

Chapter 4

Current Situation of Solid Waste Management

4 Current Situation of Solid Waste Management

4.1 Service Projected Population

As for the present population of the Study Area, appropriate data does not exist. An estimated population by the Statistic and Census Department, Ministry of Economy ("Proyección de la Población de El Salvador") is one of reliable data as same as the estimated population in the country.

"Proyección de la Población de El Salvador" and other materials such as "Encuesta de Hogares de Propósitos Múltiples 1998¹" consider no rural area in AMSS except Tonacatepeque. In view of waste collection service, however, the Study Team take into account rural area in some municipalities. Therefore, the population in the columns of "urban" in the table is defined as "service projected population".

Table 4-1: Estimated Population in the Study Area in 1998 and 1999

No.	Municipality	1998			1999		
		Urban	Rural	Total	Urban	Rural	Total
1	San Salvador	467,006	0	467,006	473,374	0	473,374
2	Mejicanos	180,775	0	180,775	185,204	0	185,204
3	Ciudad Delgado	145,189	0	145,189	149,394	0	149,394
4	Cuscatancingo	85,825	0	85,825	90,079	0	90,079
5	Ayutuxtepeque	26,216	10,028	36,244	28,000	10,158	38,158
6	San Marcos	68,685	0	68,685	69,660	0	69,660
7	Nueva San Salvador	133,461	13,820	147,281	138,723	14,000	152,723
8	Antiguo Cuscatlán	40,515	0	40,515	42,773	0	42,773
9	Soyapango	282,066	0	282,066	283,598	0	283,598
10	Ilopango	122,309	0	122,309	127,434	0	127,434
11	San Martín	66,861	27,726	94,587	73,000	28,086	101,086
12	Apopa	155,588	0	155,588	163,974	0	163,974
13	Nejapa	14,464	16,255	30,719	15,000	16,466	31,466
14	Tonacatepeque	27,640	10,731	38,371	29,000	10,871	39,871
Total population		1,816,600	78,560	1,895,160	1,869,213	79,581	1,948,794

Source: arranged by the Study Team on the basis of information from the municipalities and Dirección General de Estadística y Censos, Ministerio de Economía, 1995, "Proyección de la Población de El Salvador," El Salvador

4.2 History of Solid Waste Management

San Salvador Metropolitan Area has had an intensive activity regarding solid waste management, and because of their background deriving from the Spanish colonization, the cities preserve their customs. Therefore, it can be said that the responsibility of cleansing duties has belonged to the municipalities since the colonial age. In recent years, the cleansing service has been operated both by private entities

¹ Ministerio de Economía Dirección General de Estadística y Censos Digestyc, 1999, Encuesta de Hogares de Propósitos Múltiples 1998, El Salvador

and the municipality, with good experiences that unfortunately have not been taken advantage of.

a. Period of 1955-1967

The service is rendered by the private sector through a public tender, which is awarded to Mr. Francisco Sabater Araza. Operations began on October 1st, 1955, and employing 11 compaction trucks, and wastes were delivered to a compost processing plant (which worked during the initial years of this period), but later wastes were disposed of directly to the Acelhuate river.

b. Period of 1967-1979

The service is run by the municipality and the duties become more technical. Sanitary landfills with the use of tractors are first utilized, such as that of *colonia* Escalón, Avenida José Matías Delgado where the soccer fields of the Salvadoran Soccer Association are currently located (1968-1971); Las Margaritas landfill in Boulevard del Ejército that is currently known as *colonia* 22 de abril (1969-1977); likewise, the land located in Soyapango and called as La Oliva landfill is also utilized. During this period inter-municipal collaboration appears, and municipalities such as Mejicanos, Delgado, Soyapango, Ilopango and San Marcos used these disposal sites.

c. Period of 1978-1989

This period began with several social problems, to the extent that being a public official was a reason for being killed, and of course these problems impinged upon the collection service; therefore, this period caused that the service provided underwent a substantial backwardness.

In 1989 the Japanese government donated 56, 16yd³ compactor trucks and 8 container lifter trucks, 94 7yd³ containers and 6 D6H Caterpillar tractors with special blades for sanitary landfills, which were evenly distributed among 12 municipalities in the metropolitan area.

This decade was positive regarding technical support and knowledge, and several studies were developed, including the Master Plan for AMMS; training for officials and employees involved in the system, as well as the proposal to allow the cleansing service to become a metropolitan service operated by means of a decentralized enterprise.² However, these studies were not executed by the authorities and is forgotten due to the war going on at that time.

d. Period of 1990-1999

This period began with the donation by the Japanese government to the municipality of San Salvador. The constant changes of staff and operation chiefs brought the loss of important technical human resources, but the experience and knowledge acquired at the beginning of this period is considerable. In 1992 the site known as Nejapa, Mariona and/or Apopa controlled dumping site was utilized. Fortunately, in that same year (1992) peace was signed between the guerrilla and the government. However, despite all the knowledge acquired, the site was not prepared properly, as the system had no leachate evacuation system.

