G.3.2 Medical Waste

G.3.2.1 Concept of Waste Stream

The present waste stream in the Study Area was formulated based on the following surveys and analysis:

- Medical Waste survey
- Analysis of existing disposal amount data (weighing data at final disposal site)

The concept of present waste stream is shown in Figure G-17.

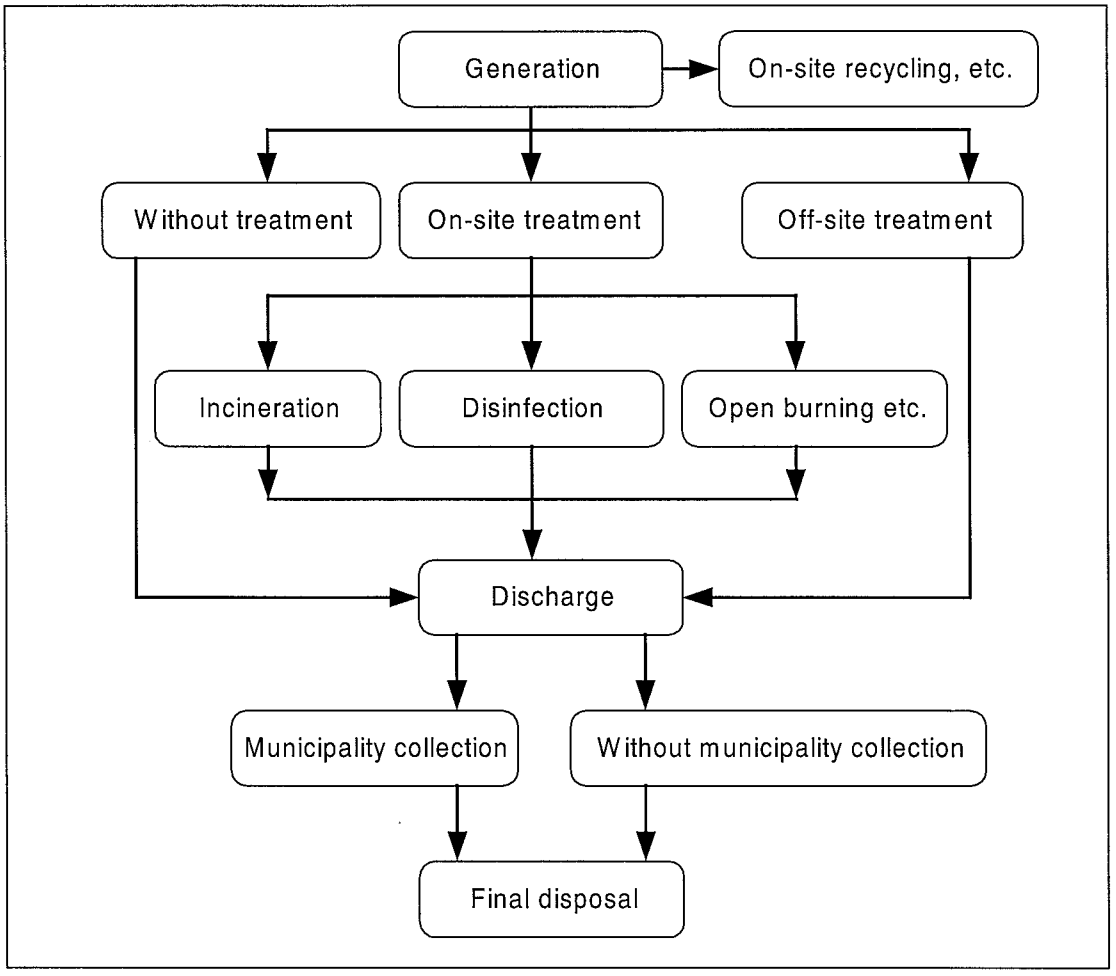


Figure G-17: Concept of Present Medical Waste Stream

According to the concept above, the Study Team has quantified the waste amount in each component of the waste stream.

G.3.2.2 Waste Generation Ratio and Generation Amount

a. Waste Generation Ratio

The study sets up waste generation ratio based on the result of Medical Waste Survey (MWS) and referred to the existing data in AMSS[7].

[7] Data from MSPAS-Transporte Guadalupe 1999

Table G-20: Waste Generation Ratio

Category	Item	MSPAS 1999	JICA Study (MWS)
I (more than 200 beds)	Waste generation ratio (kg/bed/day)	0.652	0.553
II (50 to 200 beds)	Waste generation ratio (kg/bed/day)	0.699	0.675
III (less than 50 beds)	Waste generation ratio (kg/bed/day)	0.465	0.329

b. Waste Generation Amount

The generation amount of medical waste was calculated by multiplying the waste generation ratios above (Table G-20) by number of beds (Table G-21) in medical institutions in the study area. The total medical waste generation is estimated as shown in Table G-22.

Table G-21: Number of Bed

Category	Private	Public	Total
I	-	3,690	3,690
II	485	538	1,023
III	277	465	742
Total	762	4,693	5,455

Table G-22: Waste Generation Amount

	Category	Generation ratio (kg/bed/day)	Generation amount (ton/day)
JICA study	I	0.553	2.0
	II	0.675	0.7
	III	0.329	0.2
	Total	-	**2.9**
MSPAS 1999	I	0.652	2.4
	II	0.699	0.7
	III	0.465	0.3
	Total	-	**3.4**

As a result, the medical waste generation amount in AMSS is estimated to range from 2.9 to 3.4ton/day. This study employs the mean value 3.2ton/day for estimating the medical waste stream in AMSS.

G.3.2.3 Waste Stream

a. Waste Disposal Amount

Table G-23 shows medical waste disposal amount in MIDES Nejapa landfill from December 1999 to January 2000. It gives about 3.3ton/day of final disposal amount for medical waste.

Table G-23: Weighting Data in Nejapa Final Disposal Site

Collector	Municipality code	Medical waste disposal amount (ton/60 days)	Medical waste disposal amount (ton/days)
Municipality	01SS	40.68	0.68
	02MJ	5.56	0.09
	03CD	6.46	0.11
	05AY	-	-
	06SM	-	-
	07ST	2.72	0.05
	09SY	9.92	0.17
	10IL	-	-
	12AP	15.69	0.26
	13NJ	-	-
	total	81.03	1.36
Direct haulage	01SS	116.59	1.94
	02MJ	-	-
	06SM	-	-
	07ST	-	-
	08AC	-	-
	09SY	-	-
	10IL	0.59	0.01
	12AP	-	-
	13NJ	-	-
	total	117.18	1.95
Total		198.21	3.31

Source: MIDES S.E.M. DE C.V. , Dec./1999 to Jan. /2000

b. Waste Stream

Based on the concept shown in Figure G-17 and the outcome of the MWS, the ratios for respective components shown in Table G-24 are set up for the estimation of the medical waste stream.

Table G-24: Distribution Ratio

Item	Ratio(%)	Remarks
On-site recycling, etc.	4.9	for "generation amount"
Without treatment	23.8	for "generation amount" – "on-site recycling amount"
On-site treatment	41.8	
Off-site treatment	34.4	
Incineration	1.6	for "on-site treatment"
Disinfection	87.0	
Open burning, etc.	11.4	
Municipality collection	22.0	for "discharge amount"
Without municipality collection	88.0	

As the on-site disinfection treatment is carried out by either chemical treatment or autoclave treatment, it is assumed that the treated medical waste will increase its volume by about 30%.

Consequently, the present medical waste stream in AMSS is estimated in Figure G-18.

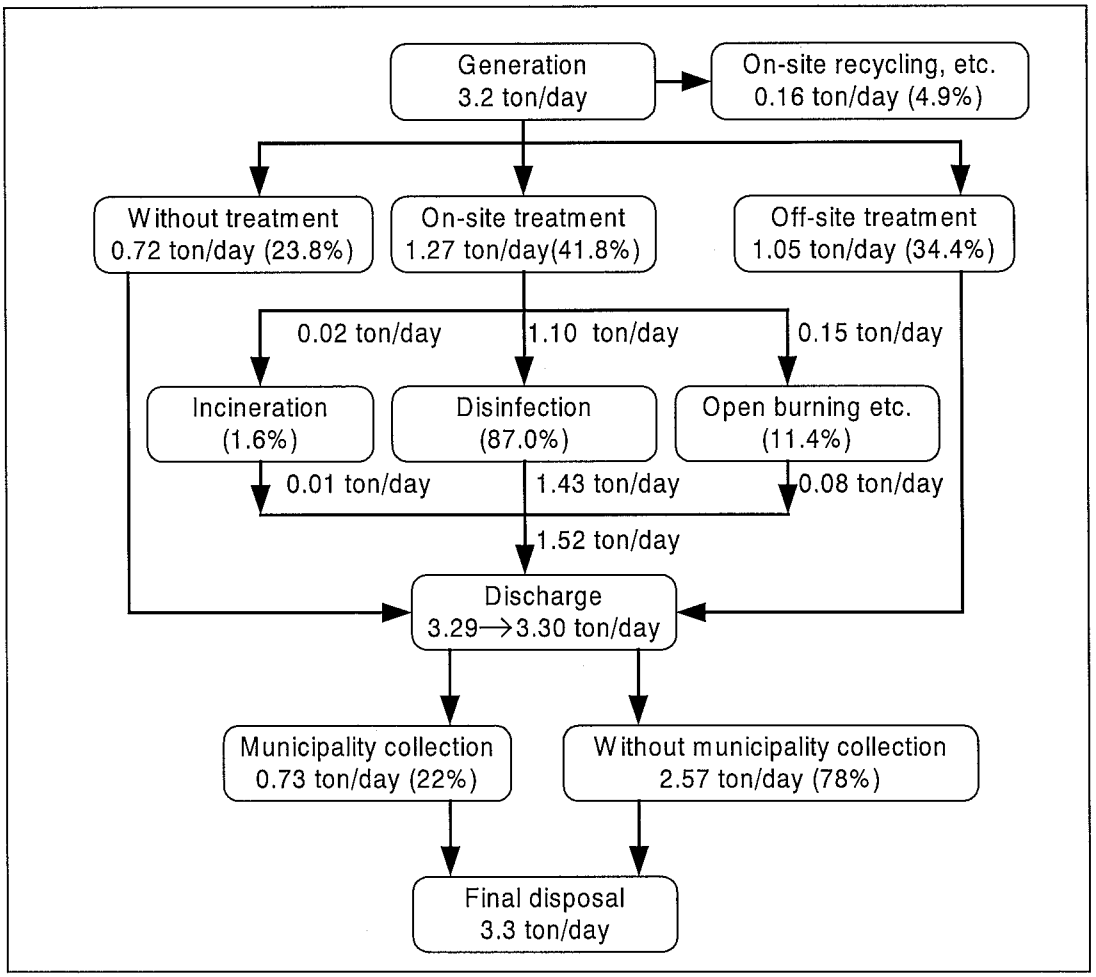


Figure G-18: Present Medical Waste Stream

G.4 Technical System

G.4.1 Storage and Discharge System

a. Storage

a.1. Households

State of storage is various depending on housing type. People living in detached houses have enough spaces for storing their wastes. Some apartment houses, where high-income people are living, have also enough space to store. Meanwhile, houses and apartment, where low-income people are living, do not have enough space to store.

