ANNEX F

PRESENT MUNICIPAL SOLID WASTE MANAGEMENT

CONTENTS

LIST OF TABLES

LIST OF FIGURES

F.1 Waste Stream

F.1.1 Concept of Waste Stream

The waste stream in the Study Area is formulated based on the following surveys:

- WACS (Waste Amount and Composition Survey)
- POS (Public Opinion Survey)
- DWAS (Disposal Waste Amount Survey at Acahualinca D.S.)
- Disposal amount obtained by the truck scale at Acahualinca D.S. from August to November 1994

The waste stream concept is illustrated and shown in Figure F.1.1a. Solid waste from each generation source is classified into three categories, i.e. recycled, discharged and self-disposed waste. Discharged waste is divided into waste collected by collection services and waste dumped illegally or littered. Collected waste is transported to the disposal site where reusable materials are picked out by collectors and scavengers (churequeros). Wastes disposed at the disposal site are not only those collected by the Municipality, but those hauled directly by factories as well.

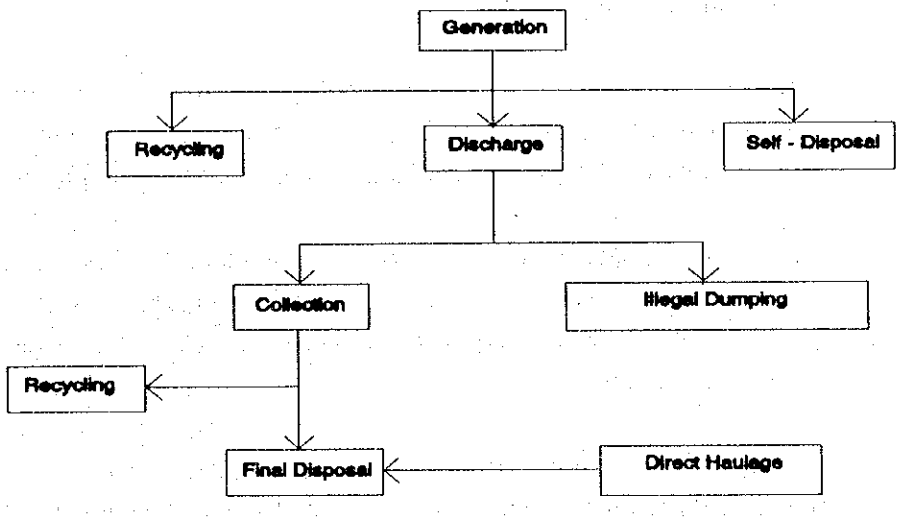


Figure F.1.1a Concept of Waste Stream

F.1.2 Waste Generation and Discharge

a. Generation Sources

The generation sources in the Study Area are classified as follows:

- Residence (Household Waste)
- Restaurants (Commercial Waste)
- Other Shops (Commercial Waste)
- Markets (Market Waste)
- Offices (Institutional Waste)
- Hospitals (Hospital Waste)
- Roads (Street Sweeping Waste)
- Parks and Green Areas (Park and Green Area Waste)
- Factories (Industrial Waste)

The Municipality collects a limited amount of industrial waste.

aa. Household Waste

The generation and discharge of household waste in the collection area is estimated using the results of WACS and POS, and is shown in Figure F.1.2a. The bases of the estimation are explained as follows:

i. Household waste in the study are classified into food wastes used as animal food (#2), garden waste (#3) and rubbish (#4). Total generation ratio of household waste per capita is estimated at 664 g/d/person.

ii. 33% of households surveyed use their food waste (#2) as animal food – a method considered as a type of recycling. The amount of food waste recycled is calculated at 20 g/day/person below, based on the result of the POS:

0.35 liter/d/household x 0.33 / 5.8 persons/household = 0.02 liter/d/person
0.02 liter/d/person x specific volume of food waste (1 kg/liter) = 0.02 kg. Therefore, the amount of food waste recycled is 20g/d/person.

Note:

0.35 liter/d/household :	Average amount of food waste fed to domestic animals per day per household.

33% :	Ratio of household with domestic animals.
5.8 persons/household :	Average number of family members in the POS.

iii. The composition of household wastes obtained from the results of the WACS is tabulated in Table F.1.2a. Based on the fact that garden waste covers 40% of the total amount of waste generated, the calculated daily amount of garden waste (#3) generated per person was 261 g/day/person (664 x 0.393). Garden wastes consist of wood and bamboo (#5) and others (#6), the latter mainly referring to soil and sand accumulated from gardening work. The amount of rubbish (#4)discharged, which is defined in the study as discharged waste, is calculated at 383 g/d/person, 57.7% of the total amount of waste generated.

iv. 77% of the households surveyed produce garden waste, and 25% carry out open combustion. Garden waste is considered as waste amount for self-disposal which is calculated below to amount to 95 g/day/person based on the results of the POS:

81.2 / 7 / 5.8 x 0.25 x 0.19 x 1000 = 95 g/d/person

Note:

81.2 liters/week/household :	Average amount of garden waste discharged by households per week.
5.8 persons/household :	Average number of family members in POS
0.25 :	Ratio of households self-disposing garden waste.
0.19 :	ASG (Apparent Specific Gravity) of street sweeping waste.

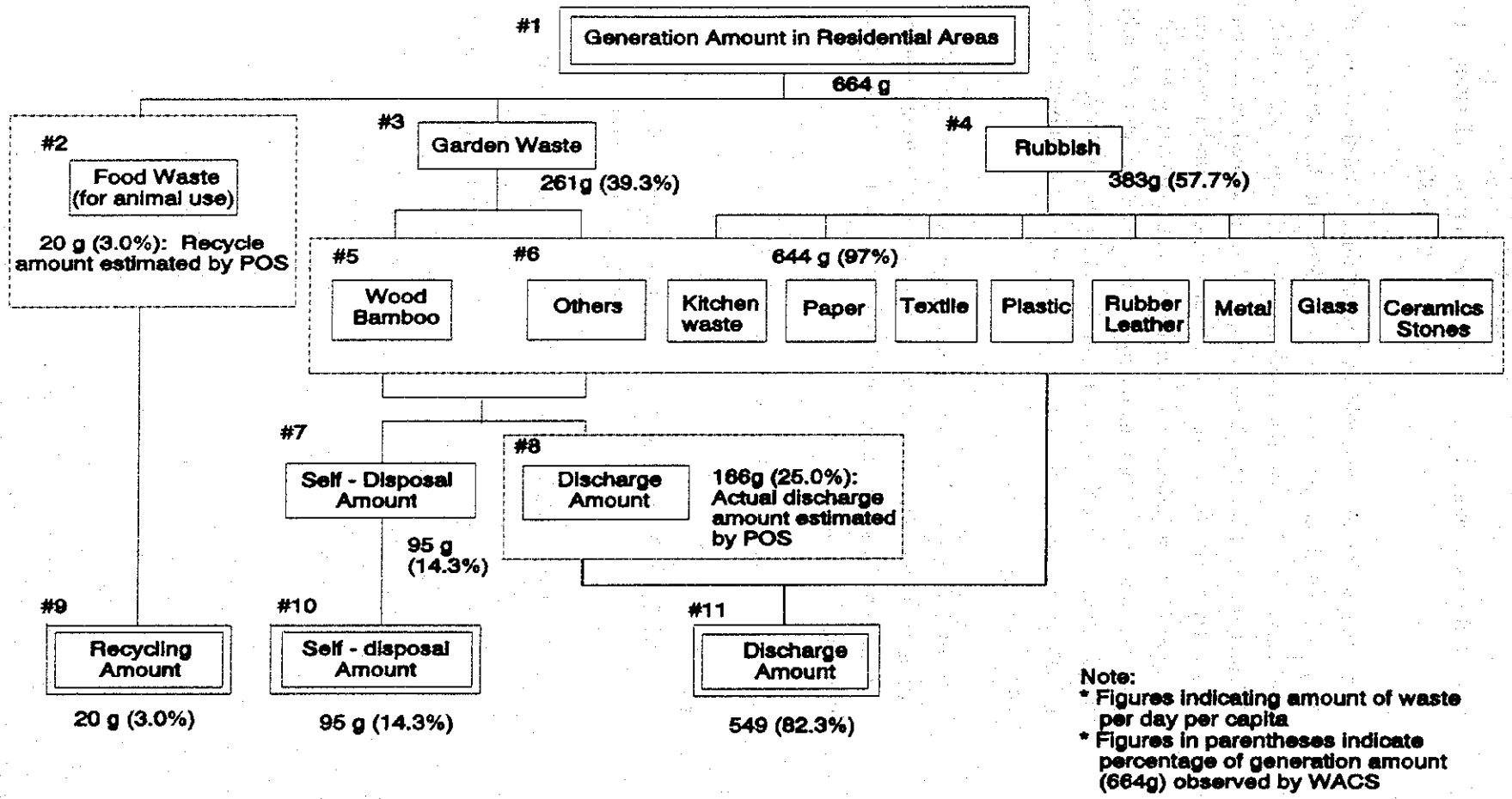


Figure F.1.2a Generation and Discharge of Household Waste in Collection Area

Table F.1.2a Composition of Household Waste (Wet Base)

Category	Physical Composition (%)					
	Kitchen Waste	Paper	Textile	Plastic	Grass, Wood	Leather, Rubber
High Income	54.35	12.55	2.59	6.15	11.44	0.21
Middle Income	43.66	9.05	1.65	4.74	23.61	0.54
Low In-come	29.02	2.98	1.95	3.29	29.93	2.87
Weighted Average	34.86	5.37	1.87	3.88	27.11	2.00

Category	Physical Composition (%)					Apparent Specific Gravity
	Metal	Glass	Ceramic, Stone	Others	Total	
High Income	2.72	4.69	2.05	3.25	100	0.19
Middle Income	1.09	3.27	4.16	8.22	100	0.16
Low In-come	1.94	2.61	10.50	14.91	100	0.22
Weighted Average	1.69	2.91	8.07	12.24	100	0.20

v. The recycling amount in these sources is disregarded since more than 80% of the residents interviewed in the POS stated the absence of collection services or buyers of reusable or recyclable materials.

ab. Other Generation Sources

Generation rate of other sources according to the WACS, medical waste survey, etc., is shown as follows:

–	Restaurants	13,828 g/shop/day
–	Other shops	999 g/shop/day
–	Markets	3,875 g/shop/day
–	Offices	61 g/shop/day
–	Hospitals	2,897 g/bed/day
–	Street sweeping	49,850 g/shop/day
–	Park and green areas	83.8 kg/ha/day

The recycling amount in these resources is disregarded since people interviewed in the above mentioned sources stated that recycling activities are very limited. Consequently, the generation rates of the above-mentioned sources are considered to be equal to their discharge rates.

b. Coverage of Waste Collection Services

The coverage of the waste collection services in the Study Area is summarized in Table F.1.2b.

Table F.1.2b Coverage of Waste Collection Services

Generation Source		Service Coverage
Residential Area		76.9% (642,077 persons)
Commercial Area	Restaurants	100% (1,838 shops)
	Other shops	100% (393 shops)
Markets		100% (6,712 shops)
Institutions		100% (38,029 employees)
Hospitals		100% (2,175 beds)
Roads		47% (331.0 km)
Park and Green Areas		19% (16.7 ha)

ba. Residential Area

The coverage of waste collection services in residential areas is estimated and shown in Figure F.1.2b.

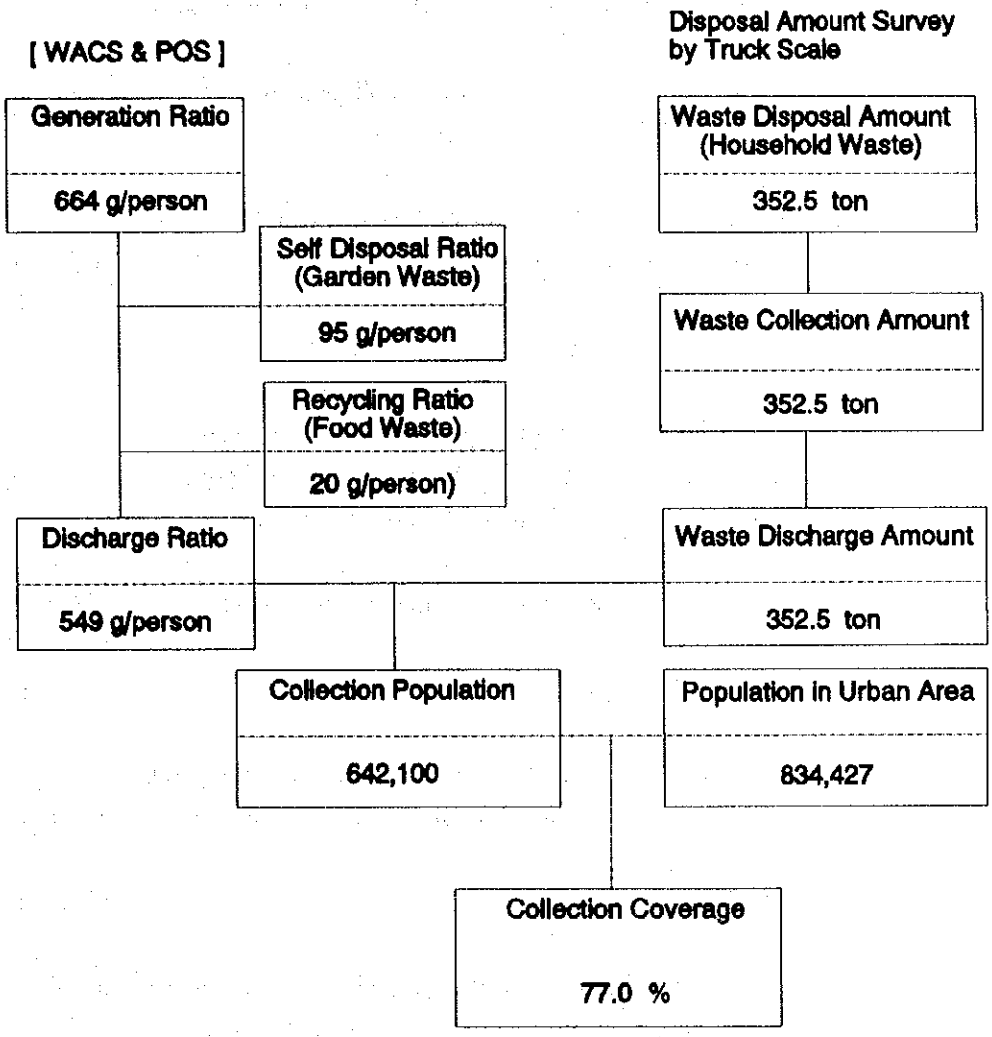


Figure F.1.2b Waste Collection Coverage in Residential Area

- There are 2 types of collection areas in the residential area. The area with good access roads where compactor truck collection is regularly carried out, and the area where residents dispose of their waste in registered illegal dump sites (RIDS) due to poor access roads and electric cable system. Waste disposed in the RIDS are irregularly collected by a combination of wheel loaders and dump trucks, and mainly consist of household and construction wastes. According to the Nicaraguan Staff and the Study Team, approximately 20% of the waste dumped in RIDS is household waste.

- The total discharge amount of waste collected from the residential area was estimated at 352.2 tons per day as follows:

  i. Residential waste amount collected through curb collection system :305.2 t/d

  330.6 - 25.4 = 305.2

  330.6 t/d = amount collected by compactors
  25.4 t/d = restaurant waste amount collected by compactors along with residential waste

  ii. Residential waste amount collected from RIDS : 47.0 t/d

  235 x 0.2 = 47.0

  235 t/d = waste amount collected from RIDS
  0.2 : the ratio of household waste heaped in RIDS

  iii. Total :352.2 t/d

- The ratio of household waste discharged daily per person was observed as being 549 g based on the results of the WACS and POS.

- The number of residents receiving collection services was rounded off to 642,100 from the calculation below:

  352.2 tons x 1,000,000 / 549 g = 642,077

- The waste collection service was calculated to have made a coverage of 77.0%.

  642,100 / 834,427 x 100 = 77.0 %

where 834,427 is the Study Area Urban Population.

bb. Commercial Areas

In the study, commercial areas include supermarkets and restaurants. There are 7 large scale commercial areas in the study area and the municipality carries out waste collection mainly through the container collection system. Restaurant wastes, however, are collected using the curb collection system (door to door collection).

Almost all of the commercial areas and restaurants are covered by the waste collection service.

The number of restaurants in the city is shown in Table F.1.2c. The list of large commercial areas and the number of shops in these areas are shown in Table F.1.2d.

Table F.1.2c Number of Restaurants in the City

District	Number of Restaurants
D1	35
D2	216
D3	388
D4	574
D5	307
D6	318
D7	0
Total	1,838

Table F.1.2d List of Commercial Areas and Number of Shops

Commercial Area	Number of shops	District
CENTRO COMERCIAL MANAGUA	250	D5
CENTRO COMERCIAL CIUDAD JARDIN	14	D4
CENTRO COMERCIAL SAN FRANCISCO	25	D5
METROCENTRO	44	D5
PLAZA ESPAÑA	30	D3
CENTRO COMERCIAL LINDA VISTA	20	D2
CENTRO COMERCIAL EL ZUMEN	10	D3
TOTAL	393	-

bc. Markets

There are 8 markets in the city and they are listed in Table F.1.2e. All these markets are covered by the waste collection service of the municipality which is carried out in these areas using the container collection system.

Table F.1.2e List of Markets and Number of Shops

Markets	Number of Shops			District
	Fixed	Occasional	Total	
AUGUSTO CESAR SANDINO	107	33	140	D1
OCCIDENTAL VIRGEN DE CANDELARIA	204	0	204	D2
BOER (ISRAEL LEWITES)	437	236	673	D3
OSCAR PEREZ CASSAR	89	8	97	D3
ORIENTAL	3,319	5,487	8,806	D4
CENTRAL (ROBERTO HUEMBES)	1,345	947	2,292	D5
SAN MIGUEL (IVAN MONTENEGRO)	414	680	1,094	D6
MAYOR	459	310	769	D6
TOTAL	6,374	7,701	14,075	-

Note: The information was supplied by each respective administration.

bd. Institutions

Government and municipal offices are classified as institutions in this study and almost all of the offices in the study area are covered by the collection services of the Municipality. Waste discharged from the offices are collected mainly through the container collection system.

The total number of central government and municipal employees in the city is about 38,029.

Table F.1.2f Number of Central Government and Municipal Employees

Classification	Number of Employees
Central Government	34,203
Municipality	3,355
Total	38,029

Source: ALMA

be. Hospitals

Hospitals receiving municipality waste collection services and their respective number of beds are shown in Table F.1.2g. Hospital wastes are fully covered by the collection services.

Table F.1.2g List of Medical Institutions Receiving Solid Waste Collection Service from the Municipality

Medical Institutions	District	Number of Beds
Hospital Carlos Roberto Huembes	2	127
Hospital Psiquiátrico Nacional	2	165
Hospital Rehabilitación Aldo Chavarría	2	48
Hospital Dermatológico	2	70
C.S Sócrates Flores	2	0
C.S Francisco Morazán	2	0
Hospital Lenin Fonseca	2	270
Policlínica Central	2	0
C.S Niños y M. Ayapal	3	0
Hospital Bertha Calderón	3	313
Hospital Monte España	3	20
Centro Nacional Cruz Roja Nicaraguense	3	0
Hospital Fernando Velez Paiz	3	250
C.S Roberto Clemente	4	0
C.S Francisco Buitrago	4	0
Oficinas INSSBI	4	0
Hospital Bautista	4	40
Hospital Militar "Dávila Bolaños"	4	156
Hospital Manolo Morales	5	210
Hospital del Niño "La Mascota"	5	259
C.S Sivia Ferrufino	6	0
Hospital Carlos Marx (Alemán Nicaraguense)	6	247
Total		2,175

bf. Street Sweeping

The total length of roads paved with asphalt and stone covered by the cleansing services of the Municipality is shown in Table F.1.2h. According to the data, 47% of the total number of paved roads is covered by street sweeping services carried out by the District Offices.

