SOURCE SEPARATION OF CONSTRUCTION WASTES IN NEW ZEALAND

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Abstract
This study investigated options to divert reusable and recyclable materials from the waste stream produced by the New Zealand construction industry. It identified methods of construction waste separation and recycling overseas and identified the options in Auckland and in New Zealand. Previous research had indicated that a change in waste handling on construction sites could provide extremely high waste savings at a very minimal behavioural cost and without any financial risk.

A site trial was undertaken on a large construction site in the Auckland Region, with source separation bins being installed on site. Approximately 56% of construction waste by weight (50% by volume) was diverted from landfills. The major wastes which were included in this study were timber, steel, cardboard and plasterboard. The management costs arising from the set-up and operation of the source separation were minimal and easily compensated by the 19% saving in disposal costs.

Source separation is a viable option for construction wastes in the Auckland region. The main factors are availability of space on site, support from site management and operatives, as well as co-operation from the waste contractor. Source separation offers the combination of no risk and the potential to achieve significant financial savings. The documented techniques for achieving high diversion rates as well as significant financial savings are readily applicable to most construction projects in New Zealand, as well as in the rest of the world.

Introduction

The construction, repair, maintenance and demolition of buildings and structures consume energy and resources, and generate waste on a scale, which dwarfs most other industrial sectors. Worldwide, the construction of buildings consumes approximately three billion tonnes of raw materials, or forty percent of the total material flow into the global economy. Beaudoin (1995) reported that although the building industry in Portland, Oregon only constituted a little more than three percent of the work force, it created 23 percent of the waste generated in that area, an average of 16 tonnes of waste for every building industry worker each year.

To become sustainable, the construction industry must reduce its waste, reuse waste whenever feasible, and facilitate recycling (Kibert, 1995). Waste in the industry has been regarded as an inevitable part of the construction process, a process designed to complete projects on time and within budget with little regard for any factors falling outside these two immediate goals (McDonald, 1994).

In New Zealand, construction and demolition (C&D) waste accounts for 20.1 percent of the total landfilled waste, 11.7 percent of the residential landfilled waste, and 26.7 percent of the industrial landfilled waste (Street, 1997). In addition to the 198,000 tonnes of C&D waste disposed of in landfills in the Auckland Region in 1995, another 826,000 tonnes (526,000 demolition and 350,000 excavation) of C&D waste were disposed of in cleanfills (Ministry for the Environment, 1997a). The objectives of this research were to evaluate options for recovery and diversion of construction waste and assess the feasibility and cost of source separation for recycling.

1. Options for the recovery and diversion of construction wastes

Waste separation is the sorting and diversion of various components destined for disposal. In order to enable their reuse or processing materials must be sorted according to their material group, treatment and level of contamination. In some cases size will be another factor that determines whether reuse or recycling of the material is called for (Mincks, 1996). In addition to the material characteristics, several other factors influence the method of separation that will be used, such as the amount of the individual material expected, physical characteristics of the construction site and the proximity and type of collectors or processors.

Sorting competes financially against the cost of disposal and is heavily affected by the market value of secondary raw materials. Depending on the technical level of sorting and recovery operation applied, 50 to 80 percent (by weight) of the C&D waste materials currently being disposed of in landfills could be diverted from landfills and the materials re-used or recycled (Mincks, 1996). A number of options, illustrated in Figure 1, are applicable to construction and demolition waste.

1.1 Source separation

Traditional waste management practice disposes of all unwanted materials through one commingled waste stream. Source separation eliminates the mixing of components and thus contamination, which would result in rejection of the material from recyclers (Leiter, 1997). Therefore source separation provides higher material quality than sorting of materials from mixed waste, thereby increasing the value of waste materials or decreasing the cost of disposal.

Separating wastes on site involves the use of multiple bins or disposal areas, one for each type of material, and thus is most effective on sites with sufficient space (Mincks, 1996). Most construction occurs in phases which increases the potential of separating and compiling similar materials as they can be readily discarded into the relevant bin. Problems occur on smaller jobs, especially inner-city locations, with space constraints (CIRIA, 1997). Some of these problems can be overcome by targeting certain construction stages and by the availability of various container sizes (NAHB, 1997). Targeting wood waste during the framing stage, for example, permits recycling of 80 to 90 percent of this material and requires a wood bin on site for only a limited time.