² César Tapia Gamarra, *Propuesta de Organización para la Empresa Metropolitana de Aseo (EMA)*, 1989

By 1992 as Table 4-2 shows, the collection service rendered by the municipalities that currently form AMSS had an average coverage of 57.14% in their urban areas.

Table 4-2: Collection Coverage in the Urban Area in 1992 and 1996

Municipality	Municipal service 1992 ¹ %	Private service 1992 ¹ %	Total 1992 %	Municipal service 1996 ² %	Municipal service 1998 ³ %	Private service 1998 ³ %	Total 1998 %
San Salvador	78.07	4.04	82.11	75.60	80.57	0.57	81.14
Mejicanos	55.99	16.97	72.96	41.06	65.63	19.27	84.90
Delgado	33.59	1.80	35.39	13.60	71.00	4.00	75.00
Cuscatancingo	39.48	3.26	42.74	25.99	70.97	0.54	71.51
Ayutuxtepeque	53.60	2.41	56.01	54.19	66.67	0.00	66.67
San Marcos	53.76	2.44	56.20	53.20	63.69	1.12	64.81
Nueva San Salvador	61.72	22.10	83.82	56.07	67.06	26.47	93.53
Antiguo Cuscatlán	88.80	2.86	91.66	56.54	92.11	0.00	92.11
Soyapango	48.85	36.90	85.75	28.50	82.11	12.63	94.74
Ilopango	52.05	9.54	61.59	41.03	40.12	9.88	50.00
San Martín	15.18	14.81	29.99	9.40	52.63	12.72	65.35
Apopa	59.39	2.00	61.39	29.20	72.73	0.00	72.73
Nejapa	10.92	0.28	11.2	22.24	52.66	0.00	52.66
Tonacatepeque	14.40	0.28	NA	NA	NA	NA	NA
Total	57.14	12.43	69.57	51.18	67.09	6.75	73.84

Source: ¹ Made with the IV Housing Census information, 1992.

² Department of Environmental Sanitation, municipality of San Salvador.

³ DIGESTYC, *Encuesta de hogares de propósitos Múltiples 1998*.

NA: Not available

In 1993 the Executive Secretariat of Environment (which would eventually become MARN in 1998), with the collaboration of the municipality of San Salvador and the Ministry of Health made a request to the Japanese government for the donation of collection trucks, which was accepted by the government of Japan. Therefore, in September 1994, a Japanese Study Mission arrived to the country and a minute is signed, being COAMSS the counterpart.

In 1995 San Salvador acquires two mechanical sweepers for the main roads. During this period the idea of acquiring of a new land to use it as a landfill began to shape, since the Mariona landfill had the capacity for two years more.

The 14 municipalities belonging to COAMSS begin a search of final disposal alternatives, as the Mariona site was about to be closed. Different alternatives were received, of which two were chosen and eventually the environmental-friendly choice that was closer to the integral management was selected³. From that moment, due to political and economic reasons, four municipalities did not longer continue with the project, reason why only 10 Mayors of COAMSS signed in November 1997 the agreement of concession of haulage and final disposal of wastes with the Canadian company CINTEC INC, which offered financing. Therefore, the 10 municipalities and the company formed a mixed enterprise known as *Sociedades de Economía*

³ Integral management should be understood as that integrating all the stages in the management and the financial-economic part.

Mixta and called MIDES SEM de CV, in which 10% of the shares were owned by the municipalities and the rest to CINTEC INC. Within the agreement reached there was the construction of a modern sanitary landfill that meet the highest technical specifications such as geomembranes, leachate treatment and not receiving medical or industrial waste, as well as the construction of a transfer station furnished or not with a separation facility; all the aforementioned should be ready in no more than a 5-year period.

On May 3rd, 1999 the sanitary landfill was opened, which was located north of the municipality of Nejapa. The cost per ton received was US\$18.00 + 13% V.A.T. The enterprise has also acquired a land in the municipality of Apopa, 5 km to the south of the former Mariona dumping site to build the transfer station.

The expected amount of wastes to be received by this landfill is of 360,000 ton/year, of which 168,000 ton will belong to San Salvador that accounts for 46.67% of the total.

4.3 Waste Stream

The waste stream was formulated on municipal SW and medical waste.

4.3.1 Municipal Solid Waste

4.3.1.1 Concept of Waste Stream

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

- Waste Amount and Composition Survey (WACS)
- Interview Survey at Generation Sources
- Analysis of existing disposal amount data (weighing data at final disposal site)

The concept of present waste stream is shown in Figure 4-1.

