

KANDAHAR CITY MUNICIPAL SOLID WASTE COMPOSITION AND CHARACTERIZATION ANALYSIS



Results from Waste Composition, Quantification and Characterization Analysis conducted on behalf of the Municipality of Kandahar



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MUNICIPALITY OF KANDAHAR

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KANDAHAR, AFGHANISTAN

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The opinions expressed herein are those of the author and do not necessarily reflect the views of the Government of the Islamic Republic of Afghanistan, Independent Directorate for Local Government, the U.S. Agency for International Development, or Chemonics International.

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1 Introduction

Kandahar city, as with most urban conurbations within Afghanistan, is facing many challenges in the Municipal Solid Waste (MSW) management sector. Urban population expansion, economic growth coupled with increased waste production, dilapidated waste handling equipment due to lack of investment, and limited financial, institutional, human, and infrastructural resources result in an ineffective municipal waste management system with associated adverse environment, health and safety impacts. Waste collection coverage throughout Kandahar is severely limited and ineffective, no sanitary or environmentally controlled waste disposal or treatment facilities and where waste is deposited in an open dump site which is largely undefined, uncontrolled, unregulated, and unmanaged with no environmental control.

In order to plan, design a waste management improvement plan and operate a solid waste management system, a thorough knowledge of the quantities generated, the composition of wastes and its characteristics are essential. Waste composition analysis provides information about the types and amounts of the materials that are in a given waste stream.

Such analysis is essential for the following reasons:

- It provides the basic data on which the management system is planned, designed and operated;
- It provides the information for the selection of equipment and appropriate technology (including size of waste containers, vehicles, compaction ability (and thereafter route planning) etc.;
- It indicates the amount and type of material suitable for processing, recovery and recycling as well as the choice of a suitable method of disposal
- Forecasts trends assisting designers and manufacturers in the production of vehicles and equipment suitable for future needs.
- Provides a determination of the environmental impact exerted by the wastes if they are improperly managed.

Such analysis was conducted in July 2011 by Exact Energy and Environmental Services (EEES) of Kabul under sub-contract to Chemonics International as implementers of USAID's RAMP-UP South. EEES implemented this project in accordance with the analysis methodology developed by RAMP-UP South and present in Annex 2 of this document. This involved physically separating the waste into a number of predetermined categories. Each category was then weighed to quantify it and these weights collated to provide a breakdown of the total composition of waste which has been sampled. This provides a snapshot in time of the waste stream being analysed which the results of are summarized within this document.

2 Population, size, and waste producers

Table 1: Approximate population numbers

City	Population	Households	Notes
Kandahar	1,109,990	113,400	Economic centre of South

Waste is produced by the following generators:

- Family houses (average members per household is 10 persons)
- Commercial premises (shops, light industry units, restaurants, offices, and others)
- Public Institutions (Government offices, schools, hospitals)
- ISAF/Afghan security bases (ANA & ANP compounds), etc
- International organizations (PRT, NGOs & implementing partner compounds, etc)
- Street and ditch clearing operations

This waste composition and characterization study is focused on municipal solid waste which arises from:

- Family houses (average members per household is 10 persons)
- Commercial premises (shops, light industry units, restaurants, offices, and others)

As such the composition analysis collected samples from the locations detailed in the following table and according to the schedule detailed in Annex 2, Methodology

CODE	STRATA SAMPLING LOCATION
1.A.	High income residential district - individual households
1.B.	High income residential district - community bins
2.A.	Medium income residential district - individual household
2.B.	Medium income residential district - community bins
3.A.	Low income residential district - individual households
3.B.	Low income residential district - community bins
4.A.	Non-food goods (i.e. electronic goods) commercial district - individual premises
4.B.	Non-food goods (i.e. electronic goods) commercial district - community bins
5.A.	Food market commercial district - individual premises
5.B.	Food market commercial district - community bins
6.A.	Large, multi-product commercial district and offices - individual premises
6.B.	Large, multi-product commercial district and offices - community bins
7.A.	City waste disposal site - Tarnak site

Waste generation is expected to grow as urban populations, the economy, availability of disposable goods etc all grow. An assumed natural population and waste growth rate of 2.5% per annum is probably likely though would require further study. This figure should be used for waste production growth for the Kandahar area. Composition shall also change as the economy develops etc. however this has not been modelled in this document due to unknown variables.

A map of the survey area and locations is presented at the end of this document.

3 Waste Composition and production quantities Summary

Waste production and composition will differ between different waste producers and economic level of residents. The following table presents the composition of residual Municipal Solid Waste in Kandahar city (July 2011) as an average % by weight per average household and per average commercial district at point of production (prior to scavenging activities) with graphical representation of this in the subsequent charts.

Table 2: Averaged daily waste production in Kandahar City

Waste Material	Ave Density (kg/m ³)	Household	Commercial
Organic (food etc)	288	32%	37%
Plastic (bottles and film etc)	40	13%	9%
Paper & cardboard	60	5%	11%
Glass	188	5%	8%
Metal (cans etc)	100	4%	4%
Other (Ashes, dust and Misc.)	380	41% (29+10+2)	31% (19+8+3+1)
Average Density (loose)		269.6 kg/m³	253.6 kg/m³

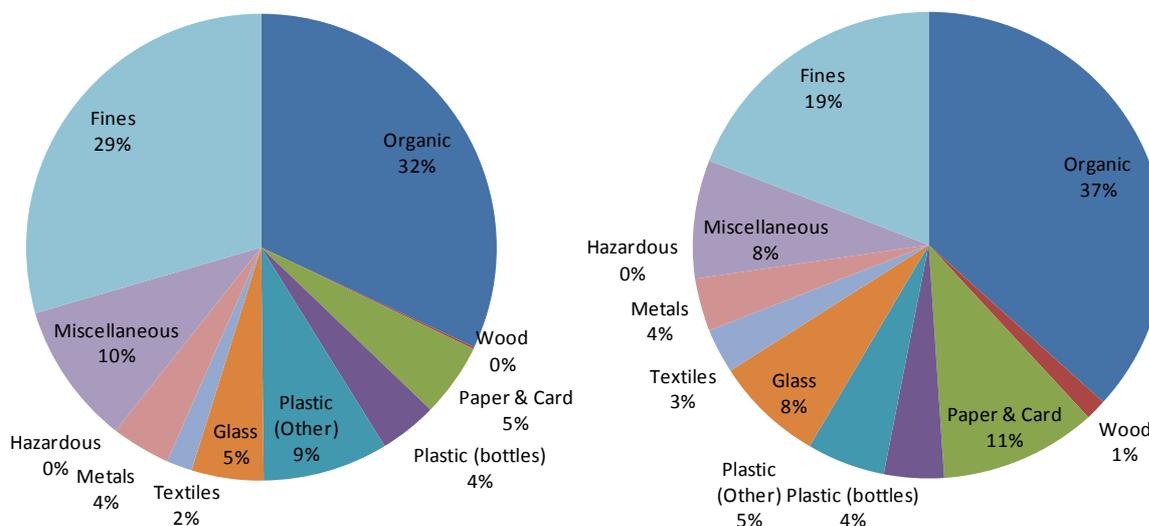


Figure 1: Kandahar City waste composition by average % weight (July 2011) per household (left) and per commercial district (right)

Waste producer	Weight / day	volume / day	Compacted volume/ day (landfill)
Average per Household	3.1 kg (High income)	0.012 m ³	0.008 m ³ (400kg/m ³)
	2.2 kg (Mid income)	0.009 m ³	
	2.5 kg (Low income)	0.009 m ³	
Average per Commercial district	3.8 kg (food market)	0.015 m ³	0.01 m ³ (400kg/m ³)
	2.0 kg (dry goods market)	0.008 m ³	

Roughly one third of the Municipal Solid Waste production in Southern Afghanistan cities is organic waste, a further third is soils, floor sweepings, ash and other fine particles and miscellaneous particles, with the remaining third being mixed consumables, a portion of this fraction is collected by scavengers in the community (metals, plastic bottles, glass for recycling sale, paper and wood for burning). Very little hazardous wastes are produced at present though are increasing.

The following tables and charts provide full summaries of the waste composition and analysis data findings. In total Kandahar produces approximately the following loose waste (as collected) volumes and associated weight per defined period:

Table 3: Kandahar total waste production Volume estimate (cubic metres)

Volume per time period	/day	/week	/month	/year
m ³	1,357	9,501	40,719	488,627

Table 4: Kandahar total waste production Weight estimate (metric Tonnes)

Weight per time period	/day	/week	/month	/year
metric Tonnes	353	2,468	10,576	126,911

These numbers assume a population of 1.1million though does not consider industrial and institution wastes and certain assumptions have been made for commercial and residential property numbers as detailed in the following sections.

3.1 Summary Tables of Residential group waste productions (density and weight)

1.A. High Income Residential (Wet)

	weight	Ave Material Density	kg/m3
Organic	43.74	288	125.98
Paper & Card	4.58	60	2.75
Plastic	10.81	40	4.32
Glass	3.61	188	6.79
Metals	4.06	100	4.06
Other	30.53	380	116.03

259.94 kg/m3
0.31 kg/per/day
0.0012 m3/per/day
0.012 m3/HH/day

2.A. Medium Income Residential (Wet)

	weight	Ave Material Density	kg/m3
Organic	33.01	288	95.07
Paper & Card	5.92	60	3.55
Plastic	13.82	40	5.53
Glass	6.71	188	12.61
Metals	5.49	100	5.49
Other	35.00	380	133.01

255.27 kg/m3
0.22 kg/per/day
0.0009 m3/per/day
0.009 m3/HH/day

3.A. Low Income Residential (Wet)

	weight	Ave Material Density	kg/m3
Organic	18.72	288	53.93
Paper & Card	4.55	60	2.73
Plastic	12.78	40	5.11
Glass	4.46	188	8.39
Metals	2.51	100	2.51
Other	56.63	380	215.21

287.88 kg/m3
0.25 kg/per/day
0.0009 m3/per/day
0.009 m3/HH/day

1.A. High Income Residential (Dry)

	weight	Ave Material Density	kg/m3
Organic	39.03	288	112.41
Paper & Card	5.04	60	3.03
Plastic	11.82	40	4.73
Glass	3.94	188	7.40
Metals	4.48	100	4.48
Other	33.09	380	125.74

257.78 kg/m3
0.28 kg/per/day
0.0011 m3/per/day
0.011 m3/HH/day

2.A. Medium Income Residential (Dry)

	weight	Ave Material Density	kg/m3
Organic	22.00	288	63.35
Paper & Card	6.96	60	4.18
Plastic	16.23	40	6.49
Glass	8.18	188	15.38
Metals	6.34	100	6.34
Other	40.36	380	153.36

249.10 kg/m3
0.19 kg/per/day
0.0008 m3/per/day
0.008 m3/HH/day

3.A. Low Income Residential (Dry)

	weight	Ave Material Density	kg/m3
Organic	10.87	288	31.30
Paper & Card	5.18	60	3.11
Plastic	14.16	40	5.66
Glass	5.12	188	9.62
Metals	2.95	100	2.95
Other	61.73	380	234.58

287.23 kg/m3
0.22 kg/per/day
0.0008 m3/per/day
0.008 m3/HH/day

HH = Household

per = Person or Capita

m3 = Cubic metres

kg = Kilograms

Ave = Average

3.2 Summary Tables of Commercial group waste productions (density and weight)

4.A. Non-food commercial (Wet)

	weight	Ave Material Density	kg/m3
Organic	28.82	288	83.02
Paper & Card	14.44	60	8.67
Plastic	11.28	40	4.51
Glass	9.57	188	18.00
Metals	4.48	100	4.48
Other	26.31	380	99.97

218.64 kg/m3
2.08 kg/prem/day
0.0095 m3/prem/day

5.A. Food Market Commercial (Wet)

	weight	Ave Material Density	kg/m3
Organic	57.04	288	164.27
Paper & Card	4.65	60	2.79
Plastic	5.83	40	2.33
Glass	1.80	188	3.38
Metals	0.84	100	0.84
Other	26.85	380	102.04

275.65 kg/m3
3.80 kg/prem/day
0.0138 m3/prem/day

6.A. Multi-product Commercial (Wet)

	weight	Ave Material Density	kg/m3
Organic	23.92	288	68.88
Paper & Card	11.96	60	7.18
Plastic	10.15	40	4.06
Glass	10.19	188	19.15
Metals	5.167019	100	5.17
Other	34.25146	380	130.16

234.59 kg/m3
2.00 kg/prem/day
0.0085 m3/prem/day

4.A. Non-food commercial (Dry)

	weight	Ave Material Density	kg/m3
Organic	22.07	288	63.57
Paper & Card	16.57	60	9.94
Plastic	13.58	40	5.43
Glass	10.95	188	20.58
Metals	5.36	100	5.36
Other	31.47	380	119.58

224.46 kg/m3
1.71 kg/prem/day
0.008 m3/prem/day

5.A. Food Market Commercial (Dry)

	weight	Ave Material Density	kg/m3
Organic	55.62	288	160.20
Paper & Card	5.17	60	3.10
Plastic	6.47	40	2.59
Glass	1.94	188	3.65
Metals	0.93	100	0.93
Other	29.86	380	113.47

