POTENTIAL AND STATUS OF RECYCLING AT CITY OF SUBIACO, PERTH, DETERMINED BY WASTE ANALYSIS

by

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Abstract The composition of collected solid waste in the City of Subiaco was determined prior to the introduction of kerbside recycling, and again after its introduction to assess the potential and status of recycling. The survey was conducted for two weeks each time at about the same time of the year two years apart. In each case one out of 35 mobile garbage bins was sampled ahead of the normal collection vehicle. The content of 200 bins (out of about 7000) was sorted into 17 components. Significant reductions in paper (13.5 tonnes/week) and glass (4.2 tonnes/week) was established from the results of the two surveys, and confirmed by the tonnages of collected recyclables. The waste analysis provided a quantitative picture of the amount of waste collected, potential and status of recycling, average participation rate by householders, frequency of bins containing particular recyclables, and therefore a useful tool in the management of solid waste and recycling program.

1 INTRODUCTION

An essential and important prerequisite to the management of solid waste is the quantification of the volume/weight and composition of the waste. Without the quantification it is impossible to determine whether the outcome of changes in management, such as the introduction of a recycling scheme, has been achieved.

Prior to the introduction of kerbside recycling at the City of Subiaco an analysis of the composition of council collected domestic solid waste was carried out to provide the baseline information on the waste. The same analysis was carried out two years after the introduction of the kerbside recycling scheme to determine the degree of recycling achieved.

This paper describes the methodology and the results of the analysis, and shows that properly carried out the analysis can provide a quantitative tool of waste management. Material balances can be obtained for major components of the waste despite the heterogeneous nature of the waste.

2 METHODOLOGY

Because solid waste put out for collection by householders is heterogeneous in nature, a minimum of 200 samples is required to obtain a higher than 90% (statistical) confidence of the results of major components of the waste (Musa and Ho, 1981). A total of 7026 bins were collected per week in the City and it was decided to collect one every 35 bins ahead of the collection vehicle, resulting in 200 bins being sorted.

Collection of the samples was by a separate truck with the content of each bin transferred to a plastic bag. Each bag was then weighed and sorted into 17 components.

Paper	1. Newspaper	Metals	9. Steel drink cans
	2. Other recyclable paper		10. Steel food cans
	3. Soiled/composite paper		11. Other ferrous metals
Food	4. Food waste		12. Aluminium drink cans
Garden	5. Garden waste		13. Other non-ferrous metals
Glass	6. Soft drink bottles	Plastics	14. Polythene plastics
	7. Beer bottles/flagons		15. Other plastics
	8. Other glass	Other	16. Wood, textile, rubber
			17. Ceramics, dirt and dust

After sorting each bin the components were weighed.

Each analysis was carried out for two weeks with the first carried out between 26 July and 8 August 1989, and the second survey between 22 July and 2 August 1991.

3 RESULTS AND DISCUSSION

3.1 Composition of Sorted Waste

A total of about 3.3 and 2.7 tonnes of waste was sorted in the first and second surveys respectively (Table I). The composition of the waste from the two surveys is similar to previous surveys conducted in Perth (Ho, 1983). One major difference has been in the increased amount of garden waste. This has been observed elsewhere with the introduction of 240 L mobile garbage bins.

Table I Summary of survey results

Components	1989 survey		1991 survey	
	kg	%	kg	%
Paper	830.6	25.2	675.3	24.7
Food	1105.8	33.6	650.7	23.8
Garden waste	493.0	15.0	749.1	27.4
Glass	267.8	8.1	135.8	5.0
Metals	121.5	3.7	90.1	3.3
Plastics	185.9	5.6	211.8	7.7
Wood, Textile, Rubber	94.1	2.9	93.1	3.4
Ceramics, Dirt, Dust	194.1	5.9	129.9	4.7
Total	3292.8	100.0	2735.8	100.0

3.2 Average Weight

The average weight of the content of bins was 16.1 kg in the first survey and 13.6 kg in the second survey. There has been a reduction of 2.5 kg in the average bin weight between the two surveys.

To illustrate the accuracy of the average weight figure a check with the total amount of waste collected was made.The total amount of waste calculated from the average weight in the second survey is (7026 x 13.6 kg) = 95.6 tonnes/week. This figure is higher than the total weight obtained from truck weighing of 89.1 tonnes/week for the first week of the survey period and 90.4 tonnes/week for the second week, but within the standard error of the average bin weight estimate (± 0.7 kg, see Table II).

3.3 Detailed Breakdown of Waste Components

Table II illustrates the statistical information that can be obtained from conducting a waste survey as described above. The results in Table II are for the second survey.