Generally the focus is on the most common or the most valuable materials. The materials most frequently separated and recovered from general construction and renovation activities include wood waste, plasterboard, metal, paper, and cardboard (CIWMB, 1998). Depending on the resources and willingness, most conventional waste service companies can supply the services required for source separation.

1.2 Off-Site Separation

In some localities, permanent co-mingled facilities have been constructed. In these cases, the facility receives the mixed waste, possibly charging a fee lower than the tipping fee for landfill disposal but higher than the fee charged by other recyclers for separated waste (Mincks, 1996). All C&D waste is put in a conventional receptacle and pickup service is provided when needed. The mixed waste is then sorted at the facility and recycled where possible. Contamination is the major concern as it is difficult to fully separate all waste. In addition, the cost of separating the waste is high as much of it must be done by hand.

1.3 Removal of waste by subcontractor

Once those who supply materials and/or services are made responsible for handling and disposing of their own wastes at their own financial and time expense, they have a vested interest in waste reduction. Subcontractors usually generate a specific type of waste and therefore, if waste is cleaned up and separated as it is generated, recycling should be simple.

While this kind of waste removal has the potential to decrease the overall cost for waste removal on that particular site, the disposal is left to the direct generator of the waste. It becomes the waste producer's choice whether to reuse, recycle, or dispose of the waste materials. Consequently, this option does not ensure that waste materials are reduced, recycled or even disposed of properly.

1.4 Cleaning Contractor

Some specialised waste contractors clean up and sort wastes from construction sites. This saves the time of on-site workers from sorting the wastes. The contractor knows waste disposal costs up front, can determine the level of service required (number of job-site visits and degree of clean up), and saves money while someone else determines what can and cannot be recycled.

1.5 Take Back Policies

It is the manufacturer who develops and designs the product or package, and it is the manufacturer who chooses the materials for that product or package. Therefore, the most efficient and effective point at which to reduce waste and encourage reuse, reduction and recycling, is at the product development stage. It is at that point in the product's life cycle that decisions can be made to minimise the environmental impact of the product. While some manufacturers see material take back as a disadvantage, others see it as a business opportunity or even a cheap supply for raw materials.

2. Site Trial

Of the options outlined, source separation was deemed to be the most efficient and cost effective for recycling wastes, although it would have little effect on waste volumes. The purpose of initiating and monitoring a site trial for source separation was to determine whether source separation could be both feasible and profitable on construction sites in New Zealand. A commercial construction site on Auckland's North Shore was used for the trial.