283.94 kg/m3
3.43 kg/prem/day
0.012 m3/prem/day

6.A. Multi-product Commercial (Dry)

	weight	Ave Material Density	kg/m3
Organic	22.68	288	65.32
Paper & Card	12.78	60	7.67
Plastic	10.96	40	4.38
Glass	10.93	188	20.56
Metals	5.57	100	5.57
Other	37.07	380	140.86

244.36 kg/m3
1.85 kg/prem/day
0.008 m3/prem/day

prem = premises or commercial property

m3 = Cubic metres

kg = Kilograms

Ave = Average

3.3 Summary Tables of Residential Property waste productions (volume (and weight) per district)

	District 1	District 2	District 3	District 4	District 5	District 6	District 7	District 8	District 9	District 10	Totals
<i>Total Population</i>	126,390	126,000	130,000	98,300	76,000	73,000	98,300	76,500	173,000	132,500	1,109,990
<i>% high income</i>	60%	50%	40%	40%	60%	30%	30%	30%	20%	15%	37%
<i>% medium income</i>	20%	20%	30%	40%	20%	40%	30%	30%	20%	20%	27%
<i>% low income</i>	20%	30%	30%	20%	20%	30%	40%	40%	60%	65%	36%

Population High Income	75,834	63,000	52,000	39,320	45,600	21,900	29,490	22,950	34,600	19,875	410,696
m3/capita/day	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012	0.0012
m3/District/Day	90.4	75.1	62.0	46.9	54.4	26.1	35.2	27.4	41.3	23.7	489.8

Population Medium Income	25,278	25,200	39,000	39,320	15,200	29,200	29,490	22,950	34,600	26,500	299,697
m3/capita/day	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
m3/District/Day	21.8	21.7	33.6	33.9	13.1	25.2	25.4	19.8	29.8	22.8	258.3

Population Low Income	25,278	37,800	39,000	19,660	15,200	21,900	39,320	30,600	103,800	86,125	399,596
m3/capita/day	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009	0.0009
m3/District/Day	22.0	32.8	33.9	17.1	13.2	19.0	34.1	26.6	90.1	74.8	347.0

m3/District/Day (district totals)	134	130	129	98	81	70	95	74	161	121
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Total Residential Waste Production (m3/day)	1,095
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Tonnes/District/Day (district totals)	35	35	34	26	21	19	25	20	44	34
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Total Residential Waste Production (Tonnes/day)	293
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Due to ambiguity in the available statistics for number of residential premises and population figures for Kandahar as a whole and for each district and economic group, the above figures are not regarded as 100% accurate though are presented here to provide an estimate for the areas. This table will be revised as more accurate and reliable data becomes available.

3.4 Summary Tables of Commercial Property waste productions (volume (and weight) per district)

	District 1	District 2	District 3	District 4	District 5	District 6	District 7	District 8	District 9	District 10	Totals
<i>Total number of Shops</i>	5,766	4,800	3,800	4,400	2,050	530	2,500	800	1,000	740	26,386
<i>Veg. and Fruit Shops</i>	120	240	48	160	80	50	45	28	250	120	1,141
<i>Butcher Shops</i>	48	64	20	65	11	12	16	10	95	50	391
<i>Dry goods shops</i>	5,378	4,296	3,672	4,250	1,500	460	2,289	720	655	550	23,770

Food Market Shops	388	504	128	150	550	70	211	80	345	190	2,616
m3/premises/day	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138	0.0138
m3/District/Day	5.3	6.9	1.8	2.1	7.6	1.0	2.9	1.1	4.8	2.6	36.1

Dry Good Shops	5,378	4,296	3,672	4,250	1,500	460	2,289	720	655	550	23,770
m3/premises/day	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095	0.0095
m3/District/Day	51.2	40.9	34.9	40.4	14.3	4.4	21.8	6.8	6.2	5.2	226.1

m3/District/Day (district totals)	57	48	37	43	22	5	25	8	11	8
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Total Commercial sector Waste Production (m3/day)	262
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Tonnes/District/Day (district totals)	13	11	8	9	5	1	6	2	3	2
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Total Commercial sector Waste Production (Tonnes/day)	59.38
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Due to ambiguity in the available statistics for number of residential premises and population figures for Kandahar as a whole and for each district and commercial sector group, the above figures are not regarded as 100% accurate though are presented here to provide an idea of waste production rates for x number of premises. This table will be revised once more accurate and reliable data becomes available.

1.A. High income residential district - individual households

Points of Note:

1. Presence of paper and metals at household level
2. Relatively high average weight per household and per person

Table 5: Waste composition % by weight (summary)

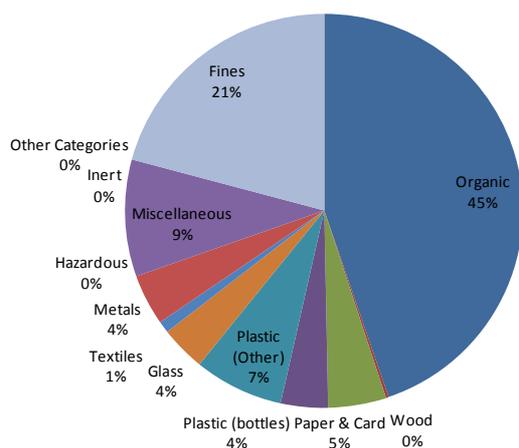
Waste Composition % by weight (summary)	Average	
	Wet	Dry
Organic	43.5	38.4
Wood	0.2	0.6
Paper & Card	4.6	5.0
Plastic (bottles)	3.8	4.2
Plastic (Other)	7.1	7.7
Glass	3.6	3.9
Textiles	0.9	1.0
Metals	4.1	4.5
Hazardous	0	0
Miscellaneous	9.4	10.2
Inert	0	0
Other Categories	0	0
Fines	20.2	21.9

and

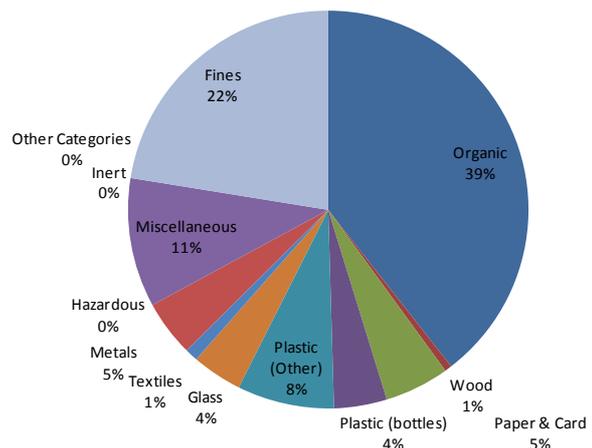
Weight

	Weight	
	Wet	Dry
	33.8	32.4
	29.1	26.2
	26.2	25.2
	36.2	32.8
	35.5	33.6
	26.8	20.8
	35.5	33.3
	22.7	19.8
Mean	30.3	27.4
Average	30.7	28.0
Average/household	3.07 kg	
Average/person	0.31 kg	

Waste Composition - % by weight (kg) - wet (1.A. High Income Household)



Waste Composition - % by weight (kg) - Dry (1.A. High Income Household)



Sample Collection from High Income residential properties



1.B. High income residential district - community bins

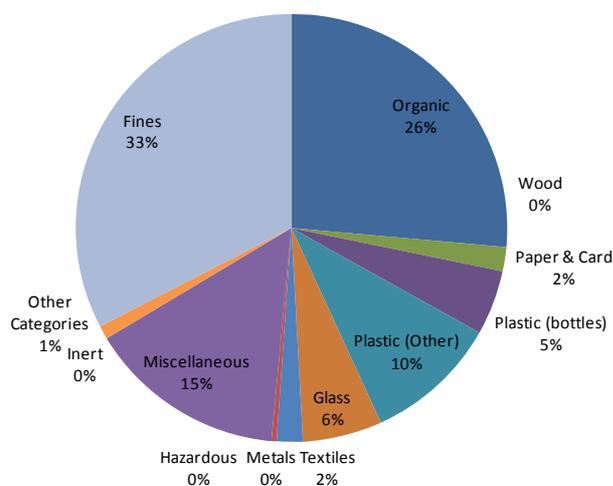
Points of Note:

1. Near absence of metals, wood – removed from waste stream by scavengers after household disposal
2. Surprisingly large proportion of plastics in waste stream at community level (not being removed/recovered)
3. Lower organic content, due to desiccation, animal consuming scraps and other dispersal.

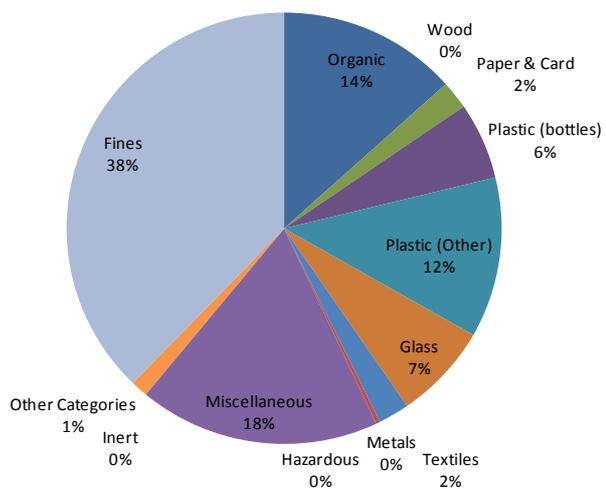
Table 6: Waste composition % by weight (summary)

Waste Composition % by weight (summary)	8 day Average	
	Wet	Dry
Organic	26.4	13.3
Wood	0.0	0.0
Paper & Card	1.8	2.1
Plastic (bottles)	4.9	5.8
Plastic (Other)	10.0	12.0
Glass	6.0	7.2
Textiles	2.0	2.3
Metals	0.4	0.3
Hazardous	0	0
Miscellaneous	14.9	17.9
Inert	0	0
Other Categories	1	1
Fines	32.6	37.7

Waste Composition - % by weight - Wet
(1.B. High income community bins)



Waste Composition - % by weight - Dry
(1.B. High income community bins)



Sample Collection from High Income residential community bins



2.A. Medium income residential district - individual household

Points of Note:

1. Presence of paper, metals and plastic at higher percentage than high income households.
2. Greater number and wider distribution of materials within composition than other sources
3. Lower overall weight per household and person than high income

Table 7: Waste composition % by weight (summary)

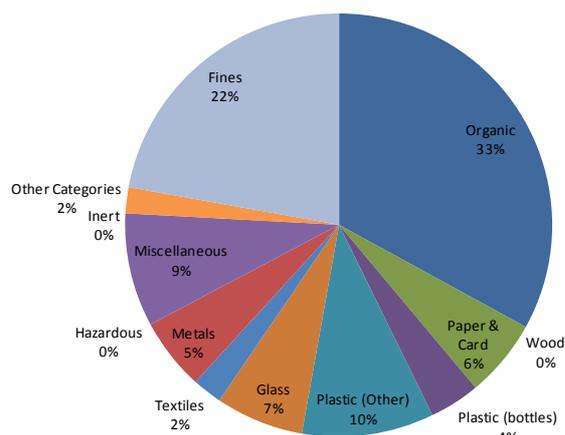
Waste Composition % by weight (summary)	8 day Average	
	Wet	Dry
	Organic	33.0
Wood	0.0	0.0
Paper & Card	5.9	7.0
Plastic (bottles)	3.8	4.6
Plastic (Other)	10.0	11.6
Glass	6.7	8.2
Textiles	2.3	2.6
Metals	5.5	6.3
Hazardous	-	-
Miscellaneous	8.6	10.0
Inert	-	-
Other Categories	2.0	2.2
Fines	22.1	25.5

and

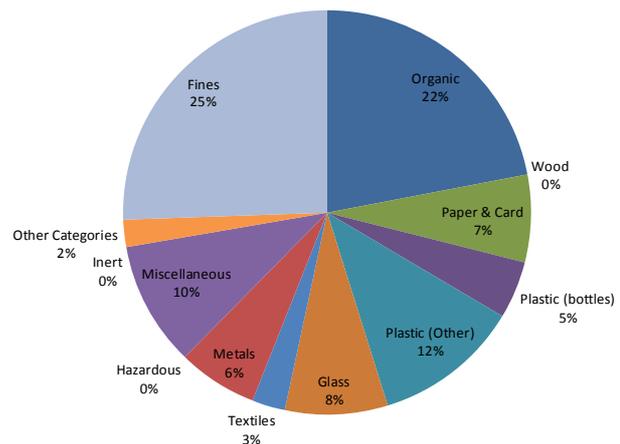
Weight

	Weight	
	Wet	Dry
	24.7	22.9
	15.8	14.5
	25.6	23.6
	24.0	22.1
	21.2	19.5
	21.6	17.5
	30.1	17.5
	14.7	13.0
Mean	21.7	18.5
Average	22.2	18.8
Average/household	2.22 kg	
Average/person	0.22 kg	