Table II.Statistical Summary — Subiaco Waste Survey July/August 1991

I	II	III	IV	V	VI	VII
Components	Wt kg	Weight %	Freq %	Ave. Weight kg/bin	St.Dev. kg/bin	St.Error kg/bin
Total Weight	2727			13.6	9.7	0.69
Paper						
Newspapers	127.9	4.68	40	1.6	2.1	0.15
Other Recyclable Paper	155.2	5.67	52.5	1.5	1.6	0.11
Soiled/Composite Paper	392.2	14.34	98.5	2	2	0.14
Food	650.7	23.79	95.5	3.4	2.8	0.2
Garden Waste	749.1	27.38	56.5	6.6	8.7	0.62
Glass						
Soft Drink Bottles	18.2	0.67	7.5	1.2	0.9	0.06
Beer Bottles/Flagons	14.8	0.54	7	1.1	1.4	0.1
Other Glass	102.8	3.76	61.5	0.8	1.1	0.08
Metals						
Steel Drink Cans	0.2	0.01	0.5	0.2	0	0
Steel Food Cans	49	1.79	65.5	0.4	0.3	0.02
Other Ferrous	24.6	0.9	30	0.4	0.7	0.05
Aluminium Drink Cans	9.8	0.36	43.5	0.1	0.2	0.01
Other Non-Ferrous	6.5	0.24	65	0.02	0.1	0.01
Plastics						
Polythene Film	80.9	2.96	97	0.4	0.3	0.02
Other Plastics	130.9	4.78	95	0.7	0.8	0.06
Wood, Textile, Rubber	93.1	3.4	64.5	0.7	2.3	0.17
Ceramics, Dirt, Dust	129.9	4.75	36.5	1.8	3.7	0.26
Total	2736	100.02				

Notes on statistical parameters of the waste analyasis:

Column I : Breakdown of waste into 17 components.
Column II: Total weight at the top of the column is the summation of sample weights before sorting, whereas total weight at the bottom of the column is a summation of component weights. Agreement between the two is excellent.
Column III: Weight percentage of each component.
Column IV: Frequency of occurrence is expressed as percentage of bins containing a particular component. E.g. for Newspapers - Only 40 % of bins analysed contained newspapers.
Column V: Average weight of component per bin for bins containing that component. E.g. for Newspapers - Average weight of newspapers in bins containing newspapers was 1.6 kg/bin.
Column VI: Standard deviation expresses the degree of variation of a particular component. The larger the standard deviation relative to the average the greater the variation. For example for Newspapers the average weight per bin was 1.6 kg and its standard deviation was 2.1 kg. This reflects the fact that some bins had very little newspapers, whereas the maximum weight recorded was 13.4 kg in one bin.
Column VII: Standard error expresses the confidence we can place on the average weight (Column V). The smaller the value the more accurate the estimate of the average. We have a 95% degree of confidence that the average value is within twice the standard error.

The statistical analysis provides not only a measure of the spread of the data for each component (standard deviation), but also a measure of the variation about the average figure (standard error) and the frequency of occurrence of a particular component in the bins.

3.4 Comparison between the Results of the Two Surveys

Comparison between the results of the two surveys is clearer when actual weights of components, rather than percentage composition, are used, because there has been a reduction in the total weight, and as well food and garden wastes could be expected to vary more than others (Table III).

3.4.1 Paper

Table III shows that for 'newspapers' and 'other recyclable paper' categories there have been reductions of 0.8 and 0.7 kg/bin respectively, making an overall reduction of 1.5 kg/bin or 10.5 tonnes/week.

Table IV reinforces the above observation in that the number bins containing newspapers decreased from 69 % in 1989 to 40 % of all bins in 1991, and of 'other recyclable paper' from 95 % to 52 %. Interestingly the weight of the paper category (newspapers, other recyclable paper and soiled/composite paper) in bins containing these components have not changed significantly at about 5 kg total paper.

Table III Comparison of weights of components

Components	1989 survey kg/bin	1991 survey kg/bin	Difference kg/bin	Difference tonnes/ week
Newspaper	1.43	0.64	-0.79	-5.6
Other recyclable paper	1.47	0.77	-0.70	-4.9
Soiled/composite paper	1.18	1.95		
Total paper	4.08	3.36		
Food	5.41	3.24		
Garden waste	2.42	3.72		
Soft drink bottles	0.05	0.09		
Beer bottles/flagons	0.16	0.07	-0.09	0.63
Other glass	1.11	0.51	-0.60	4.2
Total glass	1.32	0.67		
Steel drink cans	-----	---		
Steel food cans	0.27	0.24		
Other ferrous	0.23	0.12		
Aluminium drink cans	0.06	0.05	-0.01	-0.07
Other non-ferrous	0.03	0.03		
Total metals	0.59	0.44		
Polythene film	0.27	0.40		
Other plastics	0.63	0.65		
Total plastics	0.90	1.05		
Wood, Textile, Rubber	0.47	0.46		
Ceramic, Dirt, Dust	0.95	0.65		
TOTAL	16.1	13.6		

3.4.2 Glass

Table III shows that there has been a reduction in 'beer bottles/flagons' and 'other glass' of 0.09 and 0.60 kg/bin respectively making an overal reduction of 0.69 kg/bin or 4.8 tonnes/week. The frequency of occurrence of these items have also decreased (Table IV). In particular 'other glass' has decreased from 79 % to 62 %. There has, however, been an increase in the weight of soft drink bottles. The frequency of occurrence of soft drink bottles has also increased (Table IV). Overall there has been a drop in the total weight of glass even in bins containing one of the glass categories.

