Procedures for Solid Waste Characterisation Surveys in Pacific island countries

1.0 Introduction

In the Pacific island countries (PICs) one of the factors that contributes to relatively poor waste management is a lack of consistent data on the quantity and composition of the solid waste stream. A good database is a prerequisite to setting realistic targets for waste reduction, reuse and recycling, and to be able to measure success rates against. The measurement of the waste stream on a regular basis, say every three years, would enable planners to better monitor the efforts made to minimise and better manage waste in a municipality or on an island. Whilst better database on the waste stream does not necessarily mean that the stream would be better managed, it is virtually impossible to manage and monitor the same stream without a good baseline database.

A wide variety of materials make up municipal solid waste (MSW). In typical Pacific island waste streams, biodegradable material is present in relatively large proportions and is easy to measure from a small sampling of waste. Other components which are of interest, such as bottles, metal and plastics for recycling, are usually present in smaller proportions. To gain a reliable estimate of these types involves more intensive sampling and analysis effort. Therefore it is important that any waste analysis exercise have clear objectives and that the sampling effort be designed to provide the level of data needed.

For the purposes of better management of the waste streams in most PICs, an overview of waste composition of the main components is sufficient, and a detailed analysis of all the waste types is not necessary. The procedures provided in this document would be sufficient to give this overview. If a more detailed analysis of the waste stream is required, then a more intensive survey would need to be undertaken. Such a survey could be based on any of the references listed at the end of this document.

Waste may need to be analysed and characterised at more than one location in some islands. Where about 20% of total refuse is collected in bags and/or bins from domestic premises in a particular village or settlement or from commercial premises, it would be appropriate to conduct a waste analysis on the refuse as collected. This would enable conclusions to be drawn on a kg/person/day basis, and comparisons made between different commercial enterprises in terms of kg/m2/day. However most rubbish is delivered direct to the disposal sites, and an analysis needs to be carried out only at the disposal site.

This document presents procedures for carrying out analyses both at the household or commercial enterprise level and at the disposal sites.

2.0 Waste Classifications

The number of primary waste classification categories is determined by a number of factors such as:

- the size and nature of the PIC economy;
- the purpose of the survey;
- the size of sample needed to obtain a statistically meaningful result for its intended use.

It is clear that as the number of categories increase, the proportion of waste in each will decrease. This will require greater effort to obtain a precise estimate for the less common fractions of the waste.

The Waste Survey Record Sheet (Table 1) gives a recommended classification of nine primary waste classification categories, each divided into several subcategories. This is sufficient to cover both bag & bin collections and waste delivered direct to landfill. Some countries may want to reduce the number of primary categories, and others may adjust the "secondary classification" sub-category to suit their particular needs.

Whatever methodology is chosen for waste classification, it is important that any future analyses of the same waste stream be carried out with the same methodology so that the results are comparable over time.

3.0 Sample Size

3.1 Bag & Bin Collections

Sample size will be directed by the accuracy needed for the least common waste type of interest. Reliable estimates for the main 5 constituents of the 9 (paper, plastic, glass, metals and biodegradable) can be obtained from approximately 50 samples. A maximum practical sample size is probably 300 households (and in many island situations there will not be that many households with regular collections). Sampling at this level would give accuracy of say within 10% for the main 5 constituents mentioned above. Quantities of potentially hazardous materials, which are typically less than 1 % in MSW would be indicative only.

A sampling strategy would be to collect every "nth" bag or bin for sampling, where "n" is chosen to give the required number. Sampling at the disposal site is not a preferred strategy.

3.2 Refuse delivered to landfill

A typical landfill will receive loads each day from a large number of cars and pickups carrying relatively small loads and a small number of trucks carrying proportionally much larger loads. To design a survey for a particular facility it is really necessary to have knowledge of the vehicle counts in each category, and how these vary through the week. However for a smaller, rural landfill typical of the situations likely to be encountered in the island states the following survey methodology would yield useful data:

- ♦ Set up electronic or mechanical wheel scales
- ♦ Weigh all incoming trucks and trailers (in and out) for all operating hours over a week.
- ♦ The week to be typical of the period. Record all vehicle movements for the period.
- ♦ Sample and classify refuse from all trucks (excepting the municipal collection where this has been sampled separately)
- ♦ Sample and classify refuse from a large proportion of trailers (all if possible)
- ♦ Sample and classify refuse from a proportion (say 25 %) of cars/pickups. Cars are not weighed, load sizes for cars are obtained from those that are sorted.