**Waste Composition - % by weight (kg) - wet
(2.A. - Medium income households)**



**Waste Composition - % by weight (kg) - Dry
(2.A. - Medium income households)**



Sample Collection from Medium Income residential properties



2.B. Medium income residential district - community bins

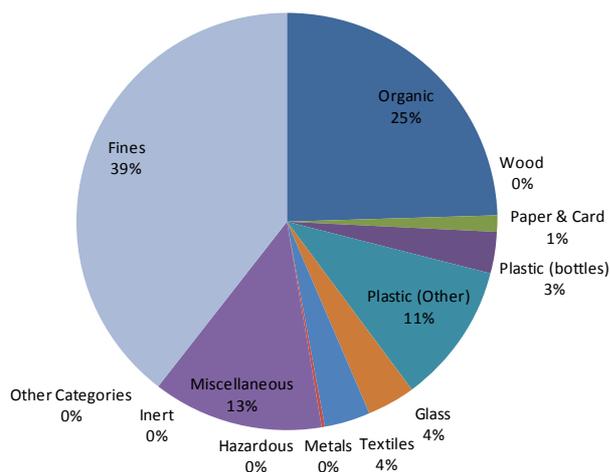
Points of Note:

1. Near absence of metals, wood – removed from waste stream by scavengers after household disposal
2. Surprisingly high percentage of plastics remaining in waste stream at community level

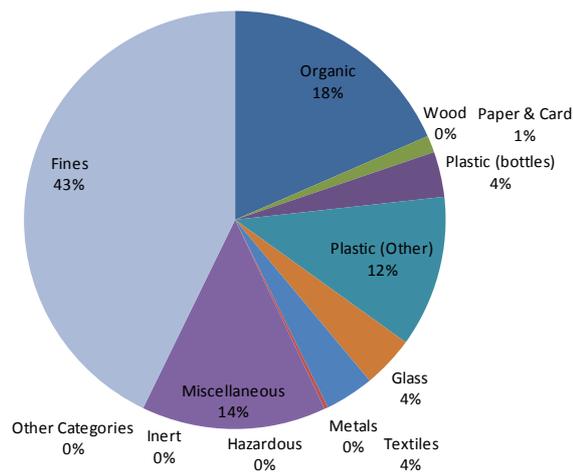
Table 8: Waste composition % by weight (summary)

Waste Composition % by weight (summary)	8 day Average	
	Wet	Dry
Organic	24.5	18.4
Wood	0.0	0.0
Paper & Card	1.2	1.3
Plastic (bottles)	3.2	3.5
Plastic (Other)	10.9	11.8
Glass	3.7	3.9
Textiles	3.5	3.8
Metals	0.2	0.2
Hazardous	0	0
Miscellaneous	13.2	14.2
Inert	0	0
Other Categories	0	0
Fines	39.5	42.8

**Waste Composition - % by weight - wet
(2.B. Medium income community bins)**



**Waste Composition - % by weight - Dry
(2.B. Medium income community bins)**



Sample Collection from Medium Income residential community bins



3.A. Low income residential district - individual households

Points of Note:

1. Very high fines content (sand and soil from floor sweepings etc)
2. Presence of paper and metals (though lower than in other economic classes)
3. Lower distribution of materials within composition than medium income
4. Lower weight per household and person than high income though similarity to medium (greater weight due to greater fines fraction which is denser and heavier)

Table 9: Waste composition % by weight (summary)

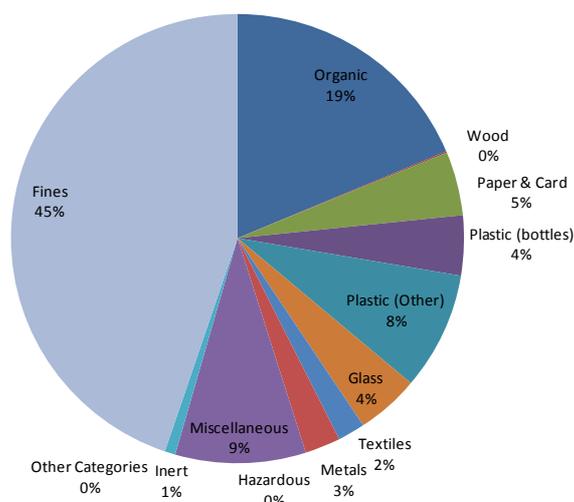
Waste Composition % by weight (summary)	8 day Average	
	Wet	Dry
Organic	18.6	10.3
Wood	0.1	0.6
Paper & Card	4.5	5.2
Plastic (bottles)	4.3	4.8
Plastic (Other)	8.5	9.4
Glass	4.5	5.1
Textiles	2.0	2.4
Metals	2.5	3.0
Hazardous	-	-
Miscellaneous	9.3	10.3
Inert	1	1
Other Categories	-	-
Fines	44.7	48.0

and

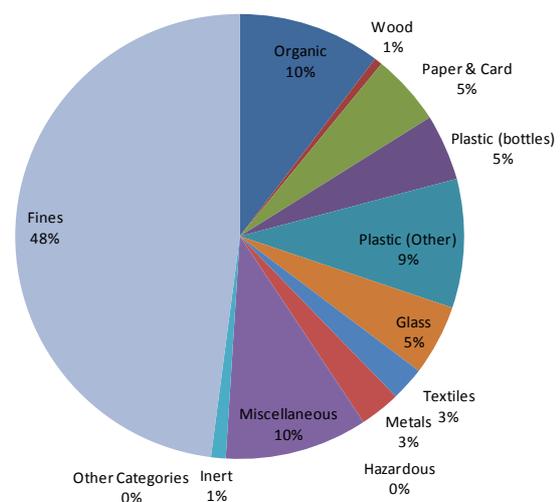
Weight

	Weight	
	Wet	Dry
	22.3	19.1
	14.2	15.7
	29.2	21.2
	30.7	27.7
	29.6	29.2
	21.0	21.0
	33.7	25.2
	21.1	20.3
Mean	24.4	22.0
Average	25.2	22.4
Average/household	2.52 kg	
Average/person	0.25 kg	

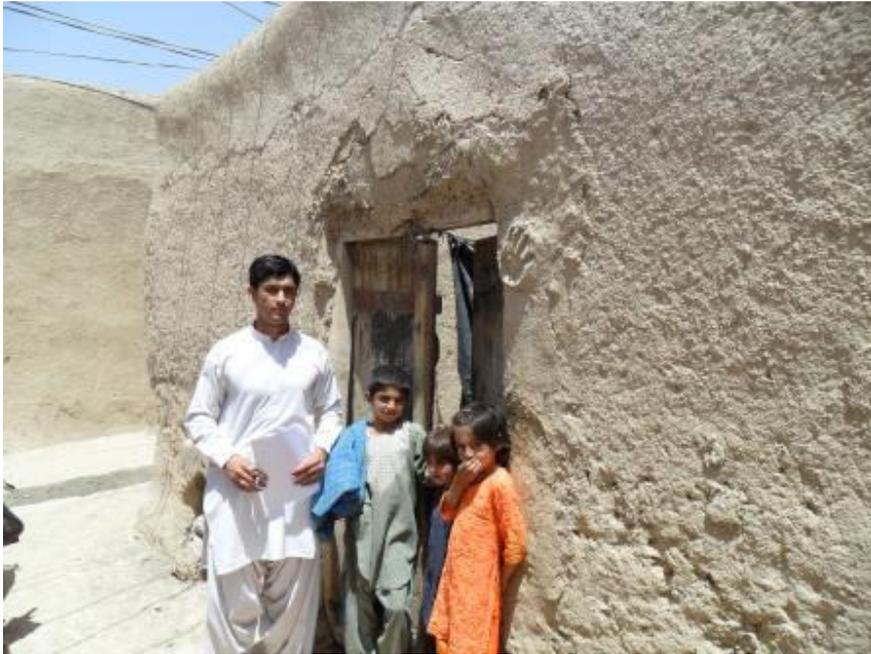
Waste Composition - % by weight (kg) - wet (3.A. - Low income household)



Waste Composition - % by weight (kg) - Dry (3.A. - Low income household)



Sample Collection from Low Income residential properties



3.B. Low income residential district - community bins

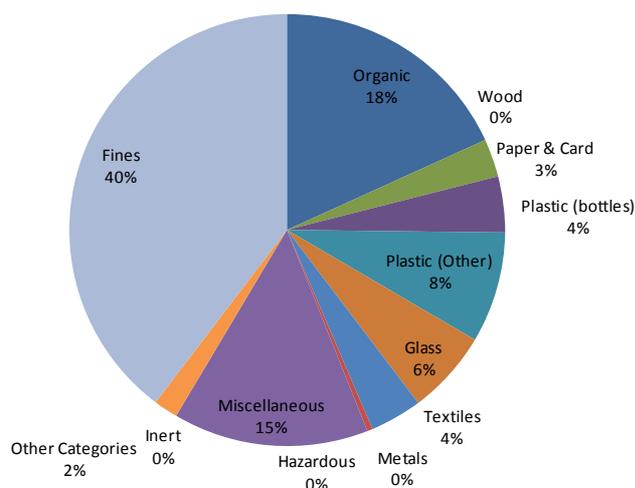
Points of Note:

1. Near absence of metals, wood – removed from waste stream by scavengers after household disposal
2. High fines content is retained at community bins and lower organic content (due to less food wastage at household etc)

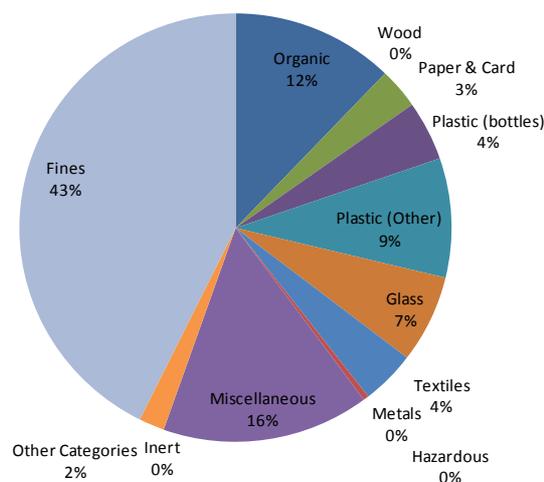
Table 10: Waste composition % by weight (summary)

	Waste Composition % by weight (kg)	
	summary	
	8 day Average	
	Wet	Dry
Organic	18.2	12.2
Wood	0.0	0.0
Paper & Card	2.8	3.0
Plastic (bottles)	4.2	4.5
Plastic (Other)	8.3	9.0
Glass	6.2	6.6
Textiles	3.9	4.1
Metals	0.4	0.4
Hazardous	0	0
Miscellaneous	14.5	15.5
Inert	0	0
Other Categories	2	2
Fines	39.7	42.7

**Waste Composition - % by weight - wet
(3.B. Low income community bins)**



**Waste Composition - % by weight - dry
(3.B. Low income community bins)**



Sample Collection from Low Income residential community bins



4.A. Non-food goods commercial district - individual premises

Points of Note:

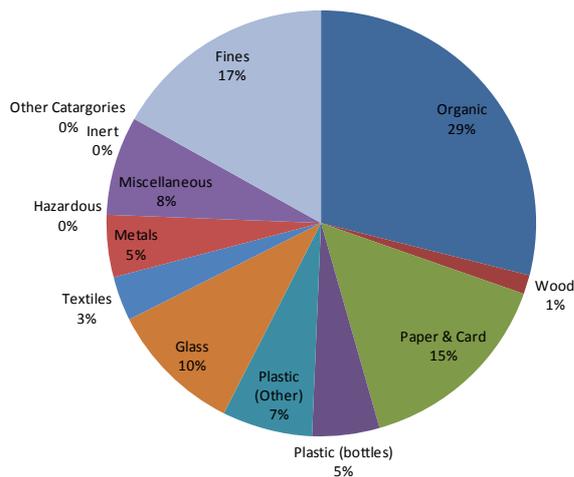
1. Wide spread and more even spread of composition than household premises.
2. Relative low weight per premises being reported is questionable though not discounted.
3. Higher percentage of packaging type materials (plastics, cardboard, wood etc).