According to the results of POS, 89.0% out of 420 houses are using plastic bag as a recipient of waste, 20.7% uses metal/plastic/wood container, a small population uses paper bag (1.0%) and carton box (1.4%), and 3.1% answered that they use other containers.

The top three reasons why they use such container are easy handling (47.5%), cleanness (24.0%) and keeping away form pest (12.5%).

It can be seen that many people are suffering from animal scavenging (mainly by dogs); 35.0% are frequently and 15.0% are sometimes suffering. To avoid the animal scavenging some people have elevated "Canaster" in front of their houses in which they put their wastes for collection. However, some of these still suffer from scavenging by waste pickers.

Separation at source is not common but practiced by some people. This is seen that 20.7% answered that someone comes to their houses to buy reusable and recyclable materials. As for garden waste, 41.7% answered that they produce it. Out of them, 71.3% discharges it with other wastes, 14.3% self-disposal and 5.1% composting.

As for manner of discharge, 48.0% put waste in front of their houses, 32.7% carry to containers which are placed on roads by the municipalities and 18.0% pass to collection vehicles when they come.

a.2. Institutions (Commercial entities and institutions)

According to the results of POS (total interviewee is 52 institutions), a major part of institutions, 28, uses plastic bag as recipient of waste, 19 metal container and 11 carton box. Most of the institutions, 42, stores waste within their premises.

a.3. Market

Containers mainly found in markets are concrete container, metal container ($2m^3$), and drum. Most of containers are placed in certain places under control of personnel of markets to avoid scavenging by waste pickers and animals.

b. Discharge

b.1. Households

Most of the municipalities do not recommend citizens to use a specific recipient when they discharge waste, but 2 municipalities, Cuscatancingo and Nueva San Salvador suggest to use plastic bag for the convenience of collection. No municipality requires citizens to separately discharge waste.

Meanwhile 20.7% of households answered in POS that certain person(s) comes to collect reusable/recyclable materials. This means that those households separately store such materials and do not mixed with other waste in discharging.

b.2. Institutions and Markets

According to POS, a major number of institutions, 37 out of 52, do not separate their waste for recycling. Only 6 institutions answered that they usually separate it for recycling.

A major number, especially shops, put their waste for collection in front of their buildings when they discharge. A considerable number, 10, says that collection workers come into their premises to pick up waste.

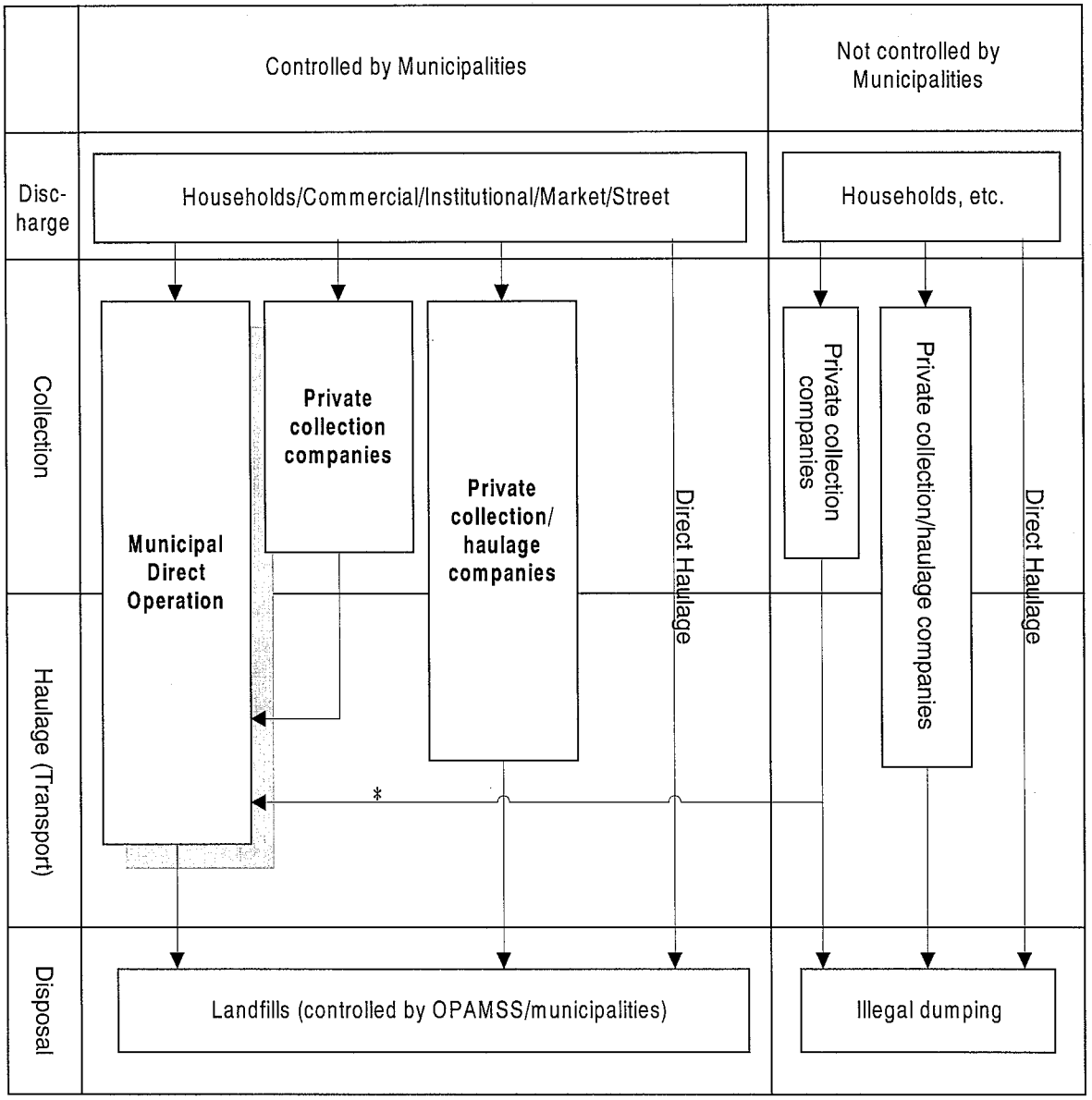
In markets, normally collection vehicle(s) comes into the premises to collect.

Table G-25: Storage and Discharge System in AMSS

Category	Storage	Discharge
Households	• not unified but use of plastic bag is preferable.	• mixed discharge prevails. • about 2/3 of households put their waste at the curb or take it out when a collection vehicle comes, the other 1/3 carry it to a container placed on the road.
Institutions (restaurant, other commercial, public institutions, etc.)	• use of plastic bag is major, but metal container and carton box are also used as container.	• a major part of institutions put their waste at the curb as well as households. • in a part of institutions, collection workers come into their premises to collect.
Markets	• waste are normally stored in certain place(s) to avoid scavenging by waste pickers and animals.	• normally collection vehicle enter into the premises of market to collect

G.4.2 Collection and Haulage System

Figure G-19 schematically shows collection and haulage system in AMSS, which can be divided into two areas; with municipalities' control (municipal direct operation and private companies' operation with contract or authorization by municipalities) and without control (operation without contract or authorization by municipalities). This section is mainly devoted to municipal direct operation, but some issues about private collectors are presented in the last part of this section.



* Waste is placed at municipalities' containers but not controlled by municipalities.

Figure G-19: Collection and Haulage System in AMSS

a. Municipal Direct Operation

In this section, the current collection and haulage system of municipal direct operation is presented.

a.1 Collection

a.1.1 Collection Method

Curb side and bell collection is a popular **collection method** in the Study Area. Waste is put on the curb side in front of the house and the collection vehicle picks up it. Also the collection vehicle inform of the arrival in the collection area with ringing a bell. Use of containers is also a widespread method. A major number of containers used in the Study Area are $2m^3$ metal containers that are compatible with $18yd^3$ and $25yd^3$

compactor trucks having a winch for lifting the container. However, some municipalities make use of concrete containers. Also, some "botadero," which is a place where waste is piled up, are considered collection points like containers in some municipalities.

Collection frequency is various depending on municipalities. The most applied frequency is 3 times a week. The 2nd one is 6 times a week. Some municipalities give downtown more collection service than other areas.

As for **collection shift**, 2 municipalities, San Salvador and Nueva San Salvador, have 3 shifts. Other 2 municipalities, Mejicanos and Ilopango, have 2 shifts. The rest of municipalities set 1 shift for the waste collection.