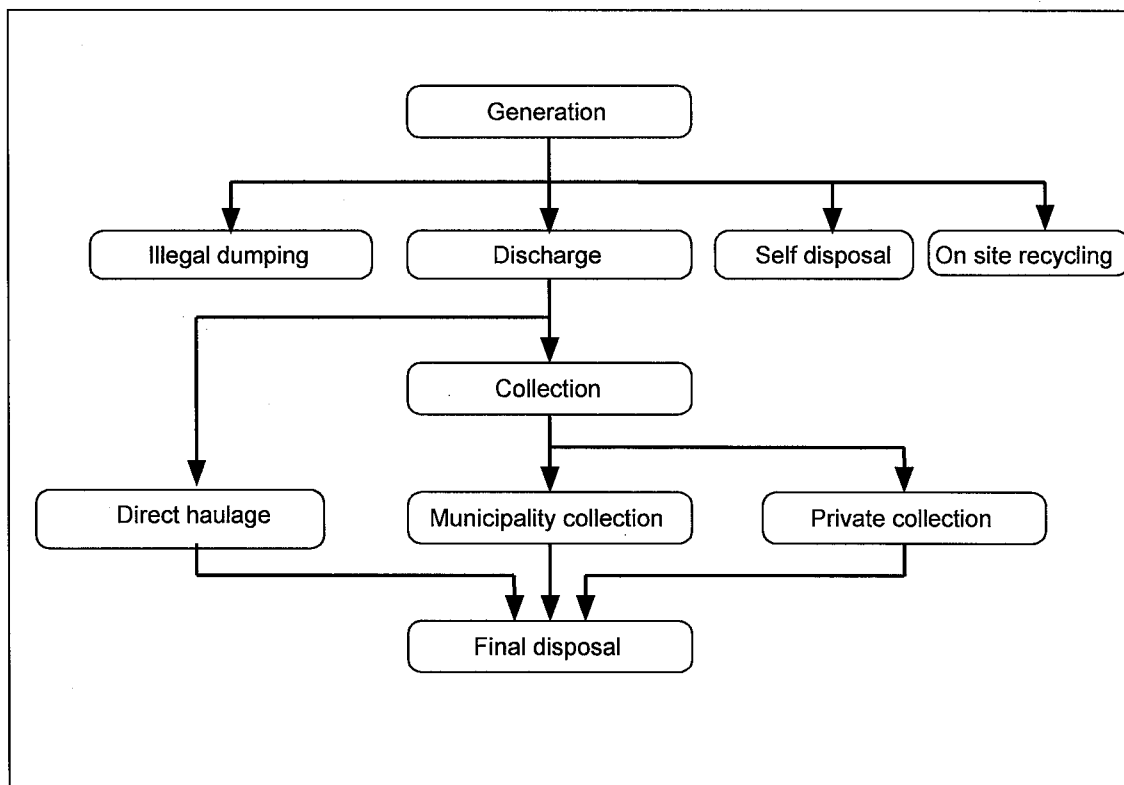


Figure 4-1: Concept of Present Waste Stream

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

4.3.1.2 Waste Generation Ratio and Generation Amount

a. Waste Generation Ratio

The study set up waste generation ratio based on the result of WACS and referred to such data in Latin American countries (shown in Table 4-3 and Table 4-4).

Table 4-3: Comparison of Waste Generation Ratio in Latin American Countries

Sources	unit	AMSS		Mexico ² D.F./1998	Nicaragua principal cities ³ 1996	Honduras Tegucigalpa ⁴ /1997	Paraguay Asuncion ⁵ /1994	
		WACS in this Study	PAHO ¹					
Household	High income	g/person/day	600 (500 to 700)	750	616	675	566	682
	Middle income	g/person/day	540 (420 to 670)					
	Low income	g/person/day	420 (320 to 520)					
Commercial	Restaurant	g/seat/day	466	NA	NA	NA	NA	NA
	Others	g/employee/day	482	NA	NA	1,676	NA	NA
Institutional		g/employee/day	196	NA	413	98	NA	NA
Market		g/stall/day	1,674	NA	1,025	2,827	NA	NA
Street sweeping		g/m/day	198	NA	NA	NA	NA	NA

Source : ¹ SOLID WASTE SECTORAL ANALYSIS IN EL SALVADOR July 1998 PAHO

² JICA study 1999 ³ JICA study 1997 ⁴ JICA study 1998 ⁵ JICA study 1996

Table 4-4: Waste Generation Ratio

Source		unit	Generation ratio
Household waste	High income	g/person/day	600
	Middle income		540
	Low income		420
Commercial waste	Restaurant	g/seat/day	466
	Others	g/employee/day	482
Institutional waste		g/employee/day	196
Market waste		g/stall/day	1,674
Street sweeping waste		g/m/day	198

b. Waste Generation Amount

Waste generation amount is calculated based on the data of WACS, POS and weighing data at the final disposal site. The weighing data for the months from April 1999 to November 1999 given to the Team seem unrealistic and not to encompass the total actual amount disposed, therefore, the 1998 weighing data was used for the calculation of the waste generation amount.

b.1 Aggregate Waste Generation Amount

Waste generation amount per respective generation source is summarized as shown in Table 4-5.