Table 11: Waste composition % by weight (summary) and Weight

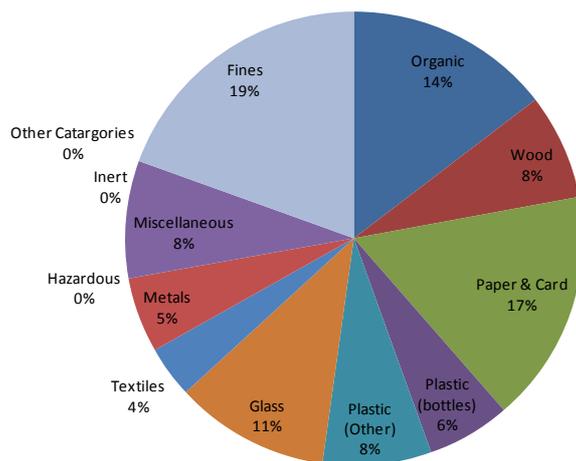
Waste Composition % by weight (summary)	8 day Average	
	Wet	Dry
Organic	27.5	14.5
Wood	1.4	7.5
Paper & Card	14.4	16.6
Plastic (bottles)	4.8	5.9
Plastic (Other)	6.5	7.7
Glass	9.6	10.9
Textiles	3.2	3.7
Metals	4.5	5.4
Hazardous	-	-
Miscellaneous	7.1	8.3
Inert	-	-
Other Catargories	-	-
Fines	16.0	19.5

Weight	Weight	
	Wet	Dry
	16.3	15.2
	22.6	20.3
	29.9	21.8
	17.0	16.5
	21.8	19.8
	31.6	21.1
	17.1	13.4
	9.9	9.1
Mean	19.6	16.5
Average	20.8	17.1
Average/premises	2.08 kg	

Waste Composition - % by weight (kg) - wet (4.A. - Dry goods commercial premises)



Waste Composition - % by weight (kg) - dry (4.A. - Dry goods commercial premises)



Sample Collection from non-food good commercial premises



4.B. Non-food goods commercial district - community bins

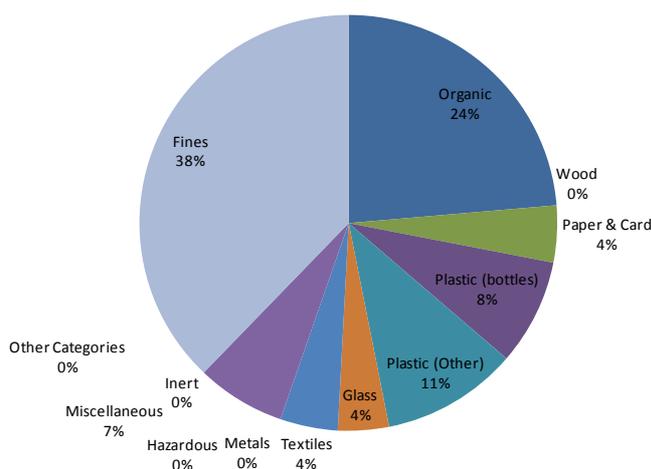
Points of Note:

1. Wide spread of composition reduced as materials are scavenged out.
2. Near absence of metals, wood – removed from waste stream by scavengers after premises disposal

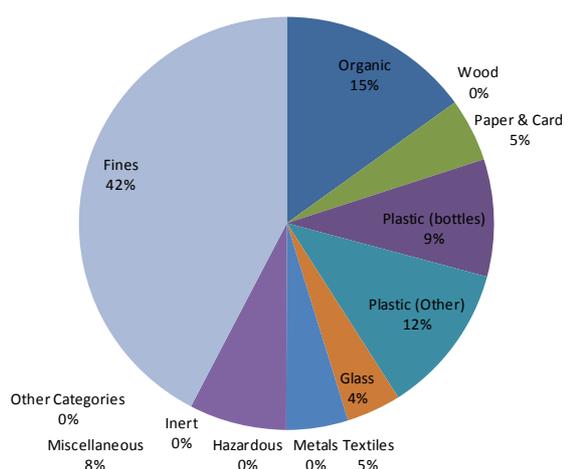
Table 12: Waste composition % by weight (summary)

Waste Composition % by weight (kg) summary		
	3 day Average	
	Wet	Dry
Organic	23.6	15.0
Wood	0.0	0.0
Paper & Card	4.4	4.9
Plastic (bottles)	8.3	9.2
Plastic (Other)	10.5	11.8
Glass	3.9	4.2
Textiles	4.4	4.8
Metals	0.0	0.0
Hazardous	0	0
Miscellaneous	6.9	7.6
Inert	0	0
Other Categories	0	0
Fines	37.8	42.4

Waste Composition - % by weight - wet
(4.B. Dry good commercial community bins)



Waste Composition - % by weight - dry
(4.B. Dry good commercial community bins)



Sample Collection from non-food good commercial area community bins



5.A. Food market commercial district - individual premises

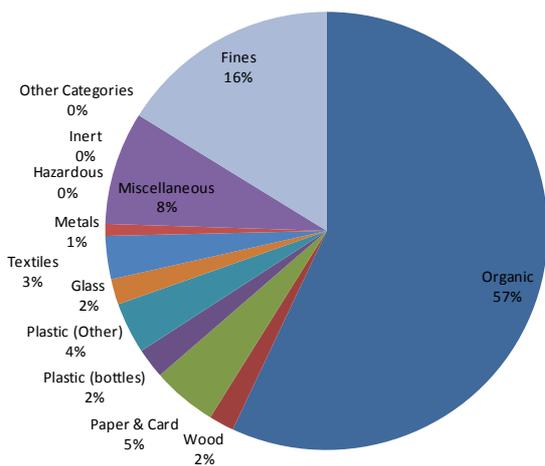
Points of Note:

1. Very high organic content due to type of market and resultant organic waste content.
2. Low percentage of other materials but relatively high weight per premises

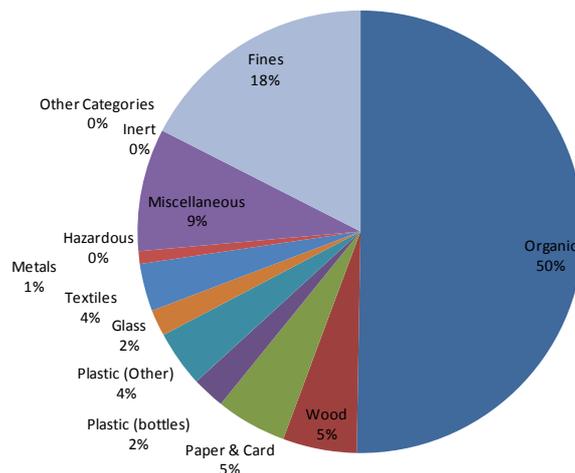
Table 13: Waste composition % by weight (summary) and Weight

Waste Composition % by weight (summary)			Weight		
	8 day Average			Weight	
	Wet	Dry		Wet	Dry
Organic	55.2	50.3			
Wood	1.8	5.4	33.4	29.4	
Paper & Card	4.6	5.2	35.8	32.0	
Plastic (bottles)	2.1	2.4	43.0	38.3	
Plastic (Other)	3.7	4.1	42.9	39.9	
Glass	1.8	1.9	39.8	38.0	
Textiles	3.1	3.4	44.4	40.4	
Metals	0.8	0.9	30.3	25.4	
Hazardous	-	-	34.1	31.2	
Miscellaneous	8.1	9.0	Mean	37.7	33.9
Inert	-	-	Average	38.0	34.3
Other Categories	-	-	Average/premises	3.80 kg	
Fines	15.7	17.4			

Waste Composition - % by weight (kg) - wet (5.A. - Food market commercial premises)



Waste Composition - % by weight (kg) - dry (5.A. - Food market commercial premises)



Sample Collection from food good commercial premises



5.B. Food market commercial district - community bins

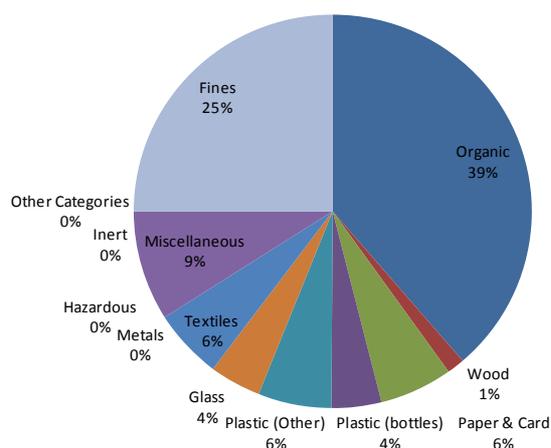
Points of Note:

1. Relatively high wood and paper/card content due to type of market and resultant packaging waste content.
2. Near absence of metals- removed from waste stream by scavengers after premises disposal

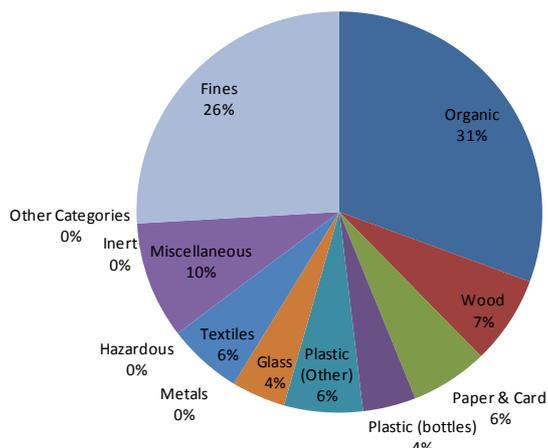
Table 14: Waste composition % by weight (summary)

	Waste Composition % by weight (kg)	
	summary	
	3 day Average	
	Wet	Dry
Organic	36.7	30.6
Wood	1.3	7.1
Paper & Card	5.7	6.2
Plastic (bottles)	3.8	4.2
Plastic (Other)	5.7	6.3
Glass	4.0	4.3
Textiles	5.4	6.0
Metals	0.0	0.0
Hazardous	0	0
Miscellaneous	8.5	9.4
Inert	0	0
Other Categories	0	0
Fines	23.7	25.9

**Waste Composition - % by weight - wet
(5.B Food market commercial community bins)**



**Waste Composition - % by weight - dry
(5.B Food market commercial community bins)**



Sample Collection from food good commercial area community bins



6.A. Large, multi-product commercial district - individual premises

Points of Note:

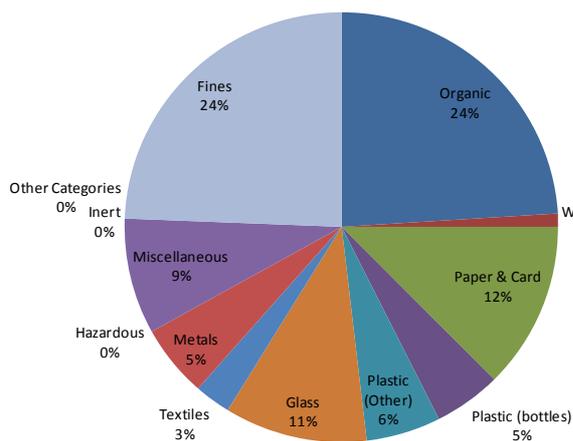
1. Wide spread and more even spread of composition than household premises.
2. Relative low weight per premises.
3. Materials arising are mostly packaging type materials

Table 15: Waste composition % by weight (summary) and

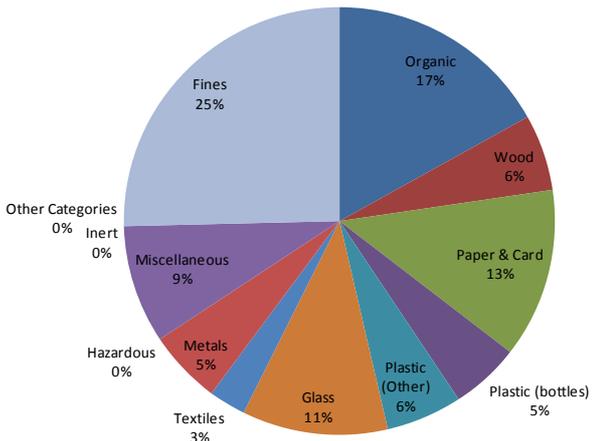
Waste Composition % by weight (summary)	8 day Average	
	Wet	Dry
	Organic	22.9
Wood	1.0	5.8
Paper & Card	12.0	12.8
Plastic (bottles)	4.8	5.2
Plastic (Other)	5.3	5.7
Glass	10.2	10.9
Textiles	2.6	2.8
Metals	5.2	5.6
Hazardous	-	-
Miscellaneous	8.3	8.9
Inert	-	-
Other Categories	-	-
Fines	23.3	25.4

Weight	Weight	
	Wet	Dry
	19.4	18.7
	24.0	22.0
	24.4	23.2
	16.8	16.1
	25.1	22.7
	15.6	14.5
	19.4	17.1
	15.0	13.5
Mean	19.6	18.1
Average	20.0	18.5
Average/premises	2.00 kg	

Waste Composition - % by weight (kg) - wet (6.A. - Multi-market commercial premises)



Waste Composition - % by weight (kg) - dry (6.A. - Multi-market commercial premises)



Sample Collection from multi-good commercial market area premises



6.B. Large, multi-product commercial district - community bins

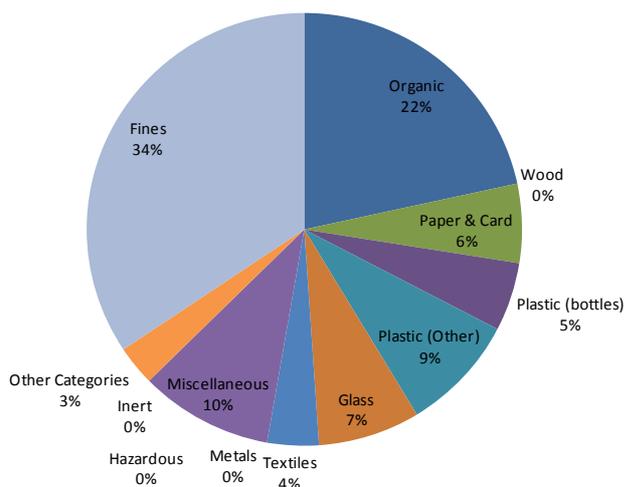
Points of Note:

