste Management Plans: Guidance for Construction Contractors and Clients (Voluntary Code of Practice)

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In terms of the Waste Market Development Group, SEEDA works collaboratively with partners including the Environment Agency, the Regional Assembly, local authorities and commercial organisations such as Biffa Waste Services.

A critical project in this arena will be BREW – the Business Resource Efficiency and Waste programme. This is a Government initiative to help businesses become more resource efficient in materials, energy and water and to minimise waste despatched to landfill. SEEDA will take responsibility for co-ordination of strategic players such as the Carbon Trust, Envirowise and the regional Sustainable Business Partnerships.

However, the real incentive for moving away from waste into integrated resource management is the enormous potential for economic development real business opportunities and job creation.

2.5.2 Regional Planning Guidance – Waste and Minerals[24]

The South East Region is one of the most pressed regions for waste management capacity[25] as such diversion from landfill is a priority for this region.

The South East England Regional Assembly (SEERA) finalised Regional Planning Guidance for the South East (RPG9) – Waste and Minerals in 2006, with new policies addressing waste reduction, sustainable design and construction, and targets for recovery, recycling, diversion from landfill and the amount of waste to be managed. The Strategy identifies C&DW as a significant contributor to landfill and states that more efficient on-site re-use of this waste is required to reduce disposal[26].

2.5.3 Draft Regional Housing Strategy[27]

The Government Office of the South East (GOSE) is currently consulting on a draft Regional Housing Strategy, which states that "the long-term sustainability of buildings is critical". It goes on to say that extensive new development in the region "provides an opportunity to create a significant shift towards more sustainable homes and an increased use of more sustainable construction techniques".

It takes up the theme of C&DW, stating that approximately "70% of landfill arises from construction activity", and that the region "should aim to minimise waste in our developments through better design and planning, localised/on-site recycling and re-use of core material streams such as wood, metal, glass, aggregate and plastics".

[24] SEERA.(2006) Regional Planning Guidance (http://www.southeast-ra.gov.uk/publications/strategies/waste.html)

[25] SEERA Waste Management Capacity in the South East Region (http://www.southeast-ra.gov.uk/publications/strategies/waste/apr_2004/waste_man_cap_se.pdf)

[26] SEERA (2004) Proposed Alterations to Regional Planning Guidance, South East – Regional Waste Management Strategy. http://www.southeast-ra.gov.uk/publications/strategies/waste/feb_2004/waste_strategy.pdf

[27] SERHB (2006) Towards the South East Regional Housing Strategy (http://www.gose.gov.uk/497648/docs/163661/179152/DraftRegHousing2006-09.pdf)

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2.6 Case Studies - Better Practice Guidance and Waste Auditing

2.6.1 Business Resource Efficiency and Waste Programme

Defra's Business Resource Efficiency and Waste (BREW) Programme uses money derived from increases in Landfill Tax to encourage, support and help businesses improve their resource efficiency. The BREW Programme has been developed in consultation with business representatives, the Treasury, and DTI to meet this need.

2.6.2 National Industrial Symbiosis Programme

The National Industrial Symbiosis Programme (NISP)[28] is an innovative business opportunity programme that delivers bottom line benefits for business whilst generating positive outcomes for the environment and society. It helps companies take a fresh look at their resources, using industrial symbiosis to identify sustainable resource management solutions for business.

NISP is a national programme delivered at the regional level across the UK, including the South East since 2005. It is part funded by Defra through the BREW Programme, see Section 2.6.1. Some of the regional programmes also receive additional funding from their respective regional development agencies and other organisations.

2.6.3 Envirowise

Envirowise offers UK businesses free, independent, confidential advice and support on practical ways to increase profits, minimise waste and reduce environmental impact.

2.6.4 Waste & Resource Action Programme

The Waste & Resource Action Programme (WRAP) is a private business that "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. It helps to minimise landfill, reduce carbon emissions and improve our environment."[29]

WRAP aims to help the construction industry to cut costs and increase efficiency through better use of materials, with a focus on:

- Information and guidance on construction resource efficiency and specification requirements;
- Sustainable design practices that reduce waste and provide cost effective buildings;
- Help in specifying products and materials with recycled content for many applications;

[28] NISP website (http://www.nisp.org.uk)

[29] WRAP (http://www.wrap.org.uk/wrap_corporate/about_wrap/index.html)

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- Information about sustainable materials, products and components with a high recycled content;
- Tools and guidance for waste management and recycling on site;
- Opportunities for optimising resource efficiency in asset management; and
- Minimising waste arisings and implementing resource efficiency in demolition.

Materials resource efficiency on-site means using recycled materials or products with recycled content, reducing the amount of waste generated and ensuring that any discarded material can be recovered in the highest value application.

The AggRegain website (www.aggregain.org.uk) is an information service provided by WRAP on sustainable aggregates. A series of diagrams outlining construction and demolition best practice for waste management are available from this reference.

2.6.5 Building Research Establishment

The Building Research Establishment (BRE) is a private business that aims to provide support to the construction industry by providing independent advice on better practices in housing development. They provide guidance and specific training on a range of housing waste management, including:

- Modern methods of construction;
- Sustainable housing;
- Retrofitting existing housing;
- Construction site packaging wastes;
- Deconstruction and reuse of construction materials;
- Reclamation and recycling of building materials; and
- Waste minimisation on site.

With respect to waste management, BRE provides **SMARTWaste ™** (Site Methodology to Audit, Reduce and Target Waste) – a system that "provides a web-based, integrated, practical approach to evaluating waste and its generation"[30].

It consists of the following key components for waste data collection and management:

SMARTStart™ – a waste auditing tool that begins the process of evaluating waste management across all of a company's sites aiding in the application of the sustainable waste management concept. This enables the user to define their environmental

[30] SMARTWaste website (http://www.bre.co.uk/service.jsp?id=314)

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performance indicators (EPIs) for waste generation on a site by site, and organisation basis. The data are reported as:

- EPI - Environmental Performance Indicator -– m3 waste per 100m2 floor area
- KPI - Key Performance Indicator – m3 waste per £100,000 project value

SMARTStart+ - SMARTStart+ is for companies that want to:

- compare performance across sites, projects and contracts;
- set performance targets for recycling and segregation; and
- monitor companies and contractors on a site-by-site and company-wide basis.

This tool is designed for construction, facilities or waste management contractors as part of day-to-day activities.

SMARTAudit™ – a more detailed mechanism than SMARTStart, SMARTAudit provides a method by which wastes arising during a project's life cycle can be benchmarked and categorised by source, type, amount, cause and cost. These data are a springboard to identifying and prioritising actions to reduce waste arising, reuse at source, and maximise recovery to extend materials' life cycles. SMARTAudit provides a more robust and higher resolution auditing tool which is designed to complement SMARTStart. SMARTAudit is a waste auditing methodology that is available in two formats. The methodology can be bought as a consultancy package, or as a training package, depending on the requirements and capacities of the organisation.

BREMAP : FREE web based geographical information system (GIS). This can be used by anyone with internet access and a post code to:

- Reduce transport of bulky waste by locating the nearest most suitable waste management site;
- Find your nearest recycling sites, reclamation companies, composting facilities, manufacturer take-back schemes, transfer stations, landfill sites, and incinerators; and
- Find local reclaimed and recycled products.

The development of this system was funded by Biffaward through landfill tax credits and a donation from The Institution of Civil Engineers (ICE).

2.6.6 Other Drivers for Better Practice

Other organisations that provide assistance for waste management include:

The Institute of Civil Engineers

The Institute of Civil Engineers is a charity that exists to promote and progress civil engineering. It provides a range of information to assist in waste management, including C&DW.

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The Construction Research and Information Association

CIRIA is a company owned by other companies, universities, government departments and other public sector agencies, organisations and regulators, including representatives from all parts of the supply chains of the modern built environment, covering building and civil engineering as well as transport and utilities infrastructure[31]. They provide a range of support materials that assist to identify waste streams and redeploy wastes generated throughout a construction process back into the resource stream.

A range of CIRIA publications exist, that while not Statutory act as drivers on the market and the definition of best practice. The following is an abbreviated list of some of the key guides:

- **Waste minimisation in construction - site guide** (SP133) 1997 - Practical tips on how to reduce, reuse and recycle construction and demolition wastes, the guide tells you why you should manage wastes properly and the best ways to go about it. It then gives the user some top tips for dealing with a whole range of wastes from concrete and topsoil to timber and packaging.

- **Waste minimisation and recycling in construction - design manual** (SP134) 1998 - This handbook focuses on the opportunities available to designers. It aims to help you think about waste minimisation issues by introducing measures and ideas so that you can review the efficiency of your designs. The contents concentrate on three key aspects: how you can minimise waste by reducing the resources needed for construction; reducing the quantity of waste generated from construction and demolition sites; and improving the reclamation of materials from the waste stream.

- **Demonstrating waste minimisation benefits in construction** (C536) 2001 CIRIA studied waste minimisation initiatives being undertaken on 10 live projects that were under way during 1999–2000, recommending further initiatives where practicable. Waste audits were undertaken on a number of sites, and the relevant data were collected, enabling the benefits of waste minimisation to be quantified. This report emphasises that waste minimisation can save money as well as having environmental benefits.

- **The reclaimed and recycled construction materials handbook (C513) 1999 Description:** It summarises the opportunities for using these materials in different areas of construction and give comprehensive details on properties and performance, sources and availability, current applications, specifications, advantages and constraints, and potential future uses.