Table G-26: Collection Method

Municipality	Collection method	Nos. of containers	Collection frequency (times/week)		Shift (times/day)
SS	• curbside and bell • container	92 metal, 31 concrete	3		3[1]
MJ	• curbside and bell • container	8	2 and 3	Certain areas 3; others 2	2
CD	• curbside and bell • container	7	3 and 6	Basically 6	1
CT	• curbside and bell • container	6	3 and 6	Basically 3; downtown 6	1
AY	• curbside and bell • container	8	3 and 6		1
SM	• curbside and bell • container	6 metal, 9 concrete	3		1
ST	• curbside and bell • container	28	3 and 7	Basically 3; downtown 7.	3[2]
AC	• curbside and bell • container	2	6	7 days/week for market	1
SY	• curbside and bell • container	29	3		1
IL	• curbside and bell • container	6 metal, 5 concrete	2, 3 and 7		2[3]
SMT	• curb side	0	6		1[4]
AP	• curbside and bell • container	19	2		1
NJ	• curbside	0	3 and 6		1
TN	• curbside and bell • container	concrete	6		1[4]

Note:
[1] 1. 6:30-13:00; 2. 12:00-19:30; 3. 18:00-0:30.
[2] 1. 7:30-13:00; 2. 13:00-18:00; 3. 18:00-24:00.
[3] 1. 6:00-13:00, 2. 13:00-19:00, 3. 19:00-24:00, 1 and 2 are basic operation, 3 is a special operation when it is needed.
[4] 6:00-14:00.

a.1.2 Collection Area and Route

Collection areas and routes are empirically set in the most municipalities, however, San Salvador municipality has set their collection areas according to criteria; collection amount of one collection area should be less than 15,000 pounds (6,800kg) and collection work should complete within 6 hours.

The Study Team made maps that show the present collection area and collection route of each municipality according to the information from the C/Ps. On the basis of the

maps, area and length of the collection areas and the collection routes were measured (See Table G-27).

As Table G-27 shows, length of collection route per collection area (average collection route length) is various depending on municipalities, the maximum is 17.27 km in Tonacatepeque and the minimum is 3.87 km in Ilopango. The difference is extremely large.

Table G-27: Present Collection Areas and Routes

Municipality	Nos. of collection area	Collection area (km^2)		Collection route (km)	
		Total	Average	Total	Average
SS	*50	40.37	0.81	644.12	12.88
MJ	25	8.72	0.35	111.82	4.47
CD	5	6.35	1.27	54.91	10.98
CT	9	4.18	0.46	43.15	4.79
AY	2	1.07	0.54	17.26	8.63
SM	7	3.59	0.51	50.44	7.21
ST	13	6.12	0.47	112.67	8.67
AC	10	6.48	0.65	90.46	9.05
SY	17	10.83	0.64	118.02	6.94
IL	10	3.91	0.39	38.72	3.87
SMT	5	1.26	0.25	38.41	7.68
AP	7	4.87	0.70	55.39	7.91
NJ	2	1.28	0.64	25.38	12.69
TN	2	1.75	0.88	34.53	17.27
Total/average	164	100.78	0.61	1435.28	8.79

Note: * San Salvador has other 20 routes for containers besides the 50 routes.

a.1.3 Collection Vehicles

Inventory

Currently, 155 collection vehicles are working in the Study Area (See Table G-28). 134 Compactor trucks occupy the most of them (86.5%) and are used in 13 municipalities. Dump trucks are also used in 6 municipalities (19 trucks, 12.2%). Only 2 flat trucks are working in 2 municipalities (1.3%).

In 134 compactor trucks (See Table G-29), the $18yd^3$ truck counts 76 (56.7%), the $16yd^3$ truck 34 (25.4%) and the $11yd^3$ truck 20 (14.9%). Those three types of vehicles are common in the Study Area.

Table G-28: Collection Vehicles Currently Owned by Municipalities

Municipality	Compactor	Dump truck	Flat truck	Total
San Salvador	49	5	-	54
Mejicanos	9	-	1	10
Ciudad Delgado	7	-	-	7
Cuscatancingo	6	1	-	7
Ayutuxtepeque	2	-	-	2
San Marcos	7	1	-	8
Nueva San Salvador	11	4	-	15
Antiguo Cuscatlán	5	6	-	11
Soyapango	16	-	-	16
Ilopango	9	-	-	9
San Martín	4	-	1	5
Apopa	7	-	-	7
Nejapa	2	-	-	2
Tonacatepeque	-	2	-	2
Total	134	19	2	155

Table G-29: Types of Compactor Trucks Used in the Study Area

Municipality	$8m^3$ ($11yd^3$)	$12m^3$ ($16yd^3$)	$14m^3$ ($18yd^3$)	$15m^3$ ($20yd^3$)	$19m^3$ ($25yd^3$)	Total
San Salvador	5	8	34	-	2	49
Mejicanos	2	2	5	-	-	9
Ciudad Delgado	2	-	5	-	-	7
Cuscatancingo	1	2	3	-	-	6
Ayutuxtepeque	-	1	1	-	-	2
San Marcos	1	4	2	-	-	7
Nueva San Salvador	1	5	4	1	-	11
Antiguo Cuscatlán	1	3	1	-	-	5
Soyapango	3	3	9	-	1	16
Ilopango	1	4	4	-	-	9
San Martín	1	-	3	-	-	4
Apopa	1	2	4	-	-	7
Nejapa	1	-	1	-	-	2
Tonacatepeque	-	-	-	-	-	-
Total	20	34	76	1	3	134

Conditions

One third of the vehicles (48; 31.0%) have been used more than 10 years. The rest of the vehicles (107; 69.0%) have been operated less than 5 years. The operation time clearly reflects the conditions of the vehicles. The Study Team asked the C/Ps about conditions of their vehicles. Table G-30 and Figure G-20 shows the results. Bad means that the vehicle has serious problem, it can not work properly. Regular means that the vehicle has a problem but it is not so serious. Good means that there is no problem. According to Table G-30 and Figure G-20, it is clearly known that only few

vehicles are in good conditions out of the vehicles having worked more than ten years.

Table G-30: Conditions of Collection Vehicles

Year	Bad (Nos. of vehicle)	Regular (Nos. of vehicle)	Good (Nos. of vehicle)	Total (Nos. of vehicle)
1975-1989	6	34	8	48
1995-1999	2	17	88	107
Total	8	51	96	155

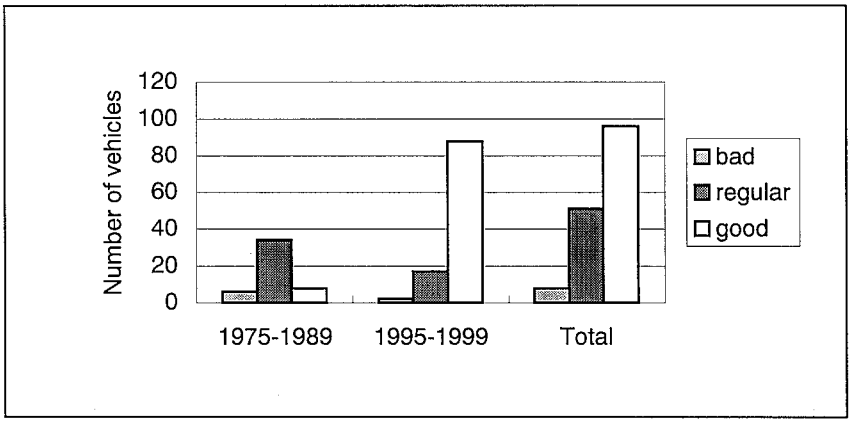


Figure G-20: Conditions of Collection Vehicles

Working rate

Based on the weighbridges' data at Mariona in 1998, working rate of vehicles were analyzed. Table G-31 clearly shows that the older vehicles, the lower working rate and vice versa. Table G-32 presents working rate at each municipality. It varies between 61.7% of San Salvador and 80.7% of Soyapango. The average working rate of vehicle in AMSS is 69.6%. However, it should be noted that this working rate does not take each municipality's own conditions into account. The working rate should be considered as one of parameters when evaluating efficiency of collection vehicles.

Table G-31: Working Rate of Vehicle according to Manufacture Year

Item	1975-1989	1995-1996	Total/average
Vehicle working days [a)]	8,515	20,884	29,399
Nos. of vehicles [b)]	46	89	135
Possible vehicle working days [c)]	14,391	27,844	42,235
Working rate [d)]	59.2%	75.0%	69.6%

Note: a) Number of days on which the vehicles worked in 1998.
b) Number of vehicles in 1998.
c) b) x 365 days x 6/7 (taking Sunday into account).
d) a)/c) in percent.

Table G-32: Working Rate of Vehicle according to Municipality

Municipality	Vehicle working days	Nos. of vehicles	Possible vehicle working days	Working rate
SS	8,305	43	13,453	61.7%
MJ	2,403	10	3,129	76.8%
CD	1,399	7	2,190	63.9%
CT	1,448	7	2,190	66.1%
AY	449	2	626	71.7%
SM	1,594	8	2,503	63.7%
ST	3,642	15	4,693	77.6%
AC	2,267	11	3,441	65.9%
SY	4,041	16	5,006	80.7%
IL	1,676	7	2,190	76.5%
AP	1,691	7	2,190	77.2%
NJ	484	2	626	77.3%
Total	29,399	135	42,236	69.6%

Productivity

Productivity of the vehicles, which are mainly used in the Study Area, i.e., 11yd^3 (8m^3), 16 yd^3 (12m^3) and 18yd^3 (14m^3), were analyzed based on the data at Mariona in 1998. Table G-33 shows considerably low productivity of the 16yd^3-compactor truck compared with the other two compactors.

