Final Report

Co-mingled recycling collection and recovery of materials

Prepared for

Glass Packaging Forum

by
Covec in association with
Environmental Resources Management

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ERM's Waste Management Team includes expertise on the technical, economic and operational analysis of all aspects of waste management, both in the UK and overseas.

ERM's scope in respect to this study was to provide international data on dry recyclables waste collection practices. ERM's work focused on understanding the implications, based on international experience, of shifting from source segregated to co-mingled collection on particularly the quality and volume of recyclables.

Authorship

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Executive Summary

Auckland and Manukau City Councils intend to switch their kerbside recycling collection systems from segregated, crate-based collection systems, where different materials are manually sorted at the kerbside, to co-mingled wheelie bin collection systems, where materials are collected together from the kerbside and then sorted at a centralised Materials Recovery Facility. The Glass Packaging Forum and others have raised concerns that this change, while increasing levels of collection of recyclable materials, might lead to greater levels of contamination, particularly of glass and paper. This could result in reduced total rates of recycling or reduced rates of diversion to high-value end uses such as glass manufacture. This has the potential to hinder the achievement of national material-specific recycling targets.

This report is an independent analysis of the effects of a shift towards co-mingling on quantities and qualities of collected material. Specifically, it addresses the concerns raised about the impacts on achievement of recycling targets. It examines current New Zealand and international experience to provide guidance on the expected effects.

The evidence from the New Zealand experience to date suggests that there are a number of advantages of a co-mingled kerbside collection, including potentially lower costs of collection, increased volumes collected, improved occupational health and safety and reduced litter. The health and safety issues are regarded as significant set against a recent history in which there has been at least one fatality associated with kerbside collection of recyclables. However, co-mingled systems can also have some significant, and potentially costly, drawbacks. Chief of these is a reduction in the quality of some of the materials recovered, particularly glass and paper. This occurs because co-mingled collections, in which unsorted materials are deposited into a truck and compacted, result in increased glass breakage, making it harder to sort glass by colour or to separate it from other small items, and contamination of other materials, including paper.

The result is that a significant proportion of the glass collected is no longer usable for higher value uses (production of glass bottles) and instead must be used for lower value uses (eg hard fill). In the worst case scenario, a significant proportion of the glass could be unrecoverable altogether, leading to the landfilling of otherwise recyclable material. This contrasts with source-segregated, crate-based systems, where glass is manually sorted by colour at the kerbside. This means that any subsequent breakage does not reduce the proportion that is able to be processed for recycling. The co-mingled collection used by North Shore and Waitakere councils has led to a breakage rate upwards of 25 – 30%. A similar rate of glass breakage for Auckland and Manukau could result in up to an additional 10,000 tonnes per year being unable to be recycled in glass manufacture.

If a full co-mingled system is used, where paper is collected in the same kerbside wheelie bin, glass breakage will tend to result in a lower quality of recovered paper because of contamination by small shards of glass. In addition, paper can be contaminated with food scraps and liquids that have leaked from unwashed containers.

Paper from co-mingled collection can fetch a lower price than that from separate collection, increasing the net costs of undertaking recycling activity.

A range of international experience with co-mingled collections is consistent with the New Zealand experience.

- On the one hand, typically, although not unanimously, co-mingling results in larger amounts of recycling materials being collected at kerbside.

- On the other hand, evidence from a range of countries, including Australia, UK, France, Netherlands, Ireland and Italy, confirms that the quality of materials recovered from co-mingled collections is lower. Furthermore, higher proportions of otherwise recoverable materials are lost because of contamination, where this contamination includes broken glass that is unable to be sorted.

The choice of co-mingling appears to involve a careful balance between lower collection costs and lower revenues. In addition, other factors may be important in the choice, particularly impacts on litter and employee safety that are enhanced through co-mingling.

Waitakere and North Shore City Councils let tenders competitively and gave bidders freedom of choice over the collection system used. The contractual incentives faced by recycling contractors were thus to optimise the recovery of recyclable material where the benefits were greater than the costs of landfill. In this context, the successful bidder chose to use a co-mingling system rather than a conventional kerbside separation system. Local authority representatives suggest that some of the poor results to date are teething troubles rather than clear evidence of co-mingling being second best. In addition, the health and safety concerns may be of significant importance in the choice.

The issue going forward is whether co-mingling inevitably leads to lower quality levels of recovered materials and potentially lower rates of recycling as the experience suggests, or whether there are unique aspects of the experience to date involving equipment problems, management error or some other factors that can be corrected. Analysis of international and local experience suggests that the adverse impacts are inevitable in the absence of optical sorting. Co-mingling glass with other recyclable material in collection trucks, followed by compaction, results in glass breakage and the mixing of different coloured glass fragments with other materials. Using sorting systems currently available in New Zealand, much of this material cannot be separated into cullet streams that meet the quality requirements required for glass manufacture. It is possible that high capital cost optical sorting equipment could be used to separate the glass into colour streams, but this would add considerably to costs. If co-mingling systems are adopted elsewhere in New Zealand and particularly in Auckland, rates of recycling glass into glass bottle manufacture will fall.

This suggests that councils should proceed with considerable caution if introducing a co-mingled collection system. If they decide to proceed with some form of co-mingling or to allow it as a collection method, they should require guarantees of contractors on

specific aspects of their operations that affect product quality, for example rates of glass breakage, compaction rates, how recovered glass and paper will be sorted and processed, or the quality of paper and glass. Alternatively, they should ensure that contractual arrangements pass risks fully on to contractors.

Despite international shifts towards greater use of co-mingling, the experience to date does not demonstrate that it is necessarily the optimal choice. Councils in New Zealand should not proceed without a clear understanding of how the problems that have arisen in Waitakere and North Shore cities would be addressed and without a good understanding of the inevitable trade-off between reduced collection costs and reduced revenues from some material streams.

1. Introduction

1.1. Background

Auckland and Manukau City Councils intend to switch their kerbside recycling collection systems from segregated, crate-based collection systems, where different materials are manually sorted at the kerbside, to co-mingled mobile garbage bin (MGB or wheelie bin) collection systems, where materials are collected together from the kerbside and then sorted at a centralised Materials Recovery Facility. The Glass Packaging Forum and others have raised concerns that this change, while increasing levels of collection of recyclable materials, will lead to greater levels of contamination particularly of glass and paper. This could result in reduced total rates of recycling or reduced rates of diversion to high value end uses such as glass manufacture; this has potential implications for the achievement of material-specific recycling targets.

This report is an independent analysis of the effects on quantities and qualities of collected material of a shift towards co-mingling. Specifically it addresses the concerns raised about the impacts on achievement of recycling targets. It examines current New Zealand and international experience to provide guidance on the expected effects.

The concerns arise because an unintended consequence of co-mingled collection is glass breakage. This can reduce the volume of glass that can be sorted by colour and hinder its recovery because of the difficulties of separating very small pieces. In a co-mingled system, all kerbside materials are collected together and deposited into a collection truck unsorted. Once in the truck, the materials are compacted to reduce the volume of the material to allow each truck to collect over a larger area before returning to a Material Recovery Facility (MRF) where the material is then sorted. Because of the relatively fragile nature of glass bottles, when dropped into the storage compartment of a truck and compacted, some proportion of bottles will break. Much of this broken glass is difficult to sort by colour, which is necessary for recovery for high-value uses. Smaller pieces are often unable even to be separated from non-recyclable material (contaminants). In the worst case scenario, some proportion of the collected glass may have to be disposed of as landfill along with other contaminants.