- **Tools for measuring and forecasting waste generated on site**. Scoping study (PR083) 2001 to find out how to determine the feasibility of developing a tool or mechanism to measure and forecast the production of waste on construction sites. This study, identified as a priority by CIRIA Core members, was based on consultation with industry members, a workshop and a review of published data from across Europe. This study concludes that there is a need for a waste

[31] CIRIA Construction Waste and Resources website (http://www.ciria.org/cwr/index.html)

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minimisation tool to help construction practitioners to identify priority waste minimisation plans. It recommended that the tool should include an electronic element for forecasting waste, a database for industry waste benchmarks, guidelines for developing a waste management plan, and an electronic method for monitoring waste generation.

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CIRIA has also reported the data below in CIRIA 536, 2001 Demonstrating Waste Minimisation Benefits in Construction.

Table 1.1 ***Demonstration projects – benefits and savings of waste minimisation initiatives***

Project	Type	Construction	Waste Disposal as % of Construction Cost	Key Benefits/ Initiatives/ findings	Savings due to Benefits/ Initiatives
Laing – Langley Park Housing	Housing	£15 m	0.21	➢ Waste disposal costs reduced by 60% by waste segregation and strict sub-contracts ➢ Reuse of roof tiles and demolition arisings	£45 000 £480 000
TRY Stanhope Gate	Office Construction	£7.2 m	0.44	➢ Wastage of bricks – at low level of 4%, due to strict ordering and management systems	£2 000
Scottish Executive – Echline	Road Construction	N/A	N/A	➢ Highway pavement constructed withsome 90% of recycled aggregate	N/A
Environment Agency – Ipswich HQ	Office	£1.6 m	N/A	➢ Environmental Refurbishment credentials used in choice of architect and contractor. Both combined in design process to minimise waste	N/A
AMEC – Budds Farm	Waste Water Treatment Works Modernisation	£75 m	0.13	➢ Cost saving achieved by recycling clinker filter material and crushed concrete ➢ Waste segregated	£250 000 £2 000
Wren & Bell – Comely Green Place	Housing	£4.5m	0.40	➢ Use of standard dimensions, prefabricated units and strict use of offcuts reduced waste to below 50% of "normal"	£320 000
Mace – Wessex Water Operations Centre	Office Construction	£22.5 m	0.25	➢ Strict segregation of waste saved 20% in disposal costs ➢ Savings made by reuse of excavated material	£15 000 £25,000
AMEC – Novartis	Pharmaceutical Facility	£27 m	0.74	➢ Data from audits of waste segregation by operation allowed design process on future projects to be improved	N/A
Carillion –Area 8	Highway Maintenance	N/A	N/A	➢ Study highlighted the effects of legal restrictions on the storage of recyclable road maintenance waste on its future use	N/A
Schal – BP Amoco Facility	Offices and Laboratories	£58 m	0.21	➢ Use of materials predicted at the end of project with reduced packaging saved 40% of packaging waste. ➢ 46% of site waste recycled ➢ Mass of waste some 8% below "normal" site	– £6 000 £130 000

The Laing and Wren & Bell studies generated important financial benefit for those projects but many others under the conditions at the time produced only marginal return if any.

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The Chartered Institute of Wastes Management

This is the key professional body for waste management professionals and information within the UK. It has in excess of 5000 members and has excellent links with national and international bodies involved in the management of wastes around the world. It is also active as an educational and lobbying organisation.

2.7 Key Drivers Summary

From the above review the key drivers for the RTDS concept include:

- The Landfill (England and Wales) Regulations 2002 – SI 1559, particularly the requirement for the treatment of non-hazardous waste by October 2007;
- SEEDA - particularly the waste initiatives in the RES and via BREW;
- The Duty of Care requirement to ensure that the waste being transferred is accompanied by a written description that will enable the recipient to dispose of it or handle it in accordance with his or her own Duty of Care.
- The Landfill Tax Escalator now up to £24 per tonne
- Site Waste Management Plans (SWMPs) - These are key to encouraging and enforcing better waste management, of the type that a RTDS could facilitate.
- Other drivers include environmental awareness (saving the planet and the resources that we use, i.e. altruism), PR opportunities, and the intention to achieve cost savings.

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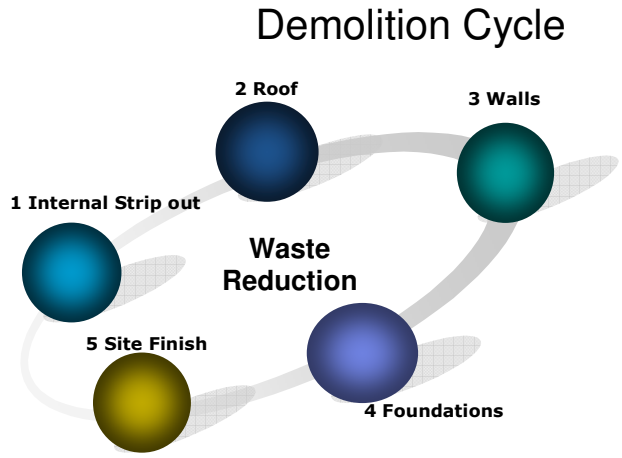
3 REVIEW OF REAL-TIME DATA SYSTEM PILOT

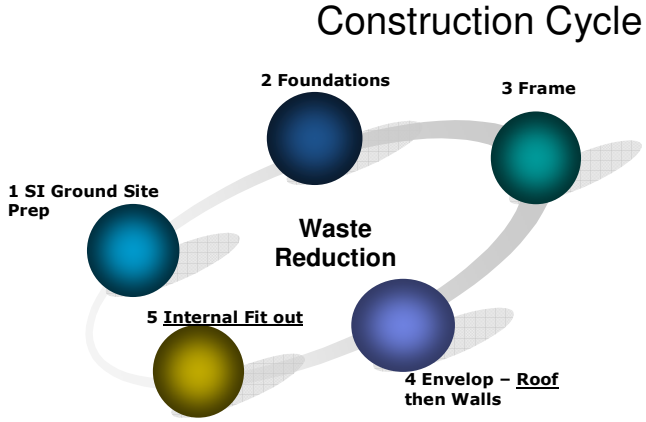
3.1 Construction and Demolition Process Waste Overview

The complexity of both the construction and demolition process is dependent upon the particular project. Factors, including site characteristics, geographical location and building type will determine the mechanics of the process and the composition of the likely C&D waste streams.

Despite the variety and complexity of individual projects, this report has considered generic construction and demolition cycles. Although it is acknowledged that both the construction and demolition processes are often integrated, with demolition taking place before construction, for the purpose of clarity, we have considered both the construction and demolition process as distinct processes.

The figures below illustrate a **generic demolition cycle**, consisting of internal strip out, roof, walls, foundations and then site finish, and a **generic construction cycle** consisting of site investigation/ground work and site preparation, foundations, frame, envelopes (walls and roof), and internal fit out.





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Construction and Demolition waste management requires a great deal of coordination and expertise amongst key stakeholders. Whilst the above processes (cycles) may appear simple, it is important to remember that in order to effect waste minimisation within this context, a large number of stakeholders need to be involved and to "own" or at least contribute to the effectiveness of the system.

The contractor needs to have the experience and expertise to be able to act as the "hub of the wheel" to achieve waste reduction through the supply chain and in ensuring effective construction site waste management systems are in place. The collection of accurate data, the monitoring of system performance and the communication of such results is of critical importance in managing a complex and interdependent system.

To effect change and savings, it is important to understand where the savings can be most efficiently achieved. It has been shown that approximately 70%[32] of the opportunity for waste minimisation is within the design phase. The remaining 30% is found within the operational phase – the construction site. Of this 30% there are two key phases of the construction process that offer the greatest opportunity for waste minimisation and reduction which are the construction of the roof and the internal "fit out".

Therefore in attempting to develop an effective real time data system it is important to understand in holistic terms all the elements from the design phase through to construction and fit-out and the critical support systems such as supply chain management, on-site operational and technical constraints and site waste management.

This report will consider such factors in reviewing the SECBE RTDS pilot and in our recommendations for RTDS process improvements.

3.2 Assessment of SECBE Real-Time Data System Performance

3.2.1 The original concept

The flow chart, see **Figure 3.1,** shows the original concept of the RTDS as understood by our team preparing this report. The key stages of the SECBE RTDS process are listed below (numbers added by this project team):

1. Skip of waste arrives from the construction site to a sorting facility;
2. Waste is segregated and analysed, initially by sorting into specific waste stockpiles which are then weighed. Another option is waste is sorted into specific stockpiles and volumes are estimated visually (qualitatively)
3. Data on waste streams generated is fed back to the construction site (7) for consideration and change of site practices;
4. Data on waste streams generated is fed back to the supply team responsible for purchasing materials;

[32] Innes S, 2004 Developing Tools for Designing out Waste, Pre-site and On-site. Proceedings of the Minimising Construction Waste Conference: Developing Resource Efficiency and Waste Minimisation in Redesign and Construction from *New Civil Engineer 2004*

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5. The Supply team can review waste data and alter ordering/procurement strategies, avoiding just-in-case orders and procurement processes;
6. The supply team can liaise with the construction team and design team to improve site practices, reducing wastage and, preferentially, design out waste at the design stage;
7. Better site practices can be adopted on-site i.e. segregated waste collection
8. Waste can also be segregated on-site,
9. Waste is re-used/recycled and waste data is sent back to the supply team.
10. Information fed back through industry bodies to facilitate development of best practice guidelines;
11. Non-recyclable material is disposed of to landfill;
12. Specified materials are recovered from the waste stream.