Table G-34, Table G-35 and Table G-36 show average collection amount per truck through the year 1998 for each municipality. It varies between 761 ton/year/vehicle of Nejapa and 2,333 ton/year/vehicle of Mejicanos for the 11yd^3-compactor truck, 705 ton/year/vehicle of Cuscatancingo and 1,877 ton/year/vehicle of San Salvador for the 16yd^3-compactor truck, and 892 ton/year/vehicle of Nejapa and 3,316 ton/year/vehicle of Soyapango for the 18yd^3-compactor truck.

Table G-33: Productivity of Compactor Truck

Type of compactor		Ton/year	Nos. of vehicle	ton/year /vehicle	ton/year/m^3
yd^3	m^3				
11	8	32,521	19	1712	214
16	12	53,477	37	1445	120
18	14	171,273	61	2808	201
total/average		257,271	117	1988	178

Table G-34: Productivity of 11yd^3 Compactor Truck

Municipality	Nos. of vehicles	ton/year	ton/year/ vehicle
SS	5	7,675	1,535
MJ	2	4,465	2,233
CD	2	3,215	1,608
CT	1	1,580	1,580
AY	-	-	-
SM	1	1,199	1,199
ST	1	1,906	1,906
AC	1	1,785	1,785
SY	3	6,194	2,065
IL	1	1,902	1,902
AP	1	1,839	1,839
NJ	1	761	761
Total/average	19	32,521	1,712

Table G-35: Productivity of 16yd^3 Compactor Truck

Municipality	Nos. of vehicles	ton/year	ton/year /vehicle
SS	8	15,013	1,877
MJ	2	2,417	1,209
CD	-	-	-
CT	2	1,410	705
AY	1	1,094	1,094
SM	4	5,662	1,415
ST	9	12,218	1,358
AC	3	5,103	1,701
SY	3	3,293	1,098
IL	3	4,936	1,645
AP	2	2,330	1,165
NJ	-	-	-
Total/average	37	53,477	1,445

Table G-36: Productivity of 18yd^3 Compactor Truck

Municipality	Nos. of vehicles	ton/year	ton/year /vehicle
SS	22	71,838	3,265
MJ	6	16,047	2,675
CD	5	7,280	1,456
CT	3	5,984	1,995
AY	1	2,154	2,154
SM	2	3,919	1,960
ST	4	11,061	2,765
AC	1	3,145	3,145
SY	9	29,844	3,316
IL	3	8,021	2,674
AP	4	11,087	2,772
NJ	1	892	892
Total/average	61	171,273	2,808

Loading conditions

Overload would damage vehicles, while a smaller load to capacity would result in inefficient collection, e.g., fuel consumption per ton of collection amount is large and collection amount per worker is small.

Compared with payload of the trucks, 4,500kg for the 11yd^3-compactor and 7,500kg for the 18yd^3-compactor, the average loads per trip of the vehicles are generally appropriate, although there are some unevenness among municipalities.

Table G-37: Loading Condition of 11 yd^3 Compactor Truck

Municipality	ton/year	nos. trip	ton/trip
SS	7,675	1,740	4.41
MJ	4,465	969	4.61
CD	3,215	681	4.72
CT	1,580	391	4.04
AY	-	-	-
SM	1,199	230	5.21
ST	1,906	385	4.95
AC	1,785	446	4.00
SY	6,194	1,406	4.41
IL	1,902	502	3.79
AP	1,839	360	5.11
NJ	761	319	2.39
Total/average	32,521	7,429	4.38

Table G-38: Loading Condition of 16 yd^3 Compactor Truck

Municipality	ton/year	nos. of trip	ton/trip
SS	15,013	2,413	6.22
MJ	2,417	532	4.54
CD	-	-	-
CT	1,410	355	3.97
AY	1,094	217	5.04
SM	5,662	983	5.76
ST	12,218	2,606	4.69
AC	5,103	860	5.93
SY	3,293	733	4.49
IL	4,936	1,020	4.84
AP	2,330	423	5.51
NJ	-	-	-
Total/average	53,477	10,142	5.27

Table G-39: Loading Condition of 18 yd^3 Compactor Truck

Municipality	ton/year	nos. of trip	ton/trip
SS	71,838	10,809	6.65
MJ	16,047	2,679	5.99
CD	7,280	1,074	6.78
CT	5,984	1,060	5.65
AY	2,154	377	5.71
SM	3,919	574	6.83
ST	11,061	1,670	6.62
AC	3,145	455	6.91
SY	29,844	4,526	6.59
IL	8,021	1,532	5.24
AP	11,087	1,672	6.63
NJ	892	269	3.32
Total/average	171,273	26,697	6.42

a.1.4 Estimation of Collection Time

From the result of T&M survey, the following average collection amounts were obtained:

- Large compactor truck (18yd^3) collects about 2,500 kg of waste per hour, and
- Small compactor truck (11yd^3) collects about 2,000 kg of waste per hour.

On the other hand, optimum load (payload) for the large compactor truck is 7,500kg, and it for the small compactor truck is 4,500kg. Therefore, it is expected for the large compactor to fulfill its payload in 3 hours collection and for small compactor truck in 2.25 hours collection on average.

b. Haulage

Haulage, transport from a collection area to a landfill and vice versa, is conducted by the collection vehicles. However, there is one exception that MIDES transport waste from Mariona transfer site to Nejapa landfill (See Table G-40).

Currently, 10 municipalities haul their waste to Mariona transfer site or directly Nejapa landfill. Other municipalities haul their waste to Espiga disposal site or disposal sites in their own municipalities. Table G-41 shows average distance from each municipality to a disposal site.

Table G-40: Haulage Data of MIDES from Mariona to Nejapa

Item	Data
Type of vehicle	Dump truck
Nos. of vehicles	16 units
Capacity of vehicles	12.00-24.80 m^3
Nos. of trip per day	5-7 trips/day
Average haulage amount	420 ton/day

Table G-41: Haulage Distance

Municipality	Distance		
	Nejapa	Mariona	Others
San Salvador	28.9	19.9	
Mejicanos	25.5	16.5	
Ciudad Delgado	22.2	13.2	
Cuscatancingo			35[1]
Ayutuxtepeque	24.5	15.5	
San Marcos	32.1	23.1	
Nueva San Salvador	37.8	37.2	
Antiguo Cuscatlán			35[1]
Soyapango	29.3	20.3	
Ilopango	33.9	24.9	
San Martín			2[2]
Apopa	14.0	5.0	
Nejapa	9.6	2.6	
Tonacatepeque			3[3]

Note: [1] Espiga disposal site
[2] a disposal site in San Martin municipality
[3] a disposal site in Tonacatepeque municipality

c. Maintenance of Vehicles

Present situation of vehicle maintenance is also various in municipalities. 5 municipalities do not own their workshops for maintenance of the collection vehicle. Even municipalities that have workshops are having problems, such as lack of tools and spare parts. In case of Mejicanos, the cleansing section has a difficulty to control the workshop as it belongs to another section.

San Salvador has 5 mobile workshops that were donated by the Japanese government in 1996 besides two workshops. They are used for repairing out of the workshops.

Having a good workshop and operating it for the collection vehicle maintenance is not cost-effective for municipalities having small number of vehicles.

Table G-42: Workshops in AMSS

Municipality	Nos. of workshop	Remarks
San Salvador	2	1 is for corrective work and the other is for preventive work
Mejicanos	1	-
Ciudad Delgado	1	For daily inspection and small repair
Cuscatancingo	1	-
Ayutuxtepeque	none	-
San Marcos	none	When repair is necessary, a truck is brought to a private workshop.
Nueva San Salvador	1	The workshop mainly devotes the collection vehicles, but also deals with other vehicles.
Antiguo Cuscatlán	1	Beside the workshop, there is a garage where small maintenance work is available.
Soyapango	1	-
Ilopango	1	-
San Martín	none	When repair is necessary, a truck is brought to a private workshop.
Apopa	1	-
Nejapa	none	-
Tonacatepeque	none	-

d. Evaluation of Present System

Ringing bell with curbside collection would be effective to inform people of a collection vehicle coming. Curbside collection and container collection should not be mixed in one collection route, as the container collection generally requires cleansing activity around containers and it needs for a quite time. Then, the curbside collection becomes inefficient.

Some municipalities practice 6 days a week collection frequency. Such high level of service would raise the operation costs. In some municipalities two or three patterns of collection frequency are introduced, and this may cause drivers and workers confusion.

Length of collection route per collection area is various depending on municipalities. Most of municipalities do not know how much of waste is collected from a collection area. Therefore, it is necessary to know collection amount from a collection area in order to set an optimum collection area.

11yd^3, 16yd^3 and 18yd^3 compactor trucks are the major collection vehicles in the Study Area. However, the 16yd^3 compactor is showing the low working rate and the low productivity due to its old age.

Haulage to Nejapa/Mariona or Espiga requires a long distances and duration. This cause large fuel consumption, shorter time for collection.

Maintenance of vehicle is not in good conditions in the most municipalities. It is difficult for small municipalities to have a workshop with appropriate tools, spare parts and personnel, as such a workshop needs a large investment and operation costs.

Consequently, the collection and haulage in AMSS are working fairly well. This would be because that the municipalities have enough experience of operating it and the personnel concerned have been get used to it. However, problems actually exist in the collection and haulage. Those are;

- the working rate and productivity decline of the 16yd^3 compactor,
- the haulage occupying the considerable portion (time and distance) in a trip, and
- the poor maintenance (in the most municipalities).

e. Private Collection

In 1995 there were 20 micro-enterprises[8] located in six municipalities of AMSS, as shown in Table G-43. These enterprises collected, transported, recovered, separated and composted wastes.

The recovery and separation enterprises originated in the 60's, whereas the collection ones were formed during the 80's and the compost plants in the 90's, along with some collection facilities. According to the researcher, all of them were originated due to the lack of collection service provided by the municipalities; this fact agrees with the political and social events that took place in El Salvador. However, the oldest facility was formed in open dumping sites; i.e., by recovering those wastes with a commercial value, such as bottles, paper, and so on.