If a full co-mingled system is used, where paper is placed in the same kerbside bin, glass breakage will also result in a lower quality of recovered paper as some proportion of the paper is likely to become contaminated by small shards of broken glass. The use of co-mingled collection can have the effect of reducing the price of the recovered paper and, consequently, increasing the costs of undertaking recycling activity.

2. Recycling collection systems

The form of household waste collection is critical in determining the effectiveness of resource recovery from the waste stream. Biffa Plc, one of the UK's largest integrated waste management companies, highlights the importance of collection systems:[1]

> *"Waste collection plays a critical role in shaping the nature, character and quality of resource recovery operations. The choice of waste transport system will dictate to a high degree the way in which the waste producers (eg the householders) can work to minimise the mass of materials that are sent finally to landfill disposal. From these preliminary stages of the waste management process will flow the accessibility and availability of materials for recycling, biological treatment or energy recovery. These are often in direct relationship to the convenience and clarity offered by collection methods applied."*

Approaches to recovering materials from the household waste stream can take a number of forms. In relation to dry recyclables, potential approaches include:

- collection of household waste from civic amenity sites or 'bring sites';
- collection of household waste from street containers, eg bottle banks;
- collection of household waste and subsequent separation of recyclable materials from the residual waste stream using a 'dirty' Material Recovery Facility (MRF);
- collection of co-mingled dry recyclable material and subsequent sorting into waste streams at a 'clean' MRF; and
- source segregating dry recyclable material with basic sort line for plastics and metals and all other material sent directly to a bulking point or transfer station before being sent to a reprocessing facility

Different collection systems require differing resources. The main components include receptacles, collection vehicles, labour and sorting facilities.

2.1.1. Collection bins

Kerbside dry recyclables can be collected in crates, sacks or mobile garbage bins (MGBs). MGBs are generally of 240 litre capacity, although bins of 360 litre capacity have been used. In practice, each collection receptacle lends itself to either source segregated or co-mingled collection. Crate-based systems tend to be used for source segregation as they can be effectively sorted at the kerbside by operators. MGBs can be adopted for both source segregated collections and co-mingled collections, if complementary collection vehicles are used. Across Europe many councils have adopted a kerbside source segregated MGB approach. Sacks have generally been used for co-mingled collections.

[1] "Future Perfect – An Analysis of Britain's Waste Production and Disposal Account, with Implications for Industry and Government for the Next Twenty Years", BIFFA, 2002.

2.1.2. Collection vehicles

Different vehicles are required for source segregated collections and co-mingled collections.[2] Source segregated collections generally deploy either 'stillage' or 'kerbsider' vehicles. Stillage vehicles are small and can carry approximately 4 tonnes of recyclable material. The vehicles consist of a series of stillage compartments which can be removed from the vehicle for unloading. Materials are source separated and sorted into the stillage compartments. This method generates a high quality of material, with contamination levels generally being low.

Kerbsider vehicles tend to be larger than the stillage vehicles. The main body of the vehicle is split into sections by vertical dividers. On the side of the vehicle are a series of troughs into which operatives sort recyclable materials. Once full, the operatives engage the hydraulic lifting mechanism which lifts the troughs to the top of the vehicle where the materials are tipped into the designated compartments in the vehicle's body. No compaction occurs, although some glass breaks into fragments on impact. This process maintains the segregation achieved by manual collection and sorting and, therefore, produces a high quality of recyclable material.

Compaction vehicles are used for collection of co-mingled dry recyclables and in some instances collection of material from multiple source segregated MGBs. These vehicles range from 1-2 tonnes up to approximately 26-28 tonnes. The vehicles incorporate a hydraulic packing mechanism which compacts material to optimise the waste collected on each round. Experiments to separate materials on board have resulted in maintenance problems, mainly associated with the independent packing mechanisms. Materials generally remain co-mingled, therefore.

2.1.3. Staffing

Source segregated collection using kerbside boxes requires a number of operatives to manually collect the boxes and sort the collected waste streams into different compartments of the stillage or kerbsider collection vehicles. Typically at least a driver and two runners are required. In comparison, staffing levels for co-mingled MGB collections or collections of multiple source segregated MGBs are lower as a hydraulic side loader can be used. In some instances only a driver is required whilst a driver plus one runner is common.[3]

Collection costs for co-mingled recyclables are generally lower than for source segregated collection. A report for the Australian National Resources and Waste Forum by Eunomia Research Consulting[4] concluded the following costs (in 2002 prices) for kerbside co-mingled and source segregated collections under a 'high recycling' scenario:

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[2] Surrey Waste: http://www.surreywaste.info/docs/pdf/JMWMS06pdf/SR4.pdf

[3] "Getting More from Our Recycling Systems - Assessment of Domestic Waste and Recycling Systems", DEC NSW, 2004.

[4] "The Legislative Driven Economic Framework Promoting MSW Recycling in the UK", Eunomia Research and Consulting, 2002.

- $NZ 273 per tonne ($NZ 76 per household) for source segregated box collections;
- $NZ 175 per tonne ($NZ 54 per household) for co-mingled collection.

Note that these costs are only for collection and do not include sorting costs.

2.1.4. Sorting

Once dry recyclables have been unloaded from the collection vehicles, some additional handling is required before the materials are dispatched for reprocessing. Kerbside sorted collections require limited sorting. This may include simple storage before loading into a vehicle for transport to a reprocessing facility, eg newspapers and magazines. Some further sorting of plastic, steel and aluminium cans may be required after kerbside source segregated collection using a basic MRF process.

Co-mingled materials will require full sorting of specific waste streams at a MRF before materials are stored or baled and sent for reprocessing. Table 1 below illustrates the increased sorting costs when the inputting waste stream is co-mingled.

Table 1: MRF costs per tonne for different kerbside collection systems (UK, 2002 prices)

	MRF Co-mingled Input	MRF Source Segregated Input
Annual costs ($NZ / t)	$112.60	$28.88
Material revenue ($NZ/ t)	$78.12	$123.02
Costs net of revenue	$34.48	-$91.60
Disposal costs	$22.04	$0.82
Total costs per tonne	$56.61	-$90.78

Source: Eunomia report for the National Resources and Waste Forum (UK), 2002.

Table 1 illustrates the variance in MRF costs between the two systems. The results are unsurprising given the reduced sorting required after kerbside segregation. In addition, the higher contamination levels associated with co-mingled collection increases the disposal costs considerably compared with source segregated collections.

Privately owned and operated MRFs charge a 'gate fee' per tonne for processing material. The gate fee charged is based on the costs for sorting input material net of the material revenues that can be achieved from sorted commodities. Contamination levels will influence the per tonne value of input and thus higher levels of contamination are reflected in a higher gate fee. In New Zealand, MRFs do not typically operate separately from the collection systems, but tend to be integrated operations.