Throughout the process information flows and associated costs savings is critical. The income generation arrows are shown to illustrate both the information flows and income generation at the various stages of the process.

Information flows will achieve income generation by:

- reducing the volume of materials purchased in any construction project;
- where wastage exists, reducing waste disposal costs;
- by efficient segregation and re-use of materials on, or off-site.

The RTDS approach is clearly a valuable concept to facilitate the transfer of information in “real time” to both the construction site and the design and supply teams, enabling more effective site wide waste management practices and more efficient design principles to reduce wastage at the design phase.

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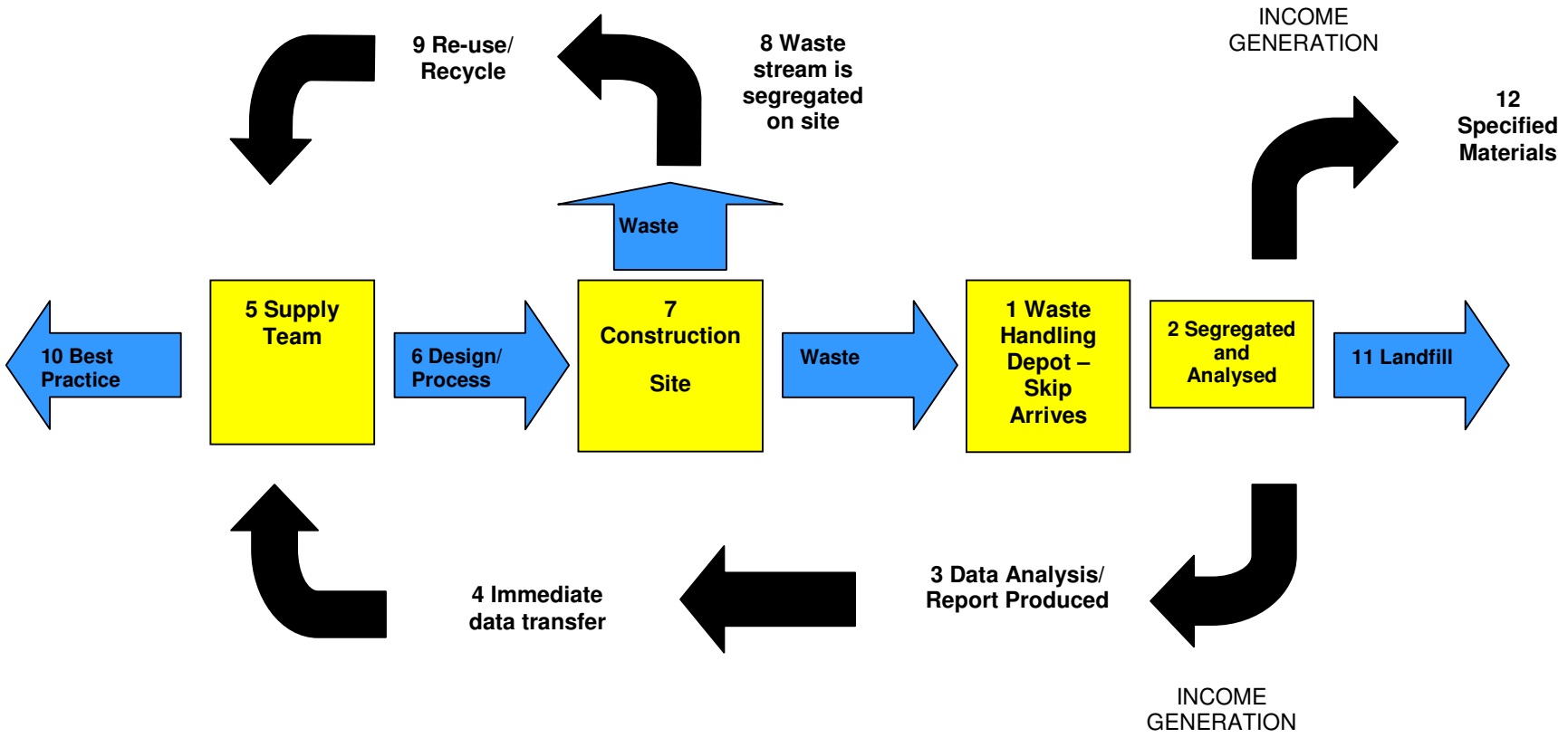
Figure 3.1 - Real-time Data System*– Waste Handling Process – Original Concept – See Text at Section 3.2.1



* as provided by SECBE

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3.2.2 Approach

As part of the RTDS pilot test review we spoke with key project partners to understand the technical and operational associated with such a concept. Waste data as provided by Kier Partnership Homes (KPH) and Thanet Waste was reviewed and those personnel working for pilot team partners, directly involved with the pilot scheme, were interviewed. Feedback from the pilot test is provided in **Section 3.3.**

The key features/finding of the RTDS pilot trial is as follows:

- The data were collected for five skips over three weeks during the fit out phase of a construction project;
- The waste was estimated by volume, and by weight with comments made on the category contents for the categories as listed below (note: percentages are of mass as shown); and
- Data/estimates were recorded to a range of significant figures, which further challenges the understanding of the volume and weight values.

The key observations were:

- Initial approaches included segregation of the waste. Each waste type was weighed. This approach was found to be too time consuming, as were segregation and volume estimates. Therefore work was deferred to a Saturday morning, and it is these data that are summarised in **Tables 3.1 and 3.2.**
- This approach was time consuming and inefficient, and whilst the RTDS was recognised to be of value for future design, it did not help to achieve immediate site waste reduction opportunities;
- The initial take up was low.
- Successful liaison between SECBE, Kier Partnership Homes (KPH) and Thanet Waste was achieved;
- Data from their modified approach has been provided to help the study team. This data is provided in Appendix 1 of this report and are summarised below.

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Table 3.1 - Kier Partnership Homes and Thanet Waste Data Jan./Feb. 2007

Key Waste Stream	22 Jan 07		6 Feb 07 – Skip 1		6 Feb 07 – Skip 2		12 Feb 07 – Skip 1		12 Feb 07 Skip 2	
	Vol %	Mass kg	Vol %.	Mass kg	Vol %	Mass kg	Vol %	Mass kg	Vol %	Mass kg
Timber	10.60	500	16.3	500	27.7	760	18.8	200	8.4	100
Plas/ Pack	2.56	120	9.8	300	5.4	80	8.5	90	1.7	20
Plas Tube/ Pipes	1.7	80	3.3	100	1.8	60	0	0	0.8	10
Metal	4.27[33]	200	0	0	0	0	26.4	280	10	120
Inert	50	2340	10.5	320	50.3	1680	5.7	60	43.3	520
Plaster board	9.82	460	43.2	13.20	0	0	0	0	10	120
Ceramics	0	0	0	0	0	0	0	0	0	0
Turf / Vegetation	7.26	340	6.5	200	11.9	400	0	0	0	0
Insulation	0	0	0.06	20	2.4	80	0	0	15	180
Residue	1.7	80	3.9	120	1.8	60	9.4	100	6.6	80
Haz Mat	0.21	10	0.6	20	0	0	5.7	60	1.7	20
General Waste	11.75	530	5.2	160	3.6	120	25.5	270	2.5	30
Other	0	0	0	0	0	0	0	0	0	0
Totals Vol	99.87		99.36		104.9		100		100	
Totals Kg		4660		1753.2		3240		1060		1200

[33] Recorded in the original data recorded as 4027

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Table 3.2 - Averages across the five Skips by Volume and Mass

Key Waste Stream	Volume Average (%)	Mass Average (kg)	Mass Percentages
Timber	16.4	412.0	17.3%
Plas/ Pack	5.6	122.0	5.1%
Plas Tube/ Pipes	1.5	50.0	2.1%
Metal	8.1	120.0	5.0%
Inert	32.0	984.0	41.3%
Plaster board	12.6	118.6	5.0%
Ceramics	0.0	0.0	0.0%
Turf / Vegetation	5.1	188.0	7.9%
Insulation	3.5	56.0	2.4%
Residue	4.7	88.0	3.7%
Hazardous Mat.	1.6	22.0	0.9%
General Waste	9.7	222.0	9.3%
Other	0.0	0.0	0.0%
Totals Vol.	100.8		
Totals Kg		2382.6	100.0%

Our observations on the waste segregation data are as follows:

- The method used to estimate volumes on 22 January and 12 February appears to be that volume as a percentage of the total mass. However the data for 6 February is not reported in this way so these are best considered as qualitative assessments.
- Varied use of significant figures in the volume entries, from one to four, when to the nearest 5% or maybe 2% is considered appropriate. Note: It is believed these are the percentages of the mass fraction as measured.
- The percentage totals are near but not all are 100% due to rounding of figures and the waste categories used in describing the waste.
- The mass amounts in the skips are very varied, from 1,060kg to 4,660kg, a factor of 4.5 times, reinforcing how difficult it is to estimate mass from volume reliably, particularly when two skips with about 50% volume of inert waste have masses that range from 1,200 to 4,660kg;

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In these waste samples the key items to focus on appear to be:

- Timber – typically above 10%
- Metal – assumed because of its inherent value
- Inert, in 3 samples nearly 50% but masses vary considerably
- Hazardous Materials – to remove them from the remaining stream

However due to the limited data points and accuracy, further study and review, as discussed below is required.