Table F.1.2h Length and Ratio of Roads Receiving Street Sweeping Service

District	Paved Roads			Unpaved Roads (km)	Total (km)	[2] Swept Roads (km)	Ratio (2:1) (%)
	Asphalt (km)	Stone (km)	[1] Sub-total (km)				
D1	20.32	2.64	22.96	75.29	98.25	11.58	50
D2	110.46	26.43	136.89	42.00	178.89	48.03	35
D3	76.56	54.92	131.48	84.85	216.33	91.85	70
D4	134.07	65.24	199.31	64.99	264.30	74.06	37
D5	88.56	43.50	132.06	46.26	178.32	36.05	27
D6	61.54	15.75	77.29	81.72	159.01	65.88	85
D7	8.35	-	8.35	9.06	17.41	3.55	43
Total	499.86	208.48	708.34	404.17	1,112.51	331.00	47

Source: District Coordination Office (ALMA)

bg. Park and Green Areas

Cleansing services for public places such as parks and green areas are carried out by the Beautification Office, and the area and ratio of the park and green areas covered by the public cleansing work are shown in Table F.1.2i. The total area covered by the public cleansing work is 16.7 ha, equivalent to 19% of the total parks and green areas in the Study Area.

Table F.1.2i Area and Ratio of Parks and Green Areas covered by Public Cleansing Services

District	Number of Parks and Green Areas	Area (ha)	Cleansing Area (ha)
D1	5	20.6	3.8
D2	25	16.5	3.0
D3	13	17.0	3.2
D4	26	22.4	4.2
D5	22	9.3	1.7
D6	6	4.3	0.8
D7	0	0.0	0.0
Total	97	90.1	16.7 (19%)

Source: General Planning Division (ALMA)

F.1.3 Waste Stream

The present waste stream in the Study Area is estimated by the Study Team and illustrated in Figure F.1.3a.

a. Amount of Generation

According to the calculation below, the total amount of waste generated in the Study Area is 871 t/d.

-	Household waste	:834,427 per x 664 g/per/d	= 554.1 t/d
-	Commercial waste (restaurants)	: 1,838 shops x 13,828 g/shop	= 25.4 t/d
-	Commercial waste (shop)	: 393 shops x 999 g/shop	= 0.4 t/d
-	Market waste	: 6,712 shops x 3,875 g/shop	= 26.0 t/d
-	Institutional waste	: 38,029 emp. x 61 g/emp.	= 2.3 t/d
-	Hospital waste	: 2,175 beds x 2,897 g/bed	= 6.3 t/d
-	Street sweeping waste	: 331 km x 49,850 g/km	= 16.5 t/d
-	Park and green area waste	: 16.7 ha x 83.8 kg/ha	= 1.4 t/d
-	Directly hauled MSW	:	= 36.6 t/d
Total MSW		:	= 669 t/d

–	Industrial waste collected by the Municipality	:	8.9 t/d
–	Wastes from RIDS, except household waste	: 235 t/d – 47 t/d	= 188.0 t/d
–	Directly hauled ISW		5.1 t/d
Total of ISW			202 t/d
Total			871 t/d

b. Amount of Food Waste Recycled by Households

As shown in the following calculation, the amount of food waste recycled by households is estimated at 16.7 t/d.

834,427 persons x 20 g/d = 16.7 t/d

c. Self-Disposal Waste Amount

The total amount of self-disposed waste is calculated at 185.2 t/d as shown below:

– Wastes self-disposed by households covered by collection services:

834,427 persons x 0.77 x 95 g/d = 61.3 t/d

– Wastes self-disposed by households not covered by collection services:

834,427 persons x 0.23 x (664–20) = 123.9 t/d

Total	= 185.2 t/d

d. Amount of Waste Collected

As shown in the following calculation, the total amount of collected waste is 627.4 t/d.

– Household waste :	834,427 per x 0.77 x 565 g/d	= 352.2 t/d
– Commercial waste (restaurants)		

	= 25.4 t/d
- Commercial waste (shops):	= 0.4 t/d
- Market waste :	= 26.0 t/d
- Institutional waste:	= 2.3 t/d
- Hospital waste :	= 6.3 t/d
- Street sweeping waste:	= 16.5 t/d
- Park and green area	= 1.4 t/d
Total MSW	430.5 t/d
- Industrial waste collected by the Municipality	= 8.9 t/d
- Waste from RIDS, except household waste	= 188.0 t/d
Total ISW	196.9 t/d
Total	627.4 t/d

e. Recycling Amount

The total amount of waste recycled is calculated at 12.8 t/d, as shown below, according to the recycling and scavenger surveys.

- Amount recycled during collection by collection workers :	10.4 t/d
- Amount recycled at the Acahualinca D.S by scavengers:	2.4 t/d
Total	12.8 t/d

f. Disposal Waste Amount at Acahualinca D.S.

The amount of waste disposed at the Acahualinca D.S for 4 months, from August to November 1994, was determined using the truck scale.

The 4-month observation period showed a disposal amount totaling 653.3 t/d, as shown in the calculation below:

- Household waste :	352.2 t/d
- Commercial waste (restaurants):	25.4 t/d
- Commercial waste (other shops):	0.4 t/d
- Market waste:	26.0 t/d
- Institutional waste:	2.3 t/d
- Hospital waste :	6.3 t/d
- Street sweeping waste :	16.5 t/d
- Park and green area waste :	1.4 t/d
- Directly hauled MSW :	36.6 t/d
Total MSW	467.1 t/d
- Industrial waste collected by the Municipality:	8.9 t/d
- Waste from RIDS, except household waste:	188.0 t/d
- Directly hauled ISW:	5.1 t/d
Total ISW	202.0 t/d
Recycling amount	-12.8 t/d
Total	656.3 t/d

g. Present Waste Stream

The present waste stream in the Study Area is illustrated in Figure F.1.3a.

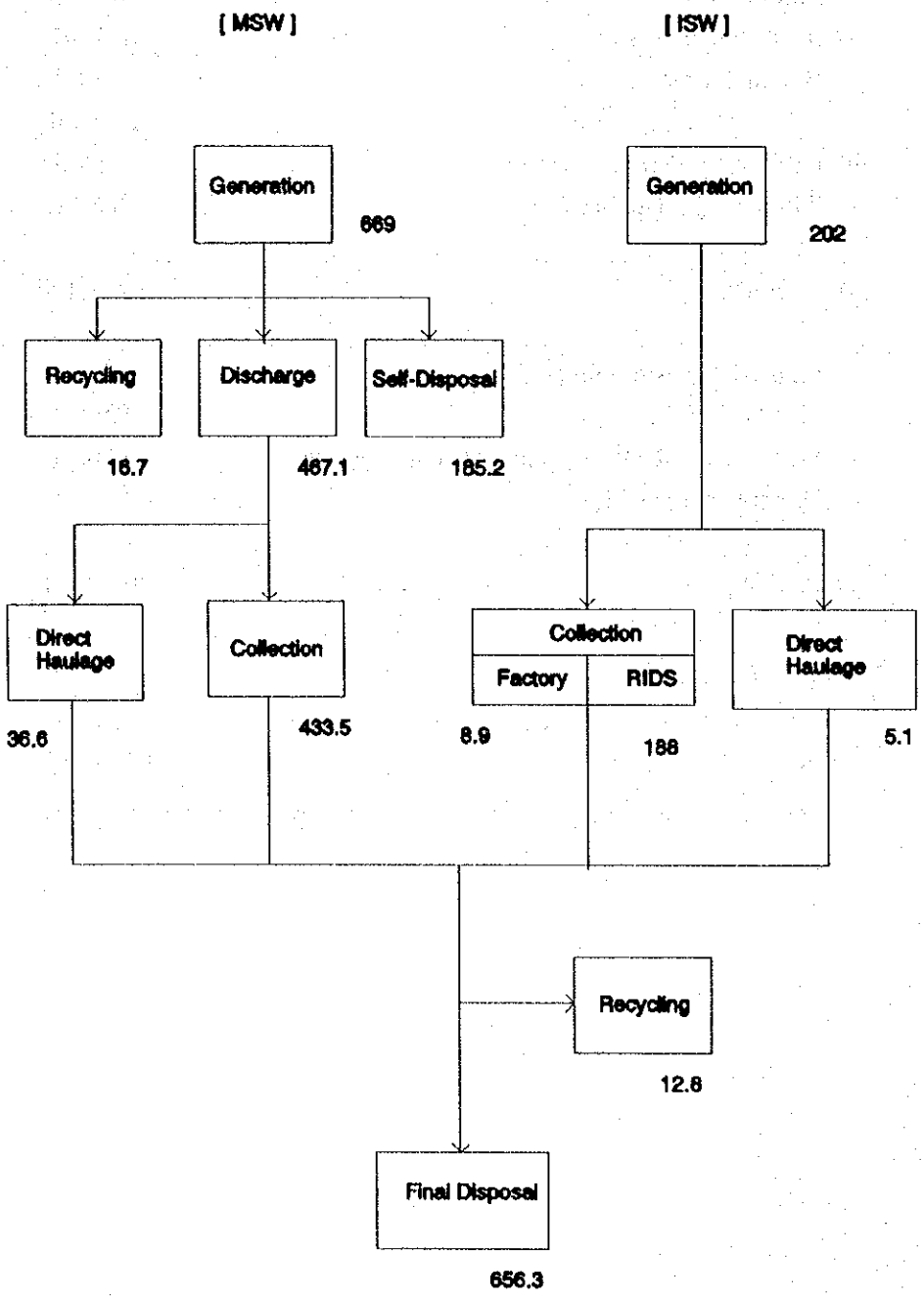


Figure F.1.3a Present Waste Stream in the Study Area (unit : ton/day)

F.2 Technical System

F.2.1 Discharge and Storage

Present discharge and storage system in the Study Area is summarized in Table F.2.1a.

a. Source Separation

Source separation at the generation sources is not established, although there is a habit to segregate waste.

In the POS, approximately 40 percent of the residents answered that they do not discharge garden waste with other waste for collection, and approximately 30 percent answered using food waste as animal feed.

The POS also showed that more than 80% of the residents and 95% of the shops think that nobody collects or buys reusable or recyclable materials in the area.

Source separation is not also established in markets, offices and hospitals. Although infectious waste is segregated at generation sources, it is discharged together with other waste without being placed in any special container.

The municipality requests contracted factories to segregate hazardous waste, e.g., glass, construction debris, etc., and not discharge them into municipal solid waste collection vehicles. Segregation is very necessary to ensure the safety of the collection workers.

Table F.2.1a Present Discharge and Storage System

Generation Sources			Source Separation	Type of Containers	Discharge Points
Resi-dential Area	Collec-tion Area	A	Mixed discharge None	Nylon sacks as waste containers in low and middle income areas. Plastic bags and drum cans are used as waste containers in high income area	In front of premises (approximately 30% of residents in high income area use waste stands)
		B	Mixed discharge None	without container	RIDS
	Non-Collection Area		Mixed discharge None	-	Self disposal outside or peripheral area of their premises
Com-mercial Area	Shops		Mixed discharge None	Container (0.83 m^3)/Drum can	Open space in a commercial area
	Restaurant		Mixed discharge None	Plastic bags/Drum can	Open space near their premises
Market			Mixed discharge None	Container (0.83 or 15 m^3)	Open space in a market
Office			Mixed discharge None	Container (0.83 m^3)	Open space outside the office
Hospital			Mixed discharge (Infectious waste is discharged with other waste)	Container (0.83 m^3)	Open space in hospital grounds
Factory			Mixed discharge None	Container (factories with an agreement with the Municipality use containers (0.83 or 15 m^3))	Open space within factory grounds
Road			Mixed discharge None	Open dumping	Roadside or vacant areas
Park and Green Area			Mixed discharge None	Open dumping	Roadside or vacant areas

b. Type of Container

A nylon sack with 80 to 100 liters capacity is commonly used in low and middle income residential areas for storage and as discharge container. On the other hand, the majority of the residents in the high income area use plastic bags and drum cans.

In commercial areas, shops use 0.83 m^3 containers with lids and drum cans for storage and as a discharge container. On the other hand, restaurants use plastic bags or drum cans.

Generally, market, office, hospital waste are discharged into a container. There are two types of containers: The 0.83 m^3 container collected by the screw type collection truck with attachment, and the 15 m^3 container placed at disposal areas of producers of large waste amount and collected by roll-on roll-off truck.

In contradiction to the above, street sweeping wastes are generally not discharged into containers, but usually in open heaps. Factories contracting the Municipality on waste collection use containers of either capacity.

c. Discharge Points

Waste in collection area A is discharged in front of household premises for collection by collection vehicles. It was observed during the Time & Motion Survey, that approximately 30% of the residents use waste stands as discharge points in high income areas. On the other hand, in collection area B, waste is discharged in the registered illegal dumping sites of the Municipality.

The containers or drum cans for storage and discharge of waste used in commercial areas, markets, offices and hospitals are usually placed in open spaces outside a premises.

On the other hand, wastes in non-collection areas are self-disposed outside or within the peripheral area of the premises, i.e., roadsides and vacant areas. Street sweeping wastes are discarded on roadsides or registered illegal dump sites.

F.2.2 Collection and Haulage

Present collection and haulage system in the study area is summarized in Table F.2.2a.

Table F.2.2a Present Collection and Haulage System

Generation Sources		Responsible Organization	Collection Waste Amount (ton/d)	Service Coverage (%)		Collection Level			Haulage and Transfer System
						Collection System	Collection Frequency	Collection Fee (per month)	
Residential Area	A	Household Collection	305.2	66.7	77.0	Curb collection	Thrice a week	C$ 0.5 – 3.0/front of length in meters	Compactor truck or dump truck without transfer system
	B	Collection through Dump Sites	47.0	10.3		Collection from RIDS	Irregular	Non paying	Dump truck without transfer system
Commercial Area	Shop	Household Collection	0.4	100		Container collection	Thrice a week	C$ 75 ~ 75,000 for each commercial area + container rental fee	Container truck without transfer system
	Restaurant	Household Collection	25.4	100		door to door collection	Thrice a week	C$ 75 ~ 75,000	Compactor truck without transfer system
Market		Household Collection and Collection through container	26.0	100		Container collection	Six times a week	C$ 75 ~ 75,000 + container rental fee	Container truck or roll-on roll-off truck without transfer system
Office		Household Collection	2.3	100		Container collection	Thrice a week	C$ 150 + container rental fee	Container truck without transfer system
Hospital		Household Collection	6.3	100		Container collection	Six times a week	C$ 150 + container rental fee	Container truck without transfer system
Factory		Household Collection	8.9	100		Container collection	Thrice a week	C$ 75 ~ 75,000 or C$ 2,000 (selected industries) + container rental fee	Container truck without transfer system
Road		District Office	16.5	100		Collection from open heaping points	Thrice or twice a week	-	Dump truck without transfer system
Park and Green Area		Department of Green Areas	1.4	100		Collection from open heaping points	daily or twice a week	-	Dump truck without transfer system

a. Organization for Waste Collection and Haulage

The present organization responsible for waste collection and haulage services is presented in section F.3, Institutional System. Here, the outline of the organization is summarized.

aa. Organization

The Department of Collection and Cleansing (DCC) of Managua Municipality is the authorized organization for waste collection and haulage work. Three sections in the department are responsible for waste collection work;

- Section for collection of household waste: in charge of collection through compactor trucks (including those collecting waste discharged in 0.83 m^3 containers), and through the 4 m^3 tractor wagon carts.

- Section for collection of waste discharged in dump sites: in charge of collection of waste discharged in several registered illegal dump sites in the city.

- Section for collection of waste by containers: in charge of removing and hauling waste to the disposal site using 15 m^3 roll-on roll-off containers.

In addition to the above organization, district offices of the District Coordination Office (DCO) and Department of Green Areas (DGA) are responsible for street sweeping and cleansing of park and green areas, respectively.

ab. Number of Personnel

The personnel for waste collection and haulage work in the DCC is shown in Table F.2.2b.

Table F.2.2b Number of Staff for Waste Collection and Haulage in the Department of Collection and Cleansing

Section	Position / Type of Worker	Number of Staff
Household Collection	Manager	4
	Collection and Haulage crew	153
	Driver	44
	Sub-total	201
Collection through Dump Sites	Manager	2
	Driver	12
	Operator	9
	Supervisor	4
	Sub-total	27
Collection through Containers	Manager	1
	Driver	5
	Sub-total	6

b. Collection Areas and Routes

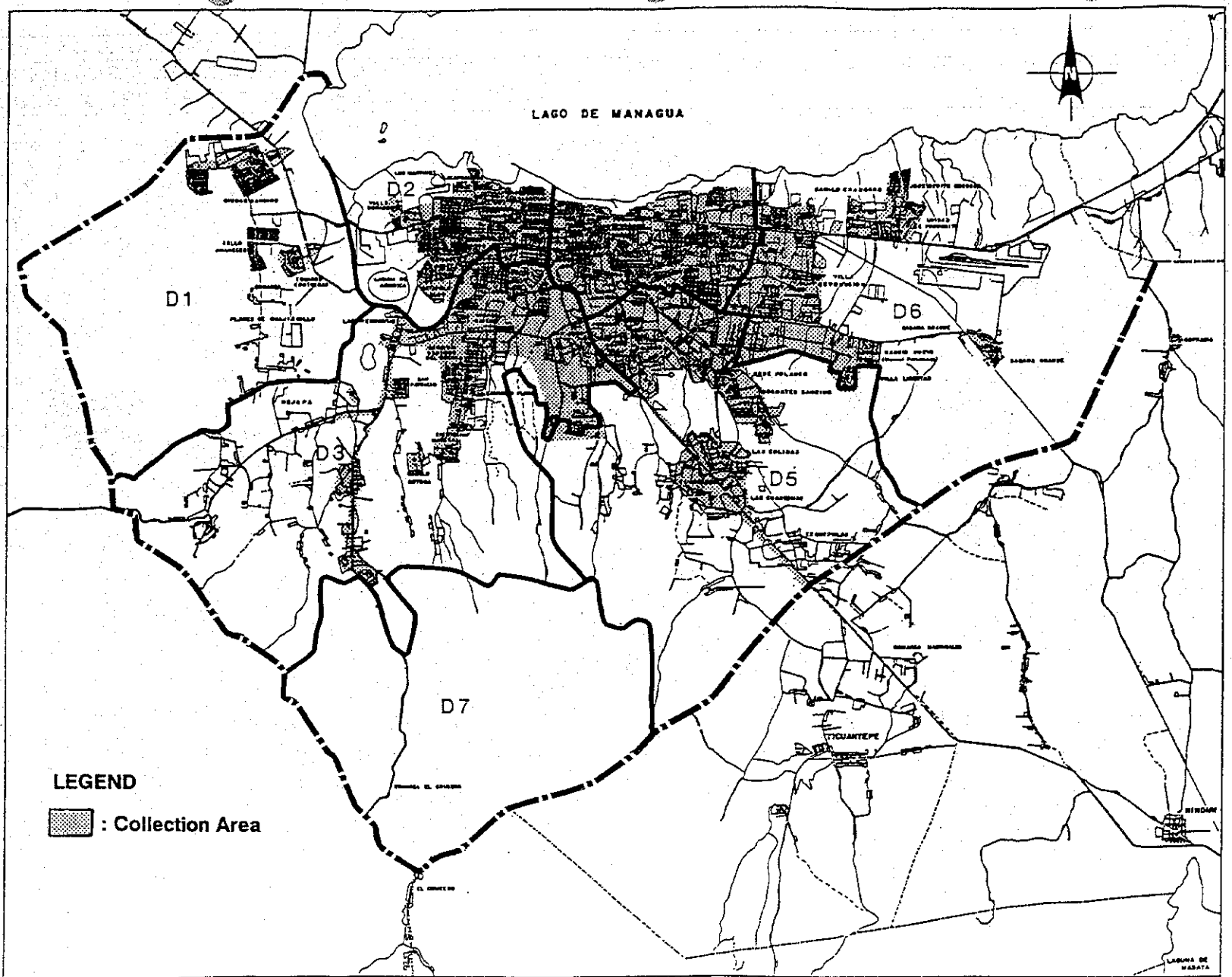
The Section of Household Collection divides the city into 81 collection areas. The collection service is carried out based on a fixed routing. Compactor trucks and cart tractors cover these areas. The collection area is shown in Figure F.2.2a.