1. Surprisingly large spread of material composition remains in waste at disposal site.
2. Total absence of metals- removed from waste stream by scavengers after premises disposal

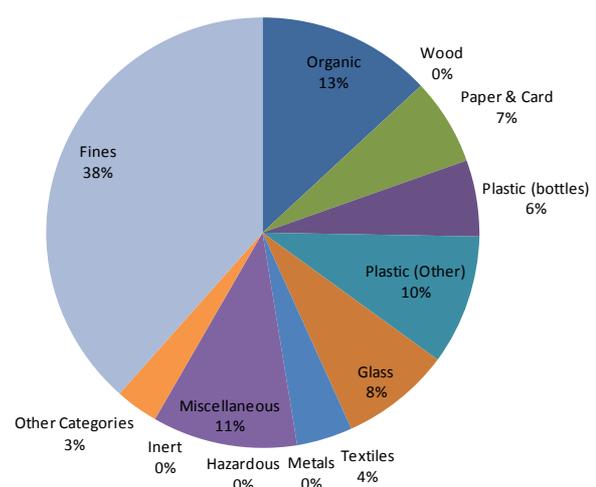
Table 16: Waste composition % by weight (summary)

Waste Composition % by weight (kg) summary		
	3 day Average	
	Wet	Dry
Organic	21.6	13.0
Wood	0.0	0.0
Paper & Card	6.0	6.5
Plastic (bottles)	5.1	5.7
Plastic (Other)	8.7	9.8
Glass	7.5	8.2
Textiles	3.8	4.2
Metals	0.0	0.0
Hazardous	0	0
Miscellaneous	9.9	10.8
Inert	0	0
Other Categories	3	3
Fines	34.4	38.5

**Waste Composition - % by weight - wet
(6.B. Mixed Market community bins)**



**Waste Composition - % by weight - dry
(6.B. Mixed Market community bins)**



Sample Collection from multi-good commercial market area community bins



7.A. Disposal site - Tarnak river site

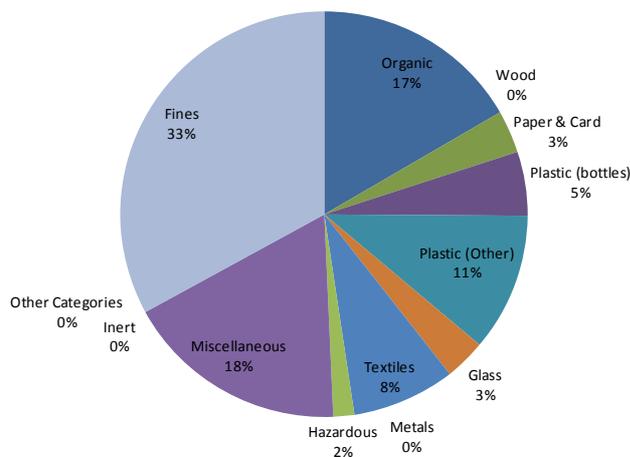
Points of Note:

1. Surprisingly large spread of material composition remains in waste at disposal site, a lot of miscellaneous due to small, undefined mixtures of materials remaining after scavenging and informal processing.
2. Total absence of metals- removed from waste stream by scavengers after community bin disposal

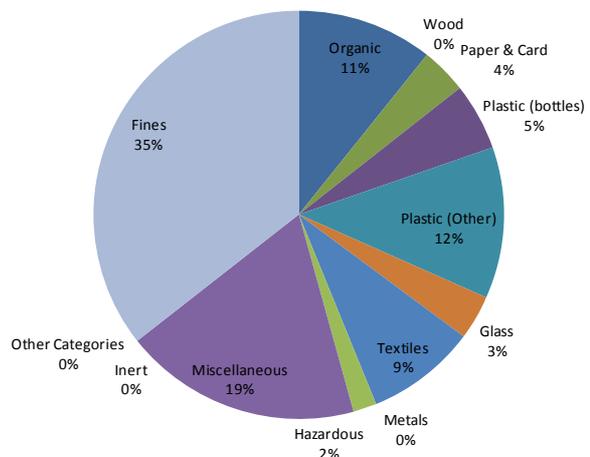
Table 17: Waste composition % by weight (summary)

Waste Composition % by weight (kg) summary		
	3 day Average	
	Wet	Dry
Organic	16.6	10.7
Wood	0.0	0.0
Paper & Card	3.4	3.6
Plastic (bottles)	5.1	5.3
Plastic (Other)	11.1	12.1
Glass	3.3	3.5
Textiles	8.2	8.7
Metals	-	-
Hazardous	2	2
Miscellaneous	17.7	18.6
Inert	0	0
Other Categories	0	0
Fines	33.0	35.6

Waste Composition - % by weight - wet
(7.A. Tarnak Dump Site)



Waste Composition - % by weight - dry
(7.A. Tarnak Dump Site)



Sample Collection from Tarnak final disposal site



Annex 1 – Kandahar City District Survey Summary Sheet

Chemmonics International

USAID RAMP UP-SOUTH

21 August 2011

Kandahar City District Survey Statistics - Summary Sheet

Information	District 1	District 2	District 3	District 4	District 5	District 6	District 7	District 8	District 9	District 10	Totals
<i>Total Population</i>	126,390	126,000	130,000	98,300	76,000	73,000	98,300	76,500	173,000	132,500	1,109,990
<i>% high income</i>	60%	50%	40%	40%	60%	30%	30%	30%	20%	15%	37%
<i>% medium income</i>	20%	20%	30%	40%	20%	40%	30%	30%	20%	20%	27%
<i>% low income</i>	20%	30%	30%	20%	20%	30%	40%	40%	60%	65%	36%
<i>Total number of houses</i>	12,000	15,000	12,000	7,200	6,000	6,000	8,700	6,500	30,000	13,000	113,400
<i>Total number of Shops</i>	5,766	4,800	3,800	4,400	2,050	530	2,500	800	1,000	740	26,386
<i>Veg. and Fruit Shops</i>	120	240	48	160	80	50	45	28	250	120	1,141
<i>Butcher Shops</i>	48	64	20	65	11	12	16	10	95	50	391
<i>Dry goods shops</i>	5,378	4,296	3,672	4,250	1,500	460	2,289	720	655	550	23,770

Annex 2 - Methodology

KANDAHAR WASTE CHARACTERISATION AND QUANTIFICATION ANALYSIS - METHODOLOGY

This methodology will establish minimum standards for sorting procedures; sorting categories and common reporting guidelines required for conducting a waste composition analysis in Kandahar city.

CONTEXT

In order to plan, design and operate a solid waste management system, a thorough knowledge of the quantities generated, the composition of wastes and its characteristics are essential. Waste composition analysis provides information about the types and amounts of the materials that are in a given waste stream.

Such analysis is essential for the following reasons:

- It provides the basic data on which the management system is planned, designed and operated;
- It provides the information for the selection of equipment and appropriate technology (including size of waste containers, vehicles, compaction ability (and thereafter route planning) etc.;
- It indicates the amount and type of material suitable for processing, recovery and recycling as well as the choice of a suitable method of disposal
- Forecasts trends assisting designers and manufacturers in the production of vehicles and equipment suitable for future needs.
- Provides a determination of the environmental impact exerted by the wastes if they are improperly managed.

Data is gathered by physically separating the waste into a number of predetermined categories. Each category is then weighed to quantify it and these weights collated to provide a breakdown of the total composition of waste which has been sampled. This provides a snapshot in time of the waste stream being analysed.

This study shall utilize an approach for the manual sorting and analysis of such waste to determine the following:

- Waste Characterisation (composition)
- Waste Quantification (amount produced) based on waste composition

WASTES TYPES UNDER ANALYSIS

The fraction of municipal solid waste defined as "daily household and commercial waste", which forms the scope of this study, includes:

- **Household waste:**

Any and all mixed solid waste (excluding night-soil/sewerage, but including inert earth floor sweepings) produced at individual households, which is collected, transported, and disposed of, either by the householder, the municipality or by any other third party in any kind of containers and/ or plastic bags;

- **Residual commercial waste:**

Mixed solid waste produced by commerce activities at commercial premises, which is collected, transported, and disposed of, either by the proprietor (or employees), the municipality or by any other third party in any kind of containers and/ or plastic bags. The amount and composition of commercial waste can vary substantially throughout the city, arising in spatial clusters depending on the business sector.

The consistency of household/commercial waste is varied in size and can range from mm (fine elements) up >1 m (e.g. parts of furniture). A **representative** sample from the total waste producing population area is to be investigated in order provide a viable description of the characteristics of the whole parent population.

WASTE ANALYSIS SAMPLE LOCATIONS

Waste samples are to be taken and analysed from the following locations

- **Household Waste**

Obtained by sampling at the individual household level, (separate sample groups from low income, middle income and high income areas) capturing and analyzing 100% of daily discarded material (i.e. prior to any scavenging activities).

- **Commercial waste**

Obtained by sampling waste from individual commercial properties (shops, butchers, small workshops, offices) again, capturing and analyzing 100% of daily discarded material (i.e. prior to any scavenging activities).

- **Community Waste Level**

Obtained by sampling at the community level from community bins or street disposal points (from freshly deposited waste, though after normal scavenging activities have taken place).

- **Final Disposal of Waste Level**

Obtained by sampling at the city waste disposal site (Tarnak river site), preferably from freshly deposited (same day) waste load, though after normal scavenging activities have taken place.

WASTE CHARACTERISATION IMPLEMENTATION METHODOLOGY

Within the sample locations identified in section 1.3, the study should include the following strata (sample groups) (if practically possible):

Table 18: Waste sampling group locations (strata)

STRATA CODE	STRATA SAMPLING LOCATION
1.A.	High income residential district - individual households
1.B.	High income residential district - community bins
2.A.	Medium income residential district - individual household
2.B.	Medium income residential district - community bins
3.A.	Low income residential district - individual households
3.B.	Low income residential district - community bins
4.A.	Non-food goods (i.e. electronic goods) commercial district - individual premises
4.B.	Non-food goods (i.e. electronic goods) commercial district - community bins
5.A.	Food market commercial district - individual premises
5.B.	Food market commercial district - community bins
6.A.	Large, multi-product commercial district and offices - individual premises
6.B.	Large, multi-product commercial district and offices - community bins
7.A.	City waste disposal site - Tarnak river site
7.B.	<i>City waste disposal site - Other site if applicable</i>

These various areas should be identified during a pre-study which evaluates and identifies socio-economic areas and commercial sector groups. See section 2 for sampling matrix.

Pre-investigation

Initial information required to be reviewed in order to identify potential study areas includes:

- Income level of household, annual turn-over of commercial premises
- Number and type (income level) of households in community serviced by community bins
- Type of business (products sold)
- Number of inhabitants/shop workers per property

Once this information is acquired, specific potential study areas to be involved in the waste analysis can be identified and participants identified.

Analysis design and planning

Selecting a random sample

In order that the study results can be considered valid, it is necessary, where practically possible, to choose a randomly selected sample of households, commercial properties and communal locations within the selected study areas. Basing selection on any predetermined criteria, rather than on a random basis, is likely to adversely affect the final results. The waste from each sample unit should be collected and identified separately. Cooperating households may require to be compensated for their participation.

Sample size

There is potential for considerable variation in the composition of the waste that is presented for collection by householders on a given day. In order that results of the study are representative of the area or waste stream as a whole, the waste sample must be of sufficient proportions to take account of this variation. In the design of the study this variation should be taken account of by taking a sufficient number of sub-samples, and by maximising the total amount of waste (by weight and volume) analysed.

For commercial and residential property strata, the number of sampling units of one stratum (i.e. socio-economic grouping of residential, and commercial/product group for commercial area studies) shall not be less than 10 and the sample size shall not be less than 6 m³ (bin volume per week).

For communal bins and waste disposal site, the cone and quarter method shall be employed. No fewer than 6 communal bins shall be studied per sample area, and at least 6 separate samples shall be taken at the Tarnak river disposal site. Each individual sample size will be no less than 150kg in weight and 1m³ in volume. See section 2 for sampling matrix.

Duration of analysis study

The duration for waste sampling and sample collection will cover a minimum of nine days of waste. This will allow the sampling of waste to be spread over each working day (Wednesday through week Thursday) covering the full collection cycle. It is important that 100% of waste produced at the household and commercial premises level is captured. Therefore waste will be collected and analysed daily, from the same premises, for one entire week. Communal bins and Tarnak river sites should be sampled at least twice in the week. See section 2 sampling matrix.