3.3 Feedback on the RTDS pilot scheme from the project partners

3.3.1 Kier Partnership Homes

The main comments / points of observation on the RTDS pilot trial were as follows:

- The data analysis process, and the quality of information collected are critical to what SECBE is trying to achieve. Unless there is confidence in the information that is being fed back from the waste characterisation process to the construction site and design teams, the objectives of the RTDS will not be achieved;
- KPH agreed that once waste reaches the yard, the objectives of the RTDS – to design out waste - have not been met.
- In terms of waste streams from a site there are 3 major components:
  - rubbish – can do very little about general site rubbish;
  - recyclables– that should be recycled, but have not been; and
  - other materials – difficult to recycle and should be either designed out of the process or their arising avoided through effective contract management and procurement procedures;
- There is a perception that it would cost companies more to have a site waste manager in place, supporting a RTDS type project, than it would be dump the waste to landfill, which may reflect a perception of the cost-benefits of effective waste management practices;
- In terms of the procurement process, KPH have in the past used a system of thresholds. It can be assumed that there will be a percentage of raw material wastage. The subcontractor will then be charged for any wastage above that percentage threshold and this is thought to be effective in reducing wastage on-site, by transpiring costs to the subcontractor;
- There needs to be a gradual change to work practices in terms of improved waste management practices, rather than a “step-change”;

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- It is important to understand how suppliers operate. They get paid for raw materials purchased, waste or no wastage. It is in their interest to sell as many blocks, 4x4s, etc. to a builder as possible. It is important to understand other issues and drivers i.e. why are pallets now disposed of to landfill, rather than being returned and re-used as was the intent; and,

- It is important to distinguish between construction and demolition. In general with demolition there is no waste – waste disposal companies work closely with demolition and recycling and recovery companies to ensure nothing gets wasted, therefore waste is primarily generated during the construction phase.

3.3.2 Thanet Waste

The key points from Thanet Waste are as follows:

- The process of categorising the aggregated waste streams was starting to get repetitive – the same types of material appearing in collected skips, supporting an argument regarding focusing on variances, as discussed in **Section 4.1.3.** Thanet Waste agreed that it might be a good idea to propose a standard skip and the waste materials that you would be likely to find in such a skip i.e. 20% timber, 35% plastics, etc., against which variances can be measured. They fully supported the idea presented in this review that the variance concept would be a good idea;

- Thanet Waste found the process to be very time consuming. Characterisation was generally completed that day, or first thing the following morning. All skips were completed within a 24-48 hour timeframe;

- Standard skips were charged per collection as is normal in the sector, with larger ro-ro skips are charged on a weight basis, again as is normal;

- At first, skips were emptied out and segregated into appropriate waste streams for example timber, bricks, soils, etc. and then weighed. This was time consuming and difficult operationally to do in a working yard. After that it was decided a visual inspection was sufficient rather than weighing each skip. Visual inspection of the skips involved the skips being emptied out and segregated into appropriate waste streams with estimates of the percentages of each waste stream being recorded. This process is again difficult and time consuming and produces less value than weights in practice;

- Thanet Waste personnel received no formal training on how best to characterise waste streams, and feel that education on proper waste management procedures is essential.

- Thanet Waste agree with the concept of having segregated skips for each different waste stream, but is a little sceptical of how well such a system would work, as contractors will dump material in the first skip they see. Skips would then have to be sorted, thus defeating the purpose of segregated skips;

- Thanet Waste feels that there needs to be a site manager keeping an eye on things at the site ensuring the effective waste management practices. The site waste manager needs to be on site walking around, inspecting skips and work practices

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ensuring that there is no wastage of raw materials or cross contamination of waste in skips;

- In terms of wastage, Thanet Waste stated that perfect doors had been dumped in skips and cross contamination became a particular problem when people dumped paint into a skip. Paint is considered as being hazardous waste and thus contaminates other non-hazardous materials in the skip, such as timbers, which then in turn must be disposed of a hazardous waste.

- It was pointed out that the waste manager's role is in many respects as important as the site manager. He/she needs to feed back information on the types of waste that are generated on-site back to the site manager so he is aware of what the problems are and the waste types such as "doors" and cross contamination issues that need to be considered;

- Thanet Waste also thought that it was important to identify, perhaps contractually, who owns the raw materials such as pipes, fittings, doors, etc. and therefore the property of contractors to dispose of to a skip. This would link to and help define "when a raw material becomes waste". Many contractors can be wasteful of raw materials because they have not paid for them particularly where contractors such as plumbers and carpenters have been provided with materials by Kier Homes. If the contractors had paid for the materials themselves they would be much more conscious of wastage as such costs would be coming from their margins; and

- The need for good quality information. This leads back to the waste categories used not being prescriptive enough, as discussed with Kier. When a person reports "timbers", all timbers have been lumped together as is the case with plastics. More detailed categorisation of wastes such as the number of 4x4's or 2x2s and lengths of 2" diameter plastic pipes cannot be provided because of time and resource constraints. Information provided is therefore not descriptive enough and therefore is not of any real value. If more detailed information on particular waste streams could be provided so waste could be traced back to particular stages of work, which could then be studied in more detail to design out waste the key objective.

3.4 Critical Review and Issues Identified (Lessons Learned)

Our review of why the RTDS did not meet its original performance objectives relate to the following range of issues:

1. Absence of regulatory drivers,
2. Technical issues (i.e. methods for data collection),
3. Operational issues (i.e. time and logistics), and;
4. Behavioural/cultural issues within the general waste sector.

This report addresses Points 1 (Section 2.0), Points 2 and 3. Point 4 is addressed in a separate report – Cultural and Mechanical Barriers to Data Collection.

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The key Issues identified are listed as follows:

- The goals of reduced waste being generated from site by “real-time” data are correct, but as discussed in Section 3.1 only 30% of savings can come from such a system, with 70% achievable in the design phase. Therefore it is important to understand where big wins can be generated, identify where value is generated and where value is lost in terms of reducing C&D waste generation;

- Such a system encounters practical, day to day, site challenges. Managing by variance and using a management systems approach (only trying to manage what is under your control and is also significant). There needs to be a screening of the issues and a focus on the better, more significant wins in terms of waste management. Such an approach is more strategic in nature and relevant to the project phase;

- The process flow, see **Figure 3.1** does not make a clear distinction between material, cost (income generation) and information flows. It is important to keep the process simple and clear and also to get the” right” information to the “right place” at “the right time”.

- The key technical issue is the lack of reliability between volume estimates and mass values and the relationship of either to financial value. There needs to be a better system of relating volume to mass and/or either to value in monetary terms.

- The data capture system, by weight or by volume needs to be easy to use. There must also be a standardised approach to data capture, which is transferable between construction sites and waste handling stations. Results for this project and generally across the waste sector demonstrate unacceptable variability in terms of the quality and accuracy of data collected across sites and waste handling stations;

- There are currently limited clear drivers to adopt the system. Site Waste Management Plans (SWMPs) and the other key drivers, see **Section 2.4.10 and Section 2.7**, will be necessary for widespread acceptance and adoption of such a system;

- The approach needs to be more of an expert user/systems approach, relying on the knowledge and sense of their construction/waste sector experience. Such an approach relies on the invaluable experience of the types of waste streams generated on-sites and can also reinforce their sense of contribution to the overall project aims;

- The double handing of the waste is not efficient, it needs a one-touch approach so that when segregated, weighed or estimated by volume, this data should be entered in a handheld computer, or onto a paper sheet with a threshold system, not a system where data are captured, then later entered on line, then later analysed, with an extended period of time before valuable feedback is received by the intended user;

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4 SUGGESTED RTDS MODIFICATIONS

4.1 Technical and Operational Constraints to Data Collection

The technical and operational constraints in collecting and disseminating information amongst key stakeholders can be significant. Such challenges must be overcome if the RTDS is to achieve its stated goals and objectives, primarily the elimination of waste from the constructions and demolition process.

The quality and accuracy of information is critical. If key stakeholders do not have confidence in the information they are receiving it is unlikely that construction managers, design engineers and supply team managers will make the necessary systemic, structural changes, required to effectively reduce the volumes of construction and demolition waste.

The real time data system concept is built upon the assumption that accurate information of waste streams will be made available to all key stakeholders in a timely and efficient manner.

To achieve this, a number of technical and operational constraints must be overcome. Section 4.1.1 and Section 4.1.2 discusses these challenges and provides appropriate recommendations and system modifications to overcome some of these constraints.

4.1.1 Technical Constraints

In terms of collecting data on waste streams it is important that there is a standardised method for recording waste data. It is important that the waste categories used in waste check sheets are standardised and sufficiently prescriptive to ensure all waste types are recorded. Although a more detailed categorisation approach will be more time consuming, the information collected is likely to be more accurate. Reporting metrics i.e. as volumes (m3) or mass (tonnes) must be agreed amongst all key stakeholder to ensure information provided is in a usable format.

More detailed information, on particular waste streams, would also be useful in tracing waste streams back to particular stages of development and identifying particularly wasteful activities. As discussed in Section 3.1 waste peaks are identified at the roof construction stage and during the internal fit-out, and it is at such stages in the construction process where “big wins” can be achieved and correspondingly where effort should be focused.

