

ANNEX B

WASTE AMOUNT AND COMPOSITION SURVEY

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ANNEX B WASTE AMOUNT AND COMPOSITION SURVEY

B.1 Objectives and Definitions

B.1.1. Objectives of the Survey

Basic information such as the quantity of solid waste generated in the survey area, the population covered by the collection services, collection area map, etc., is the key to the formulation of a successful and feasible solid waste management plan.

A Waste Amount and Composition Survey (WACS) was carried out in order to obtain the basic information on waste generation ratio, discharge and recycling amount, self-disposal and collection amount, and to clarify the waste stream in the study area.

WACS was carried out twice, in April and November 1994, in order to obtain the waste data in summer and winter. The seasonal results were used to determine the average data.

B.1.2. Definitions of wastes

In order to clarify the contents of the WACS and the waste stream, the words used in the study are defined as follows:

a. Household waste

Waste produced by households, including waste in shops but exclusive of those generated through commercial activities.

b. Commercial waste

Only refers to wastes from commercial shops, i.e., restaurants, stationery shops, grocery shops, private offices.

c. Market waste

Waste from markets of wholesale and retail industries.

d. Institutional waste

Government and municipal office wastes are examined as institutional waste in the Study.

e. Street sweeping waste

Wastes collected by the street sweeping cleansing service.

f. Hospital waste

Non-infectious wastes generated in hospitals.

g. Bulky waste

Bulky items (such as furniture and vehicles) abandoned and discharged by the above-mentioned sources.

h. Other waste

Wastes disposed of at the present disposal site in the Study area which are not considered as MSW (item a to g).

B.2 Survey Method

B.2.1 Waste Amount Survey Method

Waste amount survey was carried out in three different ways, as shown below:

- Generation ratio survey at generation sources;
- Final disposal amount survey at the present landfill;
- Interview at generation sources.

The results of the Public Opinion Survey (POS) was referred to as well when the final amount was determined. The method applied to the WACS is tabulated in Table B.2.1a.

Table B.2.1a Methodology of the Waste Amount Survey

Category	Generation Ratio Survey	Disposal Amount Survey	Interview
MSW (Total)		X	
Household Waste	X		X
Commercial	X		X
Market Waste	X		
Institutional	X		
Street Sweeping	X		
Hospital Waste			X
Bulky Waste		X	
Others (Total)		X	
Industrial Waste		X	X
Others		X	

Note: The items marked "X" were surveyed in the Study.

B.2.2 Selection of Sampling Points for the Generation Ratio and Composition Survey

a. Category of Waste, Generation Sources and Sampling Quantity

In order to obtain a representative generation ratio for each category of waste, the category of waste, generation sources and sampling quantity for the WACS is summarized in Table B.2.2a. On the other hand, the observation work carried out by this study at the present landfill only took the amount of "bulky and other" wastes into consideration.

Table B.2.2a Category of Wastes, Generation Sources and Sampling Quantity for WACS

CATEGORY OF WASTE	GENERATION SOURCES	(1) SAMPLING AREA (Nos.)	(2) SAMPLING NUMBERS PER AREA (Nos.)	(1)x(2) NUMBER OF SAMPLES
Household Waste	Residential Area (High Income)	4	5	20
	Residential Area (Middle Income)	4	5	20
	Residential Area (Low Income)	4	5	20
Commercial Waste	Commercial Area (Restaurants)	1	5	5
	Commercial Area (Other Shops)	1	5	5
Market Waste	Markets	2	1	2
Institutional Waste	Institutions (Government Offices)	1	5	5
Street Sweeping Waste	Street Sweeping	2	1	2
	TOTAL	19	-----	79

aa. Household Waste

Household waste generated at residential areas was classified into the following three categories:

- household waste generated at high income residential areas
- household waste generated at middle income residential areas
- household waste generated at low income residential areas

The sampling areas for each category were selected from the study area in the

Municipality of Managua the discussion between the Nicaraguan Coordinating Committee and the Study Team.

ab. Commercial Waste

Waste generated in restaurants and other shops quite differ in composition. Therefore, commercial waste was classified into two categories: restaurant waste and that of other shops.

The sampling areas for commercial waste were selected from the commercial areas in the Municipality of Managua.

ac. Market Waste

In consideration of the following waste collection aspects, two of the areas in the Municipality of Managua were selected for sampling.

- Amount of waste generated at one market should be less than one truck.
- Composition of waste generated at one market should not be mixed with other waste.

ad. Institutional Waste

Some government offices in the Municipality of Managua were selected as sampling areas for institutional waste.

ae. Street Sweeping Waste

Two streets were selected in the Municipality of Managua as sampling points. One is a main street and the other is in a residential area.

b. Sampling Points

The sampling points for the waste amount and composition survey is shown in Table B.2.2b and their location is shown in Figure B.2.2a.

Middle Income	RM-06	Colonia Francisco Morazán	Semáforo Linda Vista, 1 c.	Vargas
	RM-07		Semáforo Linda Vista, 1c. arriba,	Lacayo- Murillo
	RM-08		Semáforo Linda Vista, 1 c.	Rodriguez
	RM-09		arriba, 1/2 c. abajo Casa N° 462	Ortega
	RM-10		Rótulo Protecto, 1 1/2 c. al lago Casa N° A-109	Cuarezma
	RM-11	Colonia Bello Horizonte	Shell Las Brisas, 1/2 c. arriba, 1 c. al lago, 10 vrs abajo Casa N° A-24	
	RM-12		Bello Horizonte. G.III.8	Morales
	RM-13		Bello Horizonte G.III.10	Souning
	RM-14		Bello Horizonte C-IV-19	Morales de
	RM-15		Bello Horizonte H-33	García
	RM-16	Jardines de Vera- cruz	Bello Horizonte H-34	Rocha
	RM-17		Rotonda de Veracruz, 3c. al sur	Baset
	RM-18		1/2c. arriba Casa E-5	Beteta- Zúniga
	RM-19		Entrada Jardines de Veracruz 4c. al sur Casa C-31	Colegial- López
	RM-20		Casa N° C-5	Navarrete
		Casa N° E-8, Entrada principal	Hinijosa	
		3c. al sur, 1c. arriba	Morazán	
		Casa N° C-24, Parque 5c. al sur,		
		1/2c. arriba		

Table B.2.2c List of Sampling Points for the Waste Amount and Composition Survey (2)

Generation Sources		Code No.	Area	Survey Points	
				Address	Family Name
Residential Area	Low Income	RL-01	Barrio Acahualinca	Huellas de Acahualinca 3c.	Navarro Sequeira Osorio Latino González- Alvarez
		RL-02		al lago 25 vrs arriba	
		RL-03		Huellas de Acahualinca 3c.	
		RL-04		al lago 25 vrs arriba	
		RL-05		Huellas de Acahualinca 3c. al norte Huellas 3c. al lago 1/2 c. abajo Huellas 2c. al lago 1/2c. arriba	
		RL-06	Ciudad Sandino	Mini Cine Randy, 1c. arriba	Juarez- Gutiérrez Sánchez Ruíz- Gutiérrez Sánchez Martínez
		RL-07		12 vrs al sur. zona-4, T-4	
		RL-08		Iglesia Católica 2c. al lago 2c. abajo. Zona-4, T- 5	
		RL-09		Cine Randy 1 c. arriba, 1 c. al sur, 10 vrs arriba	
		RL-10		Pinal del Río 2c. abajo. Zona-4 Pinal del Río 2 1/2 c. abajo. Zona-4	
		RL-11	Asentamiento Santos López	Hotelito Kely 1/2c. al lago	Cajina- Tórres Díaz Guerrero Gutiérrez Reyes-Ruiz Tórrez- Guido Centeno
		RL-12		10 vrs abajo N° 116	
		RL-13		Hotelito Kely 1c. al lago N°	
		RL-14		077	
		RL-15*		Hotelito Kely 1c. al lago	
		RL-15**	1/2c. abajo N° 112	Hotelito Kely 1c. al lago 2 vrs abajo	
				Hotelito Kely 1c. al lago	Hotelito Kely 1c. al lago 10 vrs arriba, N° 120
		RL-16	Asentamiento A.C Sandino	Esq. opuesta al puesto de	Duma Obando Esperanza Oviedo Hurtado
		RL-17		salud. Calle 8, I-18	
		RL-18		Esq. opuesta al puesto de	
RL-19	salud. Calle 8, I-17				
RL-20	Puesto de Salud, 3ª casa al sur. Calle 8, I-16 Puesto Médico, 50 mts al sur Puesto Médico 1/2 c. al sur				