A significant factor influencing the cost of a MRF is the fraction that requires separation. A high level of sorting requires significant investment in capital intensive technologies. Automated sorting of waste fractions such as glass fines, rather than using manual labourers to sort by hand, is only viable if sufficient throughput allows economies of scale and thus required per tonne processing costs to be achieved. Australia's largest fully automated MRF was recently opened and has the ability to process approximately

300,000 tonnes per annum. This process capacity is required to generate cost efficiencies given the high capital investment of AU$18 million.[5]

2.2. New Zealand experience

Approximately 80% of New Zealand households have access to kerbside recycling collections. There are a range of methods by which local authorities collect, process and recycle material that would otherwise be disposed of as household waste. Most kerbside recycling systems are crate-based, source segregated, including those used in Auckland and Manukau City Councils. The notable exceptions to this are the partial co-mingled system employed jointly by the North Shore and Waitakere City Councils and the full co-mingled system employed in the Timaru District.

2.2.1. North Shore and Waitakere

North Shore and Waitakere cities have a combined population of close to 400,000, consisting of 134,000 households. From 1 July 2005 they ceased using an open crate-based, segregated collection and switched to a co-mingled kerbside recycling collection using 140 litre MGBs. This collection is carried out by Onyx, who previously had this responsibility for Waitakere City. Excluding paper, which continues to be collected separately, the amount of material collected has increased in the North Shore from 7,622 tonnes in 2004-05 using an open crate system to 8,534 tonnes in 2005-06. This is a 12% increase. In Waitakere the total amount of kerbside recyclables collected, excluding paper, increased from 6,758 to 8,774 over the same period, a 30% increase. It is likely that a significant proportion of this increase is owed to the shift in collection system.

Although for most individual materials the increased collection from co-mingling has led to an increase in the amount collected, glass is a notable exception. Although there has been an increase in glass collected, a significant proportion of this has not yet been sorted for reprocessing. This is because of the rate of breakage that occurs causing many pieces of glass to become too small to effectively sort into the different colours: green, brown and clear.

Because of the design of the collection and sorting process used by Onyx, breakage occurs not only when the glass is deposited into the truck and compacted, but also when the trucks are emptied at the MRF. At this point, the trucks empty their loads onto a concrete surface, causing more breakage. The material is then moved around with a front-end loader, contributing to further breakage, before being loaded onto a conveyor belt from which the different materials are manually sorted. Eight or nine people operate at a conveyor belt carrying out a 'positive pick', where recyclable items are gathered from the belt. Although people are able to pick out larger pieces of broken glass, in practice it appears that often only whole bottles are gathered because of the speed of the conveyor belt. According to Jon Roscoe, Solid Waste Manager at the Waitakere City Council, the methodology currently adopted by Onyx in both compaction levels and delivery to conveyor differs from what was both proposed and accepted. Correspondingly, the total 'loss' of glass from breakage, is estimated at

[5] Visy Recycling website: http://ww2.visy.com.au/

upwards of 25 - 30% of the total glass collected. Therefore, despite an increase in the total amount of glass collected, the amount that has been sorted for recycling has actually decreased, as shown in Table 2.

Table 2: Estimated glass collection and recycling, North Shore and Waitakere (tonnes)

	2004	2005	2006
Collected	12,800	15,000	16,300
Unsorted	-	3,000	6,000
Total recycled	12,800	12,000	10,300

Source: O-I New Zealand.

Consequently, a significant amount of the glass collected is not currently being recycled. Instead, it is being stockpiled with a view to recycling it by way of an alternative use, such as for roading or drainage. According to industry sources this stockpile may contain around 9,000 tonnes of glass, along with an unknown volume of non-recyclable contaminants. For the glass in this stockpile to be suitable for alternative uses it is likely to require further sorting to remove contaminants which would incur costs and take time.

There is a financial penalty for glass, or any other recyclable material, that is sent to landfill rather than recycled. If this stockpile of glass were to be landfilled, not only would Onyx face the associated landfill charges, but it would also lose the per tonnage revenue it receives for kerbside collection for every tonne that is instead landfilled. Thus, there is an incentive for Onyx to find alternative uses for this glass.

According to Onyx, alternative uses for the glass have been sourced, the steps needed to sort and process the glass have been identified and it has begun carrying them out. However, the potential costs involved with separating the glass from other contaminants along with processing or crushing the glass to allow it to be used for roading and drainage, give rise to uncertainty surrounding when, and if, this glass will be recycled ultimately, especially because the value of recovered glass used in roading and drainage is low.

Another factor which may be have a bearing on Onyx's incentives to prevent breakage and sort glass by colour, is the ability to sell sorted glass cullet for recycling at the O-I plant in Penrose. There is limited capacity for re-processing glass cullet, in particular green glass. This means that there may be a surplus of glass collected nationally from kerbside recycling above that which can be re-processed into glass bottles.

O-I's response options to this capacity constraint are reducing the price it will pay for glass cullet (which it has once already) and/or setting quota for the amount of green glass that it will buy from contractors. Our understanding is that O-I limits clear glass by price but green glass by quota. If there are limits to quota exchange or high prices for quota in secondary markets, Onyx may face constraints to its ability to sell its material and may consider it not worthwhile to sort all of its glass.

If this capacity constraint is part of the reason why so much of the glass collected is allowed to break and remain unsorted, this problem could be alleviated, at least partially, if and when O-I expands its recycling capacity. O-I New Zealand intends to invest in a third glass furnace which could increase its ability to recycle green glass by approximately 50% above the existing capacity. This furnace was scheduled to become operational later this year but has now been deferred for a minimum of twelve months due to capital cut-back across the O-I Group worldwide

2.2.2. Timaru

Timaru district has a population of around 50,000, consisting of approximately 19,000 households. The recycling collection in the Timaru District is operated by Envirowaste and is perhaps the only full co-mingled system in New Zealand. This system was phased in from July to September, 2006. Trials previously undertaken in Timaru had indicated that moving from a weekly, crate-based collection to a fortnightly, MGB collection would substantially increase the quantity of material collected.

Because the costs involved in transporting glass to O-I in Auckland are prohibitively high, the glass collected is not sorted by colour, but is separated from the other materials for the purpose of being crushed and used in roading and drainage. Although work has begun on utilising this glass for these end uses, the precise technology and operation of the systems used to crush the glass and remove contaminants, have not been finalised. This is important because the contamination of crushed glass hinders its usefulness for these alternative uses. Additionally, the amount of glass that is required for these uses has also not yet been determined as the Council may be required to introduce requirements regarding the use of glass in roading and drainage to ensure glass is put to these uses.

As well as paper contaminating glass, some of the glass shards broken off during collection become lodged into the paper that is also collected in the bins. These shards contaminate the paper and degrade the quality of the recovered paper to some degree, although the Timaru District Council has suggested that the level of contamination is reasonably low and within internationally acceptable standards.[6] There is some manual sorting of materials, but the sorting process at the Timaru MRF is more highly automated than the MRF for the North Shore and Waitakere City Councils. Other salient features of the collection system include the use of relatively large collection trucks with relatively low compaction rates.