Other important factors that should be considered in attempting to overcome technical barriers to data collection are:

- The aims and objectives of collecting the data should be clear and agreed. It is essential that those collecting the data understand what the information will be used for. This is important in understanding how prescriptive the categorisation of skips needs to be;

- The training of the person to collect the data should be both comprehensive and consistent. The development of an industry standard qualification should be considered. This could have a number of benefits, both on the personal level, at corporate level and across the industry. One of the main benefits would be the consistency of the reliability of the data collected;

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- Agreed data reporting methods and communication channels;
- Training should also include information on why this job is important, how it helps the wider issues, how it saves money, improves efficiency, ultimately leading to higher profits and higher pay;
- Where possible there should be segregated skips on site for specific waste streams i.e. timber, general waste and inert waste. Of course such an approach is dependent on operational (site) constraints as discussed in Section 4.1.2 below.

4.1.2 Operational Constraints

It is important that operational constraints associated with waste data collection are considered and appropriate measures are taken to address these constraints.

Inspecting skips can place a significant operational burden on staff and it is important that such burdens are minimised where possible. Therefore managing by variance (**Section 4.1.3**) is a cost effective and time efficient method of collecting data on waste streams generated on-site.

Another time efficient approach, which would also improve the quality of waste data collected is the segregation of waste on-site into inert, hazardous and timber waste streams. Such an approach is discussed in **Section 4.1.4.**

Other operation constraints include issues around the double handing of the waste data which is not efficient. An RTDS should be a one-touch approach so that when segregated, weighed or estimated by volume, data is entered in a handheld computer which then can be directly transferred to a central database. Avoiding double handling of information will avoid mistakes associated with data transfer and incorrect data interpretation.

4.1.3 Managing by Variance

The crucial factor in ensuring the waste management industry adopts such a system will be whether it can demonstrably add value and is easy to use. An effective way to accomplish this is to work with the site operative's expertise and knowledge (Expert Systems) so that they feel what they are doing makes sense and ultimately works. Expert systems are discussed in more detail in a separate report, *"Research into Behavioural Barriers and Mechanics of Data Collection".*

The approach to this overall system should be to work by variances and allow, over time, for what is considered normal and what is considered a variance to change through time having regard to the immediate, intermediate and strategic time horizons and associated improvements in terms of reduced waste generation, disposal and revenue generation/cost savings achieved.

In terms of adding value and ease of use the Pareto Principle or 80:20 rule is particularly instructive. As most value is achieved with only 20% of effort then the most effective way to develop this approach would be to let the Expert decide which skips are variances and require further analysis and which skips are normal and can be processed as normal.

The logic for such an approach is to develop a cascading management approach, only managing the items that are not as anticipated, or are at variance from the expected. So

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the “normal” skips would go to the waste handling site without analysis and be processed to recover their value normally. Where variances are identified, the skip will be analysed and data on the waste found will be fed back to the site manager and design team to understand the cause of such variances.

Logical Approach from Variance

The logic therefore leads to a RTDS system that would allow the practitioners to identify when a skip looks to be at variance from what they would have expected, to then analyse it to learn why, and for the things that can be changed either on site or at the waste handling facility, to change those that are significant. This will improve financial performance via reduction of waste costs and time/human resource costs in sorting and analysing skips.

Information should be efficiently passed upstream to change procurement practices and procedures and benefit future design principles and systems for future projects. This would then change the “normal” and so by cascading this concept this will work to reduce waste to a minimum.

Again the normal skips would pass to the handling site and be processed normally to recover value. This lets about 80% of inherent value be recovered by 20% of the total effort, and let the remainder continue until upstream changes generated by information from this work improves the design, procurement and process further.

Managing by variance would have significant benefits in terms of efficiencies in data collection and reporting to other key stakeholders.

4.1.4 Segregation on Site Options

In addition to managing by variance this report also makes the suggestion to adopt segregation at source, which is likely to generate value and reduce costs in terms of time, the purchase of raw materials where materials are recycled and income generation where material is reclaimed

This approach is generally not adopted as a waste management technique for a range of reasons, principally on-site space constraints and issues associated with cross contamination.

Our recommendation is to change this segregated waste management technique, with skips for individual waste streams, to a more phase based, focused and practical approach. Whilst we would recommend the use of separate, segregated skips on a construction site to allow the immediate segregation of materials to recover value, we would modify this concept from having a standardised range of skips for particular waste streams appropriate across the “entire project” to one focused on specific phases of construction, tailored to providing a few skips, more appropriate to the phase of the work.

Therefore by providing say three skips sized to the anticipated phase requirements and not “one size fits all”, as well as providing a general waste skip for everything else, which will avoid confusion and cross contamination, a construction site could provide immediate analysis of its (segregated) materials and then the general waste skip could be sent without analysis or as above analysed in greater detail.

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Logical Approach on Segregation

Such an approach would result in the following:

- For the initial phase of construction work, for the site investigation and ground preparation and foundations phases – skips for materials that are waste generated at this time and a general skip;
- For the frame phase it would have a skip or skips for the materials appropriate to the frame construction, e.g. one for block, one for brick and a general skip; while
- For the envelope and internal fit out phase, it would have skips appropriate to the materials used at the phase, such as:
    - Timber
    - Inert
    - Mixed – including Plasterboard
    - Hazardous Waste; and
    - General Waste

For other phases the correct choice of separate and correctly sized bins for the anticipated materials would be used.

A successful example of this practice is demonstrated by a project study in New York, as reported in the Construction & Demolition Waste Manual; the NYC Department of Design & Construction, authors Gruzen Samton LLP with City Green Inc., published in May 2003.

It can be seen from **Figure 4.1** that segregation into skips as shown increases the amount recovered increases and is easily measured, and the residual amount to landfill decreased. In addition this shows the likely pathway to recover value from these materials. Part of the advantage comes from the early separation efficiencies.

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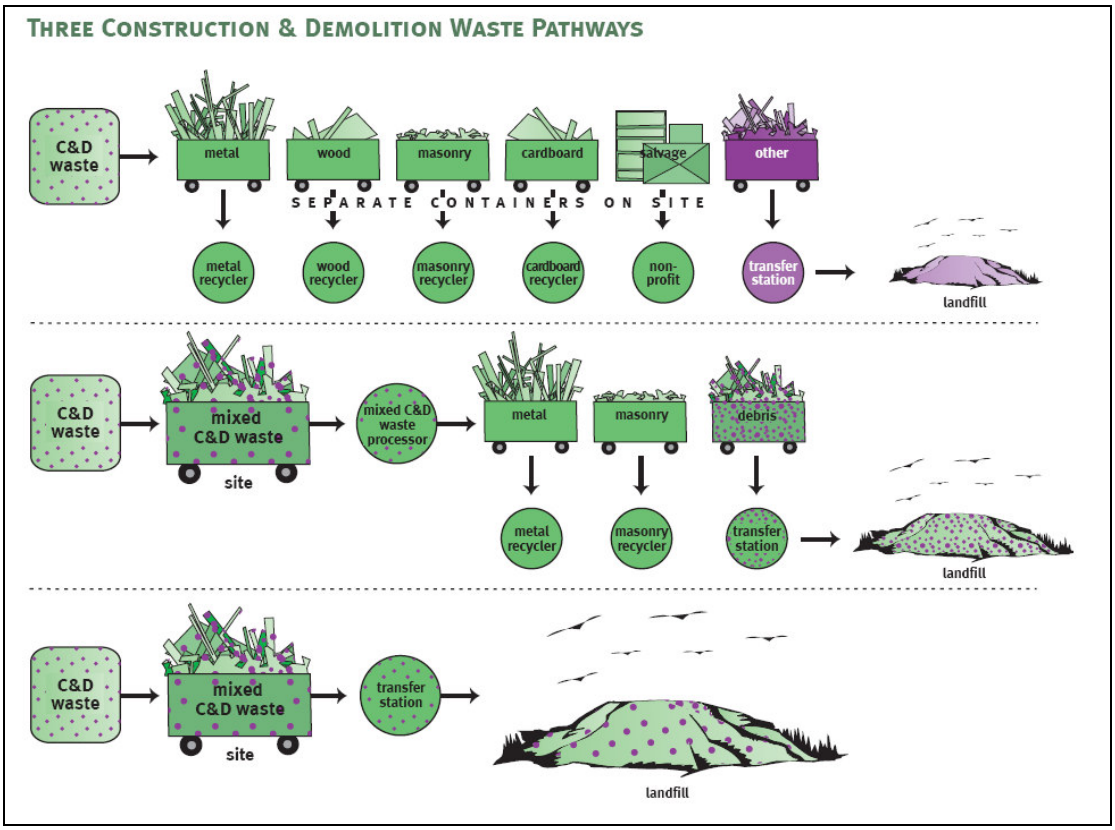
Figure 4.1 - Segregation of Materials on Site Reduces Waste and Adds Value



4.2 Original Goals and the Concept of "Real-Time"

The key objective of the RTDS was to collect data and relevant information that could be fed back into the immediate and next phase construction activities to help recover value via recycling and reuse of materials and thereby divert waste from landfill and subsequently to the design team to effectively design out waste in such projects.

The time horizons for data capture and feedback mechanisms must have consideration for each individual stage of a project, from design through demolition and construction.

The time horizons must also coordinate within the project management framework for the project in question. Therefore they need:

- to be integrated within specific work and task packages,
- to be appropriate to the stage of the construction process, and also with the timetables adhered to by the supply chain and other components of the system, and

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4.3 Redefined RTDS Goals

An essential step in making the RTDS concept "work" is to re-define what is meant by "real-time" and understand the relationship between time horizons (immediate, intermediate and strategic), Process Loops – waste generation, information flow and income generation, through each stage of the project - design, demolition, construction.