Commercial Area	Restaurants	CR-01 CR-02 CR-03 CR-04 CR-05	Rotonda de Bello Horizonte	Pizzería Los Idolos Nº 2 La Botija El Pilín Pollos Calientes El Asador Chino	José Ocón Robleto Larry Wite Joselín Díaz Ada Marlen Díaz Ada Marlen Hery Kuang Lau
	Others	CO-01 CO-02 CO-03 CO-04* CO-04** CO-05	Centro Comercial Managua	Librería González (Módulo C-47) Tienda de Calzado ADOC (Módulo C-103) Librería Rigoberto López P.(Módulo A-35-36) Tienda de Ropa (Módulo C-9) Bar Las Tejas Tienda de Electrodomésticos (Módulo C-79)	Ernesto González Osmara Zelaya. Luisa Ordoñez. Carlos de la Jara Dora Lanuza Juan López Z.
Institutions		I -01* I -01** I -02 I -03 I -04 I -05		INISER, Camino de Oriente Módulo E Biblioteca "Armando Joya" Ministerio de Acción Social (M.A.S). Entrada Instituto Rigoberto López Pérez Instituto Nacional de Energía (INE). Costado oeste Plaza 19 de Julio Ministerio de Educación. (MED) Módulo L . Centro Cívico Alcaldía de Managua (AL-MA) Módulo H. Centro Cívico	Gladys Morales. (Gerente de Seguros) Gloria Sáenz Róger Flores. (Administrador) Mª Elena Mena (Serv. Generales) Gloria Gutiérrez (Subdirector Gral) Rafael Gonzáles. (Admón. D.G.S.O.M)
Markets		M -01 M -02		Mercado San Judas "Oscar Pérez Cassar" Mercado Occidental "Virgen de Candelaria"	
Street Sweeping		S -01 S -02		Carretera Norte. Semáforo Portezuelo hasta el Dancy Pista Radial Santo Domingo. Semáforo Lozelsa hasta la entrada Barrio México	

Note: * are sampling points in summer only
** are sampling points in winter only
Without asterisk are sampling points in both summer and winter

Legend	
	Residential Area (High Income)
	Residential Area (Middle Income)
	Residential Area (Low Income)
	Commercial Area (Restaurants)
	Commercial Area (Other Shops)
	Institutions
—	Street Sweeping
●	Sampling Point

Figure B.2.2a Location of Sampling Points (Managua Municipality)

B.2.3 Method of the Generation Ratio and Composition Survey

The method of the Survey is tabulated in Table B.2.3a. Considering the fluctuation in the daily amount of waste generated, the survey was conducted continuously for 8 days. Data amassed in the first day is used only as a reference.

Table B.2.3a Method of the Survey

Generation Source	Collection of Samples	Waste Amount Survey	Waste Composition Survey
Residential Area (High Income)	by plastic bag	by spring balance	Analysis Items - Apparent Specific Gravity (ASG) - Physical composition ... wet base (kitchen waste, paper, textile, plastic, glass, grass and wood, leather and rubber, metal, ceramic and stone, others) - Chemical Analysis + Three contents (moisture, combustibles, ash) + Lower calorific value + Ultimate analysis (carbon, hydrogen, nitrogen, sulphur, chlorine, oxygen)
Residential Area (Middle Income)	by plastic bag	by spring balance	
Residential Area (Low Income)	by plastic bag	by spring balance	
Commercial Area	by plastic bag	by spring balance	
Market	by collection truck	by weighbridge	
Institution	by plastic bag	by spring balance	
Street Sweeping	by plastic bag	by spring balance	

a. Method of the Generation Ratio Survey

aa. Collection of Samples

Before the execution of the WACS, the required number of plastic bags was distributed to residences, shops and offices selected as sampling points. Samples discharged from markets were collected by collection truck.

ab. Waste Amount Survey

The weight of the plastic bag from each sampling point was weighed with a spring balance. Then, when a sample was collected, the plastic bags were bound with color strings which classified it according to generation sources. The samples transported by collection truck were measured at the truck scale of the Acahualinca disposal site.

b. Method of the Waste Composition Survey

ba. Sampling Method

The composition of the waste in wet base was measured according to the following eight categories.

- residential area (High Income)
- residential area (Middle Income)
- residential area (Low Income)
- commercial area (Restaurants)
- commercial area (Others)
- markets
- institutions
- street sweeping

Waste of the same category were mixed together, segregated and then mixed again until waste volume is reduced to between 30 and 50 liters, as shown in Figure 2.1.2b.

Mixing

Large wastes (e.g. cardboard, textile etc.) are segregated, made smaller and then mixed again with its primary group.

Dividing

Once waste is mixed well, it is divided into four blocks of approximately equal quantity and quality.

Reducing

Two of the blocks are discharged, while the remaining two blocks undergo the same process of reduction until the amount designated for the waste composition analysis, between 30-50 liters, is achieved.

Once the process is completed, waste is then loaded into a plastic bucket. The plastic bucket is then tapped from a height of 30 centimeters to the ground to compact its contents and remove air, thus reducing its volume. Waste is further added and the compacting procedure repeated thrice until the fixed volume is achieved.

ASG (Apparent Specific Gravity) was calculated using the following formula:

$$\text{ASG} = \text{Weight of Waste (Kg)} / \text{Volume of Waste (l)}$$

Waste composition survey is carried out after the ASG measurement is completed. The items of the waste composition survey are shown in Table B.2.3a.

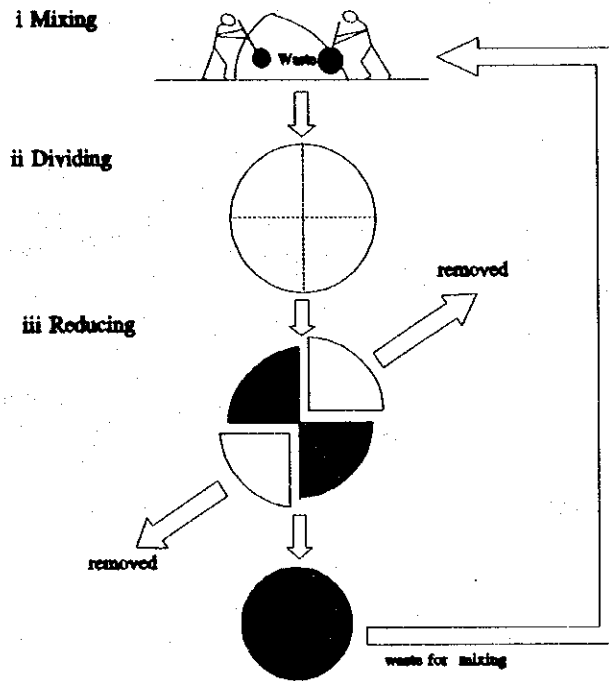


Figure B.2.3a Waste Reduction Method

bb. Composition Analysis

The procedure of the physical composition and chemical analysis is shown in Figure B.2.3b.