Table 4-5: Waste Generation Amount

	Household	Restaurant	Other than restaurant	Institutional	Market	Road sweeping	Total
Generation amount (ton/day)							
San Salvador	234.6	8.6	22.5	16.7	35.7	64.4	382.5
Mejicanos	84.1	4.0	9.1	7.1	2.4	5.8	112.5
Delgado	64.0	3.4	8.5	3.7	0.7	3.0	83.3
Cuscatancingo	37.3	2.8	4.1	2.0	0.0	1.8	48.0
Ayutuxtepeque	13.0	0.4	1.1	1.3	0.3	0.5	16.6
San Marcos	31.1	1.6	2.4	1.2	0.8	1.4	38.5
Nueva San Salvador	72.1	2.2	5.5	5.4	3.7	8.5	97.4
Antiguo Cuscatlan	22.8	0.6	2.0	2.5	0.7	10.2	38.8
Soyapango	124.1	10.2	12.2	8.1	5.6	2.5	162.7
Ilopango	54.7	2.8	4.2	2.4	0.7	0.3	65.1
San Martin	29.7	3.1	3.5	1.5	4.0	0.3	42.1
Apopa	66.2	6.1	5.9	2.1	7.5	1.1	88.9
Nejapa	6.9	0.6	1.0	0.3	0.1	0.1	9.0
Tonacatepeque	13.3	0.6	1.9	2.4	0.2	0.6	19.0
Total	853.9	47.0	83.9	56.7	62.4	100.5	1,204.4

	Household	Restaurant	Other than restaurant	Institutional	Market	Road sweeping	Total
Generation amount (ton/year)							
San Salvador	85,629	3,139	8,213	6,096	13,031	23,506	139,614
Mejicanos	30,697	1,460	3,322	2,592	876	2,117	41,064
Delgado	23,360	1,241	3,103	1,351	256	1,095	30,406
Cuscatancingo	13,615	1,022	1,497	730	0	657	17,521
Ayutuxtepeque	4,745	146	402	475	110	183	6,061
San Marcos	11,352	584	876	438	292	511	14,053
Nueva San Salvador	26,317	803	2,008	1,971	1,351	3,103	35,553
Antiguo Cuscatlan	8,322	219	730	913	256	3,723	14,163
Soyapango	45,297	3,723	4,453	2,957	2,044	913	59,387
Ilopango	19,966	1,022	1,533	876	256	110	23,763
San Martin	10,841	1,132	1,278	548	1,460	110	15,369
Apopa	24,163	2,227	2,154	767	2,738	402	32,451
Nejapa	2,519	219	365	110	37	37	3,287
Tonacatepeque	4,855	219	694	876	73	219	6,936
Total	311,678	17,156	30,628	20,700	22,780	36,686	439,628

The aggregate waste generation amount in AMSS in respective categories (e.g., household, restaurant, other commercial, institutional, market) would be reasonably judged as correct figures, because the respective population in AMSS used for this calculation is taken from the DIGESTYC census data. However, if the individual figures for respective municipality are examined, it could be judged that some of the figures might not reflect the actual situation of respective waste generation in respective municipality.

c. Waste Generation Amount in Respective Municipality

In this context, waste generation amount in respective municipality is adjusted herewith referring to the disposal amount data in 1998 that have breakdown of 3 collection routes and 3 waste categories.

The adjustment is made in the following manner.

- Respective municipality's disposal amount in 1998 is recorded with breakdown of 3 collection routes (municipal collection, direct haulage and private collection) and breakdown of 3 waste categories (market, household and commercial wastes) as shown in Table 4-6.
- The proportion of each element (breakdown into 14 municipalities, 3 collection routes, 3 waste categories) to the total disposal amount in 1998 recorded at Mariona site is automatically given.
- Those proportions are multiplied to the gross generation amount of 439,628 ton (as shown in Table 4-5) derived by the WACS in this Study, in order to estimate waste collection amount respectively for municipal collection, direct haulage and private collection for the respective 14 municipalities.

The adjusted waste generation amount in respective municipalities with breakdown of respective collection routes is summarized in Table 4-7.

Table 4-6: Weighing Data at Mariona Final Disposal Site (1998)