In addition to the collection service in residential areas, one route is established for commercial areas, markets and office, another for hospitals and three for industrial waste.

The number of collection route in charge of this section is shown in Table F.2.2c. The collection routes are shown in Figures F.2.2b and F.2.2c, and the lists of collection points are tabulated in F.2.2d – f.

Table F.2.2c Number of Collection Routes of Each Section

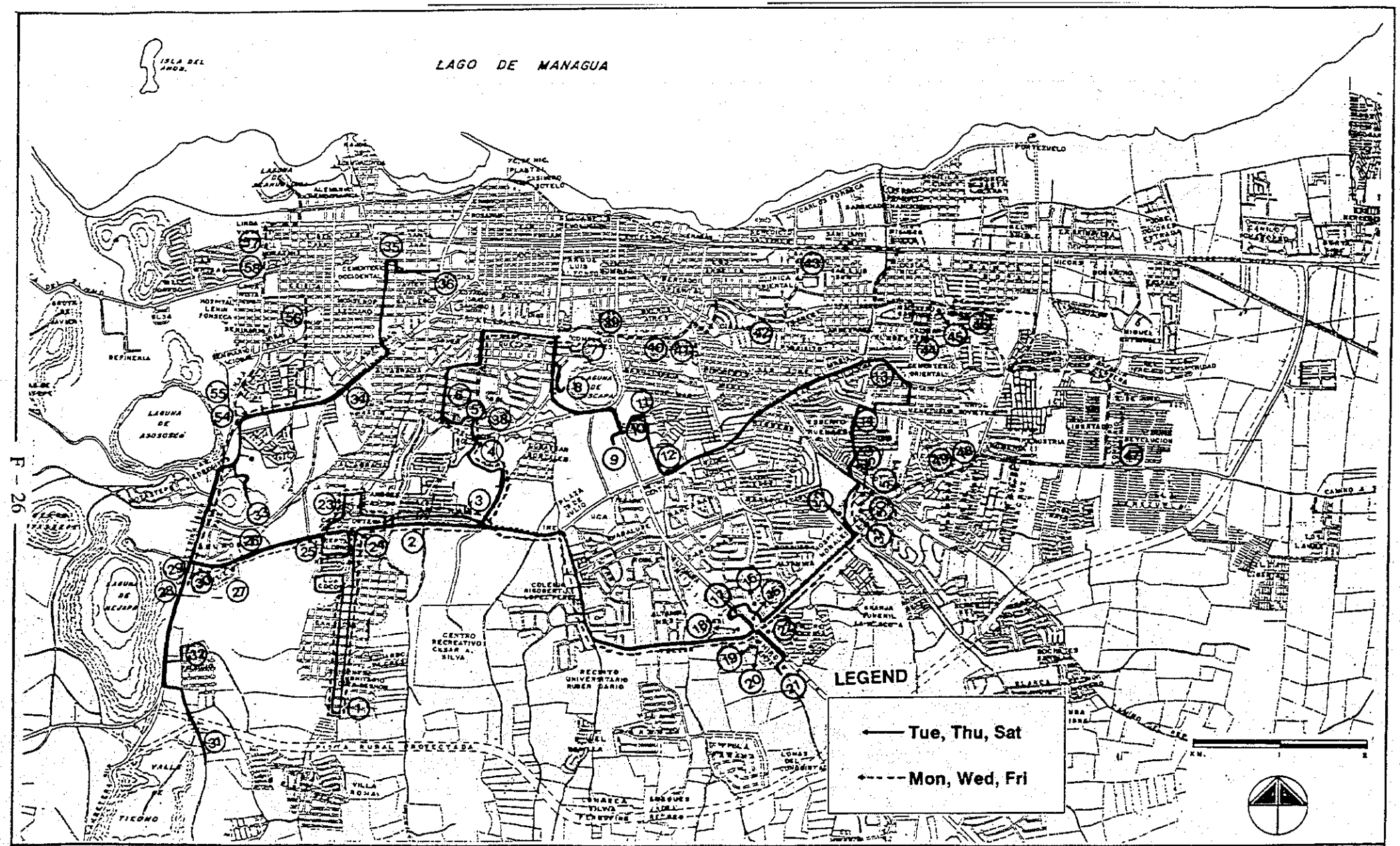
Responsible Organization	Type of Collection Vehicle	District							Total
		1	2	3	4	5	6	7	
Section of Household Collection	Compactor Truck	4	11	11	15	16	12	0	69
	Cart Tractor	0	1	2	1	2	6	0	12
	Sub-total	4	12	13	16	18	18	0	81
Section of Collection through Containers	Screw Type Collection Truck and Roll-on Roll-off Truck	Commercial areas, markets and offices							1
		Hospitals							1
		Factories							3
Total									86



THE STUDY ON THE IMPROVEMENT OF THE SOLID WASTE MANAGEMENT SYSTEM FOR THE CITY OF MANAGUA

JAPAN INTERNATIONAL COOPERATION AGENCY

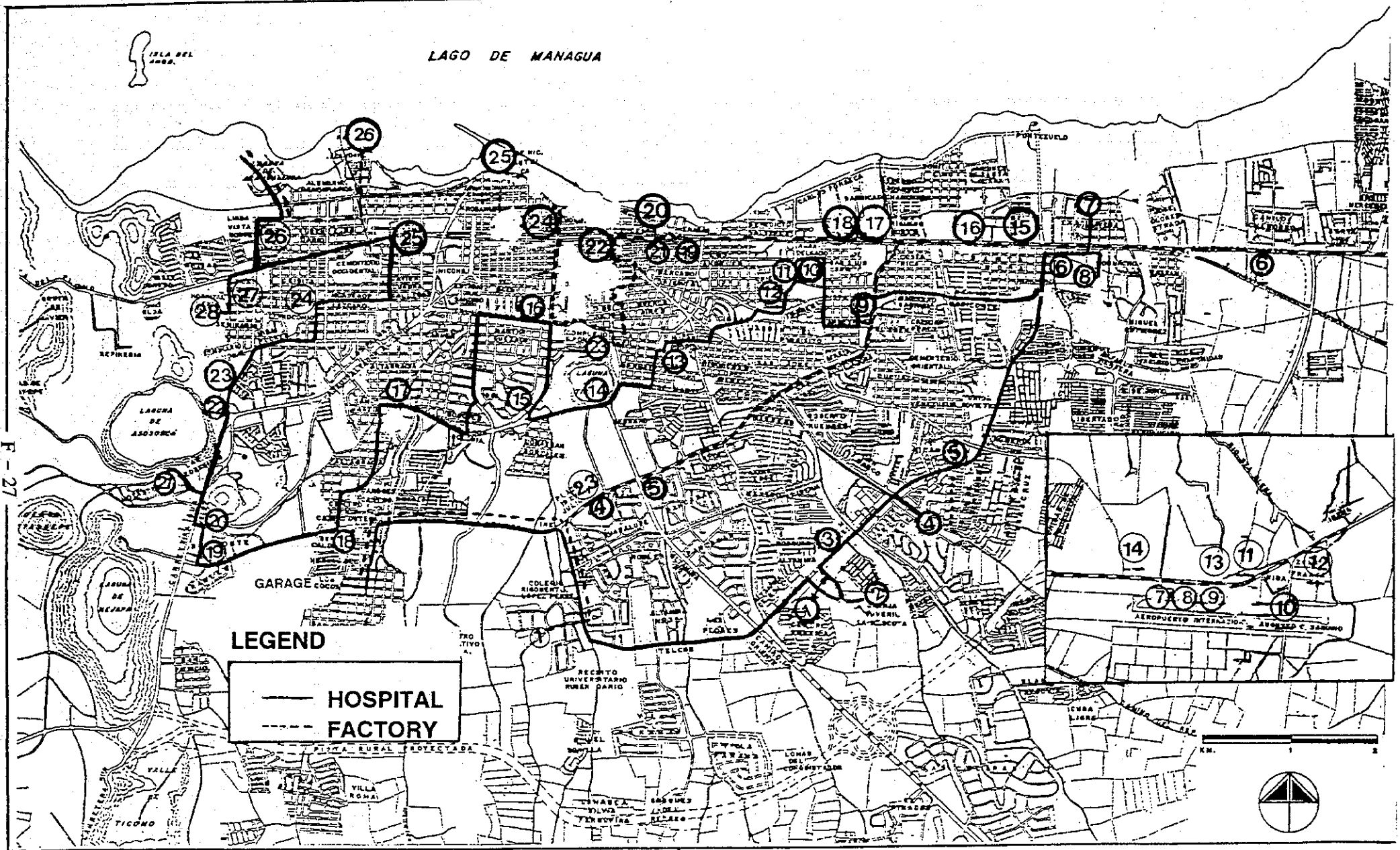
Figure F.2.2a Collection Area



THE STUDY ON THE IMPROVEMENT OF THE SOLID WASTE MANAGEMENT SYSTEM FOR THE CITY OF MANAGUA

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure F.2.2b Waste Collection Route (Commercial Areas, Markets and Offices)



THE STUDY ON THE IMPROVEMENT OF THE SOLID WASTE MANAGEMENT SYSTEM FOR THE CITY OF MANAGUA

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure F.2.2c Waste Collection Routes for Hospital and Factories

Table F.2.2d Collection Points in Commercial Areas, Markets and Offices

No.	Collection Point	Type of Waste	Number of Container	Collection Date					
				Mon	Tue	Wed	Thu	Fri	Sat
0	Plantel Los Cocos								
1	Mercado San Judas	M	4	*	*	*	*	*	*
2	Casa Comercial Julio Martínez	C	1		*		*		*
3	Puesto "Venta de Mariscos"	C	1	*	*	*	*	*	*
4	Supermercado Plaza España	S	3	*	*	*	*	*	*
5	Embajada del Japón	O	2	*	*	*	*	*	*
6	Residencia Dr. Gustavo Tablada	OT	1		*		*		*
7	Hotel Intercontinental	O	8	*	*	*	*	*	*
8	Estación de Policía "El Chipote"	OT	1		*		*		*
9	Ministerio de Agricultura	O	1		*		*		*
10	Almacenes Internacionales	C	1		*		*		*
11	Residencia del Vice-Alcalde	OT	1		*		*		*
12	Estación de Policía "Plaza el Sol"	OT	1		*		*		*
13	Mercado Periférico	M	2		*		*		*
14	Colegio 10 de Junio	OT	1		*		*		*
15	Supermercado Col.Centroamérica	S	4		*		*		*
16	Kodak, Centroamérica	O	2		*		*		*
17	Colegio Teresiano	OT	2		*		*		*
18	Banco de América Central "Interbank"	O	1		*		*		*
19	Lotería Nacional y CEFORSE	O	3		*		*		*
20	Laboratorio Bengochea	O	BARRILES		*		*		*
21	Cinemas 1 y 2	OT	1		*		*		*
22	Ministerio de Economía	O	1		*		*		*
23	Complejo Centro Cívico	O	8	*	*	*	*	*	*
24	Zumen	C	1	*	*	*	*	*	*
25	Industria NESTLE	O	1		*		*		*
26	Ministerio de Migración y Extranjería	O	BARRILES		*		*		*
27	Banco Central de Nicaragua	0	4		*		*		*
28	Residencia del Alcalde	OT	1		*		*		*
29	Centro de Rehab.Rolando Carazo	OT	1		*		*		*
30	Industria DELMOR	O	3	*	*	*	*	*	*
31	Residencia "Oscar Moreira"	OT	1		*		*		*
32	Restaurante César	OT	1		*		*		*
33	Residencia U.S.A	OT	4		*		*		*

No.	Collection Point	Type of Waste	Number of Container	Collection Date					
				Mon	Thu	Wed	Thu	Fri	Sat
34	Ferretería Lang	O	1		*		*		*
35	Merc.Occ. "Virgen de Candelaria"	M	2	*	*	*	*	*	*
36	Multitienda	C	1		*		*		*
37	Mercado Central	M	2	*	*	*	*	*	*
38	Embajada de Alemania	O	1	*		*		*	
39	Supermercado El Redentor	S	3	*		*		*	
40	Ministerio de Cooperación Externa	O	1	*		*		*	
41	Laboratorio de Inmine	O	1	*		*		*	
42	Supermercado Ciudad Jardín	S	2	*		*		*	
43	Dpto. de Patrulla "Ajax Delgado"	OT	2	*		*		*	
44	Iglesia Católica Chistian Pérez	OT	1	*		*		*	
45	Centro Comercial Bello Horizonte	C	2	*		*		*	
46	Supermercado de Bello Horizonte	S	4	*		*		*	
47	CDI Mildred Abaunza (Mcdo. San Miguel)	OT	1	*		*		*	
48	Iglesia de Dios Pentecostés Mi Redentor	OT	BARRILES	*		*		*	
49	Supermercado Colonia Rubenia	S	3	*		*		*	
50	CDI Claudia Chamorro (Mercado Central)	OT	1	*		*		*	
51	Distrito V "ALMA"	O	1	*		*		*	
52	Estación de Policía de Tránsito	OT	1	*		*		*	
53	Centro de Salud Pedro Altamirano	OT	1	*		*		*	
54	Plantel INAA	OT	2	*		*		*	
55	Oficinas INAA	O	3	*		*		*	
56	Colegio Lumen Chisti	OT	1	*		*		*	
57	Estación de Policía No.2	OT	1	*		*		*	
58	Supermercado Linda Vista	S	4	*		*		*	

Note: M:Market
S:Supermarket
C:Commercial Area
O:Office
OT:Others

Table F.2.2e Collection Points for Hospital Wastes

No.	Collection Point	Number of Container
1	Estación de Policía No.5	1
2	Centro de Rehabilitación "Hogar Zacarías Guerra"	3
3	Hospital Monolo Morales	5
4	Hospital Manuel de Jesus Rivera (Hosp. del Niño)	4
5	Sucursal INE Colonia Nicarao	1
6	Sucursal de INAA Km 5 1/2 carretera norte	2
7	Centro de Salud Silvia Ferrufino	2
8	Hospital Carlos Marx	7
9	Centro de Salud Roberto Clemente	1
10	Centro de Salud Francisco Buitrago	1
11	Policlínica Oriental	1
12	INSSBI Oficina Central	3
13	Hospital Bautista	4
14	Hospital Dávila Bolaños	2
15	Empresa Madura (Frente a Policlínica Nicaraguense)	1
16	Policlínica Central	1
17	Centro de Salud Altagracia	1
18	Hospital Bertha Calderón	5
19	Centro Nacional de Sangre (Cruz Roja)	1
20	Hospital Fernando Velez Paiz	5
21	Hospital Carlos Roberto Huembes	3
22	Hospital Psiquiatrico	2
23	Hospital de Rehabilitación Aldo Chavarría	2
24	Hospital Dermatológico Francisco Soto	2
25	Centro de Salud Sócrates Flores	1
26	Centro de Salud Francisco Morazán	1
27	INIFOM	1
28	Hospital Antonio Lenin Fonseca	3

Table F.2.2f Collection Points for Factory Wastes

No.	Collection Point	Number of Container
0	Plantel Los Cocos	
1	Colegio Americano Nicaraguense	2
2 & 3	Centro de Diversiones la Piñata y El Carnaval	2
4	Universidad Centroamericana	4
5	Metrocentro	2
6	Supermercado Cance	1
7	FASDAD	2
8	Club Recreativo FAS-DAD	1
9	Aduana-Aeropuerto Sandino	2
10	Universidad Nacional Agraria	2
11	Escuela de Agricultura	1
12	Centro Industrial Zona Franca	5
13	Hotel Las Mercedes	4
14	Hotel Camino Real	4
15	Industria Nabisco Cristal	8
16	Industria Lactea La Perfecta	10
17	Instituto Técnico Textil	1
18	Supermercado Ajax Delgado	1
19	Compañía Cervecera Victoria	Barriles
20	Museo Nacional	1
21	Instituto Loyola	1
22	Petronic	2
23	Ministerio de Gobernación	2
24	Colegio San Sebastián	1
25	Plantel Central	1
26	Plantel Calle Revestidos	1

c. Service Coverage

The service coverage of each generation source is shown in Table F.2.2g.

Table F.2.2g Amount of Waste in Each Generation Source for Collection

(Unit = ton/day)

Generation Source		Service Coverage
Residential Areas		77.0% (642,100 persons)
Commercial Areas	Restaurants	100% (1,838 shops)
	Other shops	100% (393 shops)
Markets		100% (6,374 shops)
Institutions		100% (38,029 employees)
Hospitals		100% (2,175 beds)
Roads		47% (331.0)
Parks and Green Areas		19% (16.7 ha)

d. Collection Level

da. Collection System

Two collection systems are applied in the residential areas. The curb collection system for collection area A where road condition is good and the illegal dumping site collection system (alley collection system without container) for collection area B where road condition is poor and the electric power services is not provided. In the curb collection system, a waste discharge container is placed at the roadside for collection.

In addition to these systems, the container collection system is used for the collection of wastes generated by shops in commercial areas, markets, offices and hospitals.

The street sweeping waste heaped to the small dumping sites existing in the urban area is collected using a wheel loader.

db. Collection Frequency

Collection is conducted three times a week in most of the residential areas, commercial areas and offices. On the other hand, wastes from hospitals and

markets are collected six times a week, except on Sundays.

dc. Collection Fee

The present waste collection fee system is presented in Section F.3, Institutional System. This section summarizes the waste collection fee system.

The table below shows the bases for the charging of waste collection fees.

Table F.2.2h Solid Waste Collection Fee and Container Rental Fee

(Unit: C$/month)

Type of Unit	C$ per Unit
Households in Settlements and Progressive Areas	0.50/frontal length in meters
Households in Poor Sections and Urbanized Areas	1.00/frontal length in meters
Household in Popular Settlements (consolidated)	0.75/frontal length in meters
Residential "B" (Average standard) household	2.00/frontal length in meters
Residential "A" (Good standard) household	3.00/frontal length in meters
Business Establishments	75.00 to 75,000.00
Public buildings	150.00
Selected industries	2,000.00
Container rental, (per container) 1 - 5 containers 6 - 10 containers	500 or 400 500/container 400/container

In 1993, Managua Municipality collected C$ 4,800,00 (US$ 800,000), only about 20% of the amount previously collected.

According to the results of POS, the collection fee paid by residences and shops are as follows:

High income	: C$ 65.4
Middle income	: C$ 14.0
Low income	: C$ 7.3
Weighted average	: C$ 11.8
Restaurants	: C$ 97.2
Other shops	: C$ 107.7
Average	: C$ 101.8

dd. Collection Work

dda. Crew

A collection team is made up of 4 crew members, namely a driver and 3 collectors: one stays on the truck for loading, while the other two workers collect the waste.

ddb. Working Time

Collection starts around 6 o'clock from the garbage collection point and lasts for basically 6 hours.

ddc. Working Activity

The work of the collection team is outlined below as observed by the Time & Motion Survey:

- Brief checking and cleaning of vehicle:
  The driver and collectors briefly check and clean the vehicle prior to commencing collection work.

- Daily working record
  The drivers record the daily work on the sheet shown in Figure F.2.2d.

- Working activity
  Two of the assistants collect the waste discharged from houses at both sides of the road and give it to the other assistant standing at the back of the vehicle so it can be loaded into the vehicle. The containers or nylon sacks emptied with waste are returned to the residents. The emptying of containers, especially nylon sacks, is most difficult for assistants since they have to deal with various household waste.

  Recycling activities, by separating bottles, cans, etc., and putting them in sacks hanging at the rear of the vehicle, are simultaneously carried out in a smooth and efficient way, thereby not causing any disturbance in the regular collection work.

- Filling up and washing

  After collection work, the vehicle is filled with fuel and washed.