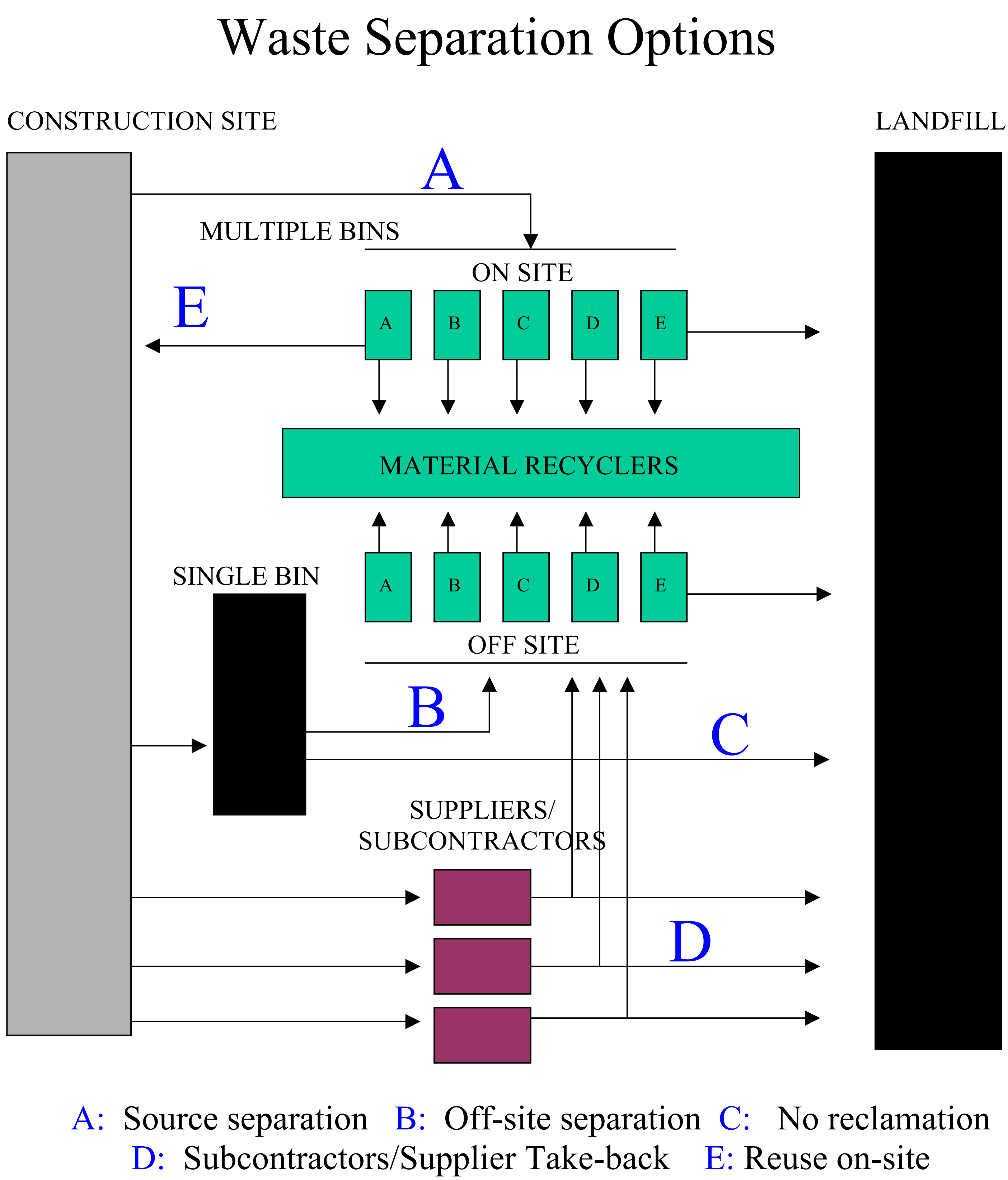

Figure 1: Diagram of Waste Separation Options

2.1 Materials Targeted by Source Separation

Recycling programmes target materials for which large quantities can be collected and for which greater value can be recovered. The most common types of C&D wastes are known from the breakdown of the C&D waste stream (Patterson, 1997), but composition can alter between projects.

The number of materials to be sorted was as important a consideration as the type of materials chosen. For sorting to be readily adopted and faithfully performed the material bins would not only need to be well labelled and colour coded, they would have to be of a manageable number. Even where space was not very limited, too many bins would slow down or intimidate staff. Given the number and market considerations for this site, the following materials were chosen for separation on site.

Wood

The size, type and quality of the waste wood define the wide variety of secondary uses, from high quality timber use in furniture manufacture to low quality timber use as fuel. This variety of end uses should enable separators to find outlets for timber of almost any quality, and makes the inclusion of wood separation imperative.

Trial findings: Wood bins were the fastest filling bins over the course of the construction project and wood waste, by weight, exceeded all other material groups in the waste stream – even the commingled stream of materials not targeted for separation. The quality of the wood collected exceeded all expectations; consequently some loads were diverted for reuse in building and as fuel. Although wood disposal was not as discounted as was metal, for example, the very high volume of wood in the waste stream made the savings from wood sorting very substantial.

Metal

Metal has long-established recycling markets. Although it contributes less by volume than wood, for example, the prospect of no disposal cost or even of revenue generation also makes it a mandatory component of any source separation scheme.

Trial findings: Metal performed very well against other materials in the sorting scheme. Metal was sorted more willingly and consistently than any other material with a low level of contamination, despite the location of the bin to other activities. The metal bin was correctly used even in the latter portion of the trial when the metal material sign was lost and not replaced.

Paper & Cardboard

Recyclable paper and cardboard from C&D are almost exclusively the result of packaging, as building paper cannot be easily recycled. While the volume of paper and cardboard from C&D is not large enough to warrant sorting based on bulk, the mature paper recycling market makes it one of the easiest materials to divert from landfill.