Table IV Comparison of bins containing paper, glass or aluminium cans

Components	1989 survey		1991 survey	
	Bins containing component	Weight in bin containing component	Bins containing component	Weight in bin containing component
	%	kg/bin	%	kg/bin
Newspapers	69.2	2.1	40.0	1.6
Other recycl.paper	95.5	1.6	52.5	1.5
Soiled/comp. paper	93.0	1.3	98.5	2.0
Total paper		5.0		5.1
Soft drink bottles	4.5	1.1	7.5	1.2
Beer bottles/flagons	9.0	1.8	7.0	1.1
Other glass	79.1	1.4	61.5	0.8
Total glass		4.3		3.1
Alum. drink cans	53.7	0.1	43.5	0.1

3.4.3 Aluminium drink cans

There has also been a reduction in the frequency of aluminium drink cans found in bins from 54 to 44 %. The corresponding reduction in average weight is, however, small due to the light weight nature of the cans (0.01 kg/bin or 70 kg/week).

3.5 Comparison with Actual Collected Recyclables

Table V show a comparison between reduction in component weights between 1989 and 1991 surveys and the actual amount of recyclables collected during the two weeks of the survey period.

Table V Comparison of estimated and actual recycled materials

Component	Estimated from surveys	Actual collected during 1991 survey	
		First week	2nd week
Paper (tonnes/week)	10.5	14.3	13.0
Soft drink bottles (tonnes/week)	(0.28)	0.30	0.34
Beer bottles/flagons (tonnes/week)	0.63	0.47	0.46
Other glass (tonnes/week)	4.2	4.5	4.1
Aluminium drink cans (kg/week)	70	220	180
Plastic bottles (kg/week)	N.D.*	39	31

*N.D. = not determined separately

Agreement between the reduction in the amount of glass from survey results and the actual amount of glass collected is excellent. For paper there is a discrepancy of about 3 tonnes/week, with the actual amount collected being greater than the amount estimated. This increased amount is due to efforts by Council to collect wastepaper from business premises, printers, schools and post office in Subiaco.

For the minor components the agreement is not particularly good, because of the uncertainty involved in statistically extrapolating the results of 200 bins to 7026 bins for those components.

3.6 Status of recycling

The status of recycling at the City of Subiaco in 1991 can be deduced from the results of the surveys and the actual amount of recyclables currently collected in the City. Based on a weekly collection of 100 tonnes of waste the potential for recycling in 1989 is indicated in Table VI. Amounts recycled in 1991 and potential for further recycling based on 90 tonnes per week of waste are also shown in Table VI.

Table VI Potential for recycling in 1989 and 1991 (tonnes/week)

Component	Potential for recycling 1989	Recycled 1991	Potential for further recycling 1991
Paper	17	13.5	9.4
Glass	8	4.8	4.5
Plastics	5	0.03	6.9
Metal (ferrous)	3	---	2.7
Aluminium	0.4	0.2	0.3

Table VI clearly indicates that a significant amount of paper and glass has been diverted from the collected waste for recycling. There is, however, still about the same amount potentially available for recycling. From a comparison of the frequencies of occurrence of recyclable papers and glass between 1989 and 1991 surveys, the average participation in the recycling programme is about 43 % for paper and 21 % for glass. About 14 tonnes per week of paper and glass can potentially be recycled.

Plastics have increased in quantity between 1989 and 1991. To recover waste plastics, market for recycled plastics in Western Autralia should be created. Recent efforts by the Plastics Industry Association to label plastic consumer goods is a first step. Further efforts should be requested from the Association, particularly in setting up receiving centres for all types of plastic materials.

Ferrous metals can be recycled. Again market for recycled ferrous metals should be explored.

3.7 Composting

Not listed in Table VI, but potentially recyclable are food and garden waste. In both surveys they constitute about 50 % by weight of collected waste. Both materials are suitable for composting. This can take the form of several local government councils

setting up separate collections of garden waste and food waste for composting to produce soil conditioner. It will therefore incur costs in collection of the raw materials and transport of the compost to users.

Composting in the City of Subiaco by householders by providing composting units at cost should continue to be encouraged. This form of composting avoids collection of raw materials and associated cost, and furthermore compost can be used where it is produced.

4 CONCLUSIONS

A waste analysis survey, when properly planned and conducted, can provide a quantitative tool to determine the outcome of a waste management action. In the case of the introduction of a recycling scheme it provides the status and potential of the recycling programme.

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