Figure F.2.2d

HOJA RUTA
ALCALDIA DE MANAGUA
Dirección General Obras Municipales

Organismo_____ Telf.:_____

Dirección_____ Ciudad:_____

ESPECIFICACION

Vehículo_____ Tipo_____ Color_____ Código_____

Placa_____ Año_____ Marca_____ Cap. Ton._____

CONTROL - SALIDA

Lugar de Salida_____ Día_____ Hora_____

Conductor_____

Misión, Destino_____

Carga que Transporta_____

Personas que Viajan_____

Ruta a Seguir_____

Nombre Resp._____ Firma_____

CONTROL - REGRESO

Lugar de Salida_____ Día_____ Hora_____

Conductor_____

Misión, Destino_____

Carga que Transporta_____

Personas que Viajan_____

Ruta a Seguir_____

Nombre Resp._____ Firma_____

HORA		ORIGEN	DESTINO	OBJETO DEL VIAJE	SOLICITANTE
SALIDA	ENTRADA				

e. Haulage and Transfer System

Collected wastes are directly hauled to the disposal site due to the absence of a transfer system. Haulage trips for residential and commercial areas are usually made twice a day.

According to the results of the Time & Motion Study, the distance consumed by the haulage trips, including trips from the collection area, from the garage to collection area and from dump site to garage, is observed as follows;

	Average Distance (Km)		
	Collection Area	Other trips	Total
Residential Area (Curb Collection)	23.2	39.9	63.1
Commercial Area (Container Collection)	46.7	25.1	71.8

F.2.3 Street Sweeping

a. Organization

aa. Organization

The street sweeping services are carried out by the District offices, which are subordinate to the District Coordination Office (DCO).

Organization chart of District Office is shown in Figure F.2.3a.

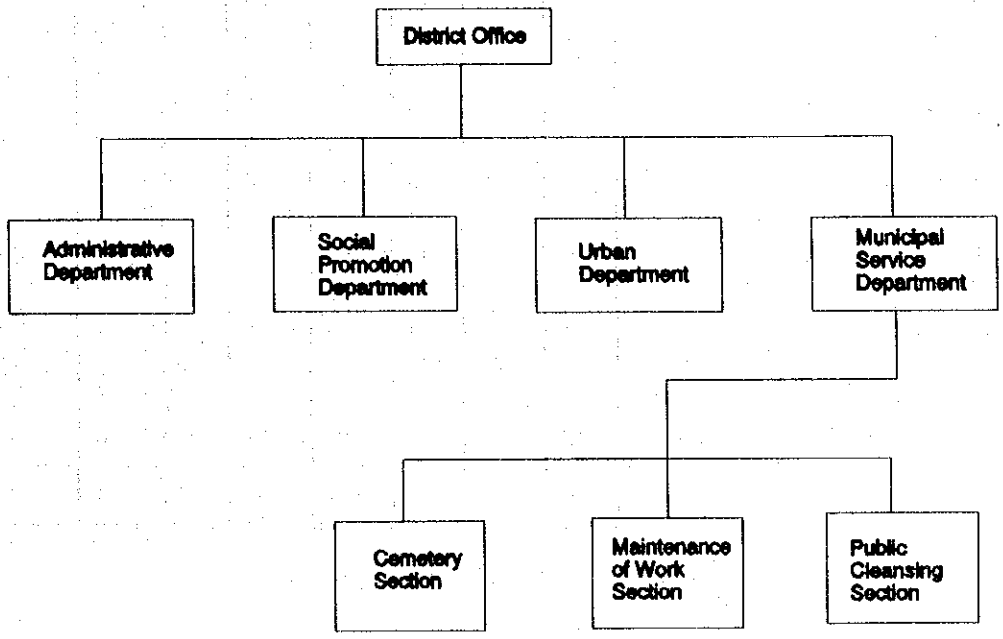


Figure F.2.3a District Office Organization Chart

Public Cleansing Section is responsible for the following cleansing works:

- Street sweeping
- Drain cleansing
- Grass cutting
- Sidewalk cleansing
- Small dumping sites cleansing
- Channel cleansing

ab. Personnel

The number of personnel in each District Office is shown in Table F.2.3a. The employees of the public cleansing section total 333 and the total number of street sweepers is 175.

Table F.2.3a District Offices Personnel

	D1	D2	D3	D4	D5	D6	D7	Total
Representatives	5	6	5	4	5	5	4	34
Administrative Department	20	30	13	12	30	21	10	136
Social Promotion Department	5	6	4	3	3	7	2	30
Urban Department	6	8	15	7	8	17	1	62
Municipal Service Department	34	80	53	99	57	80	8	411
Directory etc.	3	3	3	3	3	3	2	19
Cemetery Section	6	26	0	12	0	0	0	44
Maintenance of Work Section	6	4	1	2	1	0	1	15
Public Cleansing Section	19	47	49	82	53	77	6	333
Coordinator	1	1	1	1	1	1	0	6
Supervisor for Street Sweeping	1	4	4	6	5	4	1	25
Sweeper	5	28	32	48	15	42	5	175
Supervisor for Other Cleansing Works	5	1	0	15	8	1	0	27
Worker for Other Cleansing Works	10	13	12	12	24	29	0	100
Total	70	130	90	125	103	130	25	673

* The drivers belong to the Administrative Department.

Source : District Offices

b. Street Sweeping Cost

The expenditures of the district offices are tabulated in Table F.2.3b. The street sweeping cost was estimated as follows:

- Total expenditure of January to May, 1994 is converted into yearly expenditure.

  6,095 thousand / 5 x 12 = 14,628 thousand Cordobas

- Average yearly expenditure for three years:

  (15,059 + 17,041 + 14,628) / 3 = 15,576 thousand Cordobas

- The expenditure for street sweeping is estimated according to the number of personnel in charge of street sweeping services.

  15,576 thousand x 206/673 = 4,768 thousand Cordobas (US$ 734 thousand)/ year

- Street sweeping cost per kilometer:

  4,768 thousand / 279 = 17,090
  say 17,000 Cordobas (US$ 2,615)/km/year

- Street sweeping cost per waste:

  4,768 thousand / (16.3 x 365) = 801
  say 800 Cordobas (US$ 123)/ton/day

Exchange rate: 6.5 Cordobas = US$ 1

Table F.2.3b Expenditure of District Offices

(Unit: C$x1000)

Year	District	Personnel Services (Salary)	Non-Personnel Services	Materials and Supplies	Capital Expenditure	Contract Expenditure	Current Transfers	Total
1992	D1	1,114	191	295	12	6	95	1,713
	D2	1,707	249	227	52	337	140	2,712
	D3	1,405	129	252	89	184	118	2,177
	D4	1,896	183	326	38	227	159	2,829
	D5	1,542	152	290	46	210	146	2,386
	D6	1,415	203	222	109	210	138	2,297
	D7	388	125	214	25	112	81	945
	Total	9,467.00	1,232.00	1,826.00	371	1,286	877	15,059
1993	D1	1,253	126	193	21	87	46	1,726
	D2	1,931	167	222	88	209	144	2,761
	D3	1,450	225	287	95	171	98	2,326
	D4	2,093	154	191	338	165	111	3,052
	D5	1,899	225	228	591	217	73	3,233
	D6	1,781	207	254	58	237	115	2,652
	D7	524	74	113	513	29	38	1,291
	Total	10,931.00	1,178.00	1,488.00	1,704	1,115	625	17,041
1994	D1	517	22	86	13	3	1	642
	D2	742	46	73	0	16	32	909
	D3	593	57	166	7	88	41	952
	D4	819	39	135	50	17	29	1,089
	D5	738	51	176	23	38	39	1,065
	D6	634	80	137	5	82	27	965
	D7	227	17	79	15	130	5	437
	Total	4,270.00	312.00	852	113	374	174	6,095

* Expenditure for 1994 is based on data from Jan to May, for five months

Source: ALMA

c. Streets and illegal Dumping Sites

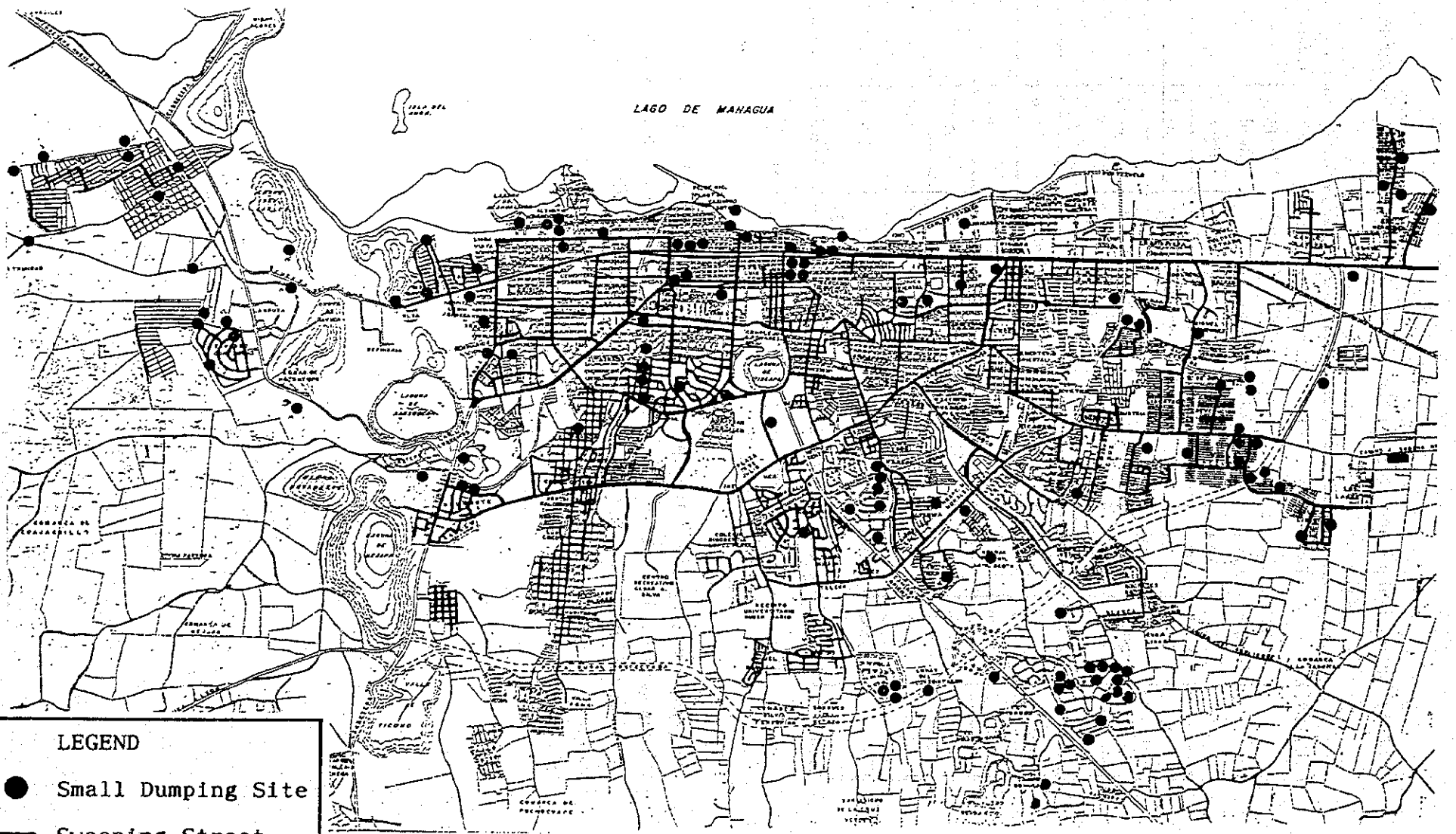
The length and ratio of the street covered by the street sweeping service are shown in Table F.2.3c. The total length of the streets covered by the service is 279 km which is equivalent to 39% of the total length of paved roads (708 km). Fig. F.2.3b shows further details on streets covered by the sweeping service.

Table F.2.3c Length and Ratio of the Roads Covered by Street Sweeping Service

District	Paved Road			Unpaved Road (km)	Total (km)	(2) Sweeping Road (km)	Ratio (2/1) (%)
	Asphalt (km)	Stone (km)	(1) Sub-total (km)				
D1	20.32	2.64	22.96	75.29	98.25	9.77	43
D2	110.46	26.43	136.89	42.00	178.89	40.53	30
D3	76.56	54.92	131.48	84.85	216.33	77.52	59
D4	134.07	65.24	199.31	64.99	264.30	62.50	31
D5	88.56	43.50	132.06	46.26	178.32	30.42	23
D6	61.54	15.75	77.29	81.72	159.01	55.60	72
D7	8.35	-	8.35	9.06	17.41	3.00	36
Total	499.86	208.48	708.34	404.17	1,11-2.51	279.34	39

Source: District Coordination Office and Planning Head Office (ALMA)

The street sweeping waste is disposed to the registered illegal dumping sites existing in the city of DCC or DCO. The number of registered small dumping sites are shown in Table F.2.3d. The 235 illegal dumping sites are registered under DCC and 108 under DCO. The location of the illegal dumping sites registered under DCC is shown in Figure F.2.3b.



THE STUDY ON THE IMPROVEMENT OF THE SOLID WASTE MANAGEMENT SYSTEM FOR THE CITY OF MANAGUA

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure F.2.3b The Location of Sweeping Streets and Small Dumping Sites

Table F.2.3d Number of Registered Illegal Dumping Sites

	D1	D2	D3	D4	D5	D6	D7	Total
Illegal dumping sites registered under DCC	16	22	15	17	30	26	0	127
Illegal dumping sites registered under DCO	0	7	30	21	16	28	6	108
Total	16	30	45	38	46	54	6	235

Source: Department of Collection and Cleansing, District Offices

d. Service Level

The working hours of major district offices for cleansing service is six, from 6:30 – 12:30. The following are the main equipment used by sweepers:

- wooden handcarts (0.2 m^3)
- plastic fiber brushes
- plastic fiber brooms
- shovels

Above mentioned equipment are stored in the district office or shed installed in the park. The storage places are shown in Table F.2.3e.

Table F.2.3e Storage Place of Equipment

District	Number of Place	Storage
D1	1	district office
D2	4	parks, district office
D3	4	parks
D4	5	parks, district office, public washing place, cemetery, community area
D5	5	parks, community area
D6	-	house of a sweeper
D7	1	district office

Source: district offices

The supervisors are responsible for the sweepers and equipment. They check the attendance of sweepers and the equipment every morning at each equipment storage place. The sweepers clean approximately 1.2 – 1.4 km of streets per day. The service frequency of each street is normally thrice or twice a week. The waste from sweeping is heaped on the illegal dumping sites or dumped on the road-sides.

These waste are then collected by the Department of Collection and Cleansing or the District Offices.

e. Equipment and Maintenance

The type and number of equipment managed by the District Offices are shown in Table F.2.3f.

Maintenance services such as oil exchange, greasing and washing are carried out every three months in the Central Workshop. On the other hand, District Offices are afforded with a budget that enables them to have private shops nearby attend to small repairs.

Table F.2.3f Type and Number of Equipment

Type of Equipments	District							Total
	1	2	3	4	5	6	7	
Dump Truck (7 m^3)	2	2	2	2	2	2	1	13
Flat Truck (6 m^3)	2	1	2	2	1	1	1	10
Motorcycle	1	1	1	1	1	2	1	8
Wheel Loader	1	1	1	1	1	1	0	6
Reaping Machine	2	0	0	0	0	0	0	2
Concrete Mixer	2	0	0	0	0	0	0	2
Tractor	0	0	0	0	0	0	1	1

Source: District Offices

F.2.4 Intermediate Treatment

a. Recycling System

aa. Background

Recycling will be a fundamental part of any integrated waste management plan. Recycling alone cannot solve the community's municipal solid waste management problem, but it can divert a significant portion of waste stream from being disposed in the landfill.

Municipal solid waste contains inherent values. Recycling provides an opportunity to recover some of these values, and may save material, money and environmental

degradation. In the process it may also reduce dependence on foreign imports, create employment and establish small scale enterprises.

ab. Present Recycling System

aba. Bottle

The level that involves direct reuse of bottles without changing its basic form and function is considered high. Standardization of bottles such as the ones used in soft drinks and beer factories has facilitated this level of reuse. Also the deposit for each bottle is high, inciting consumers to return them.

There are no glass factories in the country and demand is high; importation is expensive and recycling is helping job development and less pressure on foreign exchange. Moreover, various bottles without deposit are also being reused as containers of local products such as honey, tomato sauce, mustard and so on.

abb. Paper and Cardboard

The significant characteristic of the recycling of papers and cartons is the absence of intermediaries. Scavengers at the landfill site sort these materials in small quantities and sell it in exchange for domestic requirements.

Paper factories and related enterprises buy the material directly from the sources, offices and shops, before it is contaminated and degraded.

abc. Iron

The majority of recycled iron is exported to some countries in central america and the United States. Two recycling intermediaries located in the road to the Augusto César Sandino Airport claim to export 60 tons and 68 tons of material a month, respectively. Another intermediary, located in Acahualinca sector, claims it exports 150 tons of mixed materials in one month.

abd. Aluminum

The recycling of solid aluminum is quite famous because it can be sold for a good price. Aluminum cans are also sorted and sold by 0.77 cordobas a kilogram (approximately 55 cans in one kilogram).

There are no aluminum recycling factories in Nicaragua, therefore this material is sent abroad as a raw material for a new product.

b. Waste Amount Recycled

The waste amount recycled in the study area is estimated at 13 tons a day, according to survey results. This quantity is considered to be approximate, considering that the information was obtained through a survey with people not willing to cooperate.

c. Recent Trends in Recycling Activities

Although it is not a new technique, recycling is becoming increasingly important in municipal solid waste management, as communities, businesses, and industries battle against the rising economic costs and are beginning to consider the environmental impacts of waste disposal.

The number of scavengers is increasing rapidly due to a high rate of population growth in the country. These people live in poverty, with very low income, are highly illiterate and without job opportunities. They have therefore adopted scavenging as their way of living.

Many people are becoming interested in the potential benefits of recycling and how to achieve more sustainable economies for the city and the country.

d. Present Recycling System

The present recycling system is beneficial to the people as it compensates them for their time and effort.

The present socio-economic situation of Nicaragua encourages people to look for ways of living, and recycling is actually one of the options. Formulation of the Master Plan shall consider some of the different recycling options available. Meanwhile, the recycling program development will require strategic planning. When properly implemented, a recycling program can become a popular municipal waste management activity among citizens.

In many communities recycling represents a new waste management option that is unfamiliar to many people, however, it can be a popular activity.

The Municipality of Managua should tap into the desire of citizens and businesses to "do the right thing", should design programs that would facilitate recycling, and then aggressively promote plans and programs to all members of the community.

Public participation in recycling will be one of the most important factors that would determine the program's success.

e. Compost

ea. Purpose of Composting

Composting is a municipal waste management alternative as a way to divert significant amounts of organic wastes away from rapidly filling landfills. The wastes of Managua are ideal for conversion to organic fertilizer because of the high vegetable-putrescible content.

A successful composting should consider not only the suitability of the wastes, but also the net disposal cost which can be sustained by the local authority.

eb. Pilot Plan at Acahualinca

The following information was obtained from a Municipal source:

- The Solid Waste Management Plan for Managua, initiated in April 1993 in cooperation with the City of Amsterdam, is currently carrying out a Compost Pilot Project in the Acahualinca landfill site.

- For the operation of the project, an area of 0.7 ha was chosen to achieve production. The solid waste utilized comes from the Oriental market considered the best for the production output.

- The technology used involves forming windrows 1.5m high and 15 to 20 m long, constructed by layering raw materials.

- Windrows are turned periodically (every three weeks) to expose more of the material to the air. The material is usually suitable for use as a compost after three and a half months.

- At the beginning of the process, the windrows are formed without separation just as the wastes come from the source.

- As windrows are turned every three weeks, the large materials and those not subject to decomposition are sorted out.

- Moisture is produced only during the dry season. Actually, temperature is not

controlled because the thermometer is broken. PH is measured only when necessary.

ec. Amount of Waste utilized and Production of Compost

The project was carried out for the treatment of approximately 20 m^3 of solid waste a day. The waste amount normally treated is about 30 m^3 a day. However since the material sorted out is spread on the area waiting to be collected, hauled and disposed in the landfill, there is not enough space for daily treatment.