The re-defined goals adopt the clearly beneficial concept of "real time" which is aligned with the possible benefits in terms of information flow and resulting income generation through achieved cost savings across a range of time horizons - immediate, intermediate and strategic.

4.4 Real Time Loops – Approach

The three proposed time horizons are as follows:

1. **Immediate** - in the next 24/48 hours for the current phase of a project. Therefore this first loop is the return of information and value (income generation/cost savings) to the current construction project to help reduce waste generated on-site through improved site practices such as correct segregation of waste and prevention of cross contamination of skips (for subsequent material re-use or re-sale).

   This will focus on the more significant site process opportunities that are easy to win and will be practical in nature using a cascade or expert system approach based on variances (See Section 4.1.3). The immediate stage will be more focused on construction site **processes;**

2. **Intermediate** – the real time context here is for the next phase of the current project with a time horizon of weeks or possibly months, depending on the construction programme. This second, intermediate loop is for the return of information to the construction company's procurement office to allow procurement of the "right amount" of materials and limited consultation with suppliers and design teams to "design out" waste, This will facilitate a move away from a "Just In Case" purchasing strategy (See Section 2.4). The intermediate stage will be more focused on **procurement,** and,

3. **Strategic** – the real time context here is for the next project or to benefit the construction industry generally, through the dissemination of good construction waste management practice, with a time horizon of months or perhaps years. So information on how less waste was produced and materials were sold would create value on future projects for this company and via dissemination for the wider industry. The Strategic stage will be more focused on the **design** stage, how to effectively design out waste so that maximum cost savings are generated in terms of reduced disposal costs and raw materials purchasing costs. It is within the Strategic time horizon that advances, in terms of reducing significantly the volumes of waste disposed of to landfill can be achieved.

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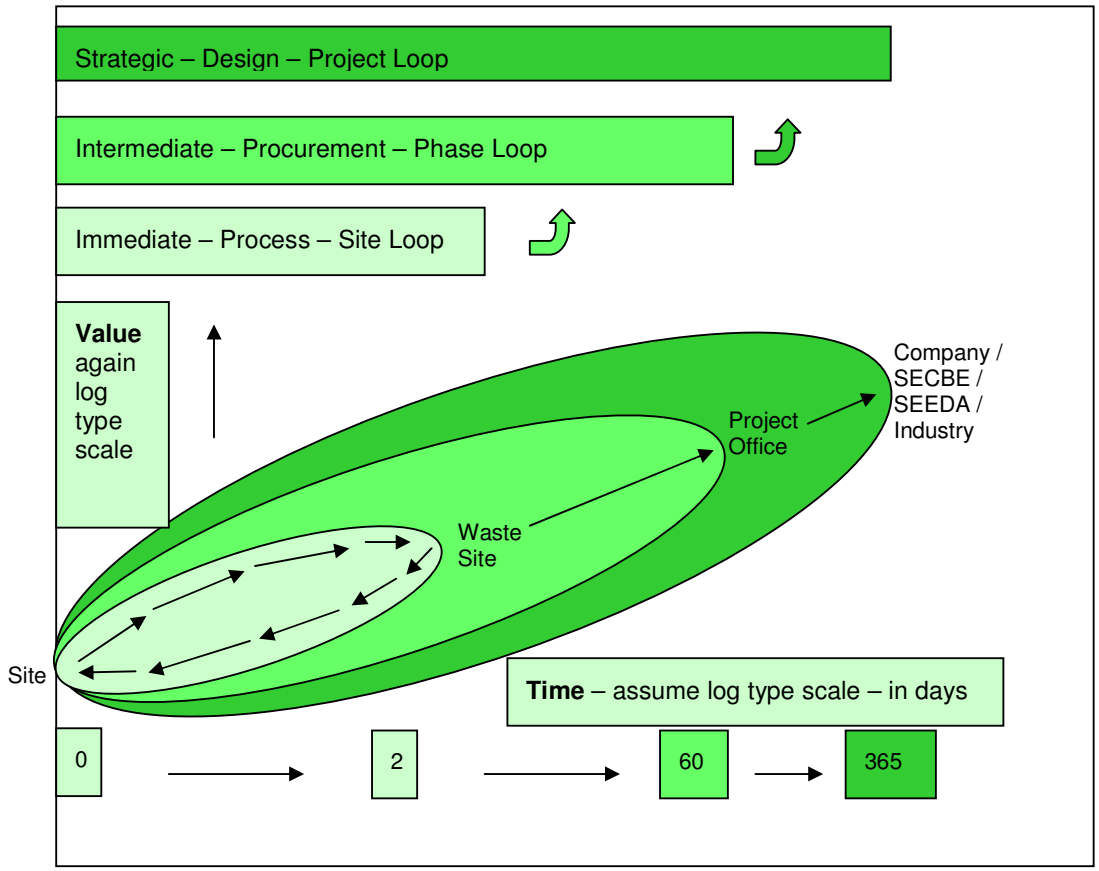
The theoretical and practical considerations of each proposed timeline is provided in Section 5.3.1 – 5.3.3

Figure 4.2 – A Diagrammatic Representation of the Feedback Loops



4.4.1 Immediate Time Horizon - Theoretical and Practical Considerations

The immediate time horizon is site based and the approach has to have regard to the following theoretical and practical considerations:

- Separate skips, for specific waste stream will be provided at the site which will reflect the phase of the project to:
- collect recoverable/recyclable materials,
- allow waste stream identification and quantification,
- allow “real time” on-site feedback to the workers to allow them to respond in real time where significant wastage is identified.

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- Such an "Expert System" will review by variances, see **Section 4.1.3,** so that if the contents of the skip are "normal" and the general waste skip is not within the expected range of content, then nothing different happens on site;

- If the contents of the skip include significant variances the workers would respond and analyse the contents and/or practices to lead to an improved practice to reduce waste generation via better material use or recovery; and

- Information would be fed up the loop to the site managers and the design team so that in the longer term loops the design and procurement could be changed on future phase or future projects, see discussion on these longer term loops below.

The use of training and tool box talks on site should be used as part of this communication with on site colleagues and suppliers of materials to the site should also be invited to attend these sessions to ensure effective segregation on-site and prevention of cross contamination.

4.4.2 Intermediate Time Horizon - Theoretical and Practical Considerations

The Intermediate Option is focused on the next phase of the programme, the next 50 of 400 homes and will provide good feedback to the Procurement and Project Design Office to allow changes over the next few months in time for the next phase of the construction programme.

This is perhaps one of the most difficult tasks. Even for small projects the supply chain can be complex. Most of the major components for the building will be supplied by main suppliers, but many of those suppliers will themselves be supplied by small companies. The further down the chain you travel the more difficult it is for the client or even contractor to exert any specific control over the chain. Supply chain management is itself a specialism which needs to be carefully considered to ensure an effective approach.

There are some general rules which should be followed. One is to involve the supply chain, on partnering principles, especially the key decisions points, as early in the design process. Full stakeholder engagement should be encouraged at every opportunity. Formal partnerships are starting to develop between contractors and suppliers. This provides a helpful context, in which supply chain issues can be discussed and resolved. Supply chain alliances with suppliers and recycling companies have been found to bring significant waste reductions. This can be achieved through a number of methods, in particular:

- Increasing the amount of on- or off- site pre-fabrication is one such method. An alliance allows the supplier to do this by providing some financial security to them. As with any product economies of scale are likely to be possible. Alliances can be particularly effective in reducing waste if they are involved within the design process itself, as they will be able to advise on the standardisation of the design which will reduce the number of off cuts. Such off-cuts are a major source of waste generated by the construction industry.

- Supply chain engagement is also beneficial in developing a just in time delivery system which reduces the need for materials to be stored and subsequently damaged or pilfered on site. This is a surprising source of construction waste.

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- A good working relationship between suppliers and contractors may allow for extra flexibility when requiring small quantities of materials, which are only needed in a small number of locations. If this material can be supplied in small quantities then this may also lead to a saving in waste generation and subsequent disposal to landfill.

Additionally and importantly, the JIT approach should save enough space on site to allow for the additional footprint for the additional few skips to allow segregation to take place in the first place to generate the benefits.

4.4.3 Strategic Time Horizon - Theoretical and Practical Considerations

The Strategic Option is focused on the future, hence the Next Project Loop, looking at design improvements and supplier relationships as discussed above. It is intended to provide good feedback to the Company management team, the design team and Key Stakeholders including SECBE and SEEDA (when not commercially sensitive) and the wider industry members, to allow changes over time for the next project of the construction process, these will focus on design and also the procurement of materials and their design, to reduce waste generation in the first place and also allow for more efficient recovery of off cuts and other materials that will be difficult to design out.

The goals and objectives are the longer term improvement of the construction sector waste generation and materials use and recovery. Dissemination through government funded agency, through the provision of training events, seminars, best practice guides.

4.5 Revised RTDS Flowchart

The revised RTDS flow chart, **Figure 4.3** has been developed from the original RTDS flowchart (**Figure 3.1**) developed by SECBE. The revised RTDS flowchart clearly identifies the following process flows:

- Information
- Income generation
- Waste

In identifying the process flows as being information, revenue/costs savings and waste, it clearly illustrates how the 3 process flows relate. Information is central to the entire RTDS process and will enable revenue generation and costs savings and reduced volumes of waste to be achieved.