Trial findings: Paper and cardboard was the least successful material when judged by most criteria used. Very small amounts of paper and cardboard, both by volume and weight, were collected. Only three cages with a capacity of 3.5 m^3 each were filled during the entire trial, representing under one percent by weight and just two percent by volume of all wastes removed from the site.

Plasterboard
Plasterboard was not recycled in New Zealand at the time of the trial but was gathered purely for research purposes. Winstone Wallboards Ltd., New Zealand's only domestic plasterboard manufacturer needed waste collection data in order to decide if it should establish a plasterboard recycling mechanism/facility. Winstone Wallboards relies exclusively on imported raw materials for their gypsum, and was interested in finding a domestic source of suitable material.

Trial findings: The quality and purity of the plasterboard collected was high enough to enable recycling. The manufacturer's decision to recycle will depend upon many factors, but the quality of plasterboard site waste will not be a constraint.

Other Materials
No on-site sorting scheme can eliminate contamination of materials or sort out every type of waste material, as too many different material types and composites are integral to the construction process. That being the case, a mixed bin needed to remain on site and be differentiated from the single material bins.

2.2 The Timing – Just in Time Bin Placement
The installation of multiple bins at the start of construction was not considered a viable option. Waste in sufficient quantity and variety would not have been present at the beginning of construction and would only increase in incremental stages. Installation of multiple bins that would remain empty on site for some time was expected to result in contamination. Furthermore, sequential installation of material bins on site, on a just in time schedule, was the best option supported by both literature and staff experience.

Until such time as material-dedicated bins were needed, a single mixed bin was the only bin placed on site. By monitoring the progress of the construction project and the composition of the mixed waste bin, it could be seen when the presence of a material such as wood, for example, was sufficient to warrant phasing in the sorting of that material.

2.3 The Training – Orientation on Arrival
Training involved a simple orientation, sufficient for the simple nature of source separation. The site manager included material sorting orientation in the initial health and safety meeting on site, and made it clear that participation was mandatory. Thus, site staff had minimal formal training in the sorting process.

3 Material Diversion Results
As illustrated in Figure 2, 86.31 tonnes of waste was generated on site during construction, of which 42.68 tonnes were sent to landfill and the rest recycled. This was equivalent to a 51 percent reduction by weight in construction waste sent to landfill (excluding the separated plasterboard which cannot yet be recycled in New Zealand).

A total of 56 percent (by weight) of all waste was sorted according to the respective materials (including plasterboard). Materials were well sorted, with all loads being accepted by recyclers. This supports findings from source separation trials in the USA

(Touart, 1998) and Australia (Stickels, 1994) which report very low contamination of source separated loads.

Sources from the US (NAHB, 1997) and the UK (CIRIA, 1997) report that source separation generally does not exceed 60 percent diversion quotas (by weight). The 56 percent achieved during this trial compare very well against this figure. This is particularly significant as source separation is a very uncommon concept in New Zealand and unlike the American and British cases previously mentioned, no formal training beyond a brief orientation was provided.