The amount of compost produced from 30 m^3 of waste from the Oriental market is 55 sacks, each one weighing approximately 35 kg. In normal conditions, a production of 66 sacks a week can be expected. The Municipality uses compost in landscaping works.

The salaries of the people engaged in the operation of the project are:

3 laborers C$ 1,679.39/month	C$ 60,458.04/year (every 3 months) (Contract Basis Worker)
1 supervisor C$ 1,679.39/month	C$ 20,152.68/year (Municipality officer)
Total	C$ 80,610.72/year

ed. Compost Quality

Laboratory analysis performed in Holland shows that heavy metals such as chrome, nickel, zinc, arsenic, cadmium, mercury and lead appear in quantities below the minimum permissible value; only copper was a bit high. Hazardous substances, carbon–hydrogen, can not be detected in small quantities.

The content of the materials and fertilizing element are as follows:

Organic material	12.5% (g/100 gr)
PH	7.7
Calcium Carbonate	3.9% (g/100 gr)
Phosphate	172 (mg/100 gr)
Potassium	705 (mg/100 gr)
Nitrogen	50 (mg/100 gr)
Moisture	20%
Dry weight	80%

An expert in Holland reported, as a final recommendation, that compost has high nutrient contents, such as Phosphorous, Potassium and Nitrogen, suitable for improvement of soils. However, phosphate and nitrogen are not sufficient to attain the minimum values of EC, Austria and Japan.

ee. Future Composting Plans by the Municipality of Managua

The Municipality of Managua plans to support the composting pilot project to the end. Monitoring and evaluation of the performance of the project will help determine whether the objectives are being met as far as production is concerned. A marketing survey will be conducted to determine the potential market of compost and the probable income that may be derived from it.

F.2.5 Final Disposal

a. Location of Final Disposal Site

The present final disposal site of the city of Managua is called "Acahualinca Disposal Site", and is located in the northwest of the city, beside Managua lake.

b. Operation of the Disposal Site

About 450 tons of waste is finally disposed per day to the Acahualinca disposal site. The area for dumping is daily indicated to the drivers of the collection vehicles by the supervisor of the municipality.

c. Others

Waste covering with soil is not done in spite of the availability of soil within the site. Leachate is assumed to permeate the ground vertically that is why it is not detected around the area.

The details concerning the Acahualinca disposal site is outlined in Table F.2.5a.

Table F.2.5a Acahualinca Final Disposal Site

Items	Description
1.Owner of land	Managua Municipality
2.Distance from Main Generation source	approx. 10 km
3.Service Area	Urbanized Area of the Municipality
4.Subject Waste	Residential,Industrial & Market Waste
5.Disposal Amount	Approx. 2,000m^3/day (not compacted)
6.Landfill Area	Approx. 40ha.
7.Year of Commencement	1975
8.Former Land Use	Cultivation of Vegetable & Fishing
9.Operating	12 hr/day
10.Method of Landfill	Semi-controlled tipping
11.Number of Landfill Equipment	Bulldozer: 2 units Landfill Compactor: 4 units Water Tank Truck: 2 units
12.Annual Landfill Expenditure	332,000 C$/year
13.Number of Scavengers	Approx. 250 persons
14.Responsible Organization	Municipality
15.Number of Staff	20 persons

F.3 Institutional System

F.3.1 Public Education System

a. Municipal Level

The Municipality of Managua has an Environmental Protection Head Office subordinated to the Mayor's Office, which is responsible for the protection of the environment by the development of surveys and enforcement of guidelines, pollution control and the rational use of natural resources. It also coordinates with the Head Offices of the municipal system.

The Environmental Regulation Head Office has a Department of Environmental Education. This department prepares an annual program which due to budget constraints cannot be implemented. They visit households and also community groups to plan seasonal clean-up campaigns as a method to encourage the residents to clean their yards and storage spaces of litter and accumulated junk. They also distribute leaflets among the residents with information such as the proper methods of storage and in site disposal of solid waste.

b. The Ministry of Education

Public health education related to solid waste management is not included in the national curriculum of compulsory education. The Department of Secondary Education was part of a team in the preparation of an Environmental Education Manual supported by UNESCO for the Central American region. Included in this manual are various educational activities regarding subjects such as:

- How to avoid pollution caused by solid waste
- Open fight against waste (game)
- Environmental Education for community leaders and members of popular organizations.

This project was prepared about two years ago, and has not yet been implemented.

c. Ministry of Health

The Ministry of Health does not have a specific public health program related to solid waste management. Even though it systematically diffuses public health education through the media, volunteers and the Integral Systems of Attention of the Health (SILAIS), to inform the public of the adverse effects of improper solid waste management, i.e., breeding of vermin and spreading of diseases.

Recently, a protocol on environmental health stipulating the need for the Ministry and the national police to cooperate was passed. Through this agreement the members of the national police will be trained and accredited as sanitary inspectors.

d. Ministry of Environment and Natural Resources

The Ministry of Environment and Natural Resources (MARENA) does not have a specific educational program for solid waste management. There is an Environmental Education and Training Head Office in charge of education programs related to the environment, which also includes solid waste management.

As a result of several meetings and seminars involving institutions and organizations related with environmental issues, the National Commission for the Environmental Education to develop and implement national polices on education was established by Presidential decree on June 4th, 1994. This commission is made up of MARENA, the Ministry of Health (MINSA), Municipal Development Institute (INIFOM), non-governmental organizations related with environmental issues and the chairman of the Environmental Commission of the national Congress.

The municipalities were authorized to form their own commissions made up of local delegates from the Environment, Education and Health Departments along with one representative from the local private sector and existing environmental association.

Due to budget restriction, MARENA, has not implemented educational programs but it expects to get some financial aid through the National Commission.

Also some projects on solid waste management education are expected to be developed with the recent creation of a Solid Waste Department in MARENA.

F.3.2 Administration (National and Local Government)

Local or Municipal Administration is ruled by the National Law N° 40 –The Municipalities Law–issued by the National Assembly on the 17th of August, 1988.

This Law states that the municipalities are autonomous bodies governed by authorities elected through popular free, secret, direct elections.

From this law, the municipalities have authority over activities, such as urban development and zoning, beautification projects, public hygiene and environmental protection, waste collection, street cleansing, disposal and treatment of solid wastes, etc.,. and complementary duties on education, sanitation, housing, water supply, street lighting (maintenance only), culture and sports.

The municipality is directed by the Municipal Council, the mayor being elected among the councilors. The municipal councilors are elected for a six year term .

An important example of direct public participation are the "Cabildos Municipales" (Public Hearings). These meetings are required twice a year: one for discussing the budget proposal for the coming year and the other to demonstrate how this same budget is being managed. Cabildo meetings are also organized several times a year in places within the city with the participation of the mayor, some of his staff, and the heads of the areas affected by the cabildo session.

Although these meetings' primary concern is the municipal budget, they also give the citizens the chance to demand directly to the authorities public services such as street paving, water supply, lighting, etc..

F.3.3 Organization and Financial Situation of the Municipality

a. Organization

aa. General Organization

The municipal government of Managua is divided into four areas (see Figure F.3.3a):

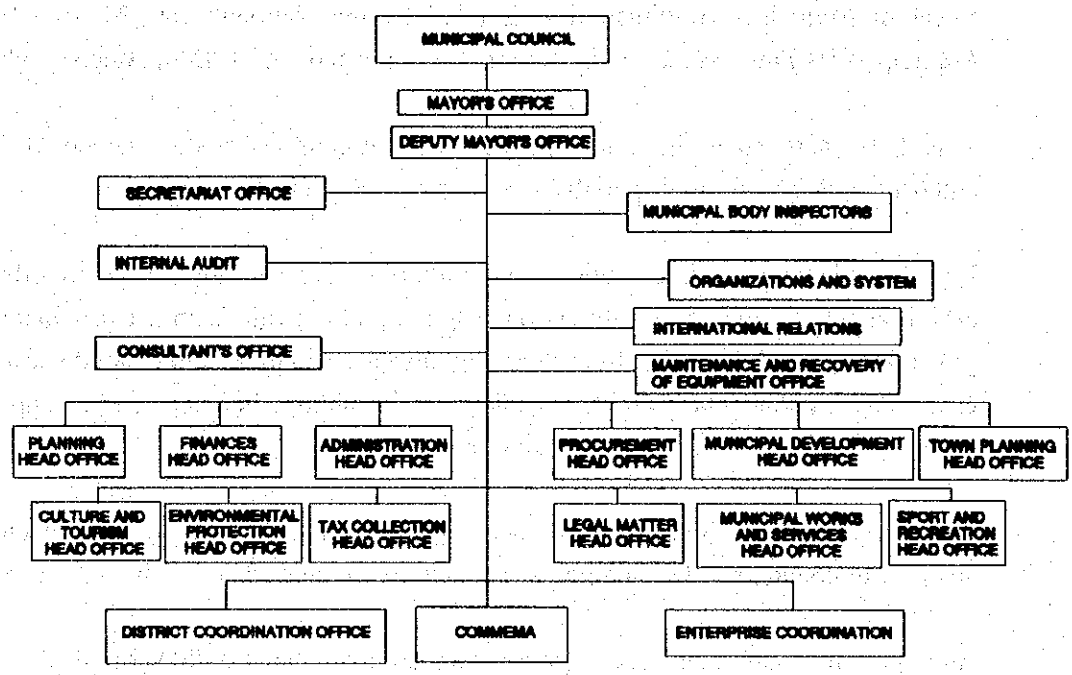


Figure F.3.3a Managua Municipality Organization Chart

aaa. Executive Offices

The Executive Offices include the Mayor and the Vice Mayor's, office their own Secretaries, the Bureaus of International Relations and Organization and Systems, the Internal Auditing Office, their Consultant's Office and the Municipal Inspectors Body.

aab. Operating Head Office

The Operating Head Offices include Culture and Tourism, Environmental Protection, Taxation and Revenues, Sports and Recreation, Municipal Works and Legal matters.

aac. Support Head Office

The Support Head Offices include Planning, Finance, Administration, Procurement, Municipal Development and Town Planning.

aad. Territorial Administration

The Territorial Administration: six urban and one rural districts[1)]

There are also two organizations directly under the mayor's jurisdiction:

- the Commema (Municipal Corporation in the Markets of Managua)
- the Enterprise Coordination Office

The latter used to be an important agency during the previous government, when several municipal government agencies were organized as a corporation. Today however, these corporations have been abolished and thus the tendency of this office is to disappear.

ab. Solid Wastes Management Organization

The management of solid wastes is shared by two institutions: The Public Cleansing Office, which is under the Municipal Works and Services Head Office, and the District offices (see Figure F.3.3b and F.3.3c).

aba. Public Cleansing Organization

The organization chart of the Public Cleansing Office is as shown in Figure F.3.3d. The Public Cleansing Office is the main institution in charge of Public Cleansing Services. The Territorial Administrations are only responsible for street cleansing and the collection of debris and refuse generally found in the streets.

Source: [1)]Managua-Capital of Nicaragua; paper provided by the chairman of Coordinating Committee.

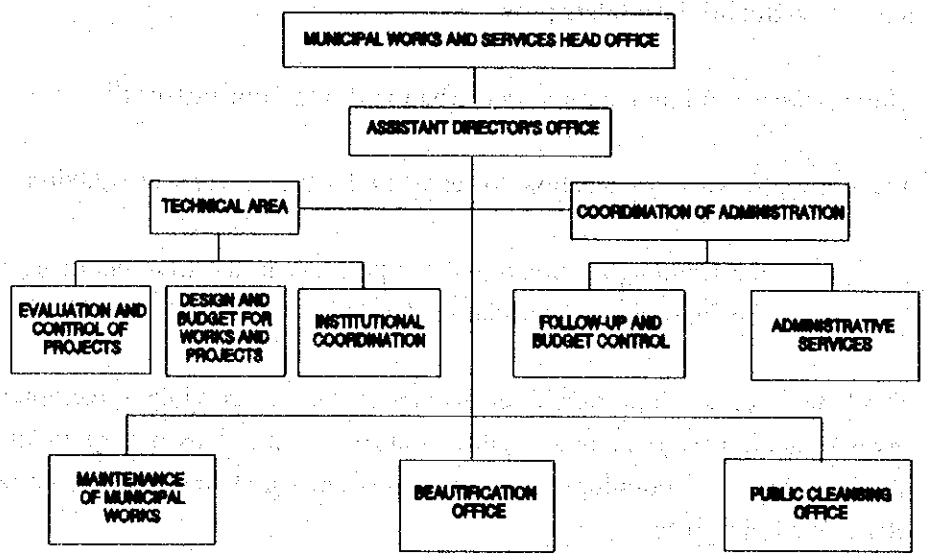


Figure F.3.3b Municipal Services Head Office Organization Chart

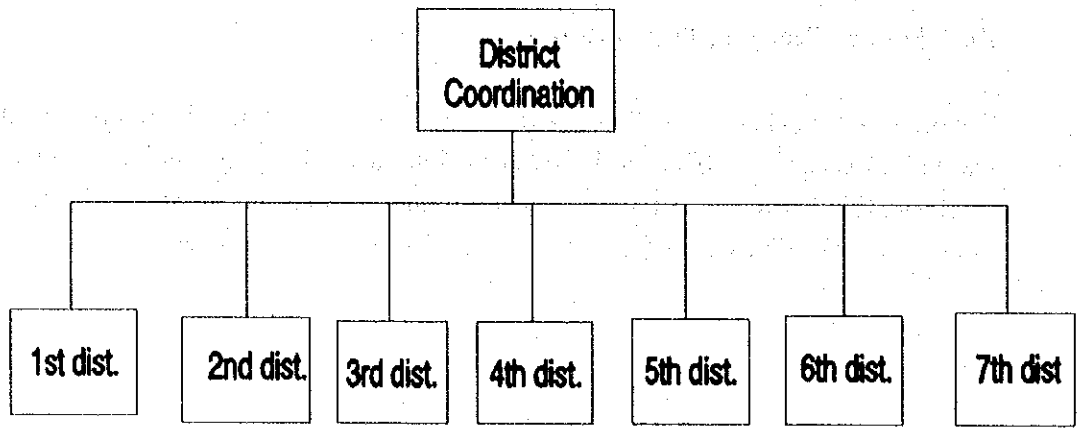


Figure F.3.3c Territorial Administration Organization Chart

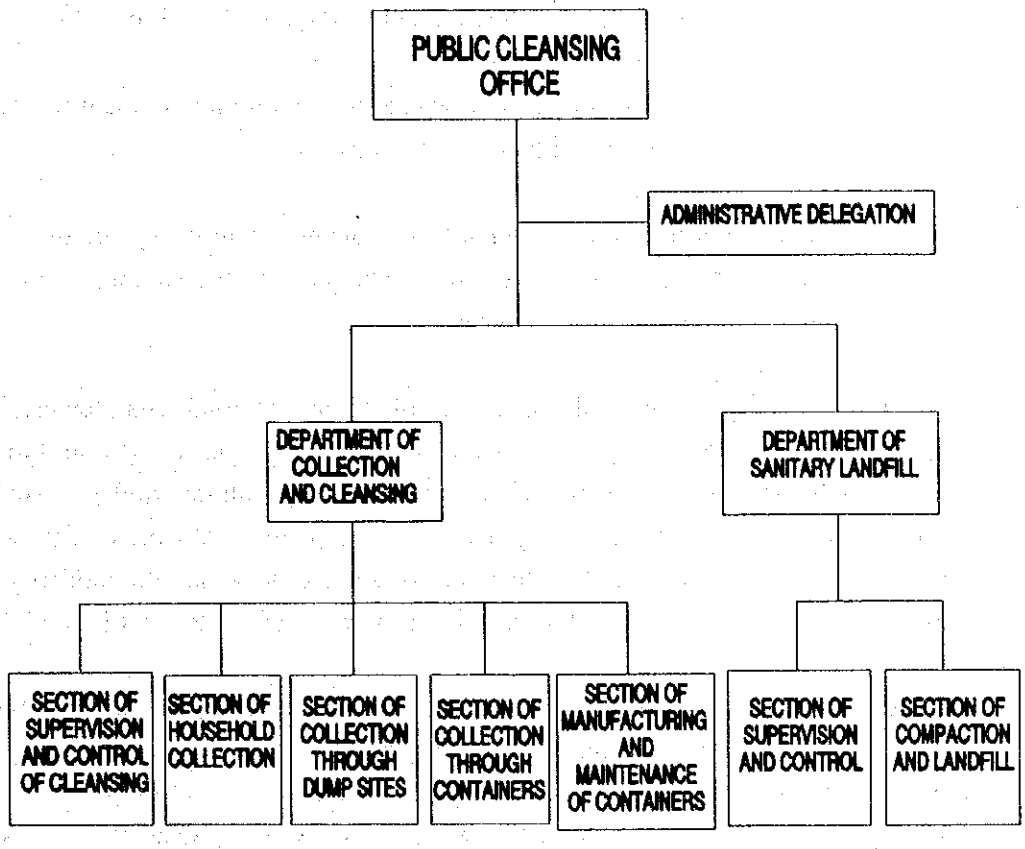


Figure F.3.3d Public Cleansing Office Organization Chart

The administrative delegation of the public cleansing office generally manages the activities of the office which are divided under two departments:

abb. Fanctions of the Department of Sanitary Landfill and Collection and Cleansing

The department of sanitary landfill is responsible for the operation and control of the Acahualinca landfill site. The department of collection and cleansing has five sections:

- supervision and cleansing control: in charge of the supervision of collection services and data collection for analysis and establishment of operational procedures
- household Collection: in charge of collection by compaction trucks (including the collection of refuse from 0.83 m^3 containers) and 4 m^3 tractor pulled carts

- collection in dump sites: in charge of collection of waste from several registered and non-registered small dump sites existing in the city

- collection through containers: in charge of removing and hauling 15 m^3 roll on-roll off containers to the landfill site

- Manufacturing and maintenance of containers: in charge of the repair of the 15m^3 as well as the 0.83m^3 containers; no containers are being manufactured at this moment.

The 6 urban districts are basically in charge of streets and roads maintenance and minor public works, as well as the issuance of construction permits (limited to one story high houses or buildings) and the promotion of cultural and recreational activities at the "barrio "level. They also help the people with their day to day needs, being consequently the first level of government to which the citizenry can appeal. The organizational structure of these districts is presented in Figure F.3.3e.

Each district has 4 departments: Administration and Finance, Social Promotion, Housing and Town Planning, and Municipal Services. These departments carry out the functions of the Municipal Works and Services Head Office and of the Town Planning Head Office at the district level. This happens because of a lack of a precise definition of the duties and responsibilities of each area of government.

ac. Solid Waste Management Staff

For the collection, transport and disposal of wastes, the Public Cleansing Office has the following staff:

- Superior staff (2)
- Administration (19)
- Technical (12)
- Services (24)
- Workers (241)

The Territorial Administration Districts has a staff of 683 people, including the direction and coordination officials; the work of these people is not only limited to street cleansing.

Organizations that contribute to solid waste management are as follows;

- The maintenance and recovery of equipment office is directly under the Mayor, and is charge of the repair and maintenance of all municipal vehicles and earth moving equipment, the majority of which are used

in solid waste management.

This Head Office has now moved the maintenance and repair works in the municipality, where the workshops, that is, Central, Los Cocos, Batahola, Acahualinca and Ornato, are located.

The new organizational chart of the Maintenance and Recovery of Equipment Head Office is presented in Figure F.3.3e. The chart states that the Central Workshop is in charge of the heavy maintenance of the municipality vehicles and equipment, while the other shops are concerned of preventive (light) maintenance. In practice, this division of tasks is not difficult to implement. The central workshop, being the best equipped, handles all the mechanical problems or body repairs not solved by the other shops, while these other shops handle the day to day greasing, washing, lubricating and fueling of vehicles and equipment, as well as changing parts, etc.. The chart also shows an Administration of Equipment Recovery in this Office. This administration, however, is inaptly named as it functions differently. Organized with three departments, allotment, evaluation and control, reception and dispatch, the administration is basically involved in operation and control activities.