4.0 Classification at Source from Bag & Bin Collection

In summary the approach is to:

- ∗ collect refuse from sampling areas (include households, shops and small businesses). Identify refuse from each household or shop or business;
- ∗ take to a sorting station;
- ∗ sort to a maximum of the 9 categories shown in Table 1;
- ∗ weigh and record data;
- ∗ determine volumes;
- ∗ statistical analysis.

4.1 Selection of sample areas

(1) Define several residential areas which represents different socio-economic population groups (eg. according to ethnic groups, income levels: low, middle, high income groups).

(2) Select 10-20 households for each of the residential areas defined in (1) totalling 50-100 households.

(3) Identify a predominantly business area where a large number of shops and offices are located.

(4) Select 10-15 shops and offices for the business area defined in (3).

(5) Alternatively to (3) and (4) further divide the business areas into different categories such as hotels and restaurants, offices, shops and stores, workshops, and for each category select 3 samples.

(6) Collect the waste generated in the above areas once a day at a fixed time for 8 consecutive days to allow variation in waste generation over the week. (Note that the first day's samples are to be excluded from the analyses as they may contain waste from 2 or more previous days).

4.2 Preparatory work required

(1) Transport of waste – an open truck will be required to transport the waste collected to the dump site where all the measurements will be taken.

(2) Manpower - a driver and an assistant worker will be required for the transportation of the waste. In addition one or two more collection workers will be required for each sample area to collect and load the waste on to the vehicle. At the dump site, two or three workers will be required to measure weights and volume of waste and separate waste into different categories. A supervisor-cum-data recorder will also be required.

(3) Equipment required (refer also to Section 7.0):

- ♦ Plastic bags = 8 days X (No. of Households + No. of Shops & Offices)
- ♦ Weighing scale: need one or two to weigh the waste with an accuracy of 100g
- ♦ Buckets: need several - to be used as weighing containers and also to measure volume of wastes
- ♦ Plastic sheets - to spread waste over it for sorting
- ♦ Gloves - for workers to handle waste

(4) Assignment of numbers to households, shops and offices – for the purpose of data recording and analysis.

(5) Coding of plastic bags by markers – according to the numbers assigned to households, shops, and offices

(6) Data sheets - refer to Tables 1 - 5.

(7) Survey of family size and floor area – the number of persons in each household and the floor area of each shop and office needs to be recorded in the data sheets, refer to Table 2.

(8) Determination of collection route - the collection route to be recorded on a map.

(9) Determination of volume and weight – the volume and weight of the buckets to be measured and recorded.

(10) Instruction to workers - workers instructed as to how they carry out the work.

(11) Distribution of leaflets and plastics bags – a leaflet explaining the study and request for cooperation, together with 8 plastic bags to be distributed to all households, shops and offices in the sample areas.

4.3 Measurement procedure

(1) Collect the plastic bags from the houses and shops/offices according to the pre – specified route. In order to make this collection process efficient, the workers in each sample area may need to collect the bags and place them at certain locations prior to loading them onto the truck.

(2) Repeat (1) for each sample area and proceed to the dump site.

(3) Weight each plastic bag and record the weight in the data sheets according to the numbers assigned to households, shops, and offices.

(4) Select randomly 5-10 bags from those collected in each sample area and record the household or shop/office numbers of these bags in the data sheets for volume measurement - Tables 3 & 4.

(5) Open these plastic bags and empty the contents in a bucket until it becomes full. The bucket will then be emptied and the contents will be spread over the plastic sheet. Repeat this process until all the bags for each sample area are emptied and count the number of bucketful loads, which is to be recorded for the volume determination.

(6) Separate the waste on the plastic sheet into four or more constituents (eg biodegradable, metal, paper, glass, etc.). The separated waste constituents will be put into different buckets for weight measurement.

(7) Measure the weight of each waste constituent and record it in the data sheet - Table 5.

(8) Dump all the waste properly and clean the equipment used.

(9) Repeat (1) to (8) everyday for the duration of the study.

4.4 Sorting

The sorting area should be about 7m x 4m, preferably covered with plastic sheets. A table is set up say 2-3m long by 1 m wide. Buckets or bins behind the table are used to receive sorted waste.

4.5 Weighing

Sorted material is weighed. The best scale is an electronic industrial scale weighing up to 70 kg by 0.1 kg. As a check weigh the total sample prior to sorting and check against the sum of the fractions.

4.6 Analysis and reporting

The main points in analysis are:

- ◊ the statistical unit is the household, not the bag
- ◊ detailed analysis and reporting is by weight.
- ◊ total volumes of wastes should also be determined to give general indications of landfill space requirement keeping in mind that volume is greatly affected by the compaction of the refuse.