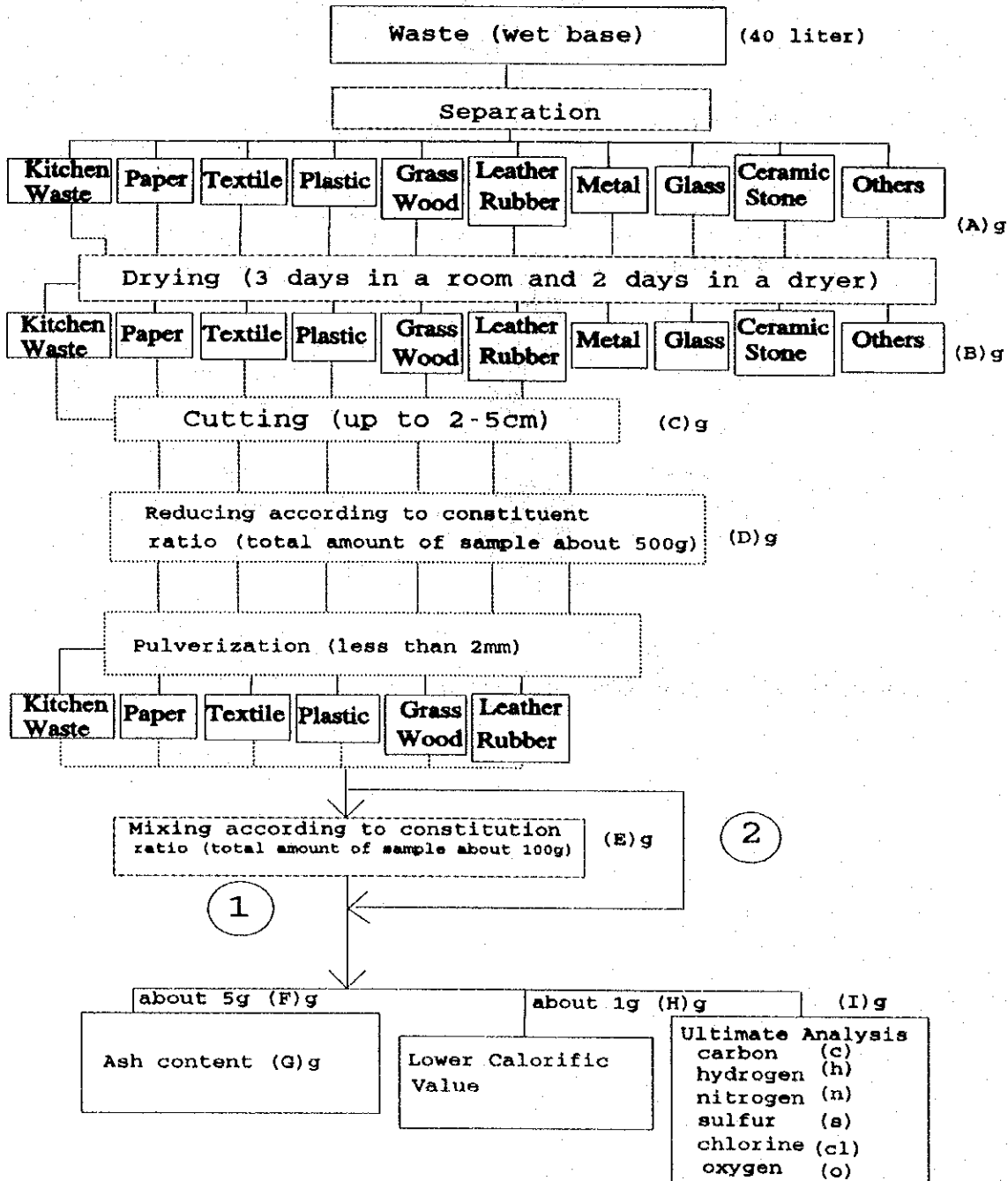


Figure B.2.3b Procedure of Waste Composition Analysis

bba. Physical Composition

Physical composition was measured in wet base. The samples were divided into the following 10 items and weighed individually before they were dried.

- kitchen waste
- paper
- textile
- plastic
- grass and wood
- leather and rubber
- metal
- glass
- ceramic and stone
- others (soil, etc.)

After the samples are weighed, they usually undergo drying for three days in a room and two days in a dryer (105°C) before they are individually weighed again. The results of the physical composition are presented in percentages.

bbb. Moisture content

Moisture content was calculated by the following formula.

$$\text{Moisture Content(\%)} = \frac{\text{Original Weight(A)} - \text{Dry Weight(B)}}{\text{Original Weight(A)}} \times 100$$

bbc. Chemical analysis

Chemical analysis and removal of combustibles were carried out after drying. The following are six samples of combustibles:

- kitchen waste
- paper
- textile
- plastic
- grass and wood
- leather and rubber

The combustible samples were cut into 2 to 5mm pieces. The six samples were reduced in size until they totaled about 500 g in accordance with each constituent ratio.

The combustible samples were each pulverized into less than 2 mm in size by a cutting mill and then mixed together again prior to undergoing chemical analysis.

The following items underwent chemical analysis:

- Ash Content

Ashes resulting from the combustion of combustible matter and the following non-combustible items:

- . metal
- . glass
- . ceramic and stone
- . others

Ash content was calculated by the following formula.

$$\text{Ash Content(\%)} = \frac{G \times \frac{C}{F} + (B - C)}{A} \times 100$$

- Combustible Content

Combustible content was obtained by subtracting the weight of the ash from that of the combustible materials.

$$\text{Combustible Content(\%)} = 100 - \text{Moisture Content} - \text{Ash Content}$$

- Lower calorific value

Lower calorific value was obtained by combustion in a calorimeter bomb, measuring the increase in water temperature through a calorimetric vessel which surrounds the bomb.

The lower calorific value (LCV) was calculated by the following formulas:

$$\text{HCV(Wet Base)} = \text{HCV(Dry Base)} \times \frac{100 - (\text{Incombustible Content(\%)} + \text{Moisture Content(\%)})}{100}$$

$$\text{LCV(Wet Base)} = \text{HCV(Wet Base)} - 6(9H + W)$$

HCV : Higher Calorific Value

H : Content of Hydrogen (%)

W : Moisture Content (%)

- Ultimate Analysis

Ultimate analysis was carried out on the combustibles to check the following 6 items:

carbon

hydrogen

nitrogen

sulphur

chlorine

oxygen

The content of each element was calculated through the following formulas.

$$\text{carbon}(\%) = (c \times \frac{C}{I}) / AX100$$

$$\text{hydrogen}(\%) = (h \times \frac{C}{I}) / AX100$$

$$\text{nitrogen}(\%) = (n \times \frac{C}{I}) / AX100$$

$$\text{sulphur}(\%) = (s \times \frac{C}{I}) / AX100$$

$$\text{chlorine}(\%) = (s \times \frac{C}{I}) / AX100$$

$$\text{oxygen}(\%) = \text{Combustible content}(\%) - \text{carbon}(\%) + \text{hydrogen}(\%) + \text{nitrogen}(\%) + \text{sulphur}(\%)$$

B.2.4 Period and Schedule of the Survey

The survey was conducted in summer, from the 25th of April till the 2nd of May, 1994.

The schedule of the survey is shown in Table B.2.4a.

Table B.2.4a Survey Period of the WACS

Items	Survey Period	
	Summer	Winter
Delivery of Plastic Bags and In- struction Papers	April 18th to April 21st	Nov. 21st to Nov. 22nd
Waste Collection From Each Generation Source	April 25th to May 2nd	Nov. 23rd to Nov.30th
Waste Amount Measurement	April 26th to May 3rd	Nov. 24th to Dec. 1st
Waste Composition Trial Analysis	April 3rd	Nov. 23rd
Waste Composition Analysis	May 3rd to June 17th	Dec. 1st to Dec.31

B.3 Results of the Survey

B.3.1 Waste Amount

a. Household Waste

The results of the waste amount survey, both in summer and winter is tabulated in Table B.3.1a. Although the waste generation ratio is basically the same in the various income levels, a slight seasonal difference was observed in high income and middle income areas.

The average generation ratio, in summer, in the high income area was 833 g/person/day, 732 g/person/day in the middle income area and 643 g/person/day in the low income area. In winter, it was 682 g/person/day, 628 g/person/day and 657 g/person/day, respectively. The average generation ratio of residential waste was 736 g/person/day in summer and 656 g/person/day in winter.

Table B.3.1a Generation Ratio of Household Waste
Unit: g/per/day

Income Level	Average	
	Summer	Winter
High	833	682
Middle	732	628
Low	643	657
Average	736	656

b. Commercial, Market, Institutional and Street Sweeping Waste

The results of the waste amount survey, both in summer and winter, are summarized in Table B.3.3a.

The waste generation ratio of each category does not differ in summer and winter, except for the slight difference observed in commercial waste (restaurant) and street sweeping waste.

Category	Unit	Generation Ratio	
		Summer	Winter
Commercial waste (restaurants)	g/shop/day	12,849	15,166
Commercial waste (others)	g/shop/day	1,007	991
Institutional waste	g/person/day	62	59
Market waste	g/shop/day	3,750	4,000
Street sweeping waste	g/km/day	58,500	41,200

B.3.2 Waste Composition

The results of the waste composition survey are tabulated in Tables B.3.3a, B.3.3b, B.3.3c, B.3.3d and shown in Figure B.3.3a.

a. Physical Composition

aa. Household Waste

The composition of household waste is characterized as follows:

- Garden waste, which consists of grass, wood and others, occupies about 31 % of the waste in summer and 29% in winter. The majority of "others" included soil and sand accumulated from gardening. According to the Public Opinion Survey (POS), about 40 % of the households disposed garden wastes in their backyards and burned them in the open.
- Kitchen waste occupies about 41% and 43% of the composition in summer and winter, respectively. The POS states that 33 % of the households feed their food waste to animals and the total amount used as animal food is 116 g/family/day, an equivalent of about 20 g/person/day.
- Kitchen waste, paper and plastic components occupy a larger percentage of the waste composition in high income than low income residences. Inversely, the percentage of grass/wood, ceramic/stone and other components is lower in high income residences than the middle and low income residences.