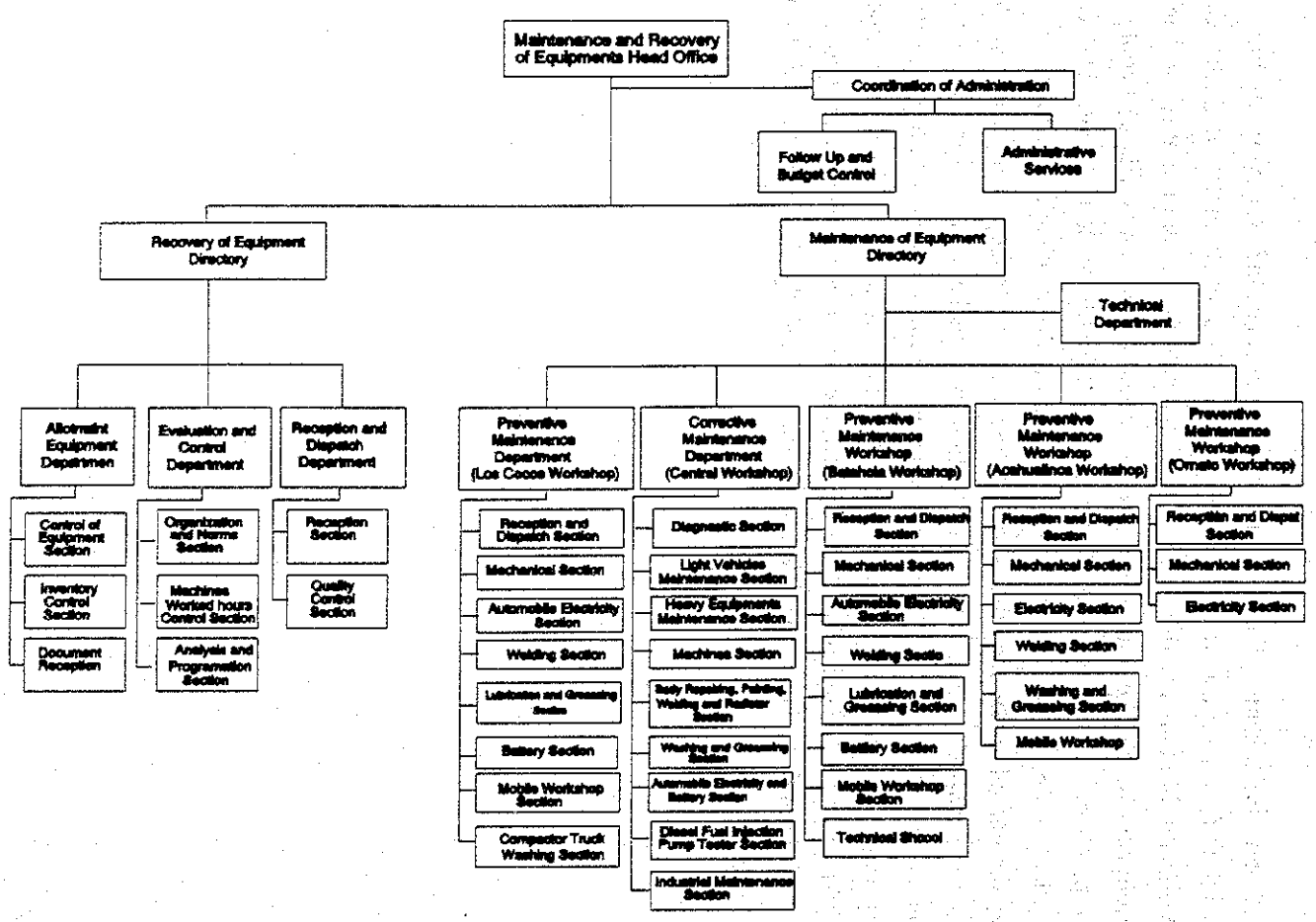


Figure F.3.3e Maintenance and Recovery of Equipments Head Office

It is also important to note that the reception and dispatch section in every maintenance workshop is not in any way related to the reception and dispatch section of the administration of equipment recovery.

Furthermore, it is also worth taking into account that either because of technical inefficiency in the part of the municipality's shops (lack of knowledge about the machine or component) or due to the expeditions services of private shops, some repair works are consigned to private shops.

- The Environmental Protectional Head Office, dealing with specific studies and environmental education. See Figure F.3.3f.

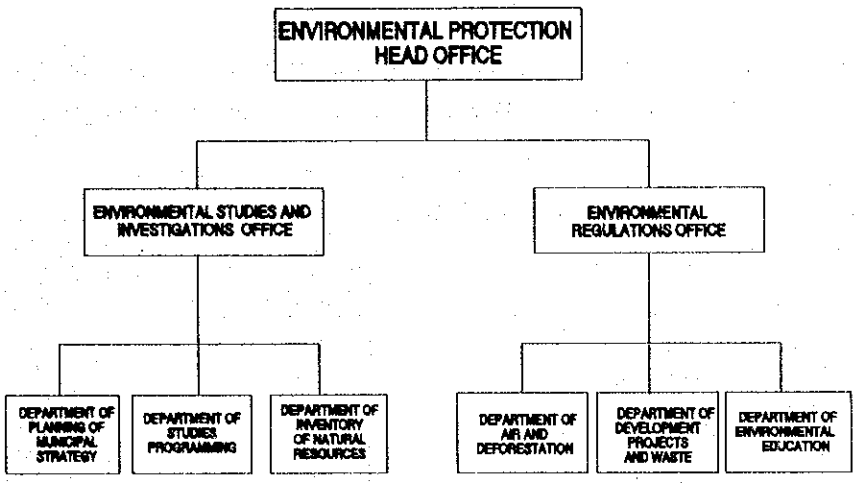


Figure F.3.3f Environmental HEAD Office Organization Chart

- The Department of Garbage Tax Collection within the Finances Head Office (see Figure F.3.3g)

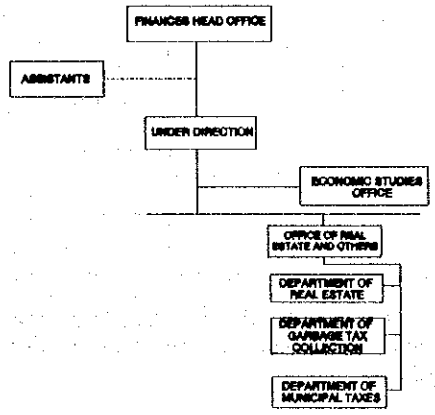


Figure F.3.3g Finances Head Office Chart

b. Financial Situation

ba. The Waste Fee

Waste taxes used to be included in electricity and telephone bills. Under this arrangement, the Municipality received C$13,666,380 in 1992 (around US$ 2,733,300), C$ 7,555,270 from INE - Instituto Nicaraguense de Energia - and C$ 6,111,110 from TELCOR - Instituto Nicaraguense de Telecomunicaciones.

However, the central government decided to cancel this form of charging waste taxes from 1993, thus allowing the Municipality to charge their residents through its own tax offices.

The new waste fee was approved by the Municipal Council through an ordinance (Acuerdo Municipal No 11/93) which states the following charging criteria:

Table F.3.3a Solid Waste Fee

Type of Unit	basis	C$/month
Households in	frontal length(m)	per meter
Progressive areas	10	0.50
Traditional settlement areas	10	1.00
Popular settlement areas	10	0.75
Residential area "B"	20	2.00
Residential area "A"	20	3.00
Companies, etc.,		C$/month
Business establishment - according to the 2% sales tax	company	
- C$ 500 monthly		75.00
C$ 501 - 3,000 monthly		250.00
C$ 3,001 - 6,000		500.00
C$ 6,001 monthly		750.00
Public Buildings	building	150.00
in case there is only one building in Managua		500.00
Selected Industries*	company	2,000.00
Container rental	container	
15 m3		12,000.00
83 m3 1 -5		500.00
6 -10		400.00
more than 11		350.00

Note: * Casa Pellas, Coca Cola, Pepsi Cola, Cerveceria Tona, Induquinisa, Cerveceria Victoria, Tanic, Cementera, Chevron, Texaco, Esso, Tropigas, Shell, Esso Gas, Kola Shaler, Fosforera.

The ordinance exempts municipal buildings, hospitals, health centers, educational centers, penitentiaries, police stations, fire stations, the Nicaraguan red cross and similar institutions from payment. Settlements where collection is made through communal containers are also exempt.

Fee collection is carried out by municipal employees by visiting house under the contract agreement. This new system, however, showed a decrease in the total amount collected due basically to the difficulties involved in charging and the weak enforcement of the collection system.

The actual fee collection condition is shown in Table F.3.3b. The table indicates a little improvement from 1993 to 1994.

Table F.3.3b Collection of Waste Fee (Unit 1,000 C$)

	Target	Household			Companies	Total	Advance (%)
		Residential A	Residential B	Other Area			
1993	5,052						
1994	20,016						
Jan.	1,668				612.5	612.5	36.7
Feb.	1,668	31.0	22.1		582.5	635.6	38.1
Mar.	1,668	47.8	38.6		502.8	589.2	35.3
Apr.	1,668	72.3	66.0		592.1	730.4	43.8
May	1,668	96.4	77.7	2.0	498.7	674.8	40.5
Jun.	1,668	136.6	116.6	9.9	507.6	770.7	46.2
Jul.	1,668	80.9	117.5	6.0	537.8	742.1	44.5
Aug.	1,668	100.2	125.3	4.2	667.6	897.3	53.8
Sep.	1,668		129.0	8.6	496.4	736.3	44.1
Oct.	1,668		117.7	38.0	599.8	858.5	51.5
Nov.	1,668					776.6	46.6
Total	18,348	770.4	810.4	72.5	5,597.8	8,024	43.7
Advance (%)		79.0	66.7	10.9			
Distribution (%)		10.6	11.2	1.0	77.2		

source: Figures are calculated by the Study Team based on ALMA information.

The table points out the following problems of the new fee collection system:

- the highest monthly amount of fee collected in 1994 was in August at C$ 897,000, 53.8% of the monthly target (C$ 1,668,000)
- the majority of the amount is collected mainly from companies (about 80%)
- the fee collected from collection area "A" is 79.0% of the monthly target (C$ 132,000), an amount which is way below the from a former target
- the fee collected from residential area "B" is 66.7% of its monthly target (C$ 171,000)
- the fee collected from the traditional area and other areas is only 10.9% of its monthly target (C$ 121,000)

The major factor that contributed to the change in fee collection is the expansion of the service area, from 39 towns in June to 45 in October 1994. The expansion showed the gradual acceptance of the residents of the collection services and resulted in the achievement of 51.5% of the monthly target when C$ 858,500 was collected in October.

In order to improve the fee collection efficiency, the cadastral maps were prepared and the collection areas were expanded in accordance with these maps. At present the fee collection area totals 45 towns and 16,650 households. The cadastral map is useful for the collection of other taxes or fees, e.g., Real Estate Tax, and was, therefore, given priority.

There is a plan to increase the number of fee collectors and to decentralize fee collection work to increase fee collection efficiency. However, it is very important for the public cleansing office and the fee collection office to establish a good relationship as irregular waste collection services further complicate fee collection.

bb. Expenditure

SWM in Managua is carried out by two different organizations: the Public Cleansing Office under the Municipal Works and Services Head Office for collection and disposal services of solid waste, and the cleaning section in the seven Territorial Administrations.

The budget of the Public Cleansing Office is shown in Table F.3.3c.

Table F.3.3c Expenditure of Public Cleansing Office

(Unit: C$ 1,000)

	1992	1993		1994		
	actual	budget	actual	initial budget	June–Oct. actual(a)	(a)+Nov.–Dec.Budget
Ordinary expenditure	7,720	7.628	9,492	9,972	6,756	8,216
Personnel services	5,293	4,792	6,469	6,096	4,149	5,373
Non personnel services	155	171	300	197	218	331
Materials & supply	1,223	1,886	2,594	2,926	1,902	2,295
Other exp.	1,050	779	129	753	487	218
Capital expenditure	0	0	0	0	0	0
Total	7,720	7,628	9,492	9,972	6,756	8,216
in US$ 1,000	1,544		1,665	1,534		1,243

notes:exchange rate in 1992: C$ 5.00=US$ 1.00
exchange rate in 1993: C$ 5.70=US$ 1.00
exchange rate in 1994: budget C$ 6.50=US$ 1.00
exchange rate in 1994 (estimate) C$ 6.61=US$ 1.00
source: ALMA

The figures show the municipality's efforts to cut down the expenses for SWM by the restricted budget distribution, which sometimes causes shortage of fuel and maintenance parts for collection vehicles and equipment, and the deterioration of SWM services.

The cost of SWM by service is shown in Table F.3.3d.

Table F.3.3d Cost of SWM by Service in 1993 and 1994

(Unit C$ 1,000)

		Personnel	Material	Equipment	Fuel/ Lub.	Total	%
1994	Total	6,462	74	1,866	1,522	9,924	100.0
	Collection	5,135	0	1,384	753	7,273	73.3
	RIDS	898	0	350	563	1,810	18.2
	Landfill	319	0	125	206	650	6.6
	Manf./Maint Container	110	74	8	0	191	1.9
	%	65.1	0.7	18.8	15.3	100.0	
1993	Total	4,932	60	1,373	1,355	7,719	100.0
	Collection	3,847	0	956	656	5,459	70.7
	RIDS	746	0	296	554	1,596	20.7
	Landfill	243	0	106	145	493	6.4
	Manf.Maint Container	96	60	15	0	171	2.2
	%	63.9	0.8	17.8	17.6	100.0	
1994/	Total	1.310	1.225	1.359	1.124	1.286	
1993	Collection	1.335		1.447	1.148	1.332	
	RIDS	1.203		1.182	1.016	1.134	
	Landfill	1.310		1.182	1.426	1.317	
	Manf./Maint Container	1.149	1.225	0.505		1.119	

note: Cost of collection through containers is included in the cost of Collection.
source: Figures are calculated by the Study Team based on ALMA information.

The figures show how equipment cost for collection services and fuel cost for sanitary landfill was increased from 1993 to 1994.

The expenditure of the cleaning sections of Territorial Administrations is not so clear. It is said that about 40% of the district budget is allocated to the street cleaning services.The number of employees engaged in street cleaning services is about 206, 30% of the employees of the Territorial Administration.

The allocated budget and the cost estimate are shown in Table F.3.3e. If the cost estimate for 1994 is the same as in 1993, the balance could put the services in the red.

Table F.3.3e Budget and Cost for Street Cleansing Service

(Unit: C$ 1,000)

	1992	1993	1994
Budget	5,424	6,118	2,208
Expenses	4,609	5,216	5,216
Personnel	2,898	3,346	3,346
Others	1,712	1,870	1,870
Balance	815	902	-3,008

source: Figures are calculated by the Study Team based on ALMA information.

The budget for park cleansing which is under the Beautification Head Office is as shown in Table F.3.3f.

Table F.3.3f Budgets for Park Cleansing

(Unit: C$ 1,000)

	1992	1993	1994
Expenses	1,775	2,090	1,805
Personnel	818	986	960
Others	957	1,104	845

sources: ALMA

bc. SWM Money Flow

From the above figures, the SWM money flow of Managua City in 1993 is summarized in Fig.F.3.3h, and is characterized by the following:

(1) The total expenses of the cleansing services cover about 8.8% of the Managua Municipality budget.

(2) The expenses of the cleansing services, which is carried out by the Public Cleansing Office(PCHO), is approximately 51% of the total SWM expenses. The expenses for the street cleansing works which are carried out by the District Coordination Office almost equal the collection expenses of PCHO.

(3) Indirect taxes are the main financial sources of Managua Municipality; the waste fee only constitutes approximately 3% of the total revenue.

(4) The ratio of commercial waste to household waste is 6:1, and the fee imposed on the former is four times more than the latter; the tipping fee for direct haulage is not included.

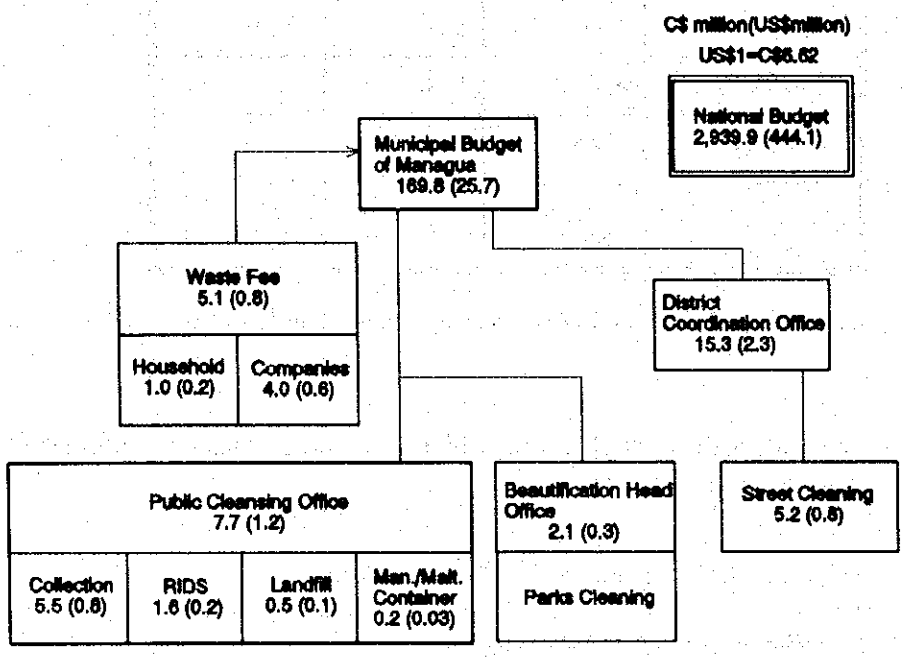


Figure F.3.3h SWM Money Flow

F.3.4 Privatization

In the past municipal administration, before the year 1990, the Municipal Council decided to organize certain Head Offices that will have functions similar to a private enterprise in order to have a better opportunity of fulfilling the needs of the population.

The Public Cleansing Head Office was one of the offices that became a municipal enterprise. It had its own budget which is determined at the beginning of the year, and the operation and administration costs were paid by the municipal treasury according to an agreement on unit prices per cubic meter of solid waste collected hauled and disposed at the Acahualinca disposal site.

The Municipality obtained the revenues from garbage taxes which are usually included in the electricity and telephone bills.

The institutional arrangement of a non profit public corporation that is financially

capable and is independent from other City Head Offices apparently did not jobs produce and high wages.

At present, some decision makers in the municipality view privatization as a prospect to deliver efficient services to the community.

F.3.5 Guidelines on Municipal Solid Waste Management

The Municipality of Managua has no MSWM guidelines.

In the past ten years some international organizations related with environmental health and municipal development, such as the Pan American Health Organization (PAHO), Spanish Agency for International Cooperation (AECI), and a Regional Federation for Central American Municipalities (FEMICA), have promoted workshops and seminars inviting the head officers of the Cleansing Office.

Although the lecture material may be different according to the purposes of each organization, the Pan American Health Organization has developed a modular program for training in the different aspects concerning solid waste management by means of the Pan American Center for Sanitary Engineering and Environmental Science at Lima, Perú. This training material has been used in many seminars held in Central America and some head officers of the Cleansing Department of Managua have received the benefits of these courses and have been issued certificates that would prove their participation.

F.3.6 Public Cooperation

The answers to the questions on the public opinion survey reflect that the residents do not have enough information and public health education to promote communal participation in solid waste management. The priority given to the garbage collection service by the residents is not so high; they have other needs that are more important such as legalization of land tenure, employment, sewerage, health care, etc.

The survey reflects that it is usual for the residents (53.3% of the population) in Managua to clean open areas adjacent to their houses and shops. But most of the time waste collected is not properly stored and are disposed in open spaces and channels.

More than 90% of the citizens surveyed believe that education and clean up campaigns are necessary to maintain a beautiful city and environment, and they consider that the municipality and the Central Government should take action in this matter.