[8] Meléndez, *Microempresas y Cooperativas en Gestión de residuos Sólidos en EL Salvador*, 1996

Table G-43: Micro-enterprises in AMSS in 1995

Activity	Municipality	Nos.
Collection and haulage	Nueva San Salvador	2
Composting	Apopa	1
Collection	San Salvador	1
Haulage	San Salvador	1
Collection	Mejicanos	4
Recovery	Apopa (Mariona final disposal site)	10
Collection and haulage	San Martín	1
Total		20

Source: Meléndez, *Microempresas y Cooperativas en Gestión de Residuos Sólidos en El Salvador*, 1996.

Currently there are more of these enterprises that have expanded to 12 municipalities of the metropolitan area. According to the units in charge of sanitation services, 48 micro-enterprises devoted to the collection, haulage, recovery and composting service have been identified. Out of this total, 37 that account for 77.08% are devoted to housing collection, whereas the remaining service other sectors, Table G-44 shows next.

Table G-44: Distribution of Registered Micro-enterprises in AMSS in 1999

Municipality serviced	Hospital	Housing	Industry	Bonding industry	Markets	Markets and housing	Rest.	Street sweeping	total	%
San Salvador	1	7	-	-	2	-	1	1	12	25.00
Mejicanos	-	5	-	-	1	-	-	-	6	12.50
Ciudad Delgado		1							1	2.08
Ayutuxtepeque		2							2	4.17
San Marcos		3		2					5	10.42
Nueva San Salvador		2							2	4.17
Antiguo Cuscatlán			1						1	2.08
Soyapango		5							5	10.42
Ilopango		6				1			7	14.58
San Martín		2							2	4.17
Apopa		1						1	2	4.17
Tonacatepeque		3							3	6.25
Total	**1**	**37**	**1**	**2**	**3**	**1**	**1**	**2**	**48**	
%	2.08	77.08	2.08	4.17	6.25	2.08	2.08	4.17		

Source: Prepared with the information provided by AMSS municipalities.

If compared with that stated by Meléndez in 1995, a rapid increase of private participation is observed, specially in the field of collection. It is observed that the rate for the municipality of San Salvador the total number accounts for 25% from the total. The field of work allowed to these enterprises by the municipalities are those areas where the conventional collection service cannot access. Regarding the contract type in 1999, none of these micro-enterprises is paid by the municipality; 16 out of these are contracted by the municipality, 9 are authorized by the municipality and directly charge the service to users, 14 are running on their own without the authorization by the municipality and the remaining 9 are allowed to operate in coordination with the municipality and both charge for the service (Table G-45). A

typical example is Mejicanos, which directly charges to the users and carry out door-to-door collection, since they work in an apartment building area and carry the wastes to a place where municipal trucks pick up such wastes, which in turn are carried to the sanitary landfill.

Table G-45: Current Contract Type

Municipality serviced	Concession (under municipal authorization)	Contract with municipality	Under their own risk	Permit and/or municipal coordination	Total	%
San Salvador		10	1	1	12	25.00
Mejicanos		1		5	6	12.50
Ciudad Delgado		1			1	2.08
Ayutuxtepeque				2	2	4.17
San Marcos	1	3	1		5	10.42
Nueva San Salvador	2					4.17
Antiguo Cuscatlán			1		1	2.08
Soyapango	5				5	10.42
Ilopango	1		6		7	14.58
San Martín			2		2	4.17
Apopa		1		1	2	4.17
Tonacatepeque			3		3	6.25
Total	**9**	**16**	**14**	**9**	**48**	
%	18.75	33.33	29.17	18.75		

Source: Prepared with the information provided by AMSS municipalities.

On the other hand, the coverage by the micro-enterprises is shown in Table G-46, which was prepared according to the information by DIGESTYC. It is observed that by 1992 private service was rendered to 12.43 % of houses in AMSS; by 1998 the private service decreased to 6.75% due mainly to the improvement in the municipal collection service, and as of 1999 the municipalities are seeking to expand their service coverage. Such is the case for San Salvador, which is executing the service by means of micro-enterprises, as marginal zones are the most uncovered part by the service and it is where these micro-enterprises are working since 1998 and are now consolidating their work. The current trend in AMSS is to expand the coverage of the service by means of micro-enterprises in those uncovered areas.

Table G-46: Coverage of the Collection Service

Municipality	Municipal Service 1992[1/] (%)	Private service 1992[1/] (%)	Municipal service 1998[3/] (%)	Private service 1998[3/] (%)
San Salvador	78.07	4.04%	80.57	0.57
Mejicanos	55.99	16.97%	65.63	19.27
Delgado	33.59	1.80%	71.00	4.00
Cuscatancingo	39.48	3.26%	70.97	0.54
Ayutuxtepeque	53.60	2.41%	66.67	0.00
San Marcos	53.76	2.44%	63.69	1.12
Nueva San Salvador	61.72	22.10%	67.06	26.47
Antiguo Cuscatlán	88.80	2.86%	92.11	0.00
Soyapango	48.85	36.90%	82.11	12.63
Ilopango	52.05	9.54%	40.12	9.88
San Martín	15.18	14.81%	52.63	12.72
Apopa	59.39	2.00%	72.73	0.00
Nejapa	10.92	0.28%	52.66	0.00
Tonacatepeque	14.40	0.28%	NA	NA
Total	57.14	12.43%	67.09	6.75

It should be pointed out that the tendency of recovery micro-enterprises is to disappearance, at least in the manner shown by Meléndez in 1995; i.e., at the final disposal site, because currently scavengers are not allowed in Nejapa sanitary landfill. Therefore, these micro-enterprises will have to change their recovery strategy. It is also important to say that MIDES project has a transfer station with material recovery facilities; this would allow scavengers to carry out their activities within a different environment.

G.4.3 Processing, Treatment and Recycling System

Large-scale processing, treatment and recycling system has not yet been found in the Study Area. In some municipalities, composting plants are operated by municipality, private company and NGO. San Salvador Municipality operates a composting plant nearby Mariona transfer site. In Mejicanos, a private company who manages cleansing in market operates a composting plant. In Ilopango, a NGO collects waste from each house and operates a composting plant at a place next to the former Ilopango disposal site. Details of the composting plants are described in Table G-47.

A major activity regarding recycling in the informal sector is found in Mariona transfer site. There are about 300 waste pickers in the site, and they sort recyclable materials, such as aluminum cans, paper, iron and glass bottles. The MIDES project has a program to construct and operate a separation plant for recycling, and the current sorting activity found in Mariona is to be transferred to the separation plant. However, it has not been realized.

Table G-47: Composting Plants in AMSS

Municipality /items	Description
San Salvador	
Biginning:	August 1997
Name and address:	Cantón el Angel, colonia Santa Carlota N°2. municipio de Apopa, sobre calle que conduce de Apopa a Nejapa.
Operator:	Gerencia de Empresas e inversiones Municipales. Y Gerencia de Saneamiento Ambiental
Source:	Waste coming from Markets, mainly from the wholesale market, Tiendona.
Input and out put:	Between February and December 1999, Input: 2,786,256 pounds (1,263.8 ton) of market waste 253,296.00 pounds / month (114.9 ton/month) 8,443 pounds / day (3.8 ton/day) Output: 378,928 pounds (171.9 ton) of compost (13.6%yeild)
Chemical characteristic	C/N ratio = 3.78 PH = 8.30 Total nitrogen = 1.55% Phosphorous = 0.90% P_2O_5 = ND Potassium = 0.27% Carbon = 5.87%, (Analysis on 28 October 1999 by the laboratory of the University of El Salvador, Agronomic Sciences. Some heavy metals were found such as lead)
Operation process:	Layer placement, of thick materials of previous piles, extraction of undesirable materials such as plastics, final cover with layer of fine material coming from previous piles, Processing time: two and a half months, In the 1st month turning is once in 3 or 4 days; 2nd month once in 5 or 6 days; and 3rd month once in 7 or 8 days Taking temperature every day, Registered maximum temperature 75 °C. 15 employees are working
Sale price, and main buyers	¢ 40.00 colons the 100 pounds (45.4 kg). Main buyers are NGO environmentalists, High demand in the rain season
Mejicanos	
Biginning:	June 1998
Name and address:	Colony Zacamil, terminal of buses route 44
Operator:	Microempresa (Cooperative of Recolectores ABAZAC)-foundation ABA
Source:	Waste coming from Markets, livestock manure from Mexicano slaughterhouse, sawdust from carpentries, etc.
Input and out put:	Input: 23,800 pounds (10.8 ton) of market waste, 300 pounds (136.1 kg) of Manure, 160 pounds (72.6 kg) of sawdust, 335 pounds (152.0 kg) of hay, 350 pounds (158.8 kg) of compost of piles, for a total of 24,945 pounds (11.3 ton).