The flow pattern based on value starts on site and follows a revised and somewhat different process, the steps are:

- At the construction site (1) the operator using their knowledge looks at each skip, if it has easy wins for material recovery or is not “normal” then a modified version of a sort and segregate is applied to learn what is in the skip (2). If it is “normal” the skip goes to (7) the depot. If it does have immediate potential value the waste is

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segregated on site; where this can allow the return of material (blue arrow) for use and value (green arrow) to the site itself;

- This will then lead to a report/information (black arrow) being sent to the Supply team, which can lead to a change in the design / procurement / process for the next set of houses / project and so recover value (green arrow and can also feed information and thereby value via Best Practice into the wider construction sector, left of figure;

- For those skips that do arrive at the depot, those that are already segregated are dispatched for immediate recovery to the correct area (e.g. wood) (7); whilst others are then segregated and analysed (8), reducing the material flow to landfill (11) (now a smaller blue line), with more to recovery (a larger blue line), therefore with value (green) and information (black) returned from both,

- The information this generates is fed back to the construction site (1) for benefit (black arrow), and also to the Supply team (including the designers, procurers and suppliers) to change the next set of houses / projects on this site (5) and future projects (5 & 6), as above. In time material flow to landfill will be reduced

The key benefit of this modified system is to ensure the accurate and efficient collection of data has greater value and delivers real benefits to future projects.

In terms of understanding how real time loops relate to the modified RTDS flowchart, the following steps (in brackets), as identified within the modified RTDS flowchart, are found within the following real time horizons:

Immediate Time Horizon

- Construction site activities (1)
- On-site waste segregation (2)
- On-site re-use and recycling (3)
- Off site segregation and analysis (8)
- Waste disposal (11)
- Information transfer from waste handling depot to construction site (9)

Intermediate Time Horizon

- Information transfer from construction site to supply team (10)
- Design/process improvements information feedback to construction site (5)

Strategic Time Horizon

- Dissemination to the wider construction industry and up the supply chain (6)

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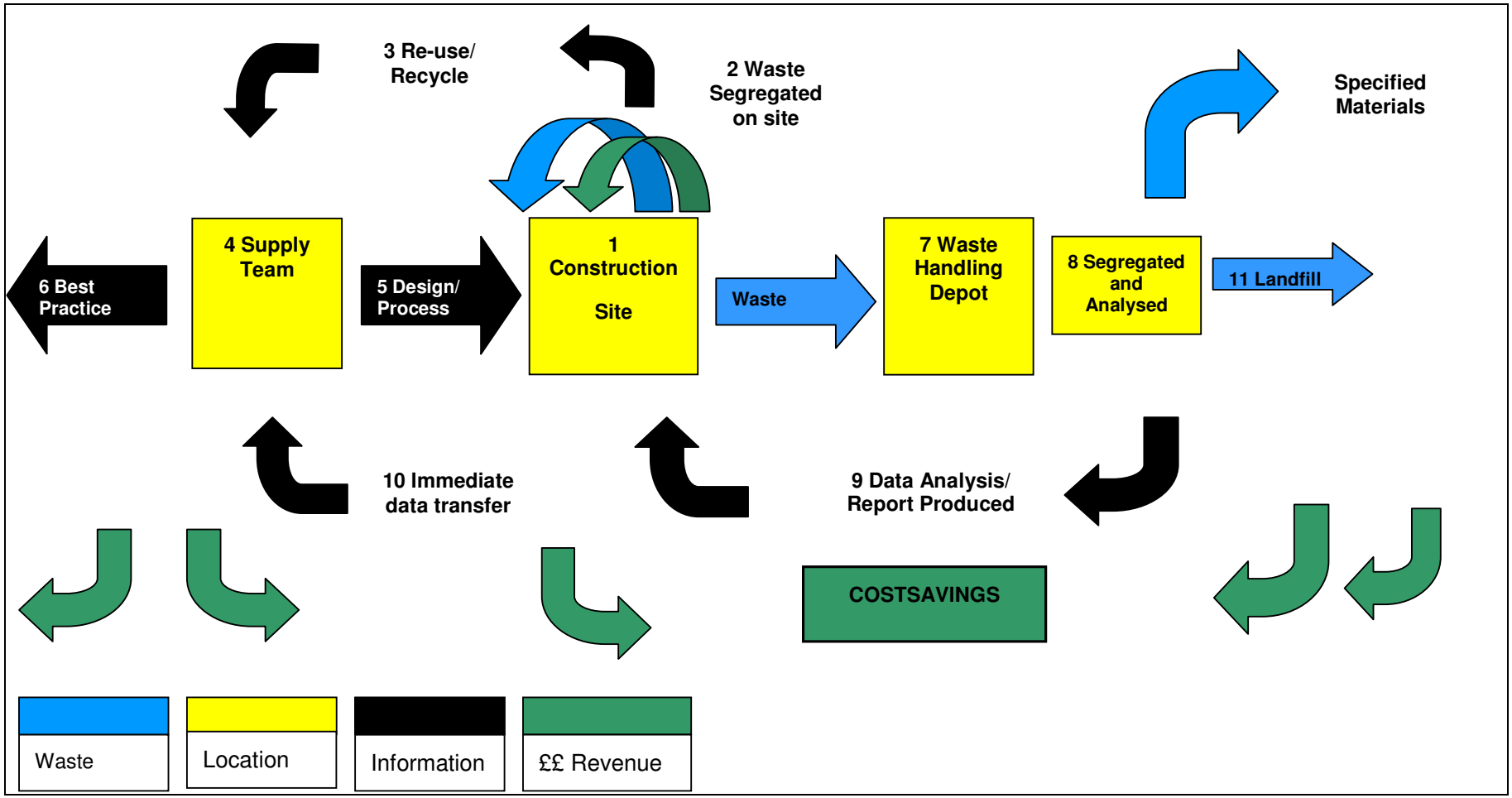
Figure 4.3 - Proposed Revised Real-time Data System



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4.6 Associated Issues

4.6.1 Suppliers for the Next Projects to Reduce Supply Chain Arisings

Key issues for this section include partnerships, alliances, education and awareness raising and stakeholder engagement, i.e. the supply chain and its components are key stakeholders within the overall process and they need to be engaged as early as possible within the process. Such feedback from the RTDS to the suppliers will over time allow them to redefine their designs and supply less wasteful products and packaging into the construction industry.

4.6.2 Material Ownership

In many cases the construction company will purchase and provide materials to the joiners, carpenters, block layers and other skilled labourers on-site. Skilled labourers do not "own" these resources, so therefore there is a "tragedy of the commons", in that they will not directly suffer the consequences of wastage during the construction process. If the contractual arrangements were changed, so that the skilled labourers had to purchase the materials for the job, it is likely that greater care would be exercised by the skilled labourers thus avoiding wastage as they would have to pay for such wastage out of their own pockets.

4.6.3 Waste Reduction

Whilst there are examples of good practice, in general terms the construction industry could do a great deal more to encourage and implement recycling and waste minimisation practice, where the demolition sector is already strongly focused on this approach. The key drivers as summarised above in **Section 3.0** will be important in progressing this in the next year.

A key issue to be considered when developing symbiotic use of materials (i.e. between companies) is the issue of re-certification for use.

4.6.4 Cost Savings

Key cost savings would include:

- Transport costs (would not pay to receive, store and dispose of unused material);
- Reduced damaged and therefore unusable materials;
- Reduced material use, via a reduction in over specification and over ordering;
- Reduction in loss of materials from site i.e. wastage;
- Reduced waste management costs (recycling leading to income and lower landfill charges); and
- Lower costs of hazardous wastes disposal (especially if they are designed out).

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5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The RTDS did not have a sufficient uptake and was carried out over a limited time period which inevitably means any findings at this stage should be viewed as tentative. However the study did highlight important transferable concepts to help focus a revised RTDS system and a possible further pilot trial (see recommendations in Section 5.2).

The main conclusions from our review of the results of the field trial were as follows:

- The users did see the potential of such a system, but were burdened by the data capture methods;
- Users were concerned by the lack of a structured approach to feed information back in “real time” to key stakeholders, whether on site, in the project office, or in the wider construction industry;
- There was also some concern regarding the methods used in quantifying waste streams and the waste categorisation approach adopted, which perhaps could be addressed by developing a more prescriptive assessment forms;
- There was some confusion regarding standardised reporting metrics;
- Inspection and assessment of the skips was perceived by operators as being very time intensive and unlikely to generate value back into the system for the companies, which ultimately resulted in limited engagement in the study;
- Education and training was needed to inform key stakeholders as to why this study was being carried out and why it was likely to generate future value.

5.2 Recommendations

Our assessment, on reviewing the original goals led to a revised definition of real time in the context of extended time horizons i.e. immediate, intermediate and strategic, see Figure 4.2, and which would provide an improved system, which ultimately would enable the RTDS concept to achieve its original objectives. Other observations and recommendations are set out in Section 4.

5.2.1 Proposals for a further Trial on revised RTDS

It is proposed that SECBE proceeds with a field trial based on the above “real time” RTDS as detailed in 4.0 above, using segregated skips, managing by variances, expert system recognition by the users and a closed loop of feedback from the site and from the waste handlers to the project office and to the company office and to the industry. This is needed to meet the drivers that are present in the industry today in particular:

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- The requirement for the treatment of non-hazardous waste by October 2007 – where more information will be required by the waste generator, and treating will be required for C&DW;
- To build capacity in the materials efficiency / re-use supply chains and to stimulate demand for recycled materials and products as well as to co-ordinate materials efficiency activities in the South East; and promote business opportunities;
- Ensure that the waste being transferred is accompanied by a written description that will enable anyone receiving it to dispose of it or handle it in accordance with his or her own Duty of Care;
- Increased Landfill Tax now £24 per tonne and set to rise in the future; and
- Realise better value from segregation.