Season	Income Level	Share of Physical Components by Income Level (%)					
		Kitchen	Paper	Plastic	Grass Wood	Ceramic Stone	Other
Summer	High	54.79	11.30	6.11	10.99	2.09	3.72
	Middle	42.10	10.57	4.23	25.66	4.37	4.87
	Low	27.20	3.15	2.82	36.35	11.61	12.87
Winter	High	53.92	13.79	6.18	11.88	2.02	2.79
	Middle	45.22	7.53	5.26	21.56	3.94	11.56
	Low	30.83	2.80	3.77	23.51	9.38	16.94

ab. Commercial Waste

The composition of commercial waste is described as follows:

- Waste of other shops is about 56 % and 69% kitchen waste in summer and winter, respectively.
- Wastes of other shops contain about 84 % and 80% paper in summer and in winter, respectively.

ac. Other wastes

Other waste composition are summarized as follows:

- Market waste is about 36% and 41% kitchen waste in summer and in winter, respectively.
- Paper occupies about 85% and 60% of institutional waste in summer and winter, respectively.
- Street sweeping wastes are about 46% and 38% grass and wood in summer and winter, respectively.

b. Apparent Specific Gravity (ASG)

The ASG of all waste categories was higher in summer than in winter except for market waste which showed equal values.

B.3.3 Chemical Analysis

a. Three Contents

Waste from high income residences and restaurants had more than 50% moisture content both in summer and winter. On the other hand, waste of other shops is made up of more than 70% combustible matter in both seasons.

The moisture content of wastes was higher in winter than in summer except for the wastes of other shops and street sweeping waste.

b. L.C.V (Lower Calorific Value)

In summer, wastes, exclusive of market waste, wastes in summer were observed to have an L.C.V of more than 1,000 kcal/kg. On the other hand, the L.C.V in winter is less than 1,000 kcal/kg, except for wastes of other shops, institutions and from street sweeping waste activities.

Conclusively, wastes were found to have higher L.C.V in summer than in winter.

Table B.3.3a Results of the Waste Composition Survey in Summer

Physical Composition (wet base)	Classification	(kg/l)	Household				Commercial		Market	Institution	Road
			High Inc.	Middle Inc.	Low Inc.	Average	Restaurant	Others			
Chemical Analysis	Apparent Specific Gravity	(%)	54.79	42.10	27.20	41.36	56.03	7.92	35.97	9.20	0.19
		(%)	11.30	10.57	3.15	8.34	10.24	84.06	7.95	85.46	17.23
	Combustibles	(%)	1.86	0.92	1.04	1.27	0.26	0.31	1.17	0.12	4.33
		(%)	6.11	4.23	2.82	4.39	2.78	5.04	5.83	2.97	5.56
		(%)	10.99	25.66	36.35	24.33	15.36	0.00	33.82	0.77	46.11
		(%)	0.34	0.77	0.71	0.61	0.00	0.00	0.38	0.06	3.40
	Incombustibles	(%)	85.39	84.25	71.27	80.30	84.67	97.33	85.12	98.58	80.34
		(%)	4.19	1.37	2.69	2.75	3.08	2.67	1.53	0.77	6.10
		(%)	4.61	5.14	1.56	3.77	7.02	0.00	2.05	0.00	0.12
		(%)	2.09	4.37	11.61	6.02	2.72	0.00	3.73	0.00	7.26
Total	(%)	3.72	4.87	12.87	7.16	2.51	0.00	7.57	0.65	6.18	
	(%)	14.61	15.75	28.73	19.70	15.33	2.67	14.88	1.42	19.66	
Chemical Analysis	Three contents	(%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(%)	32.15	34.83	32.33	33.10	28.13	78.56	28.88	75.29	36.89
		(%)	52.20	40.23	32.63	41.69	52.42	9.96	47.36	18.45	28.73
		(%)	15.65	24.94	35.04	25.21	19.45	11.48	23.76	6.26	34.38
	Ultimate Analysis of combustibles	(%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		(%)	18.13	20.37	21.66	20.05	17.65	40.51	18.77	36.08	25.15
		(%)	2.57	2.83	2.95	2.78	2.42	6.08	2.61	5.24	3.46
		(%)	0.64	0.84	0.91	0.80	0.78	0.35	0.76	0.42	1.01
		(%)	0.04	0.05	0.06	0.05	0.05	0.04	0.05	0.04	0.07
		(%)	0.28	0.27	0.26	0.27	0.20	0.76	0.24	0.46	0.35
Lower Calorific Value	(%)	10.49	10.47	6.49	9.15	7.03	30.82	6.45	33.05	6.85	
	(kcal/kg)	32.15	34.83	32.33	33.10	28.13	78.56	28.88	75.29	38.89	
C/N Ratio	(kcal/kg)	1.189	1.199	1.143	1.177	1.031	4.003	953	3,175	1,250	
	-	28.33	24.25	23.80	25.46	22.63	115.74	24.70	85.90	24.90	

Table B.3.3b Results of the Waste Composition Survey in Winter

Classification		(kg/l)	Household				Commercial			Market	Institution	Road
			High Inc.	Middle Inc.	Low Inc.	Average	Restaurant	Others				
Physical Composition (wet base)	Apparent Specific Gravity		0.18	0.15	0.19	0.17	0.31	0.03	0.28	0.02	0.12	
	Combustibles	Kitchen waste	(%)	53.92	45.22	30.83	43.33	69.23	1.27	41.57	10.75	9.04
		Paper	(%)	13.79	7.53	2.80	8.04	10.55	80.62	6.84	60.57	8.02
		Textile	(%)	3.32	2.39	2.86	2.86	0.24	0.00	1.24	5.86	4.14
		Plastic	(%)	6.18	5.26	3.77	5.07	4.82	11.97	5.79	6.83	3.62
		Grass and wood	(%)	11.88	21.56	23.51	18.98	5.42	0.00	23.38	7.03	38.55
		Leather and rubber	(%)	0.07	0.32	5.04	1.81	0.00	0.79	1.12	0.00	0.78
	Sub-total	(%)	89.16	82.28	69.81	80.09	90.26	94.65	79.94	91.04	64.15	
	Incombustibles	Metal	(%)	1.25	0.82	1.20	1.09	4.29	4.79	1.35	3.00	3.62
		Glass	(%)	4.78	1.40	3.67	3.28	4.59	0.00	2.10	0.00	0.41
Ceramic and stone		(%)	2.02	3.94	9.38	5.11	0.49	0.00	4.59	0.00	8.79	
Others (soil, etc)		(%)	2.79	11.56	16.94	10.43	0.37	0.56	12.02	5.96	23.03	
Sub-total	(%)	1.84	17.72	31.19	19.91	9.74	5.35	20.06	8.96	35.85		
Total	(%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
Chemical Analysis	Three contents	Combustibles	(%)	24.10	24.10	23.60	23.90	21.40	84.80	23.70	59.60	27.70
		Moisture	(%)	64.40	47.40	41.90	51.20	67.70	3.90	52.00	26.80	27.40
		Ash	(%)	11.50	28.50	34.50	24.90	10.90	11.30	24.30	13.60	44.90
	Ultimate Analysis of combustibles	Total	(%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
		Carbon	(%)	14.25	16.08	15.41	15.25	11.92	42.12	17.27	30.19	17.84
		Hydrogen	(%)	2.05	2.24	2.13	2.14	1.68	6.20	2.47	4.36	2.40
		Nitrogen	(%)	0.48	0.64	0.64	0.59	0.51	0.34	0.62	0.46	0.74
		Sulphur	(%)	0.03	0.04	0.04	0.04	0.02	0.04	0.04	0.04	0.05
		Chlorine	(%)	0.25	0.22	0.22	0.23	0.16	0.61	0.32	0.41	0.21
	Oxygen	(%)	7.04	4.88	5.16	5.65	7.11	35.49	2.98	24.14	6.46	
Total	(%)	24.10	24.10	23.60	23.90	21.40	84.80	23.70	59.60	27.70		
Lower Calorific Value	(kcal/kg)	854	669	947	823	787	3,796	874	2,444	1,242		
C/N Ratio	-	29.69	25.13	24.08	25.85	23.37	123.88	27.85	65.63	24.11		