Unit: ton/year

Collector	City	Market	Household	Commercial
Municipality collection	01SS	18,014.2	139,399.3	5,493.8
	02MJ	227.4	23,988.8	0.0
	03CD	15.0	10,560.8	0.0
	04CT	0.0	8,995.9	0.0
	05AY	0.0	3,531.6	0.0
	06SM	5.8	10,807.6	0.0
	07ST	197.6	26,469.6	3.1
	08AC	0.0	14,471.3	0.0
	09SY	0.0	43,231.1	2.4
	10IL	0.0	14,852.8	0.0
	11SMT	0.0	8,395.0*	0.0
	12AP	15.8	15,814.9	0.0
	13NJ	0.0	1,648.2	4.7
	14TN	0.0	7,300.0*	0.0
total	18,475.8	329,466.9	5,504.0	
Direct haulage	01SS	16.4	1,011.5	798.0
	02MJ	24.5	179.7	42.3
	03CD	0.0	0.0	0.0
	06SM	0.0	3.6	0.0
	07ST	0.0	24.4	7.2
	08AC	13.6	321.2	362.8
	09SY	20.7	1,935.1	1,450.0
	10IL	2.2	283.9	12.4
	11SMT	0.0	0.0	0.0
	12AP	0.0	25.8	0.5
	13NJ	0.0	0.0	0.0
14TN	0.0	0.0	0.0	
total	77.40	3,785.20	2,673.20	
Private Contractor	01SS	0.0	37.9	0.0
	07ST	0.0	2,986.7	0.0
	09SY	0.0	1,299.0	0.0
	total	0.00	4,323.60	0.00
Total (ton/year)		18,553.20	337,575.70	8,177.20

Note: * data from hearing survey, sources: San Salvador Municipality.

The waste stream with breakdown of 3 collection routes for each respective municipality is given in the table below.

Table 4-7: Waste Stream with Collection Routes Breakdown (After Adjustment) in 1998

Unit: ton/year

Collector	City	Market	Household	Commercial	Total
Municipality	01SS	22,118	159,486	20,577	202,181
	02MJ	279	27,445	0	27,724
	03CD	18	12,082	0	12,100
	04CT	0	10,292	0	10,292
	05AY	0	4,040	0	4,040
	06SM	7	12,365	0	12,372
	07ST	243	30,283	12	30,538
	08AC	0	16,557	0	16,557
	09SY	0	49,460	9	49,469
	10IL	0	16,993	0	16,993
	11SMT	0	9,605	0	9,605
	12AP	19	18,094	0	18,113
	13NJ	0	1,886	17	1,903
	14TN	0	8,352	0	8,352
	Total		22,684	376,940	20,615
Direct haulage	01SS	20	1,157	2,989	4,166
	02MJ	30	206	158	394
	03CD	0	0	0	0
	04CT	0	0	0	0
	05AY	0	0	0	0
	06SM	0	4	0	4
	07ST	0	28	27	55
	08AC	17	367	1,359	1,743
	09SY	26	2,214	5,431	7,671
	10IL	3	325	47	375
	11SMT	0	0	0	0
	12AP	0	30	2	32
	13NJ	0	0	0	0
	14TN	0	0	0	0
	Total		96	4,331	10,013
Private Contractor	01SS	0	43	0	43
	02MJ	0	0	0	0
	03CD	0	0	0	0
	04CT	0	0	0	0
	05AY	0	0	0	0
	06SM	0	0	0	0
	07ST	0	3,417	0	3,417
	08AC	0	0	0	0
	09SY	0	1,486	0	1,486
	10IL	0	0	0	0
	11SMT	0	0	0	0
	12AP	0	0	0	0
	13NJ	0	0	0	0
	14TN	0	0	0	0
	Total		0	4,946	0
Total		22,780	386,220	30,628	439,628

4.3.1.3 Self Disposal Amount

In setting up the waste stream, it is necessary to set up a breakdown of the self disposal amount (i.e., amounts of illegal dumping, self disposal, and on-site recycling). These figures are estimated from the DIGESTYC census data in 1998.

Table 4-8: DIGESTYC Census Data

City	Self disposal method	Unit	Bury	Burn	Dispose to anywhere	Other	NA	Total
San Salvador		No.	10	-	8	2	-	20
Mejicanos		No.	3	5	16	-	-	24
Delgado		No.	1	7	22	5	1	36
Cuscatancingo		No.	2	3	12	2	-	19
Ayutuxtepeque		No.	1	16	25	5	-	47
San Marcos		No.	3	10	23	3	-	39
Nueva San Salvador		No.	-	4	3	-	-	7
Antiguo Cuscatlan		No.	-	2	7	-	1	10
Soyapango		No.	-	3	2	-	-	5
Ilopango		No.	2	2	34	15	-	53
San Martin		No.	2	24	37	3	1	67
Apopa		No.	4	14	20	3	-	41
Nejapa		No.	16	31	36	4	1	88
Total (nos. of household)		No.	44	121	245	42	4	456
Ratio		%	10%	27%	54%	8%	1%	100%

Proportions of illegal dumping, self disposal, and on-site recycle are set up as shown in Table 4-9.

Table 4-9: Ratio of On-site Disposal Method

Item	Ratio (%)
Illegal dumping	54
Self disposal	37
On-site recycling	9

4.3.1.4 Waste Stream for Respective Municipalities

Waste stream of each municipality calculated based on the data above is summarized in Table 4-10 and illustrated in Figure 4-2.