5.2.2 Anticipated Results and Timescale

The anticipated results from implementing this system, with all the inherent further feedback loops and communication would lead to immediate waste reduction, immediate recovery of materials for reuse or recycling. Correspondingly intermediate and longer term feedback to the procurement and design loops will allow waste to be designed out of the system.

It would also lead to a better understanding of what a normal skip contains which will change through the project cycle, through time so the variance levels are narrowed and the whole system provides positive and negative feedback loops further reducing waste and improving materials use and recovery.

5.2.3 Prepare a Business Development Plan Robust Enough to Attract SEEDA or Commercial Investment to Mainstream the Service

The above provides the basis for a Business Plan, defining the idea as well as the commercial potential of this approach. SECBE would need to provide its knowledge of costs for the previous study and related studies and conduct a trial to complete the plan. To be meaningful it is suggested that the trial should be focused on a minimum of 20 sites at least and cover at least 10 different construction companies and a range of project sizes, while remaining focused on housing and other repeat construction projects.

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APPENDIX 1
Data from KPH and Thanet Waste Pilot – Five Analyses

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Material Analysis Table

Site Name: Maidstone Park Wood	**Week Beginning:** 22 January 2007
Skip No./Ref: 2x6 yard	**Skip Size:** 12 yard 2x6 yard
Construction Phase: fit out	

Key Waste Streams	Volume of Skip (%)	Weight	Comments
Timber	10.60	500	Including 2 x internal doors?
Plastic/ Packaging	2.56	120	
Plastic Tubing/ Mixed Pipes	1.7	80	
Metal	4027	200	
Inert	50	2340	
Concrete Soil Hardcore			
Plasterboard	9.82	460	Should be in the plasterboard bags (recycling)
Ceramics			
Turf/ Vegetation	7.26	340	
Insulation			
Residue	1.7	80	
Hazardous Materials	0.21	10	Should be placed in 205 ltr drums provided
General Waste	11.75	530	
Other			

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Subject: Thanet Waste - Material Analysis Table

Site Name: Maidstone Park Wood	**Date collected:** 06 February 2007
Skip No./Ref: Skip No.1	**Skip Size:** 2x6yard skips
Construction Phase: Fit Out	

Key Waste Streams	Volume of Skip (%)	Weight	Comments
Timber	16.3	500	4x2 ; 3x3 ; various off cuts nothing over 1 m ; 1 x internal door
Plastic/ Packaging	9.8	300	Clear plastic wrapping; Yellow plastic bags? ; Binding straps
Plastic Tubing/ Mixed Pipes	3.3	100	Small pieces of pipe from kitchen and bathroom fitting
Metal			
Inert	10.5	320	Bricks/ blocks/soil/some tiles; Could be viable to put inert skip on site?
Concrete Soil Hardcore			
Plasterboard	43.2	13.20	Large amount of pink faced plasterboard and white board All should be put in 1 tonne plasterboard recycling bags?
Ceramics			In with inert
Turf/ Vegetation	6.5	200	
Insulation	.06	20	Standard loft insulation ; Damaged and off cut material only
Residue	3.9	120	Brick dust/fines/all very small items
Hazardous Materials	0.6	20	7 assorted tins and tubs any remaining liquid has contaminated the recyclables
General Waste	5.2	160	Cardboard /chipboard/paper canteen waste
Other			

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Subject: Thanet Waste - Material Analysis Table

Site Name: Maidstone Park Wood	**Date collected:** 06 February 2007
Skip No./Ref: Skip No.2	**Skip Size:** 2x6yard skips
Construction Phase: Fit Out	

Key Waste Streams	Volume of Skip (%)	Weight	Comments
Timber	27.7	760	4x2 ; 3x3 ; roof joist off cuts ; various off cuts nothing over 1 m ; several ply sheets damaged
Plastic/ Packaging	5.4	80	Clear plastic wrapping ; 1/2 roll orange fencing ; Binding straps
Plastic Tubing/ Mixed Pipes	1.8	60	Small pieces of pipe from kitchen and bathroom fitting
Metal			
Inert	50.3	1680	Bricks/ blocks/soil/some tiles; Could be viable to put inert skip on site?
Concrete Soil Hardcore			Also large amounts of concrete
Plasterboard			
Ceramics			In with inert
Turf/ Vegetation	11.9	400	Damaged turf
Insulation	2.4	80	Standard loft insulation ; Damaged and off cut material only
Residue	1.8	60	Brick dust/fines/all very small items
Hazardous Materials			2 empty paint tins
General Waste	3.6	120	Cardboard /chipboard/paper canteen waste
Other			

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Subject: Thanet Waste - Material Analysis Table (1)

Site Name: Maidstone Park Wood	**Week Beginning:12** February 2007
Skip No./Ref: Skip No 2	**Skip Size:** 2 x 6 yards
Construction Phase: Fitting out	

Key Waste Streams	Volume of Skip (%)	Weight	Comments
Timber	8.4	100	Pallets covered in paint? ; Assorted lengths of timber off cuts
Plastic/ Packaging	1.7	20	Standard packaging ; Polly sheet
Plastic Tubing/ Mixed Pipes	0.8	10	Normal bath / kitchen waste pipe off cuts; Mastic tubes? Should be in haz drums?
Metal	10	120	Odd pieces of metal rebar ; 1 x step ladder ; Gates
Inert	43.3	520	Normal
Concrete Soil Hardcore			
Plasterboard	10	120	Should be in plasterboard recycling bags?
Ceramics			
Turf/ Vegetation			
Insulation	15	180	Normal loft insulation
Residue	6.6	80	Dust/fines and all small items
Hazardous Materials	1.7	20	Various paint tins x 4; The free flowing liquid contaminates the other recycling materials in the skip; SHOULD BE IN DRUMS?
General Waste	2.5	30	Chipboard ; Paper/cardboard ; straps
Other			

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Subject: Thanet Waste - Material Analysis Table (1)

Site Name: Maidstone Park Wood	**Week Beginning:12** February 2007
Skip No./Ref: Skip No 1	**Skip Size:** 2 x 6 yards
Construction Phase: Fitting out	

Key Waste Streams	Volume of Skip (%)	Weight	Comments
Timber	18.8	200	5 Pallets ; Assorted lengths ; 150x50 ; 100x100
Plastic/ Packaging	8.5	90	Flower pots? ; Standard packaging; Mixing tubs 2 x 50 ltr?
Plastic Tubing/ Mixed Pipes			
Metal	26.4	280	Harras fencing ; Odd pieces of roofing supports damaged
Inert	5.7	60	Normal
Concrete Soil Hardcore			
Plasterboard			
Ceramics			
Turf/ Vegetation			
Insulation			
Residue	9.4	100	Dust/fines and all small items
Hazardous Materials	5.7	60	Various paint tins; 2 x paint tubes; 7 x mastic tubes; SHOULD BE IN DRUMS?
General Waste	25.5	270	Chipboard; Paper/cardboard; straps; Golf bag?
Other			

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APPENDIX 2
SECBE RTDS Proposal – As Definition

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SECBE Construction Waste Minimisation Programme

Real-Time Data System – Waste Handling

Aim

To minimise waste in the construction process through accurate material collection analysis and thereby enable immediate action to be taken to reduce wastage at source.

Process

Waste collected on a construction site is usually collected by a waste handler, who transports the waste to a waste handling depot. At the depot the waste is sorted and segregated into separate waste streams. The material is then disposed of in a number of ways:

- Landfill
- Recycled
- Re-used

Proposal

This paper proposes that if a waste handling operator were able to analyse the waste material on site or at a depot and provide an accurate report within 24 hours, this would enable the contractor to make immediate provisions to reduce waste.

The contractor would then be expected to utilise the data in a number of ways depending on how accurate and frequent the information.

Benefits

Contractor

The real- time data could be fed back to a number of key players within the lifecycle of the project, particularly where there are repetitive processes, these include:

Design teams – to enable a redesign of components or specific aspects of the design

Manufacturer – to alter or improve the production of materials

On site teams – to enable different approaches or techniques to be adopted

Benefits include real time improvements to design, increased productivity and a reduction in waste and costs.

Waste Handler

The waste handler could look upon the system as an additional revenue stream, marketed at the construction industry. In addition the use of a measuring tool and real-time date could help the waste handler to monitor and refine their own processes and improve productivity.

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Construction Industry

Waste is still increasing at an unprecedented rate in the UK and the construction industry is a large contributor. Waste handling facilities have a limited life expectancy and this combined with diminishing landfill sites and rising costs is becoming a pressing issue for both government and industry. The construction industry needs the tools to enable it to design out waste during the lifecycle of the project. Real-time material analysis is a viable solution which if adopted across the industry will ease the burden on landfill sites immediately and reduce waste costs for many, particularly so for the housing industry due to it's repetitive nature.

Objectives

- Develop proposal
- Identify existing systems and understand success / barriers
- Identify leading material handlers and key contractors
- Set up a brainstorming meeting
- Develop pilot partner team
- Outline technical specification
- Identify and pilot a system or develop and trial prototype
- Promote product to contractors and waste handlers

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