Table B.3.3c Results of the Ultimate Analysis of Household Waste (Middle Income)

	Category	Ultimate Analysis						Total (%)
		Carbon (C) (%)	Hydrogen (H) (%)	Nitrogen (N) (%)	Sulfur (S) (%)	Chlorine (Cl) (%)	Oxygen (O) (%)	
Summer	Kitchen Waste	18.36	2.48	1.07	0.04	0.13	14.43	36.51
	Paper	26.90	3.88	0.21	0.03	0.29	26.26	57.57
	Textile	24.81	3.28	1.03	0.05	0.23	19.50	48.90
	Plastic	54.46	9.44	0.48	0.07	2.62	3.49	70.56
	Grass/Wood	21.18	2.76	0.90	0.08	0.19	17.62	42.73
	Leather and Rubber	49.02	6.36	3.11	0.08	0.62	35.45	94.64
Winter	Kitchen Waste	10.30	1.39	0.60	0.02	0.07	8.09	20.47
	Paper	30.66	4.41	0.23	0.03	0.33	29.94	65.60
	Textile	22.50	2.97	0.93	0.05	0.21	17.68	44.34
	Plastic	55.42	9.61	0.49	0.07	2.66	3.56	71.81
	Grass/Wood	17.75	2.32	0.75	0.07	0.16	14.76	35.81
	Leather and Rubber	32.82	4.65	2.27	0.06	0.46	25.90	69.16

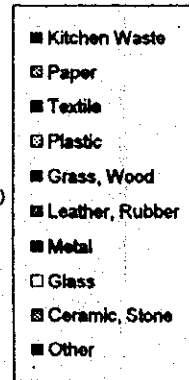
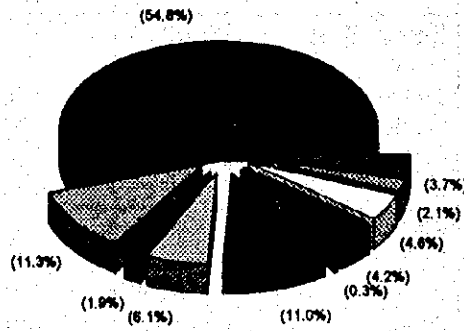
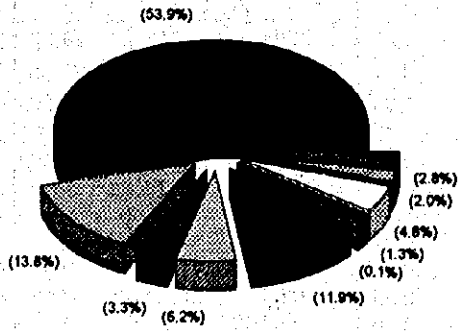
Table B.3.3d Three Contents and Lower Calorific Value Results for Household Waste (Middle Income)

	Category	Three Contents				Lower Calorific Value (kcal/kg)
		Combustibles (%)	Moisture (%)	Ash (%)	Total	
Summer	Kitchen waste	36.51	53.58	9.91	100.00	1,219
	Paper	57.57	35.34	7.09	100.00	2,665
	Textile	48.90	41.38	9.72	100.00	2,314
	Plastic	70.56	20.28	9.16	100.00	6,027
	Grass/Wood	42.73	42.51	14.76	100.00	1,524
	Leather/Rubber	94.64	1.30	4.06	100.00	3,909
Winter	Kitchen waste	20.47	71.30	8.23	100.00	341
	Paper	65.60	25.75	8.65	100.00	2,589
	Textile	44.34	48.85	6.81	100.00	1,443
	Plastic	71.82	20.68	7.50	100.00	7,360
	Grass/Wood	35.81	41.85	22.34	100.00	1,375
	Leather/Rubber	69.16	21.15	9.69	100.00	5,292

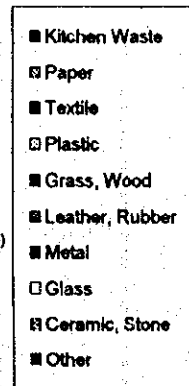
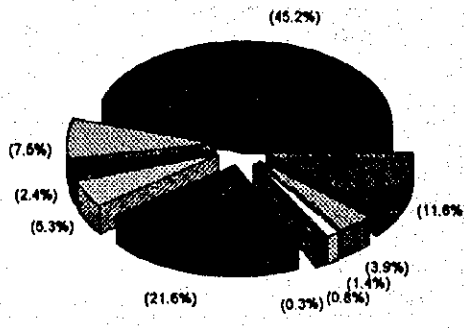
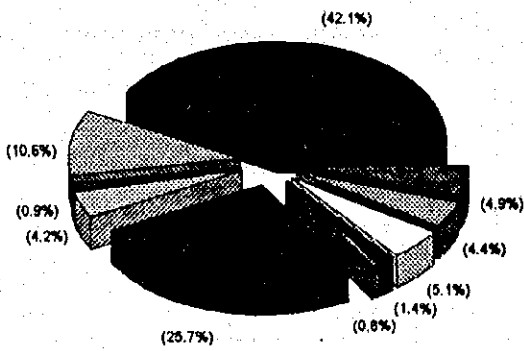
Summer

Winter

Residential Area : High Income



Residential Area : Middle Income



Residential Area : Low Income

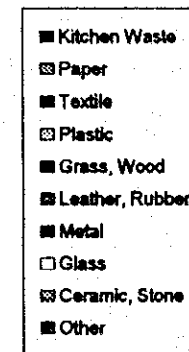
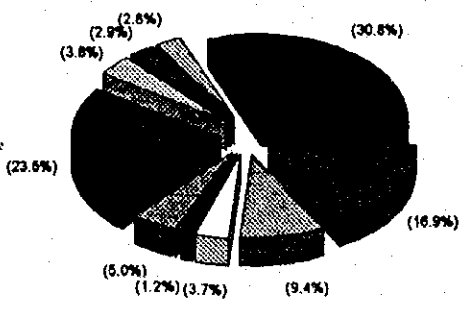
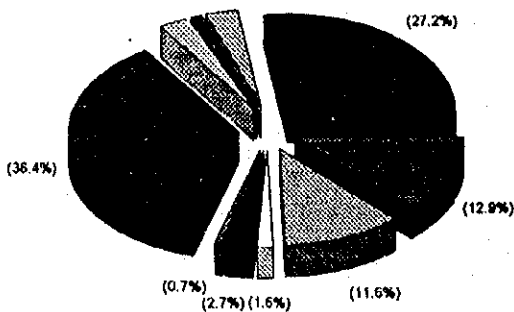
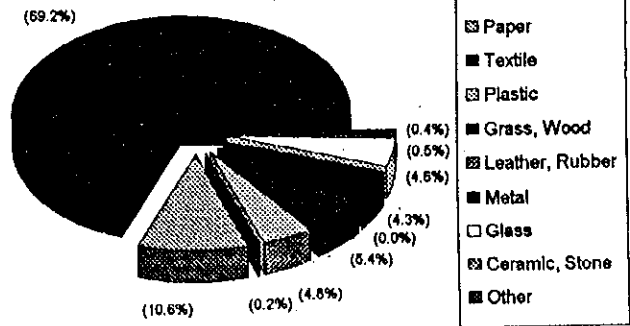
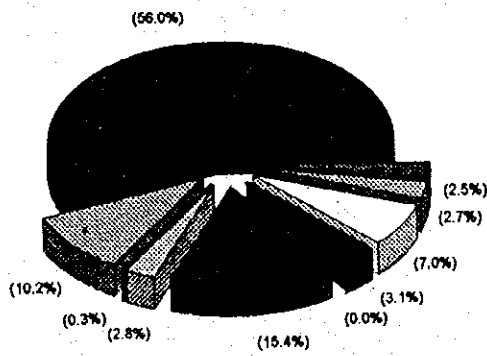


Figure B.3.3a Results of Physical Composition Survey of Household Waste in Summer and Winter (1)