The urban residents are willing to cooperate with the local and national government in order to improve the environmental conditions of their living areas. The Municipality should therefore consider educating the public on proper health and sanitation measures through the mass media. Since adults are generally reluctant to change their habits, this activity should be focused on the young generation.

Residents in areas serviced with container collection have been identified to be uncooperative. It is very necessary to analyze the factors that influence this behavior in order to take relevant measures. The typical causes of lack of user cooperation were surveyed as:

- unreliable collection services (e.g. unpunctual services)
- service users are not properly informed of the collection schedule
- the wastes are usually spilled on the ground because the container becomes too full and heavy to lift

The public should be informed about the schedule and frequency of the collection service, how a resident can obtain information or provide comment on the system, what is expected of the resident as part of the cooperative effort, and the economic and health benefits of a cleaner city.

Informing the public of the different acts of violations involved should also be included in the educational program. The provision of violation tags listing all acts prohibited and with spaces for checking specific violations committed, would remind residents of what mistakes they have to avoid. The tag may even include some information on the reasons behind certain rules and regulations.

F.3.7 Legislation and Enforcement

a. Legislation

There is no current law in Nicaragua dealing specifically with solid waste.

At this moment, the current laws that indirectly deals with SWM are:

- The Municipal law
- The Sanitary Code (Disposiciones Sanitarias)

The municipal law defines the following as municipal duties:

- the protection of public health and sanitation
- public cleansing, collection, disappearance (sic) and treatment of solid wastes

Also, this law also stipulates that it is the prerogative of the municipality to improve the health and sanitary conditions of the community and to protect the environment.

The basic Sanitary Code defines solid wastes (art.10), as those residues, putrescible or not, produced from household, commercial or industrial activities; this however excludes human excreta. This law also states that it is the duty of the public and private services to collect solid wastes as well as remove for the final disposal dead animals found on streets, in public spaces, e.g., channels and vacant lots. Finally, it states that it is the responsibility of the Health Ministry to set rules governing household and industrial solid wastes management.

First known legislation of the country about public cleansing is the National Law on Public Sanitation and Cleansing (ley sobre Aseo y Limpieza de las Poblaciones) issued on May, 6 1993 by the Minister of Public Health and Services.

This law set guidelines for the citizens stipulating their duties to keep the city clean, how they should cooperate with the collection service, prohibits the indiscriminate disposal of waste (especially on drains and water courses) and determines that the cleansing service, should be made daily in ports and downtown areas and twice a week in the surrounding areas.

Today, the piece of legislation used more often is the National Sanitary Code which was issued by the President of the Republic in September, 30, 1988. This law prohibits the discharge of waste on natural bodies of water, requires public services to carry out solid waste collection (including dead animals), determines how wastes brought in from overseas in boats or airplanes shall be collected and treated, defines toxic or hazardous substances, set guidelines for the inspectors in charge of law enforcement and sets penalties for violations.

b. Enforcement

The legislations on solid waste are weakly enforced in Managua as can be seen from the number of illegal dumping sites in the city.

In order to cope with this situation, the Ministry of Health entered into an agreement with the Health Ministry and the National Police that would employ the National Police as inspectors of matters dealing basically with liquid and solid wastes in the whole country.

Protocol has been signed on March 1994, establishing duties, activities, fines and appeals, and coordination with the sanitary inspectors of the Health Ministry. No coordination though has been established with the municipal government. Accordingly, a training course has been ministered to 200 policemen, and control measures will be carried out soon, with Managua being the first area of target.

c. National Police Action on Sanitation Code Enforcement

The agreement made by the National Police and the Health Ministry to enforce the Sanitary Code through the cooperation of policemen went into effect with the participation of the Municipality of Managua. The activity was first implemented in district zone 1 and later extended to districts 2 and 4. The remaining districts of Managua shall be included in the same proposal in the near future.

The results of this measure has not been evaluated yet, but it is evident that it improved the relationship between the National Government and the Managuan Municipal government. The 2 week activity jointly carried out by the municipality and the Ministry of Health, including the cleansing campaign in the dirtiest districts, also improved the relationship of these two government organs. The campaign is being made in districts were the National Police is assigned.

F.4 Review of Existing Plans and Studies

F.4.1 Reports to be Reviewed

The following are the existing plans and studies concerning Solid Waste Management in the Municipality of Managua, that were identified by the Study Team:

- "Evaluation of the Practice of Solid Waste Management in Managua" prepared by Frank Ohresorgen, Director of Programs for Latin America, the International City/County Management Association (ICMA), September 1993.

- "Solid Waste Management Plan for Managua", prepared by Eng. Koen de Jong, Department of Engineering, Amsterdam, March 1994.

F.4.2 Evaluation of the Practice of Solid Waste Management in Managua, September 1993

a. Outline of the Report

aa. Background

This report was prepared by the consultants of USAID (United States Agency for International Development) with the assistance of officers from the municipality of Managua, following a request from the municipality which feared that the dissemination of contaminants from the sanitary landfill in Acahualinca would cause problems related to public health.

ab. Issues and Conclusions

aba. Final Disposal Site

Although operations at Acahualinca landfill site is being controlled, the landfill has probably already contaminated Lake Managua, and will continue to do so.

The following six measures were proposed to abate the impact on Lake Managua.

(1) Reduction of Sanitary Landfill Area

The working area of the sanitary landfill must be reduced to permit a better and more efficient use of landfill equipment.

(2) Construction of a Dike

A dike, with a width of 2–3 meters, must be constructed between the sanitary landfill and Lake Managua. The dike must be one meter high on the northern elevation of the existing landfill.

(3) Construction of Monitoring Wells and Buffer Zone

Several monitoring wells must be constructed between the sanitary landfill and Lake Managua. Trees must be planted between Lake Managua and the dike and around the whole sanitary landfill as additional measures to mitigate contamination.

(4) Soil Covering for the Landfill and Around Lake Managua

At least 0.6 m of covering for the landfill area and the area near Lake Managua is required.

The area excavated for extraction of soil covering material could be used as a temporary pond to retain rain water, which would otherwise flow to Lake Managua.

(5) Establishment of a Recovery Plan for the Sanitary Landfill

The final design of the recovery plan after the closure of the sanitary landfill must be prepared in order to implement recovery works at the earliest possible opportunity.

(6) Measures to Reduce Scavenging in the Final Disposal Site

It is necessary to prepare a formal recycling program that would allow scavengers to recycle materials in a designated working area within the sanitary landfill site.

bb. Identification of Potential Future Sanitary Landfill Sites

The consultants proposed two adequate sites with the assistance of the Nicaraguan counterpart, following a field survey.

bba. Santa Ana

Santa Ana is located 17–18 km south of Managua and is outside the jurisdiction of Managua municipality. Santa Ana appears to have less risk of being environmentally effected.

bbb. Site Between San Tudas and Loma Linda

The site is smaller than the one at Santa Ana. However, it seems to comply with most of the criteria for a favorable sanitary landfill. The site has a larger population in its vicinity but there are some natural barriers which separate it from the inhabited areas.

F.4.3 Solid Waste Management Plan For Managua, March 1994

This plan was prepared during the 1993/1994 period, commemorating the 10th anniversary of Managua and Amsterdam (Holland) becoming twin cities.

The project is divided into three (3) phases.

In the first phase, a study was conducted to clarify the present situation of solid waste management in Managua. In the second phase, pilot projects that entail field studies, improvement plan of sanitation and workshop were executed. In the third phase, the final report was prepared.

F.4.4 Acahualinca Final Disposal Site

a. Actual Condition of the Acahualinca Disposal Site

aa. Disposal Sites in Managua

Previously, there were two disposal sites which were located along the shores of Lake Managua. The existing Acahualinca disposal site is the third to be built, and is located 100 meters to the north of Lake Acahualinca, near Lake Managua. In 1940, the first final disposal site was located in the northern area of the former Cathedral, while the second one was built in the Acahualinca town where the workshop for road maintenance of the municipality of Managua is currently located.

ab. Problems in Disposal Site Management

The operation works at the Acahualinca disposal site lack suitable techniques. Disposal site management problems are as follows:

(1) absence of control or recording of the type and weight of the disposed waste
(2) free access: the site is open to any person, adults and children
(3) no daily covering of wastes in the disposal site, making the surrounding environment look ugly
(4) no continuous maintenance of the access road of the disposal site
(5) no permanent fences to block the entrance of domestic animals
(6) no environmental measures against air, soil and water contamination
(7) no operation plan is established
(8) no special disposal sites for dangerous and medical wastes.

It is, therefore, important to apply the knowledge learned on how to operate and control a sanitary landfill.

b. Social Aspects of Scavengers at Acahualinca Disposal Site

The number of scavengers in Managua averages 200 a day due to low income per capita and high unemployment rate. These people are very poor and usually live in dumping sites; scavengers include many women, children and the aged. Through scavenging works, they are exposed to high risks of being injured or killed in an accident involving heavy machinery operating at the disposal site.

The most popular wastes collected by scavengers are metals (aluminum, iron and copper), glass containers and timber. However, a significant amount of material, with a good selling price, are collected before they are brought to the final disposal site by the collection workers. They select more expensive materials such as aluminum, glass etc.. The collection crews sell the materials to a fixed purchaser who pay for the goods in cash.

Most scavengers think that their activity is damaging to their health, but recycling is a source of income in order to improve their living conditions and is also for the development of the community.

c. Physical Environmental Aspects

ca. Natural conditions

Acahualinca disposal site is very near the city, therefore transportation costs will be inexpensive.

A borrowpit for covering materials is located very close to the Acahualinca disposal site; wind always blows eastward which is why there are no complaints to the Municipality from surrounding residents regarding bad odor and smoke generated from burning waste at the disposal site.

cb. Infrastructure Advantage

There is water supply, electricity and means of transport. The disposal site is accessible all throughout the year.

d. Environmental Conditions

da. Soil conditions of the disposal site

The base soil of the disposal site is made up of sandy soil, which allows water to infiltrate the ground contaminating Lake Managua, which receives all the water coming from the south basin.

In recent investigations by the National Engineering College (UNI), pollutants caused by the operation of the disposal site were detected in groundwater. It is also assumed that the water downstream moving towards Lake Managua is contaminated.

Lake Managua is not used as a water supply source, but is famous for fishing and water sports.

However, the effect caused by leachate as a pollutant from the disposal site is smaller compared with other elements such as industrial waste and sewage.

e. Land Use for Future Development

There is land available in the vicinity for future development and expansion of the disposal site. It is located to the south-east of the existing disposal site. The environmental condition of the site is similar to that of the existing disposal site.

The difference is that the groundwater level is deeper. A drainage system and a waterproof lining should be prepared.

f. Projection of Waste Generation for the Next 25 years

fa. Forecast of waste generation

Although there has not been any official census since 1971 in Managua, population figures were estimated assuming a population growth rate ranging between 2.5% and 3.5%.

Waste volume was projected for the next 25 years with the following assumptions.

Daily Waste Production	0.5 kg/capita
Waste density	330 kg/m^3
Hauling volume to disposal site	80 %
Waste volume after compaction at final disposal	40 %
Covering material volume	20 %

The results show that the volume required for the disposal site, if it were to operate for 25 years, is from 9.7 to 11.1 million cubic meters.

fb. Actual Capacity of the Existing Site

The area of the disposal site is 39.97 ha of which 25.6 ha is occupied with waste. The remaining area hosts facilities for the disposal site administration.

According to the statistical data, the water level of Lake Managua varied as follows;

Highest water level	43.44 m in 1933
Lowest water level	37.50 m in 1947
Average water level	39.00 m
Annual average rainfall	1,170 mm

In December 1993, the average soil level of the disposal site was 40 meters. 256,000 m^3 can be stored for every meter. The height limit of the disposal site will be 50 meters,which is the level where the edge of the lake depression begins. This figure was adopted considering the preservation of the natural landscape and the view of Lake Managua.

Thus, the capacity to cover the future demand of waste is 912,000 m^3,which is

equivalent to 3.56 meters high, corresponding to waste generation of Managua city for the next 3.5 years.

fc. Future Capacity

Three future disposal sites, which are adjacent to the existing disposal site, were proposed by the consultants taking into account the remaining 3–4 years life span of the existing disposal site.

The total area available is estimated as 7,750,000 m^3, which has the potential capacity of storing the waste of the Managua Municipality for the next 21–23 years i.e. up to the years 2014–2016.

g. Perspective of Acahualinca Disposal Site

ga. Financing by the Municipality of Managua

It is possible for the Municipality of Managua to finance itself under the management of one enterprise.

This enterprise would have to dispose and treat solid waste according to international standards, especially following the criteria for disposal sites of Municipalities established by the Environmental Protection Agency of the United States (EPA) and as a last resort according to the regulations of IRENA.

It is estimated that operation cost would be approximately 10.00 cordobas/m^3.

gb. Recovery of Materials and Waste

gba. Recovery of Materials by Scavengers

Many of the waste hauled to Acahualinca can be recovered in the same way as scavenging. There is an expedient measure in other countries that involves hiring scavengers as workers in real recycling companies.

gbb. Gas Production

There are signs of methane gas production for electricity generation.

gbc. Volume Reduction of Waste by Composting

Composting does not harm the environment and the by-product is used for improvement of soil condition.

A pilot project is being carried out at the Acahualinca disposal site. In Masaya, compost is being produced for sale and for use in the Municipality nursery.

gc. Acahualinca Operation

It necessary to operate according to a previously established design in order to control the optimum form of disposal not only of domestic but also industrial and harmful waste, and also take measures to aim for the closure of the existing disposal site.

gd. Closure of existing Acahualinca disposal site

The closure of the existing Acahualinca disposal site is an expensive project, because it is necessary to provide a considerable volume of covering material. In addition, mitigation measures should be taken to avoid more contamination, such as drainage, waterproofing, facilities for gas exhausting, monitoring items and indicators of environmental pollution such as the air, water and etc.

h. Conclusion

Taking into consideration the very short life span of the existing disposal site, future actions must be decided upon urgently. The action to be taken in the next 4 years is to determine the location of the new disposal site. The best alternative should be selection through cost comparison as well as from an environmental point of view.

F.5 Evaluation of Present MSWM

F.5.1 Technical System

The evaluation of the present municipal solid waste management in terms of the technical systems are summarized in Table F.5.1a. As mentioned in the table, the major issues and problems identified with the present MSWM for preliminary recommendation, for the formulation of a draft master plan, are described below.

- improvement of waste discharge method in collection area B
- extension of collection area
- promotion of container collection system for large generation sources
- improvement of public cleansing work
- consideration of recycling and composting systems
- improvement of the present workshop of the Public Cleansing Office
- improvement of sanitary condition of the present disposal site

a. Improvement of Waste Discharge Method in Collection Area B

The residents in collection area B, where infrastructure is not well established, i.e. unpaved road and illegally drawn electric cables etc., discharge their waste in RIDS (Registered Illegal Dump Sites). The waste is collected by a combination of wheel loaders and dump trucks. Improvement of the discharge system is a necessity, due to the following reasons:

- the local scenery has been ruined by waste scattering and accumulation
- insanitary conditions
- frequent illegal dumping of waste such as industrial wastes, including hazardous materials

b. Extension of the Collection Area

Currently, collection service is performed in collection area A where infrastructure is well established. However, there are approximately ten spare, brand new compactor trucks which have not yet been utilized; the most obvious use for them is to service non-collection areas where 25% of the urban population reside. Unfortunately, this is not viable as these areas tend to be squats whereby access for collection vehicles are hindered by illegally drawn electric outlets and poor road

conditions. Therefore, in order to extend the collection service to squat areas, the introduction of a public container collection system should be examined.

c. Promotion of Container System for Large Generation Sources

The container collection system is suitable for large waste generation sources, i.e. commercial areas, markets, hospitals, institutions and factories, and as the system is efficient and reliable, it should be continued. The container capacity, however, should be altered together with the increase in number of vehicles and containers.

d. Improvement of Public Cleansing Work

The present manual street sweeping and park & green area cleansing system is suitable due to the high unemployment ratio, therefore, it should be extended or implemented where it is not provided.

Installation of containers to store waste from street sweeping and park & green areas shall be examined to improve sanitary conditions and for the beautification of the area. In addition, in order to solve littering by citizens, the installation of the containers in public areas e.g. roadsides and parks is suitable in conjunction with the enforcement of anti-littering laws.

e. Consideration of Recycling and Composting systems

At present, a handful of those in the private sector conduct all recycling activities in the study area; one of the possible reasons behind this is the limited market for recycled/reused materials and compost from MSW. For future implementation of a recycling and/or composting facility, it should be examined from a market, public cooperation (waste segregation), finance (MSWM) and facilitation of engagement points of view.

f. Improvement of the Present Workshop of the Public Cleansing Office

In order to establish the efficient use of vehicles and equipment for MSWM, the present workshop at Los Cocos shall be improved to provide preventive maintenance. Complex maintenance such as overhaul shall be done either at the central workshop or at private workshops.

g. Improvement of Sanitary Conditions of the Present Disposal Site

In order to preserve the surrounding environment, appropriate measures such as defining the site boundary, regular soil covering of the disposal area and strict monitoring etc., should be established.

Table F.5.1a Evaluation of the Present Technical System

Items	Present System	Evaluation
1. Discharge & Storage		
– Source Separation	Not established.	. Discharge and storage should be examined totally from a market of recycling materials, cooperation of residents and finance of MSWM points of view. . The source segregation system of infectious waste in hospitals shall be established.
– Waste Container	. A nylon sack is commonly used in the residential area. . 15m³or 0.83m³ containers are used to collect waste from commercial areas, markets, hospitals, institutions, and factories.	. Nylon sacks are suitable in residential areas as they are cheap, easy to handle and recyclable. . The capacity and size of containers should be examined.
– Discharge Point	. In front of the premises (collection area A). . Discarding at registered illegal dump site (collection area B).	. The discharge point for collection area A is suited to the present collection system. . The sanitary condition of the area used for the registered illegal dump site shall improve if the scattered waste around the sites is removed.
2. Collection & Haulage		
– Service Coverage	The service coverage of residential areas is 73.5% of the urban area. . Almost 100% of collection area A is covered (65% of the urban area). . About 24% of collection area B is covered (8.5% of the urban area).	The collection services shall cover all of the urban area through proper collection system.
– Collection Level		
. System	. Curb collection system in collection area A. . The collection system is a combination of wheel loader and dump truck in collection area B. . Container collection system in commercial areas, markets, hospitals, institutions and factories.	. The curb collection system is suitable because of its efficiency. . The container collection system shall be examined in collection area B. . The container system is efficient and reliable in these generation sources. The collection capacity shall be improved by replacement and increase in the number of vehicles and containers.
. Frequency	. Thee times a week in most of collection area A. . The collection frequency is not regular in collection area B. . Since the capacity of 15m³ containers is too large for some facilities, it is difficult to establish the collection frequency and route.	It shall be examined considering sanitary aspects and operation cost. The collection frequency and route of 15m³ container system shall be examined by using a truck scale.
. Collection Work	Working hours is normally 6 hours a day.	It shall be examined by using a truck scale.
. Collection Efficiency		It shall be examined by using a truck scale.
3. Street Sweeping and Park and Green Area Cleansing Service		
– Responsible Organization	. Street sweeping ... District Coordination Office (DCO). . Park and Green Area Cleansing ... Department of Green Area (DGA).	
– Cleansing System	Manual	Present manual sweeping and cleansing system is suitable under the condition of high unemployment ratio, so it should be extended or implemented where this service is not provided.