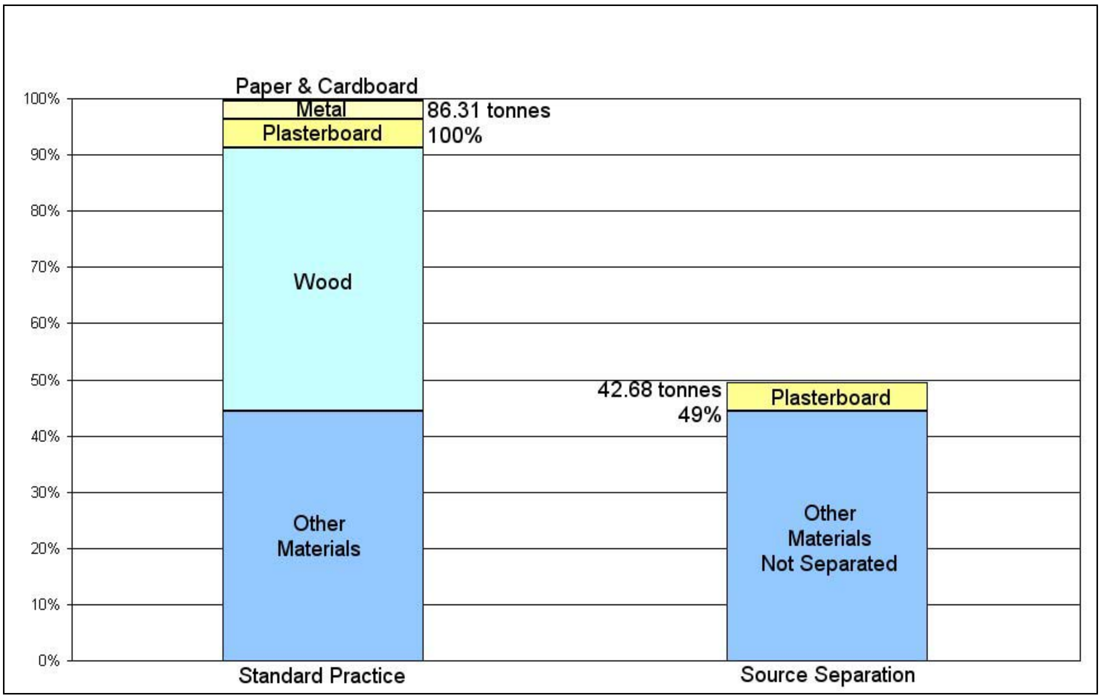

Figure 2: Comparison of Wastes Landfilled (by Weight)

4 Financial Results

The source separation trial resulted in a 19 percent financial saving over standard disposal practice, which in this trial equalled NZ$2,140. This was made possible by the fact that all separated materials were accepted either at reduced rates or free of charge by recyclers and processors.

5 Conclusion

This trial demonstrated that source separation is an inexpensive, effective, no-risk, waste diversion option. It provides a non-invasive, stand-alone waste saving mechanism that can work independently of other waste management schemes or can contribute to an integrated waste management strategy.

Source separation is both suitable and applicable to any construction project, regardless of size, provided certain basic criteria are met. These criteria include: infrastructural prerequisites; the availability of adequate space on-site; and sufficient waste quantities to interest secondary material markets and deliver appreciable financial savings.

6 Basic Rules for successful source separation

Source separation is easy to implement, but success is not guaranteed in any endeavour. For source separation programmes to operate as successfully as did this site trial, some basic rules must be followed. These basic rules are:

- space must be available for multiple bins;
- the co-operation of a minimum number of partners must be secured;
- the site manager should take ownership of sorting programme;
- the sorting process must be self-evident.

6.1 Space Availability

A space sufficiently large for multiple bins must exist. It should also allow for the equidistant placement of multiple bins within the sorting centre. Factors governing the size and location of the sorting centre include:

- distance from waste generating work site;
- ease of access by workers;
- ease of access by trucks;
- remoteness from public access (to reduce contamination).

6.2 Co-operation of Essential Partners

A minimum number of partners must be involved in any source separation project. These partners either initiate and manage the sorting scheme, or comply with the programme as established. These essential partners are:

- site manager;
- waste service provider;
- recyclers;
- site staff;
- subcontractor staff.

Smoother operations will result when the site manager actively manages the programme, monitoring contamination on a daily basis, and directing re-sorting as necessary. Waste service contractors offering source separation can greatly assist site managers by reducing the number of contacts that the latter must manage. Gaining the co-operation of site staff and subcontractors is essential. Compliance will be highest when managers lead by example, and make the process self-evident.

6.3 Programme Ownership

Faithful compliance on the part of staff is directly proportional to the commitment demonstrated by the site manager. Highly visible manager commitment can communicate more effectively than written policy, and engender commitment in others. Site managers are also best equipped to monitor and drive any sorting programme on site.

6.4 Self-evidence of Programme

For any party to instantly recognise both the nature and scope of a sorting programme, several key rules must not be overlooked. These rules are:

- all bins need to be placed together;
- bins must be clearly labelled on all sides;
- sorting centre must be keep tidy at all times;

- contamination must be removed from affected bins immediately.

An orderly, well-maintained sorting centre that appears to work well, will work well. Appearance, in this instance, guides behaviour, communicates the level of commitment, and sets the standard to be upheld. Compliance, with minimal training, is the reward of integrating all these components.

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