Table 4-10: Waste Stream in 1998

	Generation	Collection			Direct haulage	Final disposal	Final disposal ratio (%)	Without collection			
		Municipality	Private	total				Total	Illegal dumping	Self disposal	On-site recycle
unit : ton/year											
San Salvador	206,391	162,907	38	162,945	1,826	164,771	79.8	41,619	22,474	15,399	3,746
Mejicanos	28,119	24,216		24,216	247	24,463	87.0	3,656	1,974	1,353	329
Delgado	12,101	10,576		10,576	0	10,576	87.4	1,525	824	564	137
Cuscatancingo	10,292	8,996		8,996	0	8,996	87.4	1,296	700	480	116
Ayutuxtepeque	4,040	3,532		3,532	0	3,532	87.4	508	275	188	45
San Marcos	12,376	10,813		10,813	4	10,817	87.4	1,559	842	577	140
Nueva San Salvador	34,011	26,670	2,987	29,657	32	29,689	87.3	4,322	2,334	1,599	389
Antiguo Cuscatlan	18,300	14,471		14,471	698	15,169	82.9	3,131	1,691	1,159	281
Soyapango	58,627	43,234	1,299	44,533	3,406	47,938	81.8	10,689	5,772	3,955	962
Ilopango	17,368	14,853		14,853	299	15,151	87.2	2,217	1,197	820	200
San Martin	9,605	8,395		8,395	0	8,395	87.4	1,210	653	448	109
Apopa	18,145	15,831		15,831	26	15,857	87.4	2,288	1,236	847	205
Nejapa	1,903	1,653		1,653	0	1,653	86.9	250	135	93	22
Tonacatepeque	8,352	7,300		7,300	0	7,300	87.4	1,052	568	389	95
Total	439,630	353,447	4,324	357,771	6,536	364,306	82.9	75,323	40,675	27,871	6,777
unit : ton/day											
San Salvador	565.5	446.3	0.1	446.4	5.0	451.4	79.8	114.1	61.6	42.2	10.3
Mejicanos	77.0	66.3	0.0	66.3	0.7	67.0	87.0	10.0	5.4	3.7	0.9
Delgado	33.2	29.0	0.0	29.0	0.0	29.0	87.4	4.2	2.3	1.6	0.3
Cuscatancingo	28.2	24.6	0.0	24.6	0.0	24.6	87.4	3.6	1.9	1.3	0.4
Ayutuxtepeque	11.1	9.7	0.0	9.7	0.0	9.7	87.4	1.4	0.8	0.5	0.1
San Marcos	33.9	29.6	0.0	29.6	0.0	29.6	87.4	4.3	2.3	1.6	0.4
Nueva San Salvador	93.2	73.1	8.2	81.3	0.0	81.3	87.3	11.9	6.4	4.4	1.1
Antiguo Cuscatlan	50.1	39.6	0.0	39.6	2.0	41.6	82.9	8.5	4.6	3.1	0.8
Soyapango	160.6	118.4	3.6	122.0	9.3	131.3	81.8	29.3	15.8	10.8	2.7
Ilopango	47.6	40.7	0.0	40.7	0.8	41.5	87.2	6.1	3.3	2.3	0.5
San Martin	26.3	23.0	0.0	23.0	0.0	23.0	87.4	3.3	1.8	1.2	0.3
Apopa	49.7	43.4	0.0	43.4	0.1	43.5	87.4	6.2	3.4	2.2	0.6
Nejapa	5.2	4.5	0.0	4.5	0.0	4.5	86.9	0.7	0.4	0.3	0.0
Tonacatepeque	22.9	20.0	0.0	20.0	0.0	20.0	87.4	2.9	1.6	1.1	0.2
Total	1,204.5	968.2	11.9	980.1	17.9	998.0	82.9	206.5	111.6	76.3	18.6