2.2.3. Auckland and Manukau

Auckland and Manukau cities have a combined population of around 730,000, consisting of approximately 237,000 households.

Volumes collected in the source-segregated, crate-based collection operated by Streetsmart in both Auckland and Manukau have increased in recent years. For

[6] Note that international standards would tend to be based upon a large proportion of co-mingled collections that typically lead to higher contamination or 'loss' rates.

instance, in Manukau the total amount collected from kerbside, including paper, has increased from 13,913 tonnes to 20,048 tonnes over the past five years. The crate-based collection, excluding paper, has increased from 6,474 to 8,969 tonnes. In 2006, the quantity of material collected, excluding paper, increased by 7% from 2005, with the collection of glass alone increasing by 8% during this period.

The total amount of glass collected and recycled in both Auckland and Manukau combined has increased in recent years, as shown below in Table 3.

Table 3: Estimated glass collection and recycling, Auckland and Manukau (tonnes)

	2004	2005	2006
Collected & recycled	22,500	26,400	28,600

Source: O-I New Zealand.

2.3. International experience

The results from different recycling systems used in other countries provide useful information regarding various issues surrounding different systems, especially the volume of material collected and the quality of the material collected that is available for reprocessing/recycling.

This section details a number of studies focused on international recycling practices and their implications for diversion of dry recyclables from the residual waste stream.

2.3.1. United Kingdom

The UK Government has set legal targets for local authorities in England to deliver a national recycling and composting rate of 25% by 2005/6. This target is set to increase to 33% by 2015.[7]

Many waste collection authorities (WCAs) have moved towards co-mingled collection of dry recyclables, with a subsequent increase in household recycling rates. The shift towards co-mingled collection has often been through an alternate week collection system with residual waste collected one week and dry recyclables collected the following week. An alternate week approach effectively limits households' residual waste capacity, thus providing an incentive to recycle. Accompanying communication and recycling promotions have also aided increases in diversion levels.

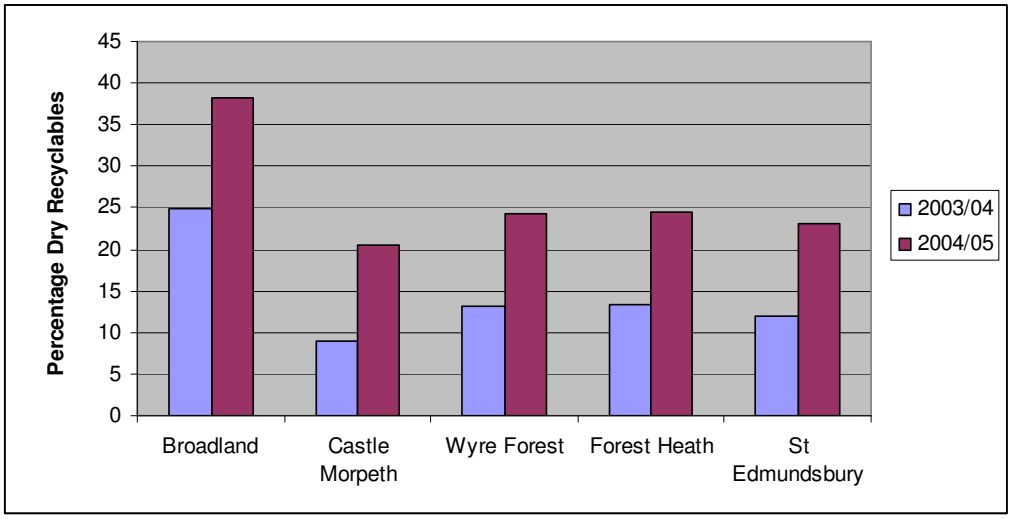
Local authority performance is measured against a statutory set of indicators known as Best Value Performance Indicators (BVPIs). Performance standard BVPI 82a measures the percentage of household waste recycled (excluding organic waste which is measured under BVPI 82b).

Based on weight of recyclable materials collected, only one of the ten top performing authorities operates a source segregated system. One uses a full co-mingled system and the others use co-mingled systems that separate or exclude glass. Figure 1 below

[7] Environment Agency England and Wales website: http://www.environment-agency.gov.uk

illustrates the five authorities that experienced the largest percentage change in tonnes of waste sent for recycling (BVPI 82a) between 2003/04 and 2004/05.

Figure 1: WCAs with the greatest percentage increase in tonnes recycled between 2003/04 and 2004/05



All of the authorities with the exception of Wyre Forest had implemented alternate week co-mingled dry recyclable collection services. Wyre Forest operates a twin box source segregated service.

2.3.2. Australia, 2001 Study

The National Packaging Covenant Council commissioned Nolan-ITU Pty Ltd in association with SKM Economics in 2001 to undertake a study of kerbside collection and recycling systems for used packaging materials in Australia.[8] The study was based on information collected and collated from about 200 Councils across the country, representing 12 million people. As part of the study, the volumes of dry recyclables collected from different recycling systems were assessed. Note the volumes detailed in Table 4 are gross, ie inclusive of contaminants. The study assessed the following recycling systems:

- System 1 - Crate based weekly collection of dry recyclables – containers MRF sorted;
- System 2 - Crate based weekly collection of dry recyclables – containers kerbside sorted;
- System 3 - Co-mingled 'mobile bin' collected fortnightly;
- System 4 – 2 separate mobile bins: one for paper, one for containers, both collected fortnightly.

On an absolute and percentage basis, System 4, separate mobile bins, yields the greatest level of recyclable material diversion from the residual waste stream. The study found that a co-mingled fortnightly collection approach yielded lower levels of diversion than

[8] "An Independent Economic Assessment of Kerbside Collection and Recycling Systems for Used Packaging Materials in Australia", National Packaging Covenant Council, 2001.

a crate based system. This appears to be in contrast to much of the literature reviewed so far. Glass and paper represent between 90 and 95% of the recyclable material by weight. Figure 1.

Table 4: Kg collected per household per year using different collection methods

Recycling System	1	2	3	4
Paper and Card	101	112	90	200
Glass	65	55	48	91
Aluminium	1	1	1	1
PET – eg plastic drinks bottle	5	4	4	6
HDPE – eg milk containers, juice bottles	3	2	3	3
LPB – eg milk and juice cartons	1	1	1	0
Steel Cans	4	4	5	5
Recyclables Total	180	179	152	306
Residual	851	794	938	636
Total	1031	973	1090	942
Percentage of Total Recycled	17%	18%	14%	32%

Source: National Packaging Covenant Council, 2001.

Figure 2 details the weights collected by each of the recycling collection systems.