Choosing a location for waste sorting

Samples should be delivered to a designated secure facility for analysis. The site should have sufficient space available for easy working and for the storage of waste to be sorted and that already sorted awaiting disposal. The sorting area should be covered and enclosed to protect the team from birds and the weather. The working area should have a sealed floor and facilities for cleaning the area (water supply, hoses) and for staff to clean-up after handling waste. Adequate lighting should also be provided. The area should be easily accessed by the vehicle used to transport the waste samples. Washing and changing facilities for staff must be provided nearby. All sorting and associated working areas should be well ventilated. An adequate external area must also be available to allow the sun/air drying of organic biodegradable waste so as to obtain a wet and dry weight sample.

Public communication

The public should be informed of this project and informed as to why the analysis is taking place and its importance to the municipality in designing and providing a successful waste management system. To ensure full cooperation, the sampling program and the rationale behind it should be fully explained to the participants (see example in section 3). An individual best qualified for such a task would be a local social worker or equivalent.

As a minimum, it is recommended that the following steps are taken:

- Collection staff should respect any householder who does not wish their bin to be included in the study;
- Each collection team should include a supervisor briefed to answer questions from householders;
- Other municipality staff likely to come into contact with the study should be suitably briefed;
- Local police should be informed of where and when the study is taking place.
- The implementer should be prepared to compensate participants for their involvement.

SWM Practices Survey

A short and limited questionnaire survey of householders, commercial proprietors, waste collection workers, and in particular scavengers (at street, community and final disposal site levels), will be conducted in order to develop a better understanding of specific aspects of solid waste management practices in Kandahar and complement the analysis study.

The information to be gathered from each stratum of the study area includes:

- Description of waste container systems in use such as household bins, communal bins and bin storage capacities
- Numbers of households and/or shops using community bin being sampled, and how many residents live in each house or employees work in each shop being sampled.
- Total bin volume; spatial distribution of bins; collection intervals
- Disposal method/location and estimate of types of waste and quantities involved.
- What waste is being collected by scavengers and in what volumes?
- Where do the scavengers take their collected materials to, and how much money do they receive for each specific item?

Questionnaire forms are included in section 4. Individual participant shall be interviewed within each of the strata identified in table 1, beginning of section 1.4. This shall include individual household/shop sampling of participants, and on-street sampling around community bins and disposal sites of scavengers and waste collectors.

Execution of waste analysis

This analysis involves the evaluation of the external waste bin/container outside the households/ commercial property, with 100% of waste production captured, prior to scavenging, and analysis of communal bins and disposal sites, after scavenging. All health and safety requirements must be adhered to as presented in section 9.

Analysis facility preparation

The following tasks will prepare the sorting area for the analysis:

- The 13 bins for each of the primary waste categories should be clearly labeled.
- Each bin should be weighed empty and the *tare weight* (empty weight) recorded.
- Ensure tarpaulins are in place and large enough to capture fines passing through screens.
- Equipment should be laid out according to ease and safety of working.

- Material identification posters should be placed where they will be clearly visible to staff.
- Scales calibrated and checked.

The following table provides a list of equipment and items that may be required in conducting the waste composition analysis.

Waste Collection	<ul style="list-style-type: none"> • Robust containers or bags to be distributed to every participant household/shop or used to collect waste at community sites every day. • Flat-bed or box van for transport of waste • Robust labeling to identify collected material by reference code
Weighing and sorting	<ul style="list-style-type: none"> • Fine screen to remove particles less than 10mm in diameter (fines) from incoming waste samples. • Tarpaulins to capture fines passing through screens. • Scales capable of weighing up to 500kg (1kg intervals) • Smaller range scales for detailed analysis (should be able to weigh accurately at 250g intervals) • Sieve/screen to separate wastes less than 10mm particle size • Containers for sorting of waste (e.g. 13, one for each category). • Robust laminate signs for the sorting bins to identify which materials are placed in each. • Materials Identification posters. Information for sorting team to help in the identification of materials. • Paperwork for recording data. • Plastic sheeting to lay out organic wastes for drying • 1m³ (or other known volume) containers constructed and ready for waste bulk density analysis.
General Handling	<ul style="list-style-type: none"> • Shovel • Broom • Litter pickers • Knives to cut open bags • Appropriate personal protective equipment as identified by risk assessment
Disposal	<ul style="list-style-type: none"> • Facilities for disposal of waste after analysis

Sample and data acquired at Residential and Household locations

Each participating household and shop will be provided with a container, (strong black plastic bag for example), in which their daily output of wastes is placed. Each day, these containers will be collected and tagged (labeled) by the waste sample collection team with information noted as per example in section 4 (this data will then be recorded on the daily record sheet presented in section 5). The participant will be supplied with a new (i.e. empty) container only when the filled one is collected. The team will then transport the samples to the study facility for analysis.

Each sample collected will be tagged with a unique identification reference code. The information stated in section 4 shall be recorded on each label, this included the following data, referenced to the sample code, for each individual sample:

1. Unique identification reference code and date of collection
2. Strata (i.e. high income residential, low income residential, or food market etc)
3. Sample address (location within the city including district number and location within district)
4. Number, type, and volume of waste containers collected
5. Visual estimation of % filling level of waste containers collected (or estimated volume of waste collected) to get the information for calculating the waste quantity

It is important that each individual waste sample collected can be clearly identified and is not mixed with any other waste samples during collection and transportation.

Sample & data acquired at community bin and disposal site locations

Analysis of waste from communal bins and disposal site

Waste samples from communal bins and final disposal site are expected to be collected at the sample location and delivered to the analysis facility using a dedicated vehicle. If it is necessary to reduce the size of the sample to a manageable level, this can be done using the “Cone and Quarter” technique described in next section. Analysis should thereafter be carried out per the same methodology as for individual household and commercial waste samples.

Cone & Quarter Methodology

The “cone and quarter” is a sampling method for extracting sub-samples from a large sample material. Although this sampling method is perhaps more time consuming than some other methods (e.g. taking “random” sub-samples from locations in the large pile that appear “normal”), the “cone and quarter” method is the least biased way of extracting a sub-sample and will yield the most accurate results.

Cone and quartering is done as follows:

1. Consolidate waste in communal bins into uniform pile, or select random load of waste delivered at disposal site;
2. All bulky items are separated from the load, categorized, weighed, and recorded;

3. The remaining material (including debris and soils) is mixed by mechanical shovel, or by hand using rakes or shovels, into a uniform pile approximately 0.8 metres high;
4. The pile is divided into two by a straight line through the centre of the pile;
5. The pile is further divided by a second line roughly perpendicular to the first (see figure 1);
6. Either pair of opposite quarters is removed, leaving half the original sample;
7. Steps 3 through 5 are repeated until the required (manageable) amount of sample material remains. The final sample size should be between 150 and 300kg and at least 1m³ in volume.

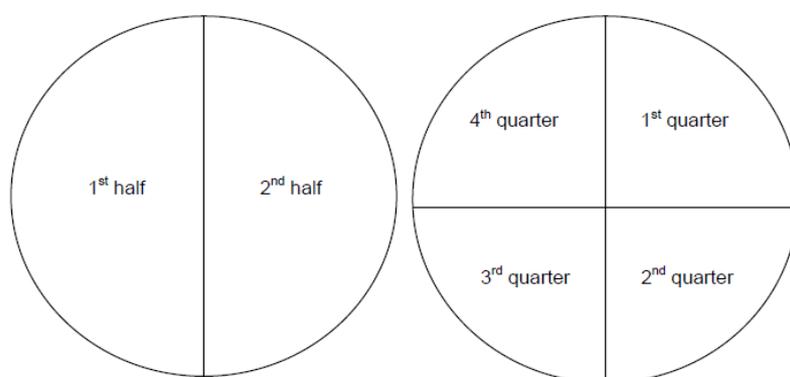


Figure 2: Cone and Quarter sampling method

Once a manageable size of waste is obtained, the sample should be loaded into a container(s) (large bin or plastic bags, use more than one if required but ensure each container from the same sample location has the same identification number). Each sample collected must then be tagged with a unique identification reference code. The following data will be recorded at the same time, referenced to the sample code, for each individual sample:

1. Unique identification reference code and date of collection
2. Stratum (i.e. high income community bin, low income community bin, or food market community waste accumulation site etc, see table 1, section 1.4)
3. Sample site location (location within the city including district number and location within district, or Tarnak river disposal site)
4. Estimated number of shops or residential properties using community bin
5. Visual estimation of volume of waste situated in community bin at time of sampling

It is important that each individual waste sample collected can be clearly identified and is not mixed with any other waste samples during collection and transportation.

Sorting and Analysis of samples

To reduce the magnitude of errors arising from moisture change and from decomposition, analysis of the samples should begin within two hours of sample collection.

Measuring weight and specific weight of individual samples

Upon arrival at the analysis facility, each and every individual sample shall be weighed and its volume measured and recorded on the individual sample daily record sheet as presented in section 5.

Measuring Bulk Density/ Specific weight of grouped stratum samples

Once each sample has been recorded individually, samples from each stratum (see table 1, section 1.4) shall be grouped together. Once grouped together, the bulk density of each mixed waste sample shall be measured and recorded (see record sheet in section 7). This is achieved by filling a container of known volume (i.e. 0.5m³ or 1m³) to the top with as many samples from the same stratum as required. Continuously shake or knock box on floor to allow material settlement (but do not push down to compress materials). Once enough material is inserted to fill the container to level, weigh box and contents. Record weight, and if enough material is present in the stratum sample, repeat the process. Repeat the process for each strata sample group as identified in section 1.4, table 1.



Figure 3: Filling 1m³ box to measure bulk density / specific weight (UNEP/CalRecovery)

Waste category separation and analysis

Each mixed sample from each stratum is sorted into 13 material categories according to the sorting catalogue (see section 8). To further assist sorting and analysis the catalogue also provides indicative examples broken down to a secondary category level for a wide range of items commonly encountered in the municipal waste stream as a guide to their appropriate classification.

To separate the expected volumes of debris and soils from the waste material and aid other component separation, the waste must first be screened on a fine, <10mm dimension screen. This is conducted onto a clean tarpaulin to capture fines which are then gathered into a container, volume estimated and weighed. All remaining materials will be separated into appropriate fractions. At the completion of the sorting, each container and its contents are weighed (gross weight). Gross and tare (empty container) weights should be recorded

(see record sheet in section 6). The difference between the two weights is the net weight of the individual components. Volume of materials is also estimated in order to record specific weight of each material sample.

Activities to be conducted during sorting and analysis include:

1. Complete a waste analysis record data sheet (see section 5) for each sampling unit.
2. The unique identification codes attached to each sample are recorded against the waste analysis record to be completed.
3. The percentage-filling ratio of the waste sample container and container volume (bin) or estimated volume (bag) is recorded.
4. The sample is weighed to an accuracy of +/- 0.1 kilograms (kg) and the weight recorded (total weight – container weight = sample weight). Weigh incoming waste to give a weight of waste for each household. Weighing should be carried out three times and an average value taken. This procedure should be followed throughout when recording weights.
5. Cut open the bags using the knives provided, taking care to adhere to proper health and safety protocols. Tearing the bags open should be avoided to reduce potential contact with sharp or harmful waste.
6. Empty samples into a container (box) of known volume (1m³ is recommended) and tare weight, shaking box as it is filled to assist in settlement, once filled to level top, weigh box and record weights in table presented in section 7.
7. Empty contents of container and any remaining sample from the stratum being analyzed onto fine holed metal screen. Screen out fine particles less than 10mm onto a clean tarpaulin located under the screen.
8. The samples are then sorted directly on the screen table into one of 13 compulsory primary waste categories as specified by the Sorting Catalogue (see section 8). The weight of each category is recorded for the sampling unit to an accuracy of +/- 0.1 kg. Weigh the bins / containers (three times as before) to record the amount of waste sorted. The 'below10'mm fraction is collected up in the tarpaulin, put into a container, volume recorded, weighed to an accuracy of +/- 0.1 kg and this weight recorded as 'Fines'. Record all data in form presented in section 6.
9. Organic fraction will be weighed and volume measured whilst wet, material will then be laid out on a plastic sheet to dry in sun before being reweighed and volume re-measured.
10. After analysis is complete and all data recorded, recyclable materials shall be taken to a junkshop for onward processing within the established system, soil shall be recovered and reused where possible, and residual waste shall be collected, and disposed of properly at the designated city disposal site near to the Tarnak.