Summer

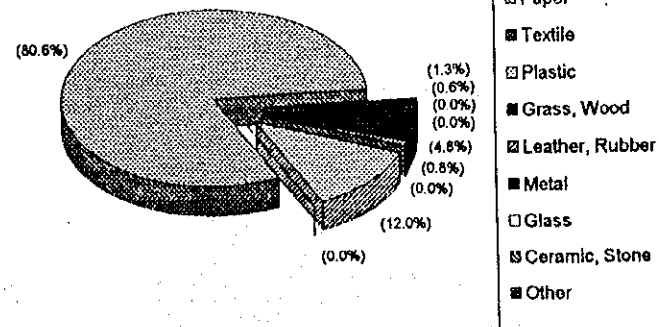
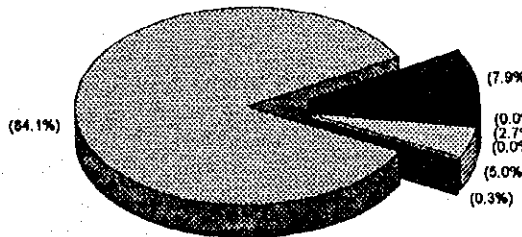
Winter

Commercial Area : Restaurant



- Kitchen Waste
- ▨ Paper
- Textile
- ▨ Plastic
- Grass, Wood
- ▨ Leather, Rubber
- Metal
- Glass
- ▨ Ceramic, Stone
- Other

Commercial Area : Other Shops



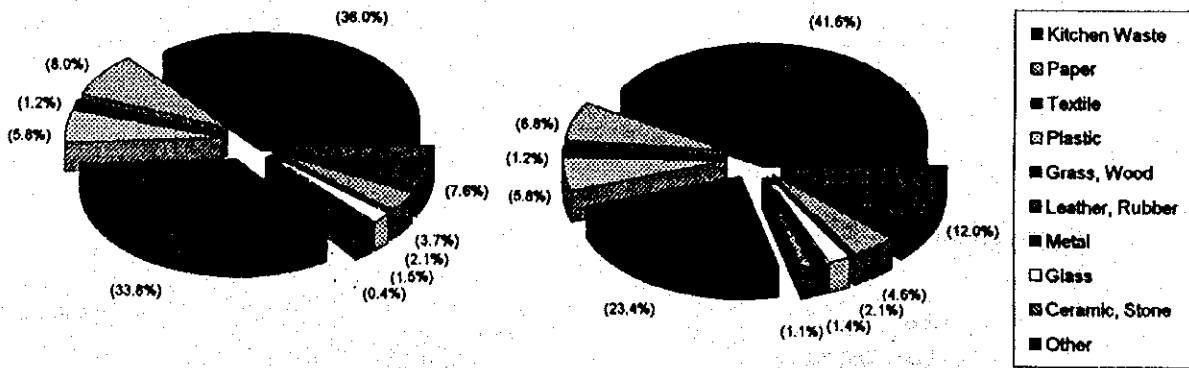
- Kitchen Waste
- ▨ Paper
- Textile
- ▨ Plastic
- Grass, Wood
- ▨ Leather, Rubber
- Metal
- Glass
- ▨ Ceramic, Stone
- Other

Figure B.3.3b Results of Physical Composition Survey of Commercial Waste in Summer and Winter (2)

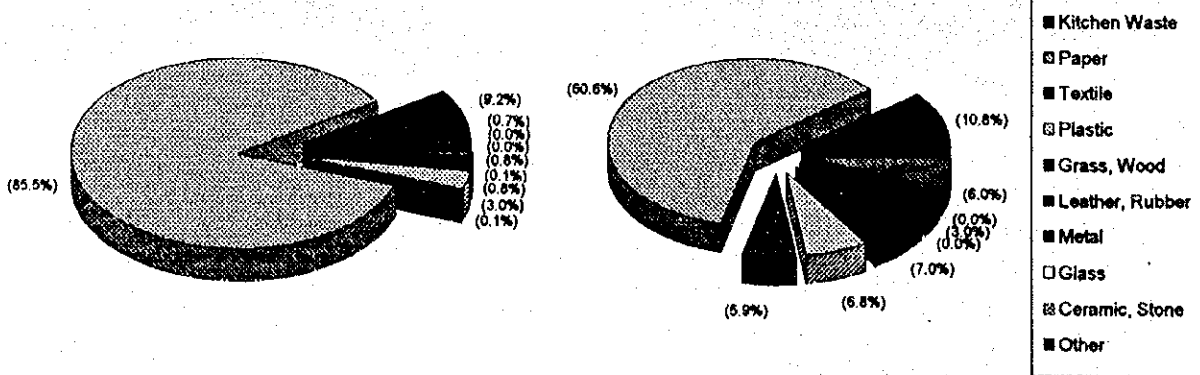
Summer

Winter

Market



Institution



Street Sweeping

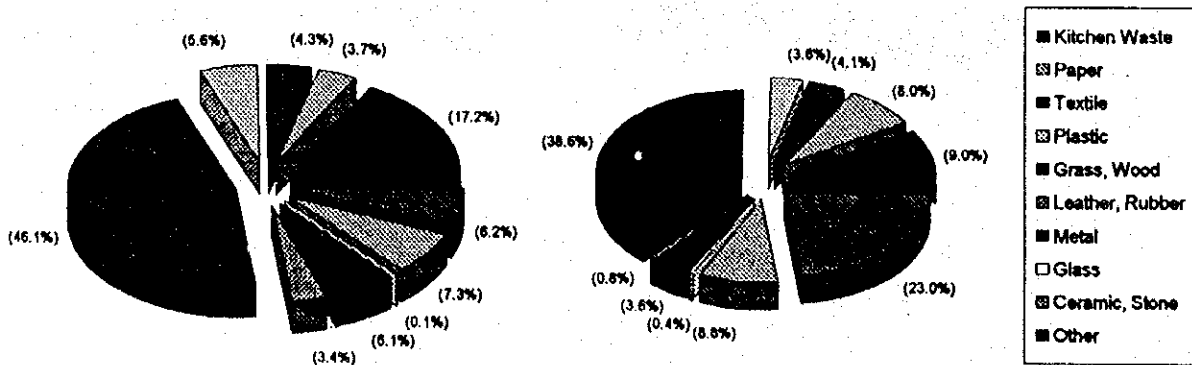


Figure B.3.3c Results of Physical Composition Survey of Other Wastes in Summer and Winter (3)

B.4 Findings

B.4.1 Waste Amount

a. Generation Ratio

aa. Household Waste

aaa. Population by income level

In order to obtain the population ratio of high, middle and low income levels, the Study Team carried out the following works:

- i. Managua City was divided into 980 wards (barrios).
- ii. The 980 wards were classified into high, middle and low income wards by the staff of the Managua Municipality.
- iii. The total population of high, middle and low income wards is as follows:

Table B.4.1a Population by Income Level in the Study Area

Category	Population	Rate
High income	42,875 persons	4.0 %
Middle income	353,716 persons	33.0 %
Low income	675,277 persons	63.0 %
Total	1,071,868 persons	100 %

aab. Generation Ratio Obtained from WACS

Generation ratio obtained from WACS is tabulated in Table 2.1.4b. The result shows a slight difference in seasonal generation ratios. Accordingly, the average generation ratio in summer and winter is adopted as the generation ratio in the study area.

Table B.4.1b Generation Ratio of Household Waste obtained from WACS
unit: g/day/person

Income Level	Summer	Winter	Average
High	833.00	682.00	757.50
Middle	732.00	628.00	680.00
Low	643.00	657.00	650.00

The weighted average of the generation ratio in the Study Area was calculated as follows:

$$757.5 \times 0.04 + 680 \times 0.33 + 650 \times 0.63 = 664.2$$

Say 664 g/day/person

ab. Commercial, Market, Institutional and Street Sweeping Waste

Generation ratios of each category of waste are shown in Table 2.1.4c. Generation ratios of commercial, market and institutional and street sweeping wastes do not differ in summer and winter. Therefore, the average generation ratios were applied to the generation ratios of each category.