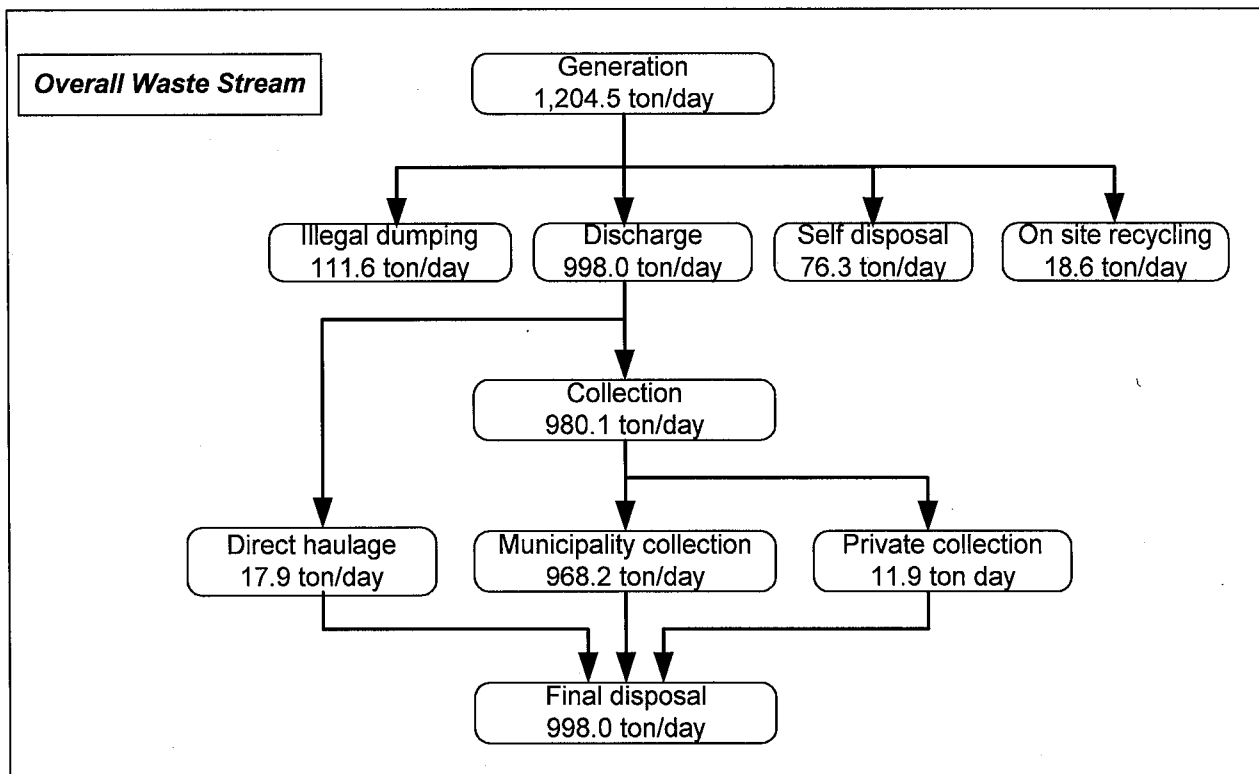


Figure 4-2: Overall Waste Stream in 1998

4.3.2 Medical Waste

4.3.2.1 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 4-3.

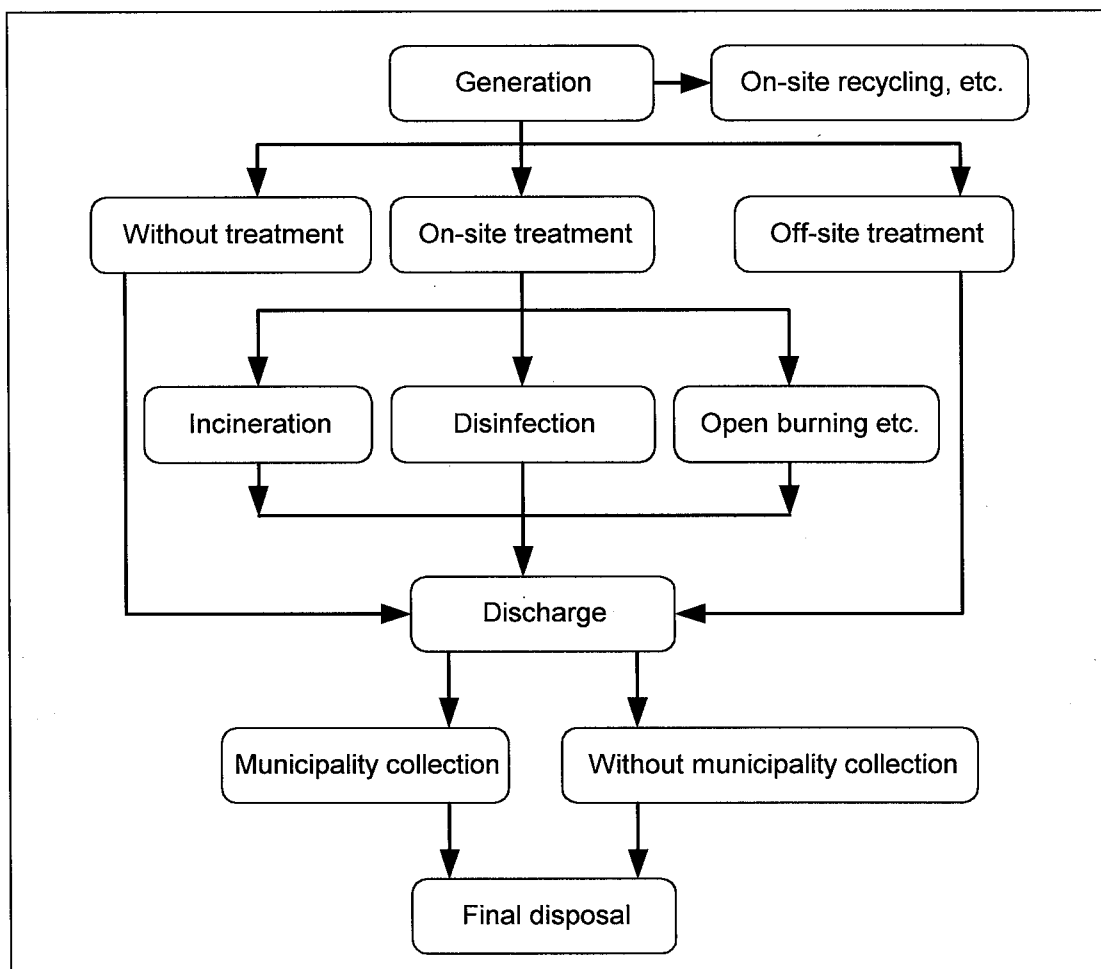


Figure 4-3: Concept of Present Medical Waste Stream

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

4.3.3 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 AMSS⁴.