Waste density is also to be calculated as part of the study using the following procedures:

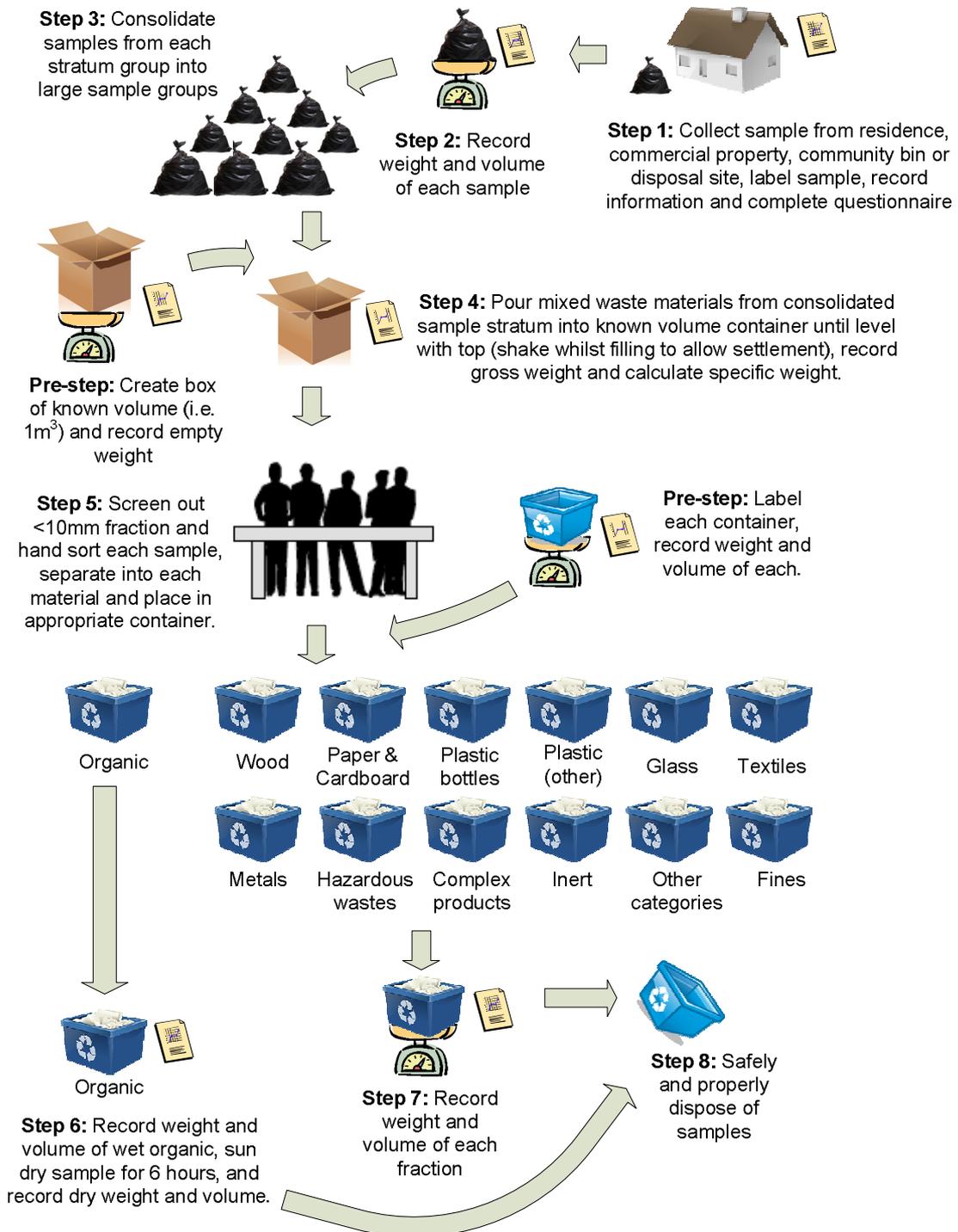
Procedure for measuring material density (specific weight)

Before emptying the sample bins containing the sorted materials (after weighing):

1. Lift and drop the bin five times to allow the waste to settle
2. Estimate the volume of the waste according to how full the bin is with waste (e.g. 30% of a 60 litre bin), bearing in mind possible tapered shape of the bin
3. Record the volume of the waste in each bin.
4. The specific weight of each of the wastes is calculated by:
Specific weight = Weight of the waste / Volume of waste

Summary of steps to be taken during analysis

The following diagram illustrates the basic sampling procedure to be conducted



SAMPLE LOCATIONS AND NUMBER MATRIX

Distribute sample collection containers / bags to participants on the Tuesday, begin collection and sampling on the Wednesday.

Sample location (strata)	Wed	Thur	Fri	Sat	Sun	Mon	Tue	Wed	Thur	Fri	Total
Low income residential district											
1.A. individual households	10	10	-	10	10	10	10	10	10	-	
1.B. community bins	6	6	-	6	6	6	6	6	6	-	
Medium income residential district											
2.A. individual households	10	10	-	10	10	10	10	10	10	-	
2.B. community bins	6	6	-	6	6	6	6	6	6	-	
High income residential district											
3.A. individual households	10	10	-	10	10	10	10	10	10	-	
3.B. community bins	6	6	-	6	6	6	6	6	6	-	
Electronic goods commercial district											
4.A. individual premises	10	10	-	10	10	10	10	10	10	-	
4.B. community bins	-	6	-	6	-	-	-	6	-	-	
Food market commercial district											
5.A. individual premises	10	10	-	10	10	10	10	10	10	-	
5.B. community bins	-	6	-	6	-	-	-	6	-	-	
Large, multi-product commercial district and offices											
6.A. individual premises	10	10	-	10	10	10	10	10	10	-	
6.B. community bins	-	6	-	6	-	-	-	6	-	-	
Waste disposal site											
7.A. Tarnak river site	-	6	-	6	-	-	-	6	-	-	
7.B. Other site (<i>only if identified</i>)	-	(6)	-	(6)	-	-	-	(6)	-	-	
TOTAL	78	102	0	10	78	78	78	102	78	0	696

SAMPLE INTRODUCTION BRIEF TO POTENTIAL PARTICIPANTS

Greetings!

The municipality is embarking on a program to improve its solid waste management services to the municipality. We will undertake a study on waste generation to determine the amount, type and composition of waste generated by various sources.

In connection with this, you were selected to participate in the study. We are requesting you to please give us your generated waste (24-hour generation) per day for seven days starting on _____ to _____. We will be providing you with plastic bags as receptacle for all of your wastes the day before. Designated collectors shall pick-up the plastic bags between 7 -8 a.m. in the morning daily and a new set of plastic bags shall be provided again for the next day.

Likewise please allow our staff to conduct interview regarding your solid waste management practices and take pictures.

Attached is the step-by-step guide for your guidance. For inquiries, please contact the following: _____

Thank you very much for your support and cooperation.

Instructions:

1. Please do not conduct a general cleaning of your residences, shops or establishments. We will be measuring your normal waste generation per day, from 8 AM to 7 AM the next day. In case, within the week, an abnormal generation occurred like broken electric bulb or any other broken appliances, destroyed shoes and bags, on-going construction, please include all of those in the receptacles provided for during that day.
2. If normally you sell waste materials to a local buyer, please refrain for the duration of the study. If you wish we may return the said materials to you as soon as we have taken their measurement.
3. A bag shall be provided to you to collect all wastes that you would normally dispose off in a bin that you wish the municipality or others to take away, this includes dirt and organic material, plastics, metals and other materials that you would normally throw away.

WASTE PRACTICES SURVEY QUESTIONNAIRE AND LABEL FORMAT

At the time of collecting samples, the following information shall be obtained from visual observation, analysis and asking questions from the relevant people at the sampling location.

Households:

Initial site visit:

Date of visit..... District.....

Address:.....

Strata code:..... Individual sample reference number:.....

How many people live in the house?.....

Describe the waste containers currently in use at the household such as plastic bins, metal bin, plastic bag or other and their volume.....

What do you normally do with your waste?..... (Write number or numbers as identified below)

- 1 - Municipality collects waste
- 2 - Feed leftovers to animals
- 3 - Sell containers to local buyers
- 4 - Pay local person to take it away
- 5 - Throw in the street
- 6 - Burn
- 7 - Give it away/donate
- 8 - Compost yard waste
- 9 - Use as fuel

Are there buyers of used containers (plastic, bottles, cans, boxes) in your locality?.....

Each site visit (written on label securely attached to sample and record kept centrally):

Date of collection..... Time..... District.....

Strata code:..... Individual sample reference number:.....

Estimated volume of sample:.....

Commercial Premises:**Initial site visit:**

Date of visit..... District.....

Address:.....

Type of business:.....

Strata code:..... Individual sample reference number:.....

How many people work in the shop?.....

Describe the waste containers currently in use at the shop to collect waste, i.e. plastic bins, metal bin, plastic bag or other and their volume.....

What do you normally do with your waste?..... (Write number or numbers as identified below)

- 1 - Municipality collects waste
- 2 - Feed leftovers to animals
- 3 - Sell containers to local buyers
- 4 - Pay local person to take it away
- 5 - Throw in the street
- 6 - Burn
- 7 - Give it away/donate
- 8 - Compost yard waste
- 9 - Use as fuel

Are there buyers of used containers (plastic, bottles, cans, boxes) in your locality?.....

Each site visit (written on label securely attached to sample and record kept centrally):

Date of collection..... Time..... District.....

Strata code:..... Individual sample reference number:.....

Estimated volume of sample:.....

Community Bin Sites:

Initial site visit:

Date of visit..... District.....

Exact location of bin:.....

Type of container:.....

Strata code:..... Individual sample reference number:.....

Estimate how many houses and shops use bin?.....

Describe the waste container and its contents, including waste around bin and if any animal have been eating from it.....

How long ago was it last emptied?.....

Estimate total volume of bin.....

What waste is being collected by scavengers and in what volumes from the bin?.....

How far away is the next nearest community bin?.....

Each site visit (written on label securely attached to sample and record kept centrally):

Date of collection..... Time..... District.....

Strata code:..... Individual sample reference number:.....

Estimate total volume of waste in bin.....

Estimated volume of sample:.....

Final disposal site:

Initial site visit:

Date of visit..... District.....

Exact location of sample taken:.....

Strata code:..... Individual sample reference number:.....

Describe the location within the Tarnak site from where the sample is taken.....

Describe the waste pile to be sampled and its contents, including how long ago it was dumped there.....

What waste is being collected by scavengers and in what volumes from the site?.....

Where do the scavengers take their collected materials to, and how much money do they receive for each specific item?.....

Each site visit (written on label securely attached to sample and record kept centrally):

Date of collection..... Time..... District.....

Strata code:..... Individual sample reference number:.....

Estimate total volume of sample pile:.....

How long ago was waste deposited on site:.....

Describe the location within the Tarnak site from where the sample is taken.....

Estimated volume of sample:.....

INDIVIDUAL SAMPLE DAILY RECORD SHEET

Households:

Date of collection..... Time..... District.....
Strata code:..... Individual sample reference number:.....
Volume of sample:.....
Weight of sample:.....

Commercial Premises:

Date of collection..... Time..... District.....
Strata code:..... Individual sample reference number:.....
Volume of sample:.....
Weight of sample:.....

Community Bin Sites:

Date of collection..... Time..... District.....
Strata code:..... Individual sample reference number:.....
Estimate total volume of waste in bin.....
Volume of sample:.....
Weight of sample:.....

Final disposal site:

Date of collection..... Time..... District.....
Strata code:..... Individual sample reference number:.....
Estimate total volume of sample pile:.....
How long ago was waste deposited on site:.....
Describe the location within the Tarnak site from where the sample is taken.....
Estimated volume of sample:..... Weight of sample:

STRATA SAMPLE WASTE ANALYSIS DATA SHEET

Date of Sample:

Strata Code:

Total Weight of Sample Collected:

MATERIAL BIN	WEIGHT OF WASTE PLUS CONTAINER (THREE READINGS) (kg)	MEAN WEIGHT OF WASTE (kg)	% OF CONTAINER FILLED	DENSITY (WEIGHT / VOLUME)	
Organic	Fresh / Wet material weight				
	Dried material weight				
Tare weight (kg)					
Container Vol. (m3)					
Wood					
Tare weight (kg)					
Container Vol. (m3)					
Paper and Cardboard					
Tare weight (kg)					
Container Vol. (m3)					
Plastics (Bottles)					
Tare weight (kg)					
Container Vol. (m3)					
Plastics (Other)					
Tare weight (kg)					
Container Vol. (m3)					

Glass	
Tare weight (kg)	
Container Vol. (m3)	

Textiles	
Tare weight (kg)	
Container Vol. (m3)	

Metals	
Tare weight (kg)	
Container Vol. (m3)	

Hazardous Household Waste	
Tare weight (kg)	
Container Vol. (m3)	

Complex Products	
Tare weight (kg)	
Container Vol. (m3)	

Inert	
Tare weight (kg)	
Container Vol. (m3)	

Other Categories	
Tare weight (kg)	
Container Vol. (m3)	

Fines	
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Tare weight (kg)	
Container Vol. (m3)	

SPECIFIC WEIGHT OF STRATA MIXED WASTE SAMPLES

Once each individual sample has been weighed and volume recorded, conglomerate samples into strata group and completely fill to level a 1m³ container/bag (or container/bag of other known specific volume). Continuously shake container to allow material settlement (but do not push down to compress materials). Once material fills container to level, weigh box and contents and complete the table below. If enough material is gathered throughout the sampling period, repeat this process a minimum of twice.