Figure 2: Volumes of glass and paper collected using different collection methods

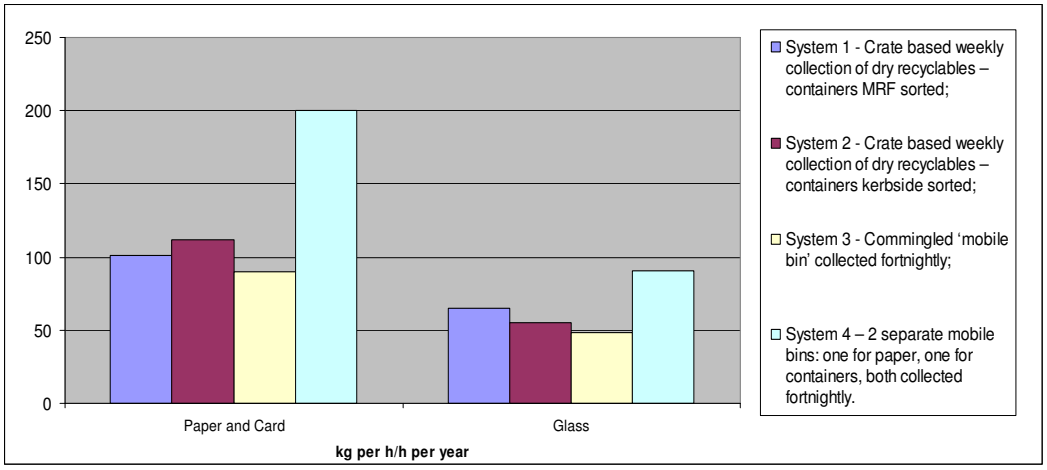


Figure 2 highlights the considerably higher volumes of paper/card and glass collected using System 4. The co-mingled fortnightly collection using a MGB (System 3) yields the lowest volumes of paper/card and glass.

2.3.3. New South Wales, Australia, 2004 Study

A similar study in 2004 focused on NSW recycling systems. The study, commissioned by the NSW Jurisdictional Recycling Group and the Publishers National Environment Bureau, assessed the technical, financial, environmental and social costs and benefits associated with different domestic waste management and recycling systems inclusive of collection and processing. The study collected a comprehensive data set on the

operational performance of a number of recyclables collection systems including recovery rates, quality rates, market values and financial costs and concluded:

"…based on the latest available recycling and waste generation data, recyclables diversion is highest for the kerbside recycling system employing fortnightly collection of commingled containers in a Mobile Garbage Bin (MGB) and fortnightly collection of paper cardboard in a separate MGB. Relatively high yields are also achieved through fully commingled recycling collections and also through crate systems (which have the lowest contamination rates)."

The recycling systems studied included:

- 'Baseline' – co-mingled recyclables (containers plus paper/cardboard) collected fortnightly in 240 litre MGBs;
- 'Scenario B - recyclables collected fortnightly in two separate 120 litre MGBs (co-mingled containers collected in one MGB, paper/cardboard collected in the other); and
- 'Scenario E' – recyclables collected weekly in two kerbside crates. Co-mingled containers collected in one crate, paper/cardboard collected in the other.

The study found metropolitan recyclable diversion rates highest for Scenario B—on average 33% of the residual waste stream. Examples of such systems can be found in Lane Cove and Manly local government areas. The second highest diversion rates were found in the 'baseline' scenario with a rate of 24% of the residual waste stream. Scenario E diversion rates were found to be 22% on average. The relative effectiveness of recycling systems differed between this study and the similar 2001 study detailed in Section 2.3.2.

Contamination levels between these three systems are detailed in Section 2.3.6.

2.3.4. Quality of materials available for reprocessing

The general perception in the waste management sector is that co-mingled collection of dry recyclables results in lower quality material sent for reprocessing because of contamination, including broken glass. This section details literature from a range of countries. Efforts have been made to select studies commissioned by government, industry bodies and independent consultants. Contamination levels for specifically the glass and paper waste streams are considered in more depth in Sections 2.3.9 and 2.3.10.

2.3.5. Australia, 2001 Study

The 2001 Nolan-ITU Pty Ltd/SKM Economics report for the National Packaging Covenant Council (referenced in Section 2.3.2) also assessed contamination levels across recycling systems. Levels of contamination in each of the collection containers are presented for the same four recycling systems. To recap, these were:

- System 1 - Crate based weekly collection of dry recyclables – containers MRF sorted;

- System 2 - Crate based weekly collection of dry recyclables – containers kerbside sorted;
- System 3 - Co-mingled 'mobile bin' collected fortnightly;
- System 4 – 2 separate mobile bins: one for paper, one for containers, both collected fortnightly.

Note that for System 4 contamination levels are presented for each of the mobile bins. The study also excluded paper contamination for Systems 1 and 2. Table 5 below details the percentage of materials lost due to contamination for each of the recycling collection systems.

Table 5: Percentage of material lost through contamination under different recycling systems (Aus)

	1 (co-mingled crate - paper excluded)	2 (segregated crate - paper excluded)	3 (full co-mingling)	4 (co-mingled MGB containers)	4 (MGB paper)
Newspaper	0	0	21	0	8
Mixed Paper	0	0	21	0	8
Glass	14	5	21	13	0
Aluminium	0	0	1	0	0
PET	0	0	1	0	0
HDPE	0	0	1	0	0
LPB	0	0	1	0	0
Steel Cans	0	0	1	0	0

Source: National Packaging Covenant Council, 2001.

The table indicates the higher levels of contamination that occur with co-mingled collections compared to source segregated collections. For example, 21% of newspaper, 21% of mixed paper and 21% of glass collected in a single co-mingled mobile bin cannot be sent for reprocessing. Partial co-mingling of containers results in 14% and 13% losses of glass for crates and bins respectively. In comparison, only 5% of glass that is manually sorted at the kerbside was found to be contaminated.

2.3.6. New South Wales, Australia, 2004

The 2004 NSW Jurisdictional Recycling Group and the Publishers National Environment Bureau study (see also Section 2.3.3) considered levels of contamination between different recycling systems. The study was focused primarily around the Sydney Metropolitan Area where co-mingled and source segregated recyclable collections are found in similar numbers.

The co-mingled recyclable container system (the 'baseline' scenario outlined in Section 2.3.3) yielded 233kg per household per year. The two crate recyclable system (Scenario E) yielded approximately 213kg per household per year. However, levels of contamination were very different. The co-mingled system had a rate of contamination of the recyclables stream of 17% compared to 4% for the crate system. Therefore, based

on the yields from the two systems, after accounting for contamination levels the following volumes could be sent for reprocessing:

- from co-mingled recyclable collection (the study's baseline) approximately 193.2kg per household per year; and
- from source segregated recyclable collection (Scenario E) approximately 204.9kg per household per year.

The system resulting in the highest volume of material available for reprocessing was from fortnightly collection of recyclables in two separate 120 litre MGBs, co-mingled containers collected in one, paper/cardboard collected in the other (Scenario B). The study found average diversion rates of 320kg per household per year. Contamination rates for Scenario B were found to be 7% resulting in a net volume available for reprocessing of 297.6kg. This value is significantly greater than the baseline and Scenario E.

To reflect the study's findings the NSW Department of Environment and Conservation released guidance specifying the preferred minimum service levels for kerbside resource recovery. The Department's first preference is for two 120 litre mobile bins for paper/cardboard and containers, collected on alternate weeks. As a second preference, department guidance specifies one 240 litre mobile bin to collect co-mingled dry recyclables, collected fortnightly.