Municipality /items	Description
	Output: They obtained a produccion 1,100 pounds (0.5 ton) (4.4% yeild)
Operation process:	Materials are placed by layers, the first layer is of thick material of previous piles, dry matter and grass successively are piled Processing time 4 to 5 months, turnning is every 8 days, Taking temperature once per week, registered maximum temperature 50°C 3 employees are working
Sale price, and main buyers	¢ 35.00 and ¢ 40.00 colons per 100 pounds (45.4 kg) Main buyers are NGOs environmentalists, High demand in the rain season
Ilopango	
Biginning:	March 1999
Name and address:	Cantón Shangallo, calle a Asino, Antiguo botadero de Ilopango
Operator:	Fundación ABA
Source:	Rastro de Soyapango: livestock manure, Beneficio de Arroz: rice bran Municipal Market Col. Santa Lucia(50 users): mainly vegetables waste Housings (130 unidades): kitchen waste except meats. Between March and December of 1999.
Input and out put:	Input: 200,000pounds (90.7 ton) of households waste, 46,766 pounds (21.2 ton) of livestock manure, 23,612pounds (10.7 ton) of rice bran, 5,515pounds (2.5 ton) of dry hay, 100pounds(45.4 kg) of compost, 1,997pounds (0.91 ton) of chicken manure, 277,990pounds (125.1 ton) of materials in total (27,799 pounds/month (12.6 ton/month), 927pounds /day (420 lg/day)) Output: 50,000 pounds (22.4 ton) of compost (17.99% yield)
Chemical characteristic	C/N ratio = 7.13 PH in H_2O = 7.7 volatile compounds = 30.40% Nitrogen = 2.37% Phosphorous = 0.912% P_2O_5 = 2.090% Potassium = 0.616% Potassium in K_2O = 0.742% Analysis; February 4 the 2000 by the laboratory of PROCAFE, heavy materials were not analyzed.
Operation process:	Materials are placed by layers, the first layer is of thick material of previous piles, dry matter and grass successively are piled Processing time is three months, turning practices each 15 or 20 days, taking of temperature once per week, registered maximum temperature 68 °C, 2 employees are working.
Sale price, and main buyers	¢ 40.00 colons the 100 pounds (45.4 kg). Main buyers are NGO environmentalists, High demand in the rain season

G.4.4 Street Sweeping System

Manual sweeping method occupies the major part of the street sweeping in AMSS. Only San Salvador has five mechanical sweepers.

Table G-48 shows that 453km of streets are manually swept and 644 workers are engaged. Each sweeper is in charge of a certain length of street with the equipment specialized for the street sweeping; a drum, blooms and a handcart to carry them.

San Salvador's mechanical sweepers are used for sweeping of main streets in the city.

Table G-48: Length of Manual Street Sweeping

Municipality	Length (m)	nos. of Sweeper	m/sweeper/day
SS	269,509	450	599
MJ	29,060	34	855
CD	15,036	9	1,671
CT	8,970	9	997
AY	2,660	2	1,330
SM	7,010	8	876
ST	43,080	66	653
AC	51,630	30	1,721
SY	12,618	12	1,052
IL	1,760	3	587
SMT	1,700	4	425
AP	5,615	10	562
NJ	668	4	167
TN	3,225	3	1,075
Total	452,541	644	703

Table G-49: Length of Street Sweeping by Mechanical Sweeper

Length (m)	Mechanical sweeper	m/unit/day
55,260	5	11,052

Table G-50: Road Sweepers owned by San Salvador

Capacity (yd^3)	Capacity (m^3)	Maker	Date of manufacture	Conditions
3	2	Elgin	1996	Good
3	2	Elgin	1996	Good
5	4	Jhonston	1998	Regular
5	4	Jhonston	1998	Regular
5	4	Jhonston	1998	Regular

G.4.5 Final Disposal System

G.4.5.1 Final Disposal Sites used in the Past and Today

Final disposal sites used in the past and today by the 14 municipalities are listed in the table below.

Table G-51: Final Disposal Sites Used by the 14 Municipalities

	1995 [1]	1997 [2]	Present [3] (1999)	Remarks
San Salvador	Mariona (19.9km)	Mariona (19.9km)	MIDES (28.9km)	
Mejicanos	Mariona (16.5km)	Mariona (16.5km)	MIDES (25.5km)	
Ciudad Delgado	Mariona (13.2km)	Mariona (13.2km)	MIDES (22.2km)	
Cuscatancingo	Mariona (12.2km)	Mariona (12.2km)	ESPIGA (35km)	
Ayutuxtepeque	Mariona (15.5km)	Mariona (15.5km)	MIDES (24.5km)	
San Marcos	Mariona (23.1km)	Mariona (23.1km)	MIDES (32.1km)	
N. San Salvador	Mariona (37.3 km)	Mariona (37.3 km)	MIDES (37.3km)	
Antig. Cuscatlan	Mariona (42.2km)	Mariona (42.2km)	ESPIGA (35km)	
Soyapango	Mariona (20.3km)	Mariona (20.3km)	MIDES (29.3km)	
Ilopango	Botadero de Ilopango (3.0km)	Mariona (24.9km)	MIDES (33.9km)	
San Martin	Botadero de Tonacatepeque (a few km)	Botadero de San Martin (a few km)	Botadero de San Martin (a few km)	
Apopa	Mariona (5.0km)	Mariona (5.0km)	MIDES (14.0km)	
Nejapa	Mariona (2.6km)	Mariona (2.6km)	MIDES (9.6km)	
Tonacatepeque	Botadero de Tonacatepeque (a few km)	Botadero de Tonacatepeque (a few km)	Botadero de Tonacatepeque (a few km)	

Note: [1] source: the Doble-G report (Proyecto de Mejoramiento del Manejo de los Desechos Sólidos de la Región Metropolitana Fase1 Diagnóstico Mayo, 1995).
[2] source: PAHO report (Análisis Sectorial de Residuos Sólidos El Salvador Agosto, 1998).
[3] source: surveyed by this study
Distance to final disposal sites: Departomento de Informática, OPAMSS.

G.4.5.2 Transport Distance to Final Disposal Site

a. Ilopango Municipality

In 1995, Ilopango municipality disposed of their municipal waste at the Ilopango open dumping site. The transport distance at that time was considerably short. However, as the environmental pollution problem of the dumping site became outstanding, the municipality decided to bring their waste to the Mariona disposal site that was about 25km away from the municipality. Today the municipality brings their waste to the MIDES landfill site that is about 34km away from the municipality.

b. San Martin and Tonacatepeque

Since long time ago, Tonacatepeque municipality disposes their waste at the open dumping site in the same municipality. It is estimated that due to mainly financial restriction on municipal budget for SWM, the municipality is and was unable to transport their waste to a distant disposal site either to the former Mariona site nor to the present MIDES Nejapa site or ESPIGA site.

Considerable years ago, San Martin municipality disposed of their waste at the open dumping site at the Tonacatepeque municipality. Since such disposal was rejected by the Tonacatepeque municipality, San Martin was forced to dispose their waste at some ravine in its municipality such as San Martin #1 open dumping site where soil cover on disposed waste is hardly difficult to carry out.

Today, San Martin and Tonacatepeque municipalities dispose of their waste respectively at their own dumping site. In so doing, transport distance becomes significantly short, however, there remains problems of environmental contamination by disposed waste.

c. Municipalities that Use MIDES Nejapa Landfill Site Today

10 municipalities such as San Salvador, Mejicanos, Ciudad Delgado, Ayutuxtepeque, San Marcos, Nueva San Salvador, Soyapango, Apopa, Nejapa, and Ilopango (mentioned above) use MIDES Nejapa landfill site today.

Before the MIDES project, they used to use the Mariona site, to which the transport distance was about **9km** shorter than that to the MIDES Nejapa site today for the 8 municipalities such as San Salvador, Mejicanos, Ciudad Delgado, Ayutuxtepeque, San Marcos, Soyapango, Apopa and San Martín.

As for Nejapa municipality, transport distance to the new disposal site (i.e., MIDES site) become about **7km** longer than to the former disposal site (i.e., Mariona site).

As for Nueva San Salvador municipality, transport distance to MIDES Nejapa landfill is approximately same as that to Mariona site.

d. Cuscatancingo and Antiguo Cuscatlán

Cuscatancingo and Antiguo Cuscatlán municipalities used to dispose of their waste at Mariona site, and their transport distances were about 12.2km and 42.2km respectively.

Today they bring their waste to ESPIGA site. The transport distance to the site from respective municipalities is about 35km. The transport distance to ESPIGA site for Antiguo Cuscatlán municipality becomes about **7km shorter** than to the formerly used Mariona site. On the other hand, as for Cuscatancingo municipality, it becomes about **23km longer**.

Formerly the two municipalities did not bear the disposal cost at Mariona site, however, today they pay the disposal fee to the owner of the ESPIGA site.

G.4.5.3 Location of Existing Final Disposal Sites

The figure below shows locations of final disposal sites currently used by the 14 municipalities of AMSS.