Table B.4.1c Generation Ratio of Market, Shop, Institutional and Street Sweeping Wastes

unit: g/day/person

Waste Category	Unit	Generation Ratio		
		In Summer	In Winter	Average
Market Waste	g/day/shop	3,750.00	4,000.00	3,875.00
Shop Waste (Restaurant)	g/day/shop	12,489.00	15,166.00	13,828.00
Shop Waste (Others)	g/day/shop	1,007.00	991.00	999.00
Institutional Waste	g/day/person	62.00	59.00	61.00
Street Sweeping Waste	g/day/Km	58,500.00	41,200.00	49,850.00

ac. Municipal Waste discharged from Medical Facilities

The generation ratio of municipal waste (non-infectious waste) discharged from medical facilities is estimated as follows:

- Municipal waste discharged from medical facilities is collected by the municipality.

- The generation ratio of waste from medical facilities is estimated according to the number of beds. The total number of beds in medical facilities receiving collection service is 2,175 beds.
- Medical facilities receive daily collection services.
- The amount of hospital waste collected daily weighs 6.3 tons according to the truck scale at the Acahualinca disposal site.

According to the above, the generation ratio of hospitals was estimated at 2,897 g/bed.

$$6.3 \text{ ton} / 2,175 \text{ bed} = 2,897 \text{ g/bed}$$

Table B.4.1d List of Medical Institutions Receiving Municipality Solid Waste Collection Services

Medical Institutions	Dis- trict	Collection Service							Number of Bed
		Mon Lun	Tue Mar	Wed Mie	Thu Jue	Fri Vie	Sat Sab	Total	
Hospital Carlos Roberto Huembes	2	●		●		●		3	127
Hospital Psiquiátrico Nacional	2		●		●		●	3	165
Hosp. Rehabilitación Aldo Chavarría	2		●		●		●	3	48
Hospital Dermatológico	2		●		●		●	3	70
C.S Sócrates Flores	2		●		●		●	3	0
C.S Francisco Morazán	2		●		●		●	3	0
Hospital Lenin Fonseca	2	●	●	●	●	●	●	6	270
Policlínica Central	2	●		●		●		3	0
C.S Niños y M. Ayapal	3	●		●		●		3	0
Hospital Bertha Calderón	3	●	●	●	●	●	●	6	313
Hospital Monte España	3	●		●		●		3	20
Centro Nac. Cruz Roja Nicaraguense	3	●				●		2	0
Hospital Fernando Vélaz Paiz	3	●	●	●	●	●	●	6	250
C.S Roberto Clemente	4	●		●		●		3	0
C.S Francisco Buitrago	4	●		●		●		3	0
Oficinas INSSBI	4	●		●		●		3	0
Hospital Bautista	4	●	●	●	●	●	●	6	40
Hospital Militar "Dávila Bolaños"	4	●	●	●	●	●	●	6	156
Hospital Manolo Morales	5	●	●	●	●	●	●	6	210
Hospital del Niño "La Mascota"	5	●	●	●	●	●	●	6	259
C.S Silvia Ferrufino	6	●					●	2	0
Hospital Carlos Marx (Aleman Nicaraguense)	6	●	●	●	●	●	●	6	247
Total		17	13	15	13	16	14	-	2,175

Note : C.S (Centro de Salud)= Health Centre

ad. Parks and Green Areas

The waste generation ratio in public areas covered by cleansing services, such as parks and green areas, is estimated to be 83.8 kg/ha according to the following calculation:

$$1.4 / 16.7 \times 1000 = 83.8$$

1.4 t/day: Collection amount weighed by truck scale

16.7 ha : Park and green areas covered by public cleansing work

b. Determination of the Number of Generation Sources

The urban population, number of shops, number of hospital beds, number of public officers, length of streets swept and the extended coverage of parks and green areas covered by the cleansing services in the study area are shown in Table B.4.1e.

Table B.4.1e Population, Number of Shops, Number of hospital beds, Number of Public Offices, Length of Streets Swept and Additional Parks and Green Areas

District	Urban Area Population (person)	Shops		Market (shop)	Hospital (beds)	No. of Public Officers			Length of Streets Swept (Km)	Park and Green Area (ha)
		Restaurant	Others			Government	Municipality	Total		
1	63,556	35	0	107	0	662	74	736	11.58	3.8
2	134,696	216	20	204	680	1,100	123	1,223	48.03	3.0
3	134,833	388	40	526	583	28,947	3,238	32,185	91.85	3.2
4	204,711	574	14	3,519	196	1,269	142	1,411	74.06	4.2
5	144,241	307	319	1,483	469	983	110	1,093	36.05	1.7
6	152,390	318	0	873	247	1,010	113	1,123	65.88	0.8
7	0	0	0	0	0	232	26	258	3.55	0.0
Total	834,427	1,838	393	6,712	2,175	34,203	3,826	38,029	331.00	16.7

Notes:

- Population : Population estimated by the Study Team based on the 1991 CSE electoral data
- Restaurant : Data supplied by the Ministry of Economy
- Other shop : Number of shops in the commercial area counted by the Study Team
- Market : Number of fixed shops supplied by the administration of each market
- Public Officer : Data supplied by ALMA
- Length of Streets Swept : Number of government officers in each district estimated according to the ratio of municipal officers in each district
- Public Cleansing Area : Data supplied by the Coordination Head Office
- : Data supplied by ALMA

c. Generation Amount

The generation amount of the municipal solid waste (MSW) calculated based on the generation ratios, unit number of generation sources and disposal amount obtained by truck scale are tabulated in Table B.4.1f

Table B.4.1f Waste Generation Amount

(Unit: ton/day)

Type of Waste	District 1	District 2	District 3	District 4	District 5	District 6	District 7	Total
Household Waste	42.2	89.4	89.5	136.0	95.8	101.2	0	554.1
Commercial Waste (Restaurant)	0.5	3.0	5.4	7.9	4.2	4.4	0	25.4
Commercial Waste (Others)	0	0.02	0.04	0.01	0.33	0	0	0.4
Market Waste	0.4	0.8	2.0	13.7	5.7	3.4	0	26.0
Institutional Waste	0.03	0.06	1.99	0.08	0.06	0.06	0.02	2.3
Street Sweeping Waste	0.6	2.4	4.5	3.7	1.8	3.3	0.2	16.5
Hospital Waste	0	1.9	1.7	0.6	1.4	0.7	0	6.3
Park and Green Area Waste	0.3	0.2	0.3	0.4	0.1	0.1	0	1.4
Bulky Waste								2.1
Other Waste								31.5
Total	44.03	97.78	105.43	162.39	109.39	113.16	0.22	666

B.4.2 Waste Composition

The physical composition, ASG and chemical analysis of household waste were calculated, taking the weighted average into consideration, in accordance with the following population ratios:

- Population ratio

High Income	4%
Middle Income	33%
Low Income	63%

- Weighted average

The physical composition ratio by income level was calculated as follows:

$$\begin{array}{l} \text{Average physical} \\ \text{composition in} \\ \text{high income areas} \end{array} \times 0.04 + \begin{array}{l} \text{Average physical} \\ \text{composition in} \\ \text{middle income areas} \end{array} \times 0.33 + \begin{array}{l} \text{Average physical} \\ \text{composition in} \\ \text{low income areas} \end{array} \times 0.63$$

The waste composition results are summarized in Table B.4.2a.