Code	Sampling location	Volume of container (m ³)	Empty weight of container (kg)	WEIGHT OF WASTE PLUS CONTAINER (three readings) (kg)		
1.A.	High income residential district - individual households					
1.B.	High income residential district - community bins					
2.A.	Medium income residential district - individual household					
2.B.	Medium income residential district - community bins					
3.A.	Low income residential district - individual households					
3.B.	Low income residential district - community bins					
4.A.	Non-food goods commercial district - individual premises					
4.B.	Non-food goods commercial district - community bins					
5.A.	Food market commercial district - individual premises					
5.B.	Food market commercial district - community bins					
6.A.	Large, multi-product commercial district -					

	individual premises					
6.B.	Large, multi-product commercial district - community bins					
7.A.	Disposal site - Tarnak river site					
7.B.	<i>Disposal site - Other if applicable</i>					

MATERIAL SORTING CATALOGUE

Primary Categories	Secondary Categories	Notes	Typical Examples
Organic	Biodegradable Kitchen/Canteen Waste	All biodegradable waste originating in domestic kitchen or commercial/industrial canteen	Bread; Coffee grinds; Cooked or Uncooked food items; Food leftovers; Fruit and vegetables; Meat and fish; Tea bags; etc
	Biodegradable Garden/Park Waste	All biodegradable waste originating in a domestic garden or municipal park, garden, or landscaping feature	Flowers; Fruit and vegetable garden waste; Grass Cuttings; Hedge trimmings; Leaves; Pruning; Tree branches; Weeds
	Other Biodegradable Waste	All biodegradable waste not applicable to either of the above categories	Animal remains; Bones, Faeces
Wood	Untreated Wood	All wood/cork items without paint, varnish, preservative, sealant etc	Bottle corks, Cork packaging, Untreated Pallets Solid timber and timber fragments untreated
	Treated Wood	All wood/cork items with paint, varnish, preservative, sealant etc	Particle board (e.g. chipboard, plywood, mdf), Solid timber and timber fragments, treated Wood fencing- treated; Treated Wood furniture; Wood kitchen units- treated
Paper and Cardboard	High gloss paper/card and wallpapers	Non-biodegradable paper	Glossy brochures e.g. shop catalogues; Glossy magazines; High gloss papers e.g. photographic papers; Waste wallpapers
	Paper/card – packaging	All non-glossy paper card packaging	Product cartons; Corrugated packaging cardboard (bulk and individual); Other non-food container packaging; Paper bags; Tissue boxes; Toy boxes; Washing powder boxes; Waxed card liquid cartons; Wrapping paper.
	Newspapers	Loose and stapled newsprint	Local and national newspapers; Newsprint-type advertising publications; Other newsprint

	Other Paper/card– non packaging	All paper card otherwise not mentioned	Birthday type cards; Books; Computer printouts; Diaries; Envelopes; Files and folders; Invoices; Kitchen roll; Letters; Loose leaf paper; Non glossy brochures and catalogues; Non-glossy junk mail; Office paper; Photocopies; Posters; Telephone directories; Tickets; Tissue paper; Toilet papers; Writing paper; Yellow pages
Plastics (Bottles)	Dense Plastic Bottles	All clear and coloured plastic bottles	All plastic bottles e.g. drinks; Bleaches; Detergents; Household products; Laundry liquid; Milk; Oil; Soft drinks; Vinegar; Water
Plastics (other)	Plastic Film – non packaging	All non packaging bags and refuse sacks	Cellotape; Garden sheets; Non-packaging film; Plastic bags; Refuse sacks; Shopping bags; Tarpaulins
	Plastic Film –packaging	All packaging bags and refuse sacks	Biscuit wrappers; Cereal packets (inside box); Cling film; Compost/peat bags; Crisp packets; Frozen food bags; Packaging plastic film; Plastic food bags/pet food/non food bags; Sandwich bags
	Dense Plastic – other packaging	All other clear and coloured plastic packaging except bottles and jars	Appliance packaging; Cleaning tubes; Cosmetic tubes; Egg boxes; Food cartons; Food packing trays; Food tubes; Ice cream cartons; Margarine tubs; Plastic lids; Ready meal trays; Roll on deodorant bottles; Trays; Yoghurt cartons; Bottle tops

	Dense Plastic –non packaging	All non-packaging dense plastic items	Air freshener holders; Bank/credit cards; Buttons; CDs'; music cassettes; Cosmetic/glue/paint applicators; Disposable razor blades; Floor Linoleum (Lino); Floor Tiles (vinyl/plastic); Garden hoses; Gardening equipment; Hard plastic; Household/car/garden accessories; Lighters; LPs; Pens; Plant pots; Plastic curtain rails; Plastic frames; Plastic sunglasses; Plastic toys; Rulers; Rulers; Seed trays; Shoes (Plastic only); Toilet lids; Toothpastes; Tubes/pumps; Video cassettes; Washing up bowls/racks
Glass	Glass Container Packaging Clear	All clear glass bottles and jars	Drinks bottles/jars (e. g. milk, water, juice) Food jars (e.g. baby foods, coffee, jams, pickles, sauces) Medicine bottles
	Glass Container Packaging Brown	All brown glass bottles and jars	Drinks bottles/jars (e. g. milk, water, juice) Food jars (e.g. baby foods, coffee, jams, pickles, sauces) Medicine bottles
	Glass Container Packaging Other	All coloured glass bottles and jars except brown and clear glass	Drinks bottles/jars (e. g. milk, water, juice) Food jars (e.g. baby foods, coffee, jams, pickles, sauces) Medicine bottles
	Miscellaneous Non Packaging Glass	All non-packaging glass	Cookware (e.g. pyrex, drinking glasses) Flat glass (e.g. table top, window, mirrors, reinforced, windscreens) Light bulbs (e.g. normal, fluorescent, energy saving Mixed broken glass Television/ computer screens separated only
Textiles	Clothes	Natural and man-made clothing items excluding shoes	Trousers; Skirts; Socks; Underwear; Shirts; Jumpers; Cardigans; Coats; Hats; Gloves
	Non-clothing textiles	Natural and man-made textiles and furnishings except clothes and shoes	Balls of wool; Blankets; Braids; Carpets; Cloths; Cords; Curtains; Household soft furnishings and upholstery; Mats; Pillow cases; Pillows; Rags; Ropes; Rugs; Sheets; Threads; Towels

Metals	Ferrous Packaging	Ferrous food, beverage and non-food cans and containers	Biscuit containers; Packaging for carbonated drinks; Shoe polish cans; Soft drinks; Soups; Sweets; Tinned food; Aerosols (deodorant, perfume, hairspray)
	Non-ferrous Packaging	All non-ferrous Cans and Containers and Aluminium Foils etc.	Aluminium foil sheets; Biscuits containers; Cake and pie containers; Carbonated drinks; Containers; Fish; Pet food; Shoe polish cans; Soft drinks; Soups; Sweets; Take away; Tinned food; Other food/non-food containers; Aerosols (deodorant, perfume, hairspray)
	Miscellaneous Ferrous	All ferrous items except food, beverage and non-food cans and containers	Bike parts; Building materials/DIY materials; Car parts; Cutlery; Keys; Licks; Metal shelves; Nails; Paper clips; Plumbing; Pots and pans; Radiators; Ring pulls; Safety pins; Screws; Tools
	Miscellaneous Non-ferrous	All non-ferrous items except Aluminium Cans and Containers and Aluminium Foils	Keys; Cutlery; Locks; Ring pulls; Tools; Car parts; Radiators; Metal shelves; Pots and pans; Screws; Nails; Building materials/DIY materials; Plumbing; Bike parts
Hazardous Household Waste	Batteries/Accumulators	All types of household and car batteries including rechargeable and non-rechargeable	Lead acid Nickel cadmium Other car and household batteries and accumulators
	Miscellaneous hazardous waste	All other potentially hazardous household type waste	Asbestos; Cooking oils; Fire extinguishers; Garden/household chemicals; Glues and solvents; Medicines; Methylated spirits; Mineral, synthetic and non-edible organic oils and fats and their filters; Motoring products; Paint products; Photo chemicals; Refrigerants; White spirits

Complex Products Complex Products	Composite/ Complex Packaging	Any complex/composite packaging that cannot be easily separated into its component materials and is therefore difficult to classify conventionally	Aluminium Foil-coated card, liquid containers e.g. milk; fruit juice
	Composite/ Complex Non-packaging	Any complex/composite item which is not packaging that cannot be easily separated into its component materials and is therefore difficult to classify conventionally	Appliance parts Car parts Engine parts Sandals (multi-material only) Shoes (multi-material only)
	Mixed WEEE	Large Household Appliances Small Household Appliances IT and Telecommunications Equipment: Lighting Equipment: Toys: Monitoring and control instruments:	Air conditioners; Carpet sweepers; Clocks; Coffee makers; Compact fluorescent lamps; Computers; Cookers; Copiers; Dishwashers; Drills; Electric knives; Electric stoves/hotplates; Electric toothbrushes; Electric trains; Electrical and Electronic Tools; Fax; Freezers; Fryers; Hair dryers; Hand held video game consoles; Heating appliances; Heating regulators/thermostats; Irons; Laptops; Large cooling appliance; Low pressure sodium lamps; Microwaves; PCs; Printers; Refrigerators; Saws; Scales; Sewing machines; Shavers; Smoke detector; Straight fluorescent lamps; Telephones/Mobile phones; Telex; Toasters; Vacuum cleaners; Video games; Washing machines
Inert	Soil and Stones		Boulders; Bricks; Gravel; Pebbles; Sand; Soil; Stones
	Miscellaneous inert	Any 'Inerts' except soil and stones	Ceramics Clay plant pots Crockery Stone/ceramic floor and wall tiles Vases
Other Categories	Nappies		Children's disposable nappies
	Health Care/Biological Wastes	Household Medical Waste	Dressings Swabs Syringes

	Miscellaneous Categories	Any other materials difficult to classify under other categories	
Fines	10mm sieved fraction		Ashes Sand Small fragments <10mm of all above categories

HEALTH AND SAFETY

The following health and safety guidelines are intended as an indicative guide. It is the implementing contractor's responsibility to ensure all regulatory and other appropriate health and safety rules are followed at all times, the implementing contractor will accept all responsibility for the health and safety of their employees whilst conducting this analysis.

Potential hazards which generally occur during the sampling, sorting and analysis stages of a waste analysis include:

- Cuts and punctures from handling hazardous materials (needles, broken glass, razor blades, aerosol cans, chemicals, etc.)
- Slipping and falling
- Heats stress and fatigue
- Traffic or heavy equipment movement
- Noise exposure
- Household hazardous wastes
- Medical wastes and sharps
- Bloody objects
- Hypodermic needles

Minimum Safety Equipment and Clothing for the sampling and sorting personnel should include:

- Hi-visibility jackets
- First aid kit
- Fire extinguisher
- Overalls (splash proof and sharp proof)
- Sharp proof gloves
- Steel toe capped boots
- Face mask
- Full face goggles/eye protection
- Safety helmet
- Anti bacterial hand/face wash
- Enzyme based deodorizers
- Ear defenders
- Site specific safety plan
- Portable telephone
- Eye wash kit
- Moist, disposable towelettes

Supervisory Personnel Responsibilities

Supervisory personnel are responsible for the following:

1. Familiarity with and provision of relevant local emergency services telephone numbers.
2. Ensure all site personnel have received, and documented training on the following health and safety issues as a minimum:

- Handling (lifting, transporting, opening where necessary) different kinds of containers (plastic sacks, wheeled bins 120/ 240 l, container from 1100 to 3300 l)
 - Eating, smoking or drinking during the sorting activities is strongly prohibited.
 - Plenty of fluids (e.g. water, sport drinks etc.) and single use, disposable cups must be available at all times in a separated area. Hands and faces must be washed before eating and drinking.
 - The sorting personnel must wear full personal protective clothing at all times during contact with waste.
 - The sorting staff must be able to identify hazardous wastes. If any hazardous wastes are detected, the supervisor shall be notified.
 - Use of relevant electrical equipment in the working area
 - Instructions for obtaining first aid
 - Dealing with any serious accident or other emergency situation, such as a fire in the working area
 - At the end of each shift, removing all disposable clothing into a plastic trash bag, and place the bag into a container. All sorters shall shower at the end of each shift.
 - The sorted waste shall be stored separately in closed containers or be deposited daily. The ground of the sorting area shall be cleaned thoroughly at least once per day.
3. In addition the supervisors must ensure the following:
- Protective equipment is properly maintained and inspected and properly used by all.
 - Collection and sorting staff have read understood and signed the health and safety policy containing the issues mentioned under this chapter of the guideline.
 - Safety guidelines are followed by the sorting and collection personnel.

Medical Aspects

All waste sorting personnel shall be in good physical condition and shall not be sensitive to odours and dust.

It is recommended that the contractor of a waste analysis shall ensure that all staff, including support staff, who will be working on any of the collection or sorting activities described in this chapter have received the following injections: Tetanus, Polio, Hepatitis A, Hepatitis B

References

1. European Commission (2004): *Methodology for the Analysis of Solid Waste (SWA-Tool), User Version*
2. SEPA (Scottish Environmental Protection Agency) (2008): *National methodology for Household Waste Composition Analysis in Scotland.*
3. UNEP (United Nations Environmental Programme) (2005): *Solid Waste Management (Volume 1)*, prepared by CalRecovery
4. UNDP-ASGP (Afghanistan Sub-National governance Programme) IDLG (Independent Directorate for Local Governance) (2010): *Integrated Solid Waste Management Program Manual, Part 1*