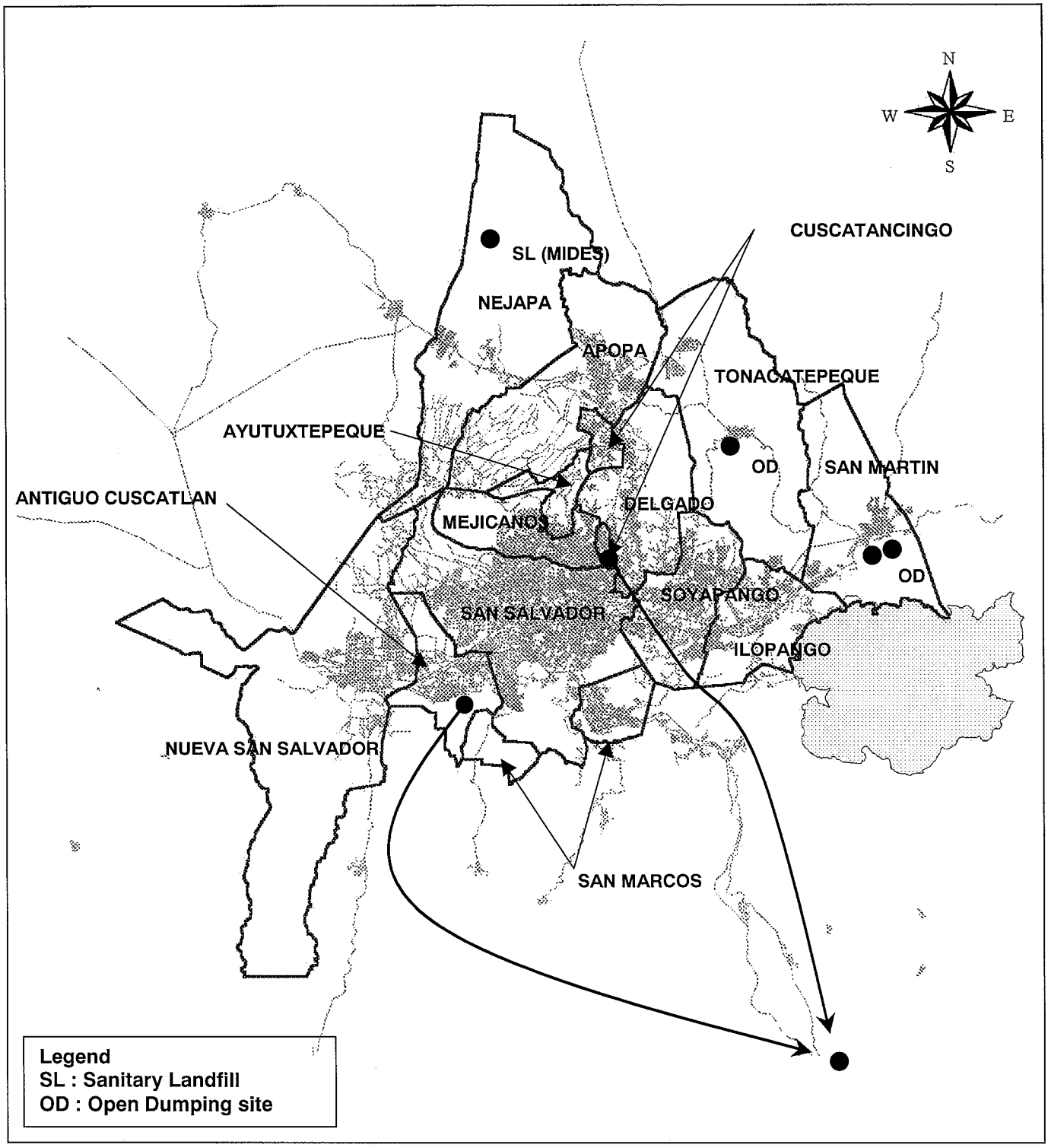


Figure G-21: Locations of Existing Final Disposal Sites

G.4.5.4 Landfilling Operation

Important practices of landfilling operation comprise accumulation/compaction of waste disposed and the daily soil coverage over the waste. However, the intensity of those practices is very different among the 4 sites (see Table G-52).

MIDES landfill constantly applies heavy equipment (such as, bulldozer, vibro-compactor, loader and dump trucks) for daily works of waste accumulation/compaction and soil cover on disposed waste.

ESPIGA site occasionally arranges a bulldozer, a vibro-compactor and a motor-grader for the waste compaction works and soil cover on top of the buried wastes.

As for so-called open dumping sites of San Martin and Tonacatepeque, mechanical equipment for waste accumulation and/or compaction is not stationed at the sites. With a help of DUA, those sites arrange the soil cover over the disposed waste once in a while.

Table G-52: Landfilling Operation of Respective FDS

Item	Nejapa MIDES	Chuca ESPIGA	San Martin open dumping site	Tonacatepeque open dumpig site
Working days	6 days a week (Mon. – Sat.)	6 days a week (Mon. – Sat.)	6 days a week (Mon. – Sat.)	6 days a week (Mon. – Sat.)
Working equipment	Constant arrangement of Bulldozer, Compactor, as well as Loader and dump trucks (for cover soil transport), and water tanker.	Occasional arrangement of Bulldozer, Compactor, and Motor-grader	Basically no.	Basically no.
Weigh-bridge control	Yes	No	No	No
Daily disposal amount	about 1000 ton	about 70 ton	about 30 ton	about 20 ton
Working cell size	Basically same as the daily disposal volume	Not managed	Not managed	Not managed
Daily soil coverage	Not daily but frequent	No (occasional)	No (once in one or two weeks)	No (once in one or two weeks)

It is appreciated but is also as a matter of course that the MIDES site has stationed heavy equipment for waste accumulation/compaction and applies soil coverage practices because the site receives as much as about 1000ton/day. In other words, if such appropriate practices are not enforced, environmental problems by 1000ton/day would be huge.

Meanwhile, as for ESPIGA site which receives about 70ton/day, it is awaited that daily waste accumulation/compaction and soil coverage should be practiced.

As for San Martin and Tonacatepeque open dumping sites, it would be very appreciated that if they are improved to apply once- or twice- a week of soil coverage. However in practice, it would be very difficult to cover soil over the disposed waste since the waste is dumped down in a ravine slope in these sites.

G.4.5.5 Landfill Structure (Specification)

The table below summarizes the landfill structure of the MIDES sanitary landfill and other 3 disposal sites that are used by the municipalities in AMSS.

Table G-53: Landfill Structure of Existing Disposal Sites

Item	MIDES Sanitary Landfill	Other 3 sites
Bottom Impermeable Liner	2 layers. (One High-Density Polyethylene (HDPE) geo-synthetic impermeable membrane of 1.5mm thick and placed over a geo-composed membrane (bentonite – geo-textile) and/or clay, compacted according to the form and nature of the soil at the site. *	No
Leachate collection system	A drainage layer with a minimum thickness of 450mm of granular material for drainage. A minimum slope of 1 to 2% to work as a gravity drainage. HDPE drilled pipeline.*1	No
Leachate treatment system	3 lagoons. The 1st lagoon is equipped with aerators. It is planned to construct and operate 3 Nos. of evaporation lagoons of 20,000m^2 on the 12m elevation of the filled cells. However, it is not practiced yet.	No
Biogas removal system	Although it is planned in the EIA report, not practiced yet to date. The report says "The system will be formed by removal shafts with a diameter of 600mm, drilled from the top part of the land up to a depth from 5 to 6m, ... A drilled polyvinyl chloride (PVC) piping will be installed within the shaft. The piping will be surrounded by pure rock."	No
Top liner	It is planned.	Not planned

Note. * Source: Estudio de Impacto Ambiental, Mejoramiento del Manejo de los Desechos de la Región Metropolitana de San Salvador, Enero 1998.

The landfill structure designed for the MIDES Nejapa site is good enough to protect the environment. The problem with MIDES landfill is that some of the measures proposed such as evaporation lagoons and biogas removal are not constructed yet.

Although the other three sites are already in use since a few years before, it is impossible today to add bottom impermeable liner or leachate collection/treatment system. A possible additional improvement measure for the 3 sites, regarding the structure, is biogas removal system. Another structural recommendation could be to employ final soil cover with enough thickness for reducing the long term environmental contamination when the 3 sites are closed.

G.4.5.6 Landfill Management

Landfill management can normally be referred to the management for **mitigating** negative environmental impacts of landfill (e.g., hygiene and safety control for people related to the landfill site, or leachate/biogas/odor management etc.). However, in addition to the mitigation management, there are **precautious** ways of the landfill management, for example environmental monitoring (of air, ground and surface water, landfill subsidence). And there are also **active** ways of landfill management in view of long term effect of disposed waste and future reuse of the sites.

Therefore, the current landfill management of the 4 sites will be diagnosed herewith by categorizing as follows.

a. Mitigation Management
b. Precaution Management
c. Active management

a. Mitigation Management

Mitigation management of final disposal system can be referred to:

- Hygiene control and safety control (including waste-pickers control)
- Leachate management (including surface water control)
- Biogas management
- Odor management

The table below summarizes the mitigation management of the 4 disposal sites in AMSS.

Table G-54: Mitigation Management of Final Disposal Site

Item	Nejapa MIDES	Chuca ESPIGA	San Martin open dumping site	Tonacatepeque open dumping site
Hygiene control (incl. vector control)	Acceptable (frequent soil cover)	Need to be improved	Need to be improved	Need to be improved
Scavenger control	Off-limits by fence. Scavenging is prohibited.	Fence. Scavenging is allowed.	No fence. No Control	No fence. No control.
Safety control	OK	Need to be improved	Need to be improved	Need to be improved
Leachate management	Yes	No	No	No
Surface water management	Yes (however, not satisfactory in 1999)	Need to be improved	Need to be improved	Need to be improved
Biogas management	No yet	No	No	No
Odor management	Yes (mainly by daily compaction and frequent soil cover)	Need to be improved	No	No

a.1 Hygiene and Scavenger Control

While MIDES site has sufficient control over hygiene and scavenging, the other 3 sites need to be improved in this context.

a.2 Surface Water Management

In the rainy season in 1999, mismanagement of surface water in MIDES site resulted in a huge generation of leachate and its discharge to the surrounding environment.

As for the former San Martin open dumping site, a vertical shaft (pozo) was constructed to connect to the storm sewer below buried waste with an aim of reducing leachate generation and its contamination. However, maybe because it is the dry season today, surface water control ditches are not yet constructed to connect to the vertical shaft. It is awaited that before the rainy season comes the surface runoff of rain water should be well controlled to direct to the vertical shaft.

b. Precautious Management

As for precautious management of final disposal system, MIDES Nejapa project plans to implement a set of precautious management, however, some of them such as groundwater monitoring are not practiced yet.

The other 3 sites do not employ any substantial measures the precautious management.

Table G-55: Precautious Management of Final Disposal Site

Item	Nejapa MIDES	Chuca ESPIGA	San Martin open dumping site	Tonacatepeque open dumping site
Leachate analysis	Yes	No	No	No
Groundwater monitoring	No yet	No	No	No
Biogas travel monitoring	No	No	No	No

c. Active Management

When viewing an objective of stabilizing the disposed waste, "active management" can be referred to several measures of facilitating the decomposition of the waste disposed.

c.1 Leachate Re-circulation

Not-costly and effective method for leachate treatment is to collect and re-circulate the leachate through landfill. During the early stages of landfill operation the leachate will contain significant amounts of total dissolved solid(TDS), BOD, COD, nutrients, and heavy metals. When the leachate is re-circulated, the constituents are attenuated by the biological activity and by other chemical and physical reactions occurring within the landfill. For example, the simple organic acids present in the leachate will be converted to CH_4 and CO_2, because of the rise in pH within the landfill. An additional benefit of recycling is the recovery of landfill gas that contains CH_4.