The mean % composition for a waste type is determined from the total weight of the constituent divided by the total weight of refuse sampled. This is not the same as the average of the compositions of the individual samples.

Data from the number of households sampled is extrapolated up to provide an estimate of refuse generation for the full number of houses in the collection area.

For potentially hazardous substances it is appropriate to only list the substances found.

5.0 Classification at Landfill from Car and Truck Delivery

In summary the approach is to:

- ⇒ weigh all or most large vehicle loads arriving at the site and a proportion of smaller loads;
- ⇒ sample a proportion of incoming loads in each category and sort and weigh a sample of refuse from these;
- ⇒ visually classify the remaining loads, or a large proportion of them.

5.1 Weighing vehicle loads

Unfortunately a weigh bridge is unlikely to be available at most island sites. In the absence of a weighbridge either wheel scales (mechanical or electronic) or platform scales will be needed. Assistance from a local motor garage and probably the shipping company will need to be sought as to what equipment is available. Vehicles are weighed in and out of the site to give the refuse load.

Where no suitable vehicle scales are available then it will be necessary to work on a volume basis. In this case the volume of each load is estimated (in litres or cubic metres). When a sample is taken for the sort and weigh analysis, the proportion of the load taken is estimated (e.g. sample is 10 % of the load). From the known weight of

the sample estimate the overall load weight. This approach will be less accurate than directly weighing.

5.2 Refuse sub sampling

It is impractical to classify a full truck load of rubbish. A 140 kg sample is found to be sufficient to give a good indication. The sample should be representative of the load, ie taken by dumping off the load, spreading it out and taking a load of about 140 kg. A more scientific method of using a marked grid could be used but is probably not necessary.

5.3 Sorting and weighing

Sorting and weighing of the sampled refuse is as per the bag collection. A larger area may be needed for processing the refuse.

5.4 Analysis and reporting

The basic statistical unit is the load (either truck, car, trailer or utility/pickup). Reporting is by weight.

5.5 Visual classification

Where there are a large number of loads coming into a site, visual classification of loads can be used to extend the survey coverage. A visual classification is obviously a lot less accurate than sort and weigh and will depend upon the classifier. A proportion of visual classifications should be checked by sorting and weighing.

6.0 Personnel

Having the right personnel on the job is essential to getting useful data. The task is not pleasant. Further, it may be offensive for cultural reasons. Personnel involved in the sorting and weighing should be given training covering the reasons for the project, why good data is important, the methodology, the classifications and the need for confidentiality. Ideally personnel should be those with an interest in the environment and public health, to whom the survey results will have some interest.

7.0 Health and Safety

The handling and classifying of refuse is potentially hazardous and advice should be sought from a public health officer on health and safety aspects.

Equipment should include overalls, heavy duty rubber or PVC gloves, foot protection, eye protection, dust masks, ear muffs (if machinery is close by), first aid kit, water and disinfectant for wash up.

8.0 Other Considerations

8.1 Seasonal variability

The refuse stream may vary through the year. Vegetation waste in particular will depend on season. Where shipping service is infrequent waste delivery to landfill from businesses will vary depending on when the ship was last in.

Sampling programmes should be matched to account for these factors, and if necessary the survey repeated on several occasions.

9.0 References

1) Municipal Solid Waste Management Planning in Small Island Developing States in the Pacific Region, SPREP & UNEP, 1998.
2) New Zealand Ministry for the Environment, “The New Zealand Waste Analysis Protocol”, November 1992.
3) New Zealand Ministry for the Environment “Waste Analysis Protocol Data Collection System: User Guide”, March 1995.
4) The Australian Waste Database and Urban Solid Waste Characterisation, Cooperative Research Centre (CRC) for Waste Management and Pollution Control Limited, School of Civil Engineering, University of New South Wales, Sydney, Australia.
5) The Australian Waste Database (AWD) Procedural Guide for Local Government, Queensland Government Department of Environment and Heritage, Australia, August 1998.
6) World Health Organisation (WHO), Guides for Municipal Solid Waste Management in Pacific Island Countries, Healthy Cities - Healthy Islands, Document Series, Number 6, December 1996.

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Solid Waste Survey Record Sheets

Location:.....
Date of waste survey: :.....
Names of people participating in waste survey: :.....
Period during which waste was collected: :.....
Source of waste:.....