2.3.7. Glass Compaction Study, Australia

A study of the impacts of compaction rates in collection vehicles on glass breakage and glass value, found that in ideal conditions with low compaction rates (120 kg/m^3), 34% of glass is broken;[9] the breakage rate increases by 2.9% for every 10kg/m^3 above this level. In Australia, many collectors have increased compaction rates to as high as 195 kg/m^3 because of the reduced costs from lower truck requirements. The study found that loss rates for glass were higher in container only collection systems (with an average breakage rate of 48%) than in fully co-mingled collections.

2.3.8. Industry Study, UK

A 2002 report by Biffa cites a study by the European Recovery and Recycling Association, which analysed contamination levels for dry recyclable collection schemes across a range of European cities. The study highlights the increased levels of contamination associated with kerbside co-mingled collection compared to kerbside separation, see Table 6. Contamination levels given are for packaging fractions only and refer to the residue left after collection and sorting.

[9] APrince Consulting (2005) Glass Compaction Study for NSW Jurisdictional Recycling Group.

Table 6: Percentage of material lost through contamination

	Contamination (%)
Bring Container Co-mingled (non-kerbside)	
Breda (Netherlands) – high rise	56
Barcelona (Spain)	41
Prato (Italy)	35
Kerbside Bin Co-mingled	
Breda (Netherlands) – low rise	32
Dunkirk (France)	27
Kerbside Box Co-mingled / Separated	
Dublin (Ireland)	5
Adur (UK)	8

Source: European Recovery and Recycling Association.

2.3.9. Glass Recycling

The American Glass Packaging Council states that to maximise glass recycling a system needs to be in place which, "results in color separated, contaminant free glass."[10] There are two main types of contamination in glass cullet (recycled container glass): the wrong colour of glass (eg green in a batch of clear glass) and a wide range of contaminants such as ceramics, stones, metals, wood, needles and syringes and non-container glass. The level of contamination is dependent on the method of glass collection.

The Italian Glass packaging collection council (COREVE) aims to maximise recovery and recycling according to the EU Directive 12/2004. COREVE undertook a study in 2004 on contamination levels associated with different collection systems. Table 7 below summarises the study findings.

Table 7: Glass contamination levels between different collection systems

	1	2	3	4
Materials Collected	Glass, Metals and Plastics	Glass and Metals	Glass and Metals	Glass
Collection system	Street Containers (mainly 4 wheels)	Mobile bins at household kerbside	Bottle Banks	Bottle Banks
% materials different from glass in the container	27.2	9.9	4.5	1.8
% contaminants residual after the sorting treatment of glass (comprising glass lost)	52.8	28.6	12	5.8
% of collected glass that can be sent for reprocessing	64.8	79.2	92.1	95.8

Source: COREVE 2004

Table 7 indicates that between 65% and 96% of total collected glass can actually be sent on for reprocessing. COREVE's analysis concluded that the optimal system, from a reduced contamination perspective, is a single stream based system using bottle banks as the collection method. A low level of glass contamination was also found in option 2

[10] American Glass Packaging Institute website: http://www.gpi.org/why/

which involved a co-mingled collection of glass and metals from MGBs. The highest levels of contamination were found in co-mingled collections using 4-wheel street containers.

Glass contamination also occurs when unwanted colours are found in single colour glass collections. Levels of colour contamination influence the price reprocessing plants will pay for glass. In the UK, glass manufacturers place the highest value on clear glass due to its scarcity in the recycled waste stream and the demand for clear glass in the UK reflecting the glass production mix (eg gin and scotch production as opposed to wine). Completely mixed glass cannot be used in the container re-melt industry, where colour purity is vital, but must go to alternative uses. This has led to controversy within the industry over the usefulness of mixed collections. In recent years some companies have developed colour sorting equipment in order to combat contamination by other colours. Some collectors will also take mixed glass as well as colour separated.

2.3.10. Paper

Recovered paper can be used as a feedstock for paper mills or exported for use overseas. In the UK there has been a trend in recent years away from source segregated kerbside paper collection towards co-mingled collection. A 'Recycling Atlas' developed by Aylesford Newsprint[11] stated that between 2001/02 and 2003/04 the number of local authorities offering dedicated paper or paper and card collections fell from 117 waste collection authorities to 55.

An incentive driving waste collection authorities towards co-mingled collections is the increased volumes of material collected. With increased volumes, however, come increased concerns regarding levels of contamination. The UK Council of Paper Industries has stated its concerns regarding paper contamination:

"the paper industry is increasingly unable and unwilling to accept contaminated raw materials that will damage or slow down the papermaking process. If recovered paper comes into contact with food that has leaked from tins or bottles the fibres are damaged. The longer the length of contact, the greater the damage. The greater the damage, the lower the yield, and the poorer the quality of the finished product.

Shards of glass, metals, adhesives, plastics and grease damage papermaking equipment that cost hundreds of millions of pounds to install. They also lead to an inferior paper product that is unacceptable to customers."[12]

This view is reflected by the Confederation of European Paper Industries:

"The collection of paper along with other dry recyclables i.e. co-mingled collections is strongly discouraged and should be phased out as soon as possible."[13]

[11] "Recycling Atlas", Aylesford Newsprint, 2006

http://www.aylesford-newsprint.co.uk/ReportFiles/recyclingAtlas-EngWales.pdf

[12] UK Confederation of Paper Industries website: http://www.paper.org.uk/index.htm

[13] "Guidelines for Responsible Sourcing and Supply of Recovered Paper", CEPI, 2006.

Source segregated collections of paper in Europe have resulted in a range of per capita collection rates. For example, in the Lille district of France 50.6 kg of paper is collected per person per year from the kerbside. In Altenkirchen, Germany, where households have 240 litre containers for papers, 76.0 kg per person per year is collected.

2.4. Findings

A number of general conclusions can be drawn from the review of the experience of different collection systems. First, based on the majority of quantitative studies and qualitative commentary, co-mingled collections of dry recyclables are generally associated with higher weights of material collected from the kerbside although this is not always the case. This mirrors the experience of North Shore and Waitakere. The majority of UK based waste collection authorities diverting the highest percentage of material away from the residual waste stream operate co-mingled collections. However, a number of additional factors contribute to high recycling rates, including frequency of residual waste collections, public awareness and direct communications. Co-mingled collections are associated with high recovery rates. In comparison, source-segregated collections tend to yield lower levels of material but the difference in yield is not always substantial.

The second main finding is that source-segregated collections have much reduced levels of contamination, so that the proportion of material collected that can be reprocessed and recycled is higher than for co-mingled collections. Therefore, the comparative effectiveness of co-mingling will depend on how much increased kerbside volumes are offset by increased contamination levels. Waste collection authorities can help reduce contamination levels through awareness raising campaigns, advertising and penalties such as non-collection for households causing contamination.

However, when materials are co-mingled, there is a level of contamination that appears to be unavoidable, particularly the quantity of pieces of mixed glass, too small to be separated by hand sorting. This occurs when mixed recyclables are compacted in collection vehicles, leading to high rates of glass breakage. The level of compaction affects breakage and contamination rates, but even at relatively low levels there are significant quantities (approximately 30%) of small pieces of mixed broken glass.