Table G-56: Landfill Active Management

Item	Nejapa MIDES	Other 3 sites
Leachate re-circulation	Not implemented as planned.	No
Biogas extraction	It is planned.	No plan

MIDES project proposed the leachate re-circulation. However, this is not practiced as planned, even though the landfill level already reaches to the 12 meter high on which evaporation lagoons (3 Nos. of 20,000m^2) is to be constructed.

c.2 Biogas Reuse

MIDES project also proposed biogas extraction system. However to date, no works of biogas removal shafts started.

G.4.6 Other SWM Activities by NGOs

There are a number of NGOs which are active in providing some assistance for the improvement of environmental problems especially on waste in AMSS. Table G-57 outlines the major activities and the background information on some of the active NGOs which have been carrying out campaigns or educational programs on solid waste issues.

The roles that NGOs play for the improvement of peoples' lives at grass root level and for the sustainable development of beneficiaries are becoming more and more important in the field of SWM. In this regard, Ministerio de Medio Ambiente y Recursos Naturales (MARN) has meetings with NGOs regularly in order to facilitate communication with and among them. It is also vital to coordinate activities and enhance cooperation among governmental organization, NGOs and international aid agencies in order to avoid duplication of their activities and multiply their effects. The major activities of five active NGOs in solid waste field are summarized below.

a. CESTA (Fundación Centro Salvadoreño de Tecnología Apropiada)[9]

CESTA is one of the most active NGOs carrying out activities on solid waste issues, though its activities are diverse covering different fields in the environmental sector. Since its foundation in 1987 as a vocational training workshop such as bicycle assembly, CESTA provides education on solid waste such as waste separation for composting, waste handling, and recycling, etc. at schools, municipalities, and communities. It carried out pilot project for composting in La Cruz Quarter of Suchitoto municipality, province of Cuscatlán in 1996 and 1997. CESTA developed "bicycle waste collector (bicirrecolector)" and they were used for the collection of waste in the pilot project. Campaign called "Evita La Basura", which aims to encourage residents to be aware of the problems of waste, has been also initiated by CESTA.

b. UNES (Unidad Ecológica Salvadoreña)

UNES has been working towards environmental conservation since 1987. It has experiences in providing environmental education on waste separation in the communities, municipalities, and schools.

c. Procomes

Working together with Fundación Olof Palme, Procomes provided alternative means of living to children who are living at the Mariona disposal site with the project called Recycling Hopes(Reciclando esperanzas) in 1998. Children under the scheme of this project were encouraged to collect papers, plastics, and cans, etc. and certain allowance is paid to them in exchange with the collected materials. As a precondition for participating in this project, children must attend schools. In this way, children have not only income to live but also a chance to receive education.

d. Fundación Olof Palme (FOP)

Fundación Olof Palme aims to protect human rights of children who are working under severe circumstances or are living on the streets or parks. Most of these children FOP supports do not have parents. In cooperation with Procomes, it has worked for the project, Recycling Hopes (Reciclando esperanzas).

e. Fundación ABA

Fundación ABA promotes establishing cooperatives which deal with collection and treatment of solid waste. It also provides technology transfer in composting as well as enhances capacity building on SWM. Environmental education on waste management is also provided with the cooperation of NGOs, schools, cooperatives, universities, markets and municipalities.

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[9]CESTA, "Experiencia Piloto del Manejo de Desechos Putrecibles en Barrio La Cruz, Suchitoto", 1997

Table G-57: SWM Activities by NGOs

Name of NGOs	Year of Establishment	Number of Staff	Special Field of Work	Areas of Work	Experiences of Campaign or Environmental/ Sanitary Education on SWM	Sponsors
CESTA[1]	1987	55	Protection of environment	Urban and rural areas in Dept. of San Miguel, Santa Ana, Sonsonate, San Vicente, Cuscatlán, Morazán, La Libertad and Usulután	• Environmental education on waste in educational centers and municipalities • Promotion of reducing, reusing, and Recycling of waste • Planning and investigation for composting • Providing advice to municipalities and some groups for waste separation and composting	Hivos (Holland), MS (Denmark)
UNES[2]	1987	15	Environment	San Luis(La Paz), Quezaltepeque (La Libertad), Soyapango (San Salvador), Apopa(San Salvador)	• Education on solid waste problems • Education on waste separation for composting • Education on waste separation methods at schools	Novib (Holland), DANIDA (Denmark), Fundación Böll (Germany)
Procomes[3]	1988	30	Environment, credit	San Salvador, Apopa, Soyapango	• "Recycling Hopes" Project (1998-99)	Procomes e Intermon
Fundación Olof Palme[4]	1988	5	Protection of victimized children	Markets, parks, streets, disposal site(Nejapa)	• Helping children working and living on the streets and protecting their human rights • Joint work with Procomes for "Recycling Hopes" project	
Fundación ABA	1998	9	Solid waste (cooperatives)	San Salvador (#1,2,3,4,5), Mejicanos (Zacamil), Ilopango, Cojutepeque	• Capacity building on SWM • Capacity building on composting • Capacity building on solid waste legislation • Formation of ecology groups	MIDES, UNEX, Hivos (Holland)

Note:
[1] Fundación Centro Salvadoreño de Tecnología Apropiada
[2] Unidad Ecológica Salvadoreña
[3] Asociación de Proyectos Comunales de el Salvador
[4] Fundación Olof Palme

G.4.7 Medical Waste Management

In El Salvador, the Ministry of Health has been working with medical waste programs since 1993 because of the initiatives and technical assistance provided since 1989 by the Pan-American Health Organization. This entity formulated a project for all the capital cities in Central America in 1990, a program that was adopted by the European Union in 1991 and commissioned in April 1994; such program was known as ALA 91/33 agreement whose purpose was to install a medical waste collection and treatment system in the six capital cities of Central America.

Unfortunately the program required 40% of qualified counterpart staff and funds for an office in the country, lands and infrastructure for the treatment plants. As a consequence, progress was slow and resources became more and more scarce and the extent of scopes of the program was also reduced; only the initial components and a small management equipment supply remained. Finally, after operating during 56 months (instead of 40) the program ended in December 1998. The final products of the program consist of four manuals for the following participants: health technicians and inspectors, medical and nursery staff, administrative and managerial personnel, as well as a popular version for the general services staff.

The ALA 91/33 program initiated a training and awareness process that cannot be overlooked, now that the diagnosis of medical waste management is being conducted. There exist highly professional medical units that deal with the problems and solve them, and perhaps the most important fact is that the biggest medical units have equipment, inputs, infrastructure and budget to pay for external services, who generate more than 80% of hospital waste.

Another remarkable point is that within the framework of the ALA 91/33 program the Ministry of Health installed a bio-infectious waste collection and final disposal system that is working since October 1st, 1997 for the 9 public hospitals in AMSS. Likewise, under an initiative of AMSS, a private haulage company already renders the service to the six hospital centers of ISSS and the biggest private hospitals. The haulage units have the basic conditions for this work, they are duly authorized by the Ministry of Environment and the Ministry of Health.

In the beginning hospital wastes were disposed of at ditch made with a machine in Apopa controlled dumping site that was operated by the municipality of San Salvador and provided the service for the entire AMSS. Later, from June to December 1999 a security cell in the current sanitary landfill of AMSS; such landfill is operated by the French-Canadian consortium CINTEC – TREDI as a mixed enterprise working for 10 municipalities and known as MIDES S.E.M de C.V. as of January 1st 2000, which has introduced the autoclave treatment system.

a. Discharge

Most hospitals under MSPAS (Ministry of Public Health and Social Welfare) practice separate discharge for medical and common waste observing the manual[10] commonly used. Some of ISSS (Salvadorian Social Security Institute) hospitals also establish and practice a separate discharge system. However, many of other medical institutions lack an appropriate system for separate discharge. As for private

[10] Manual para Personal Médico y de Enfermería, Gestión y Manejo de Desechos Sólidos Hospitalarios ALA91/33

hospitals and clinics, the great majority discharges the infectious medical waste mixed with common waste.

To cope with this situation, MSPAS (Ministry of Public Health and Social Welfare) presently plans to give such hospitals instructions to implement appropriate medical waste management (e.g., source separation, separate discharge and collection, contract for appropriate treatment/disposal).

Medical institutions that implement separate discharge employ red-color plastic bags for medical waste and black-color plastic bags for common waste. Sharps are separately discharged to a plastic medical container. Used pharmaceutical bins are also separately discharged into carton boxes.

In large hospitals, separately discharged items are temporarily stored in specific places of the institution and are transferred to the central storage room where item-wise systematical storage is practiced following the procedure stated in the manual. In many large hospitals, specialized workers wearing protection apparatus handle the medical waste.

Common wastes separately collected in black-color plastic bags in hospitals are handed to the municipal waste collection service.

b. On-site Medical Waste Incineration

Although 5 out of 39 hospitals in AMSS have incinerators, none of them are currently operated mainly because the neighbors reject it due to its smoke and offensive odor.

c. Collection and Transport

Most medical institutions receive specialized collection services for medical waste from private entities and for common waste from municipalities. The specialized private collectors visit hospitals for collecting medical waste and transporting them to the MIDES landfill site. Meanwhile, an exclusive small transfer station for medical waste deposit is also located in a zone in San Salvador, and several medical institutions themselves bring their medical waste for depositing there. The private collector collects the waste from there and transport them to the MIDES landfill site.

Workers of the private collection entities wear protection apparatus in handling the red-color plastic bags and/or deposit containers.

d. Treatment and Disposal

All medical waste collected by the specialized collectors is transported to MIDES landfill site. The medical waste received is sterilized by the autoclave equipment there and disposed of at MIDES landfill together with other waste directly disposed of. This autoclave treatment started in January 2000.