Items	Present System	Evaluation
– Discharge Point	Discarding at registered illegal dump sites.	. Installation of containers for street sweeping and Park and Green Area cleansing shall be examined to improve sanitary conditions and beautification of the area. . In order to solve littering by citizens, the municipality should install public containers in the core area of the city in addition to the enforcement of the anti-littering regulation.
4. Intermediate Treatment		
– Recycling	The majority of recycling is conducted through the private sector including scavengers at Acahualinca disposal site, collection crew, intermediaries and buyers. Approximately 13ton/day of reusable materials is recycled in the Study area. Main recyclable materials are glass, iron, aluminum, plastic, paper and cardboard, etc.. These materials are exported to neighboring countries because their national market is limited.	Recycling and composting systems should be examined totally from a market, public participation for source segregation, finance of MSWM and facilitation of engagement points of view.
– Composting	The municipality is executing a pilot project on composting from market waste with a production of 4.8 ton/month. The operation and control of the pilot project should improve the quality and quantity. The use of compost is limited to fertilizing trees along the roadside.	
5. Final Disposal		Based on the present annual amount of the waste disposed at Acahualinca, approximately 220 thousand cubic meters, the present disposal site can be used for a further four or five years.
– Outline		
. Location	Acahualinca	
. Distance	Approximately 10km from the main generation source.	
. Disposal Amount	Approximately 2,000m^3/day (not compacted).	
. Landfill Area	Approximately 40ha.	
. Year of Commencement	1975	
. Working Hour	12 hr/day	
. Method of Landfill	Semi-controlled tipping	
. Number of Landfill Equipment	Bulldozer: 2 units Landfill compactor: 4 units Water tank truck: 2 units	
. Number of Scavengers	Approximately 250 persons	
. Number of Personnel	20 persons	
– Landfill Level	Incoming waste to the disposal site is dumped under the control of a supervisor, based on their experience, without water treatment and waste covering.	
– Sanitary Condition	. As the present disposal area has been formed without prior planning, the boundary of the site is not clearly defined. . As the waste is disposed without covering, lighter wastes are scattered and blown by the wind. . The scavengers illegally live in the site.	. These present conditions debase the surrounding sites and the quality of sanitation should be improved.
5. O & M for Equipment	At Los Cocos workshop, preventative maintenance procedures are executed such as lubrication and oil exchange. Complex repair and maintenance of collection vehicles and equipment are conducted in the central workshop together with other municipal machinery.	In order to establish the efficient use of vehicles and equipment for MSWM, the present workshop for the Public Cleansing Office shall be improved.

F.5.2 Institutional System

The institutional system of the Solid Waste Management activities in Managua, like most Latin American countries, was founded without any specific planning or design. The system spontaneously evolved from several decisions of municipal administrators on responsibilities and powers assigned to various municipal organs and agencies, and their relationship to one another.

The institutional system should be improved as it has been found to have several deficiencies, not only from the organizational point of view but also in its internal communications system and administrative relations with other municipal bodies.

The disposition of the personnel for Solid Waste Management activities also needs to be improved, since many of the people hired have no formal training or educational background necessary for the development of the activities.

The main findings and the preliminary ideas and alternatives on how to improve the current situation are given hereafter.

a. Findings

The administrative and managerial system for public services in Managua has undergone a complete transformation in the past years as a result of political and economic reconstruction after the civil war.

Before the election of the current municipal government, SWM activities were performed by a Municipal Company holding a semi-autonomous economic and administrative status.

The creation of many different government enterprises to deal with public services such as Solid Waste Management was devised by the Sandinista government to control the country and municipalities. This administrative system, however, was dismantled by the newly elected municipal government of Managua on the grounds that the excessive degree of independence exercised by these public companies restricts the authority of the head of the municipal government.

Consequently, the old SWM company was abolished and its activities disintegrated into several municipal institutions. The most important of these, the Public Cleansing Office which is tied to the Municipal Works and Services Head Office is in charge of collection and disposal activities.

The Territorial Administration of the District Coordination Office, which is directly under the Mayor's Office, shares the responsibilities of the Public Cleansing Office and is responsible for street cleansing works.

Other municipal institutions dealing indirectly with Solid Waste Management activities are the tax collection head office which is responsible for the collection of service fees, and the Directory of Maintenance and Recovery of Equipment which is also under the Municipal Works and Services Head Office and on the same administrative level with the Public Cleansing Office.

The Money Flow of Managua City in 1993 is summarized in Fig. F.5.2a, and is distinctly characterized by the following:

(1) The total expenses of the cleansing services cover about 8.8% of the Managua City budget.

(2) The expenses of the cleansing services, which is supervised by the Public Cleansing Head Office (PCHO) under the umbrella of the Municipal Works and Services Head Office (MWSHO), is approximately 51% of the total MWSHO expenses. The expenses for the street cleansing works which are carried out by the District Coordination Office almost equal the collection expenses of PCHO.

(3) District taxes are the main financial sources of Managua City; taxes from waste only constitute approximately 3% of the total revenue.

(4) The ratio of commercial waste to household waste is 6:1, and the tax imposed on the former is 4 times more than the latter.

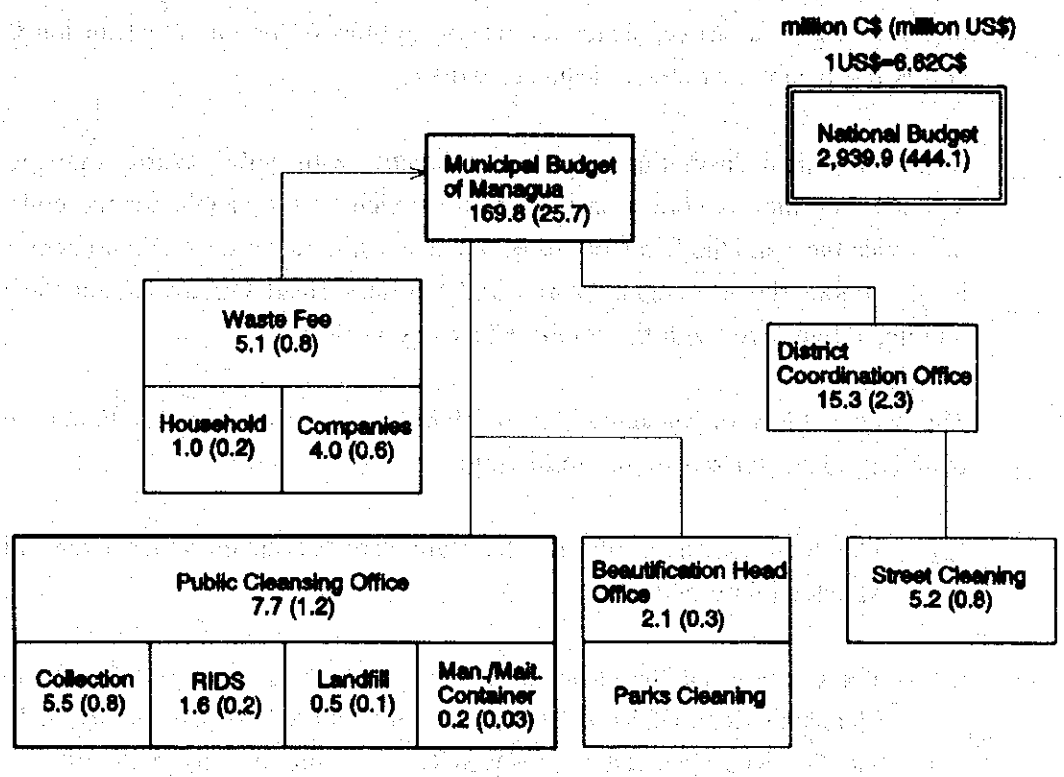


Figure F.5.2a Money Flow on SWM in 1993

b. Improvement Measures

The most important institutional measure is the reorganization of the municipality's administrative structure so that all Solid Waste Management related activities will fall under the Public Cleansing Office, especially those related to the ones carried out by the Administrative Coordination.

The reorganization will further coordinate cleansing activities by the efficient use of equipment and manpower mainly in the removal of RIDS scattered all over the city.

Although the vehicles and equipment are maintained by another municipal institution, the efficiency of the fleet operation does not seem to be affected by it. They are more affected by technical problems and by the fact that most of the equipment and vehicles (mostly those from the former Soviet Union) have no spare parts.

With regard to financial resources, the tax collection system will be improved probably by integrating them with other municipal taxes, i.e. property tax.

The solid waste collection fee is presently collected through a single system based on a makeshift cadastre using inexperienced personnel, which therefore, results in inefficiency and poor financial resources in contrast to the expenses and the collectible amount.

The improvement measures that shall be specifically taken are:

(1) Enforcement of Household Fee Collection Activities; Arrangement of Residential Register; Gradual increase of collection fees.

(2) Impartiality in the collection of fees from companies; Collection of fees from large companies; Shift to a specific system

(3) Introduction of tipping fee collection at the disposal site.

Measures shall also be taken to improve the handling of affairs within the Public Cleansing Office and among the several Municipal Organizations involved in solid waste activities.

ANNEX G

SELECTION OF FINAL DISPOSAL SITE

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ANNEX G SELECTION OF FINAL DISPOSAL SITES

G.1 Introduction

G.1.1 Present Situation of the Disposal Site

Solid waste is widely recognized to have a severe effect on the environment. People have the bad smell, dust and the insanitary appearance of their area.

Here in Managua, there is a belief that the waste in the Acahualinca disposal site pollutes the water of Managua Lake; the proximity of the lake is believed to adversely affect lake water quality. The drinking water resources of Managua is groundwater, and this is reason enough why citizens are nervous about the location of the disposal site. Considering this situation, there are two options; removal or extension of the present site.

G.1.2 Six Candidate Disposal Sites

The Municipality of Managua selected five candidate disposal sites for the removal plan. However, the Study Team proposed the extension of the Acahualinca disposal site. The following 6 candidate disposal sites were evaluated:

1) Acahualinca (Extension Plan)
2) Santa Ana (Removal Plan)
3) Cuajachillo (Removal Plan)
4) San Judas (Removal Plan)
5) Villa Fontana (Removal Plan)
6) Esquipula (Removal Plan)

In Nicaragua, it is very difficult to obtain reliable data concerning land because the land registration system is inefficient. Therefore, the survey and evaluation of potential sites were carried out based on data given by the counterparts and data collected through field reconnaissances. The data given by the counterparts was not reliable enough because it was not based on land survey works. Therefore, the Study Team cannot guarantee the reliability of the data on area, location and ownership.

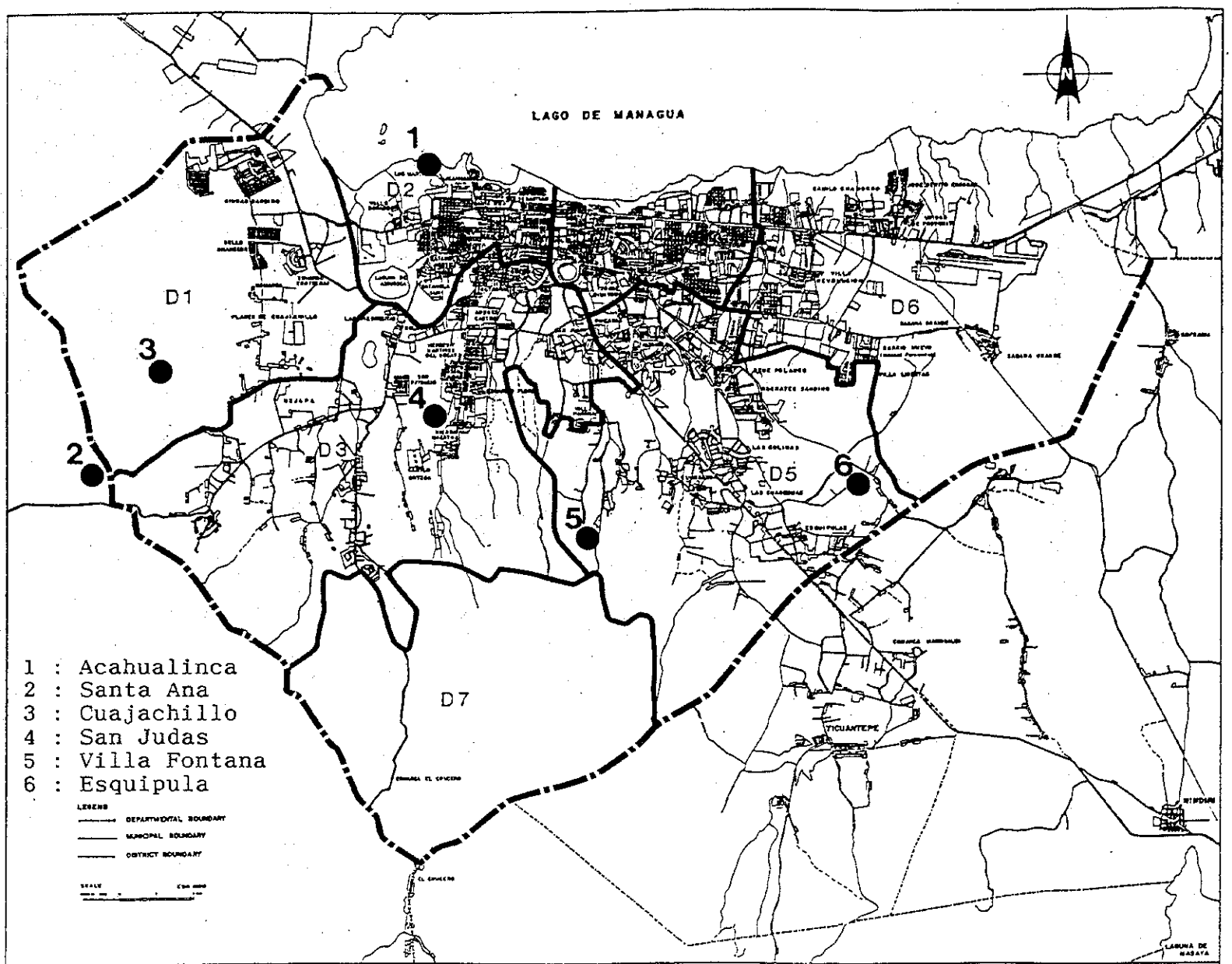
The location of the candidate disposal sites are shown in Figure G.1.1a.

G.2 Objectives of the Works

The municipality of Managua will have to prepare the final disposal site for the future SWM.

It is difficult to evaluate or assess the candidate disposal sites objectively because the rating system usually depends on the person conducting the evaluation. Therefore, site selection was carried out taking political and administrative factors into account.

The Study Team will have to conduct survey and analyses to provide the decision makers with the proper basis for selection.



THE STUDY ON THE IMPROVEMENT OF THE SOLID WASTE MANAGEMENT SYSTEM FOR THE CITY OF MANAGUA

JAPAN INTERNATIONAL COOPERATION AGENCY

Figure G.1.1a
Location Map of the Candidate Disposal Sites

G.3 Site Selection Method

G.3.1 Flow Diagram of Site Selection

The study flow diagram of the final disposal site is shown in Figure G.3.1a.

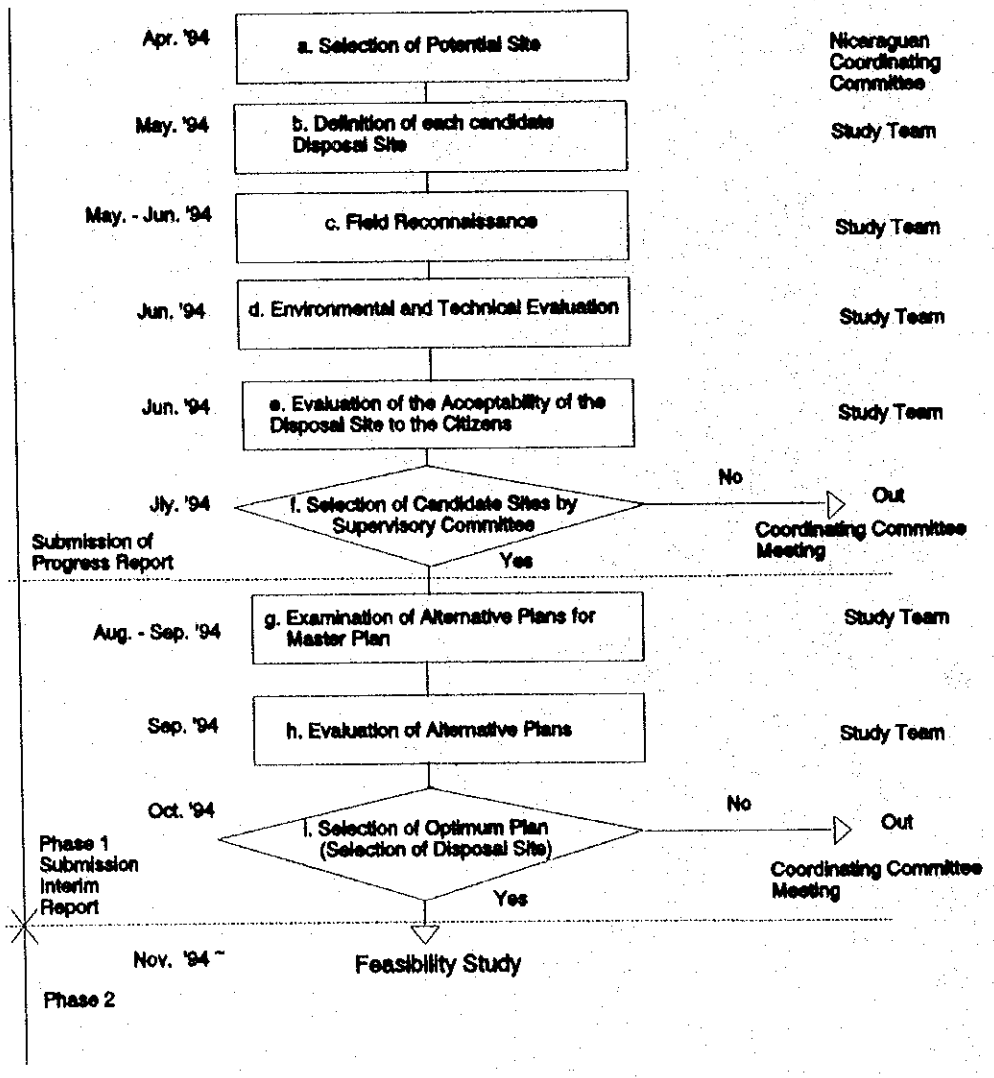


Figure G.3.1a Work Flow Diagram on Selection of Final Disposal Site

G.3.2 Evaluation Method

a. Selection of Potential Site

Of the 11 sites, five candidate disposal sites were selected by the Nicaraguan Coordinating Committee.

b. Definition of each Candidate Site

The measurement of the sites was not included in the information given by the municipality. Therefore, the Study Team measured each candidate site by using a topographical map on scale of 1:10,000.

c. Field Reconnaissance

Field reconnaissance is executed in the candidate disposal sites by the Study Team in order to collect data for further evaluation.

d. Environmental and Technical Evaluation

Environmental and technical evaluations are conducted in the candidate disposal sites. Environmental evaluation was based on the project's social impact and environmental impact e.g. pollution. The technical evaluation was based on available area, coverage soil, accessibility and capacity, etc..

e. Evaluation of the Acceptability of the Disposal Site Location to the Citizens and Municipality

The selection of a site will require the approval of the residents of neighboring areas and the municipality – people who shall be greatly influenced by the works involved on land acquisition and the operation of equipment.

f. Selection of Candidate Sites by Nicaraguan Coordinating Committee

The selection of the final disposal site greatly affects the total cost for solid waste management. The location of the final disposal site will determine haulage distance

of wastes and the haulage system, such as transfer stations. Moreover, collection and haulage costs cover a large part of the total cost. It is, therefore, important to estimate the overall solid waste management cost, including collection and haulage costs, by candidate disposal site.

g. Examination of Alternative Plans for Master Plan

The alternative plans for final disposal will be formulated either by proposing the independent use of the candidate sites for final disposal or the combined use of 2 candidate sites. The candidate sites are selected by the Municipality.

h. Evaluation of Alternative Plans

The technical system alternatives in 2010 prepared as described above were evaluated based on the following view points:

- technical points of view
- economic and financial points of view
- environmental points of view
- social points of view

i. Selection of Optimum Plan (Selection of Disposal Site)

Based on the evaluation results of the alternative plans, the coordinating committee finally selected the optimum alternative plans for the solid waste master plan. The priority projects for the feasibility study were decided and the geological survey and topographical survey were executed on the selected site in the 2nd phase of the study which commenced in November 1994.