The challenge for collection authorities' decision making is to understand the extent to which the competing factors of reduced collection costs and higher contamination and loss rates will impact in their locality. A 2004 NSW Department of Environment and Conservation study attempted to assess the full environmental costs and benefits of each recycling system in an effort to understand which system represented environmental 'best practice'. The assessment placed economic values on all resource and pollutant impacts associated with recycling systems and concluded that the highest net environmental benefit could be achieved through using two separate MGBs, one for paper and the other for containers. High net benefits were also found for a fully co-mingled collection system due to the high volumes collected. However, benefits associated with source-segregated, crate-based systems were only marginally lower despite reduced volumes collected because of the very low contamination rates. If these

results are robust, it must be remembered that that the net benefits of a co-mingled system involve a trade-off between lower collection costs and lower rates of glass recycling into glass manufacture.

3. Potential effects of co-mingling for Auckland and Manukau

The Auckland and Manukau City Councils are intending to cease operating source-segregated kerbside collections and instead adopt a co-mingled collection.[14] Instead of the existing 45 litre open crates, co-mingling would entail the use of closed MGBs, which could range in size from 80 to 240 litres. Given the larger bin size, collection frequency may be altered from weekly to fortnightly.

The use of a co-mingled collection system in Auckland and Manukau would not only have effects on the collection of recyclables from households, it would also affect the nature of downstream processing and recycling activities. The move to a co-mingled system would also necessitate a new MRF to sort the co-mingled material.

3.1. Positive effects

There are four main advantages of a co-mingled system: reduced costs, a potential increase in the amount of recyclables collected, a likely improvement in operational health and safety and a reduction in litter.

3.1.1. Reduced Collection Costs

The experience of the Waitakere and North Shore Councils is that bids involving co-mingling were lower cost than those involving crate-based, kerbside-separated systems. This is likely to continue, although it will also be revealed through appropriate tendering processes.

3.1.2. Increase in household recycling

The experience of North Shore and Waitakere, along with international evidence, suggests that more material would be diverted from the residual waste stream and put out for collection. To some extent this may be simply because MGBs are larger than existing 45 litre crates. Although households are currently entitled to up to three crates, many households are unaware of this. Additionally, because of the lifting involved, the elderly or infirm may be less inclined to place all of their recyclables in the crates.

A survey of household waste undertaken by Manukau City Council indicates how much additional recyclable material potentially could be collected if there were complete compliance with recycling guidelines, see Table 8.

Of this material, some of the glass may be already broken so that some portion of this would not be able to be recycled. Likewise, much of the paper may be 'contaminated', for example heavily covered in organic food scraps and/or wet. Paper may also be used to wrap up unrecyclable broken glass, particularly if plastic bags are used for rubbish collection instead of bins. To the extent that broken glass and contaminated paper are

[14] Update on Resource Recovery and Collection Methods for Kerbside Recyclables, Works and Services Committee, 24 October 2006.

collected via a MGB this may be included as material diverted from the waste stream, although some of this additional material collected is not likely to be recyclable, and some of it will be more difficult and expensive to reprocess.

Table 8: Recyclable material currently disposed in household waste (Manukau, 2002 - 2006)

Material	Average amount (kg/week)
Glass	0.24 – 0.34
Paper	1.45 – 1.91
Plastics	0.16 – 0.21
Metals	0.24 – 0.26
Total	2.09 – 2.72

Source: Manukau City Council

Based upon the Manukau survey figures, the additional glass collected from a co-mingled system in Auckland and Manukau could be in the vicinity of 2,000 tonnes. This assumes that only half of the glass, paper and other materials potentially recyclable are recovered, either because of contamination or continued non-compliance by some households. This compares with 28,600 tonnes of glass collected from these areas in 2006. The additional paper collected could be around 10,000 tonnes, in addition to 1,000 tonnes of plastics and 1,500 tonnes of metals.

3.1.3. Health and safety

A number of injuries occur each year in relation to recycling collection, typically from lifting recycling crates and handling the material itself. In a small number of extreme cases injuries have been fatal, typically from traffic-related accidents or the incorrect operation of machinery. A reduction in staffing and increased automation of the collection system, particularly those functions that currently require out-of-vehicle roadside activity and lifting of crates, could reduce the risk of such accidents and injuries.

Health and safety issues appear to be a significant motivating factor in the shift towards greater use of co-mingling collections.

3.1.4. Litter

Surveys of litter carried out by Waitakere City Council, where litter has been a large issue in recent years, have shown that prior to the introduction of co-mingled collection in 2004, recyclable bottles and cans amounted to 28% of litter. This proportion dropped to 10% in 2005 after co-mingling was adopted. This suggests that a move away from open crates to closed MGBs would reduce litter for Auckland and Manukau also. If a full co-mingled system were to be introduced, this would be expected to have some positive effect on reducing the amount of paper litter although the magnitude of this effect is difficult to predict.

3.2. Negative effects

The main drawback of a co-mingled collection system is that the quality of some of the materials collected (glass and, if full co-mingling, paper) for recycling are of lower quality. Some proportion of these materials is likely to be unrecoverable. The use of larger and covered bins (MGBs) can lead to a greater level of contamination in the material collected because of the ease of including additional materials. And higher rates of in-vehicle compaction increase glass breakage and subsequent contamination, both of the glass and other material streams. These factors all work to raise the costs of the recovery of recyclable materials because of increased downstream sorting costs or lead to lower revenues from some materials.

3.2.1. Glass

As a result of breakage, a lower proportion of the glass collected is likely to be usable for high-value recycling, and some may not be able to be recycled at all. Without certainty regarding either the ability to separate broken glass from contaminants or the ability to use broken glass for alternative uses, it is almost inevitable that a significant amount of the broken glass will need to be used for low value uses (while still requiring some additional processing) or even landfilled (particularly when the glass remains mixed with a range of non-glass contaminants). Although alternative uses are being investigated and pursued in some parts of New Zealand, particularly as hard fill, large scale alternative uses are not well established and a large scale, stable market for such glass does not appear to exist as yet. Even if they are, these uses are of low value in comparison to using glass in glass bottle manufacture. This is a concern if the rate of glass breakage is around 25 – 30%, or possibly higher, as is the case with North Shore and Waitakere. At these breakage rates, a co-mingled collection could lead to up to an additional 10,000 tonnes of glass per year being unsuitable for recycling by O-I. This would more than offset any increase in additional glass collected at kerbside.

Attempting to sort broken glass by colour would be considerably more difficult than the present kerbside sorting at source, followed by processing at a MRF, and would be likely to add substantial costs if the historical rate of recovery and recycling were to be maintained. Sorting can be done manually for whole bottles and large fragments, or mechanically for smaller pieces. Machinery using optical sensor technology that would enable sorting down to 10mm would cost upwards of $10 million and is likely to require around 100,000 tonnes per year to be financially viable.[15] By comparison the total amount of glass recovered throughout the entire country is currently around 93,000 tonnes.

Alternative uses for glass, rather than being recycled back into new glass bottles, means more glass must be produced from raw virgin materials. This requires more energy and more raw materials than if glass is recycled from cullet. This increased need for the production of raw materials also means that there are more negative externalities associated with these processes, for instance a higher level of carbon emissions.