Table B.4.2a Results of the Waste Composition Survey

Classification		High Inc.	Household			Commercial		Market	Institution	Road	
			Middle Inc.	Low Inc.	Weighted Avg.	Restaurant	Others				
Physical Composition (wet base)	Apparent Specific Gravity	(kg/l)	0.19	0.16	0.22	0.20	0.32	0.04	0.28	0.16	
	Combustibles	Kitchen waste	(%)	54.35	43.66	29.02	34.86	62.63	4.60	38.77	9.98
		Paper	(%)	12.55	9.05	2.98	5.37	10.40	82.34	7.40	73.02
		Textile	(%)	2.59	1.65	1.95	1.87	0.25	0.15	1.20	2.99
		Plastic	(%)	6.15	4.74	3.29	3.88	3.80	8.51	5.81	4.90
		Grass and wood	(%)	11.44	23.61	29.93	27.11	10.39	0.00	28.60	3.90
	Leather and rubber		(%)	0.21	0.54	2.87	2.00	0.00	0.39	0.75	0.03
		Sub-total	(%)	87.29	83.26	70.04	75.09	87.47	95.99	82.53	94.82
	Incombustible	Metal	(%)	2.72	1.09	1.94	1.69	3.68	3.73	1.44	1.88
		Glass	(%)	4.69	3.27	2.61	2.91	5.81	0.00	2.07	0.00
Ceramic and stone		(%)	2.05	4.16	10.50	8.07	1.60	0.00	4.16	0.00	
Others (soil, etc)		(%)	3.25	8.22	14.91	12.24	1.44	0.28	9.80	3.30	
Sub-total		(%)	12.71	16.74	29.96	24.91	12.53	4.01	17.47	5.18	
Total	(%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	
Chemical Analysis	Three contents	Combustibles	(%)	28.13	29.47	27.97	28.47	24.77	81.68	26.29	67.45
		Moisture	(%)	58.30	43.82	37.27	40.27	60.06	6.93	49.68	22.63
		Ash	(%)	13.57	26.71	34.76	31.26	15.17	11.39	24.03	9.92
	Total	(%)	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Ultimate Analysis of combustibles	Carbon	(%)	16.19	18.23	18.54	18.34	14.79	41.32	18.02	33.14	
	Hydrogen	(%)	2.31	2.54	2.54	2.53	2.05	6.14	2.54	4.80	
	Nitrogen	(%)	0.56	0.74	0.78	0.76	0.65	0.35	0.69	0.44	
	Sulphur	(%)	0.04	0.05	0.05	0.05	0.04	0.04	0.05	0.04	
	Chlorine	(%)	0.27	0.25	0.24	0.24	0.18	0.86	0.28	0.44	
Oxygen	(%)	8.76	7.66	5.82	6.55	7.06	32.97	4.45	28.59	6.65	
	Total	(%)	28.13	29.47	27.97	28.47	24.77	81.68	26.03	67.45	
Lower Calorific Value	(kcal/kg)	1,022	929	1,045	1,006	909	914	3,900	914	2,810	
C/N Ratio	-	29.01	24.69	23.94	24.39	23.00	119.81	26.28	75.77	24.51	

ANNEX C

PUBLIC OPINION SURVEY

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ANNEX C PUBLIC OPINION SURVEY

C.1 Method of the Survey

C.1.1 Objectives of the Survey

Solid waste management (SWM) is a relevant aspect in the everyday life of a community. The public opinion survey was carried out to understand the relationship and to learn the people's viewpoint concerning SWM, which will be taken into account in the formulation of the SWM master plan. The main objectives are summarized below.

- To determine the lifestyle
- To determine prevailing waste discharge methods
- To understand the existing waste collection service
- To determine if recycling is possible
- To understand fee collection and the financial state of the area
- To determine degree of public cooperation of participation that may be available

C.1.2 Selection of the Samples

In order to determine the prevailing conditions in the study area, public opinion and basic information concerning SWM in the Study Area, sample residences and shops to be subject to an interview were selected in the following manner:

- A total of 180 samples were selected, 120 of which were from residential areas and 60 samples in commercial areas.
- Residential areas were classified into three categories by income level as follows:
 - . High income residential areas
 - . Middle income residential areas
 - . Low income residential areas
- The commercial areas were classified into two categories, i.e. restaurant and other shops, and number of samples selected in each category is shown

below.

- Restaurant : 20 samples
- Other shops : 40 samples

Table C.1.2a List of Public Opinion Survey Samples

Category	Income Level	Location	Sample numbers
Residential Area	High Income	Altos de Santo Domingo	10
		Las Colinas	10
		Villa Fontana	10
		Lomas de Monserrat	10
	Middle Income	Barrio Altigracia	10
		Colonia Francisco Morazán	10
		Colonia Bello Horizonte	10
		Jardines de Veracruz	10
	Low Income	Barrio Acahualinca	10
		Ciudad Sandino	10
		Ascatamicato Santos López	10
		Ascatamicato A.C Sandino	10
Commercial Area	Restaurants	Rotonda Bello Horizonte	10
		Alrededores del super "Ciudad Jardín"	10
	Shops	Centro Comercial Managua	20
		Alrededores del super "Ciudad Jardín"	20
Total			180

The location of the sampling points for the public opinion survey are shown in Figure C.1.2a.

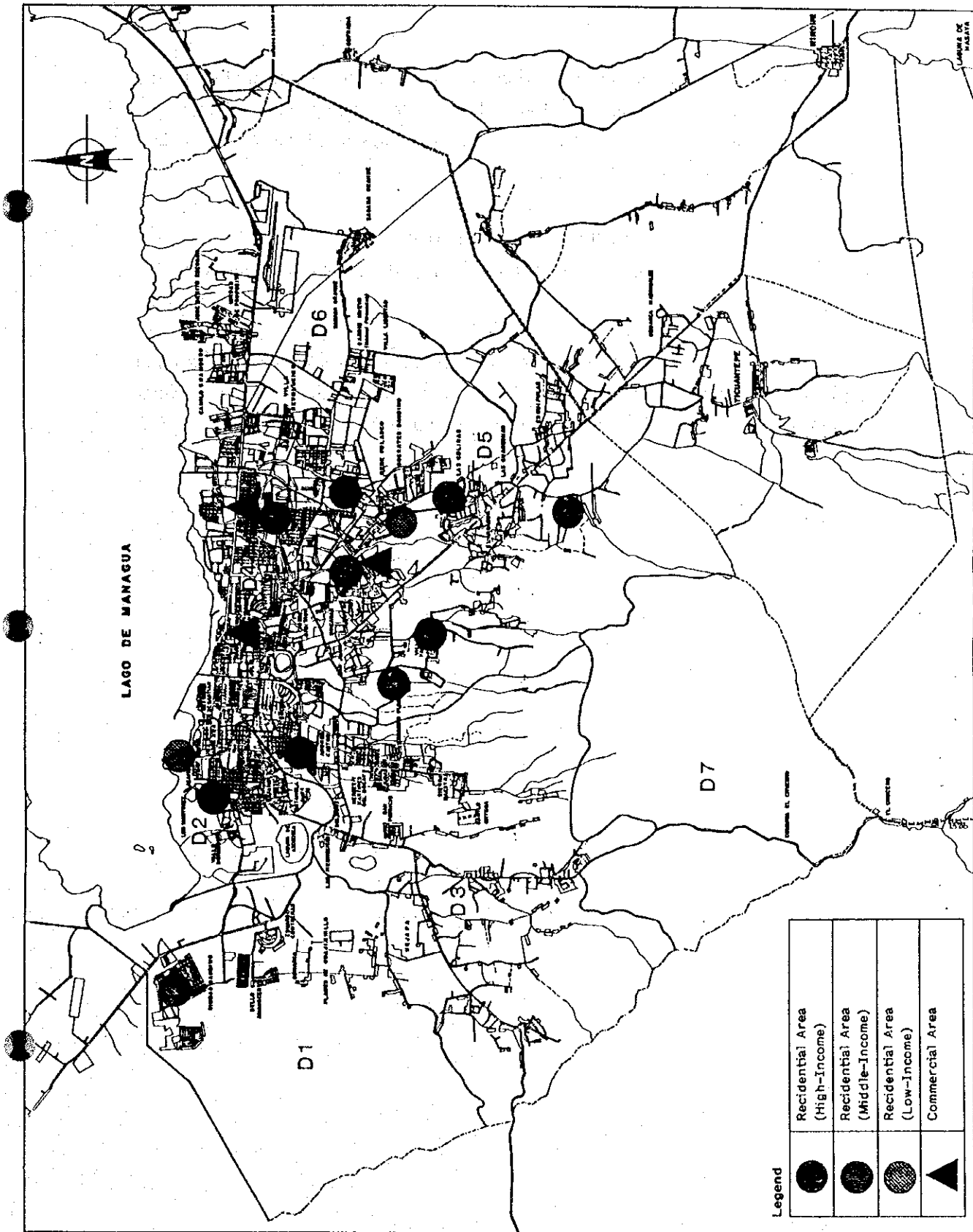


Figure C.1.2a
Map of Sampling Points for the Public Opinion Survey

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C.1.3 Method of the Survey

Taking into account the present condition of SWM and the characteristics of the Study Area the draft questionnaire in Spanish of SWM was reviewed and corrected through discussion with the counterparts so that the contents of the questionnaires meet the actual situation of the Study Area.

Before the execution of the survey, the Study Team performed a lecture for the interviewers in order to let them understand the objectives and the contents of the survey.

POS was conducted by interviewing each resident, shop and restaurant owners and employees. The interviewer visited each interviewee and collected answers from them at the same time. All the answers were entered in the a computer for analysis.