Table 1: Waste classifications and recording of weights

Primary Waste Classification	Secondary Classification	Examples of Waste	Weight of Waste Recorded
Paper	Corrugated cardboard	Boxes	
	Magazines	All magazines	
	Newspaper	All newspapers	
	Office	Computer, printer, copier	
	Tetra Pak (beverage containers)	Waxed carton	
	Other packaging	Cereal box, shoe box	
	Sanitary	Nappies	
Plastics	Polyethylene terephthalate (PET)	Soft drink bottles	
	Rigid High Density Polyethylene (HDPE)	Milk bottles	
	Flexible HDPE	Plastic bags	
	Other plastics	Not covered above	
Glass	Returnable bottles	Beer & soft drink bottles	
	Bottles and jars	Wine bottles and jam jars	
	Other glass	Window glass	
Metals	Steel cans	Baked bean can	
	Aluminium	Soft drink can, beer can	
	Appliances	Fridge	
	Other ferrous	Car body, roofing iron	
	Other non-ferrous	Copper pipe	
Biodegradable	Kitchen waste	Vegetable peelings, food scraps	
	Garden waste	Grass clippings, branches	
	Soil	Topsoil	

Primary Waste Classification	Secondary Classification	Examples of Waste	Weight of Waste Recorded
Textiles	Clothes	Clothing	
	Fittings	Carpet, curtains	
Potentially hazardous MSW	Small batteries	Dry cell, alkaline and button batteries	
	Vehicle batteries	Car, truck and motorcycle	
	Other batteries	Solar systems	
	Residuals of cleaning fluids & pesticides	Used containers	
	Other potentially hazardous	Florescent tubes, light bulbs, needles & syringes, expired drugs	
Construction and demolition (C&D)	Wood	Sawn timber	
	Wood fibre products	Softboard, hardboard, particle board	
	Rubble	Bricks, concrete	
	Cleanfill	Clay, sand, rock	
	Other C & D	Not covered above	
Other	Rubber	Tyres	
	Other	Not classified above	

Table 2: Data sheet for daily waste generation rate

House No*	Family size**	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Total
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									
more if needed									
Total	**(A)**								**(B)**

NOTES:

1) ***** Shop/Office number for commercial premises
2) ****** Floor area (m2) for commercial premises
3) Computation: (Mean) daily generation rate = (B)/(A)/7 kg/person/day for households & (B)/(A)/7 kg/m2/day for commercial premises

Table 3: Data sheet for volume recording

Day	1	2	3	4	5	6	7	Total
No. of bucketful loads*								
Daily total volume	(a)	(b)	(c)	(d)	(e)	(f)	(g)	**(A)**

NOTES:

1) ***** Enter the correct number in the appropriate cell corresponding to the day of the survey
2) Computation 1: Daily total volume, such as (a), (b), etc. = (No. of bucketful loads) X (the volume of the bucket used)
3) Computation 2: Grand total volume = (a) + (b) + ….(g) = **(A)** litres

Table 4: Data sheet for recording of weights corresponding to the volumes in Table 3

Day 1		Day 2		Day 3		Day 4		Day 5		Day 6		Day 7	
Hse No*	**Wt ****	**Hse No***	**Wt ****	**Hse No***	**Wt ****	**Hse No***	**Wt ****	**Hse No***	**Wt ****	**Hse No***	**Wt ****	**Hse No***	**Wt ****
	(a)		(b)		(c)		(d)		(e)		(f)		(g)

NOTES:

1) ***** Household number randomly selected for which the volume of waste has been measured and recorded in Table 3. Enter the household numbers in these columns.
2) ** Weight of waste which corresponds to the household number, taken from Table 2. Enter these weights in the columns. (a), (b), …etc. are the total weights of the waste on the day.
3) Computation 1: Grand total weight = (a) + (b) + ….(g) = **(B)** kg
4) Computation 2: (Mean) bulk density = (B)/(A) kg/litre

Table 5: Data sheet to determine weight of the various components

Primary waste classification	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Total Weight	Wt %
Paper	p1	p2	p3	p4	p5	p6	p7	(a)	
Plastics								(b)	
Glass								(c)	
Metals								(d)	
Biodegradable								(e)	
Textiles								(f)	
Hazardous								(g)	
Construction & Demolition								(h)	
Other								(i)	
Total								**(A)**	**100**

NOTES:

1) The entries in the cells are weights of waste corresponding to the relevant classification and day.
2) Total weight in each category is an addition of all entries across the row, for example (a) = p1 + p2 + ….+ p7.
3) Grand total weight = (a) + (b) + ….(j) = **(A)** kg
4) Computation formula for Wt % of each component = [Total Wt of the component/(A)] X 100. For example, Wt % Paper = [(a)/(A)] X 100.