[15] $10 million at a 10% cost of capital spread over 10 years would cost $16/tonne for 100,000 tonnes or $54/tonne for 30,000 tonnes (approximate volume recovered in Auckland)

3.2.2. Paper

Full co-mingled collection would contaminate the paper with other materials, particularly shards of broken glass and foodstuffs from unclean bottles and tins. This would reduce the quality of the paper and increase the costs involved with sorting and reprocessing the paper. If the quality of the recovered paper were to drop by about $10 per tonne, this could lead to a loss in value of over $200,000 per year, based upon estimates of the amounts currently recovered.

3.2.3. Costs of bins

The larger MGBs used in co-mingled collection are more expensive than the existing 45 litre crates. Switching to 140 litre MGBs as used in the North Shore and Waitakere would cost around $10 million.

3.2.4. Contamination with Non-Recyclable Materials

The dumping of non-recyclable material in MGBs can be a problem with co-mingled collections, unlike with source segregated collections where contaminants are not collected. However, Waitakere and North Shore City Councils suggest that the level of overall contamination is relatively low. This may be because households have previously been 'trained' with crate-based kerbside systems where immediate feedback is provided to households if incorrect materials are placed in crates. When MGBs were introduced in the North Shore after two months the contamination rate from non-recyclables was 15% although this subsequently fell to 4% after a year of operation. In Waitakere, the contamination rate is estimated to be around 6%.

3.3. Can Loss Rates be Improved?

A key consideration with a co-mingled collection is how to reduce the losses in recoverable materials, either caused by glass breakage or the contamination of glass itself. Factors that can influence the rate of loss include contract design and the specific design of the collection and sorting systems.

3.3.1. Contract Design

The financial incentives faced by a contractor can be aligned with the relevant overall objectives of local authorities or of government policy, which in general terms is to achieve targeted levels of waste diversion at the least possible cost.

This is achieved through ensuring that the contractual obligations include diversion to recycling and that the contractor obtains the revenues for the materials. In Waitakere and North Shore the contractor is storing materials for recycling at a later time. Whereas, there will always be a need for some need for some storage, particularly if markets are uncertain, at some stage temporary storage becomes a long run disposal route. Controls over storage lengths might be a useful component of contract design.

The choice to collect glass cullet for later use in glass manufacture then becomes a financial decision in which the value in this high end use is balanced against the additional collection and handling costs to ensure its quality versus value in other low

value end uses. For its part, O-I can ensure greater amounts of diversion through price, limited by the costs of alternative raw materials and physical capacity.

It is likely that contract design can be used to tackle most of the problems currently encountered, assuming that bidders are aware of the local and international experience and are given freedom over the collection method used. It requires councils not to specify co-mingling but give operators freedom of choice over collection methodology.

3.3.2. Improved Systems

Even if incentives are aligned as outlined above, several factors could prevent such incentives from operating effectively. For instance, any capacity constraints that apply to the recovery of a particular material could limit the incentive on contractors to undertake costly sorting activity. This is particularly relevant with respect to glass, for which there is currently a capacity constraint that limits the amount of green and flint cullet that can be recycling into new bottles. Additionally, costs involved with minimising breakage or loss rates may be sufficiently high to outweigh any financial incentives from maximising the value of the recovered materials. For instance, the costs associated with establishing an automated sorting process using optical technology may be prohibitive.

To the extent that contractual incentives may not be sufficient, local authorities may consider it necessary to have greater control over the technology used for collection and sorting in order to ensure glass breakage is minimised. For example, lower compaction rates in collection trucks used in the North Shore and Waitakere could halve the rate of glass breakage. Similarly, a sorting process that avoids materials being dropped onto concrete surfaces and moved with a front-end loader could reduce glass breakage.

However, no system improvement would be expected to be sufficient to reduce loss rates to those that existed under source-separated, crate-based recycling systems. Co-mingling leads inevitably to reductions in the quantity of glass recycled into high value uses.

4. Conclusions

Compaction of co-mingled recyclable materials in collection trucks results in glass breakage. Using sorting methods currently available in New Zealand, small fragments of mixed glass, combined with other materials, cannot be separated into product streams that can be used subsequently in glass bottle manufacture. Some glass collected for recycling has to be used subsequently in low value end uses or landfilled.

A growing body of international experience is suggesting that these effects are not teething problems associated with a new system, but an unavoidable effect of combined co-mingling and compaction.

Given these effects, local authorities face difficult decisions when considering whether to use co-mingled or crate-based, source segregated kerbside collection systems. Despite a number of advantages of co-mingling, including reduced costs of collection and reduced risks of accidents for collectors, the disadvantages include reduced rates of glass recycling into glass bottle manufacture. Co-mingled collections have only recently been introduced in New Zealand and, in the experience of the North Shore and Waitakere City Councils, they have had significant problems with glass breakage which has led to serious concerns in parts of the recycling sector.

Over the medium to long run, if and when co-mingling is adopted in other locations, the concern is that, at best, a significant proportion of glass will be unsuitable for use in high-value recycling uses (glass manufacture) and, at worst, a substantial proportion of glass collected will not be able to be recycled at all. In either case, the value of the collected materials may be lower than in crate-based systems. The analysis of experience to date in New Zealand and abroad suggests that the concerns over lost value are justified. Were the experience of North Shore and Waitakere with glass breakage replicated in Auckland and Manukau, approximately 10,000 tonnes of glass per year would be unable to be recycled through existing uses; an even greater amount would be lost if co-mingling was used more widely in New Zealand. This is of concern given the uncertainty surrounding alternative uses to which this glass could be put. The extension of co-mingling to include paper raises similar concerns over contamination and quality loss.

This study has not assessed whether co-mingling is an optimal choice for a local authority or New Zealand as a whole. This involves weighing up disparate outcomes, eg diversion rates and health and safety impacts. Such an analysis is beyond the scope of this report.

The key finding of the analysis is that choosing to use co-mingling collection will result in reduced volumes of glass recycling into glass bottle manufacture.

An analysis of the optimal approach in the New Zealand context would be useful. However, in the absence of such an analysis, if co-mingling is still pursued, there are two recommended responses in contract design:

- better control over the outcomes; or
- ensuring that risks are fully passed on to contractors.

Greater control over outcomes would entail councils taking more interest in the detailed design of the collection, handling and sorting. In particular, it would involve taking steps to ensure optimal levels of in-truck compaction, handling of the materials at the MRF and the quality of the product that results or the market to which it will be diverted. It is possible that breakage levels can be reduced through changes to existing practices, particularly handling and compaction rates.

Ensuring that risks are fully passed on would, in contrast, involve the council stipulating a requirement for materials collected to be recycled (while giving no guidance on what markets they are to be recycled into), targeted levels of collection for recycling and limits on the time of storage prior to use in end markets.

Despite international shifts towards greater use of co-mingling, the experience to date does not demonstrate that it is necessarily the optimal choice. Councils in New Zealand should not proceed without a clear understanding of how the problems that have arisen in Waitakere and North Shore cities would be addressed and without a good understanding of the inevitable trade-off between reduced collection costs and reduced revenues from some material streams.