Table 4-11: 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

⁴ Data from MSPAS-Transporte Guadalupe 1999

b. Waste Generation Amount

The generation amount of medical waste was calculated by multiplying the waste generation ratios above (Table 4-11) by number of beds (Table 4-12) in medical institutions in the study area. The total medical waste generation is estimated as shown in Table 4-13.

Table 4-12: 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 4-13: 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.

4.3.3.1 Waste Stream

a. Waste Disposal Amount

The 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.

b. Waste Stream

Based on the concept shown in Figure 4-3 and the outcome of the MWS, the ratios for respective components shown in Table 4-14 are set up for the estimation of the medical waste stream.

Table 4-14: 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 4-4.

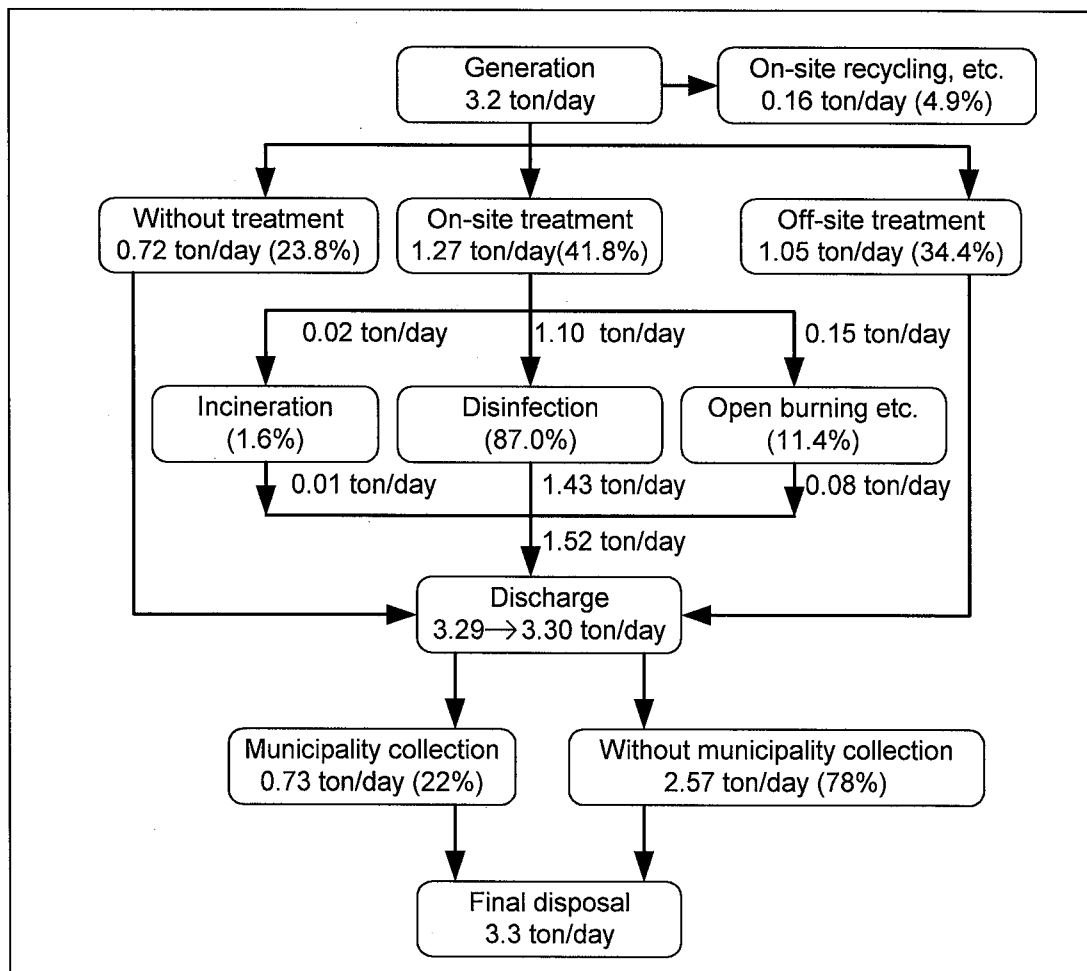


Figure 4-4: Present Medical Waste Stream

4.4 Technical System

4.4.1 Storage and Discharge System

a. Households

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.

b. 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.

c. Market

Containers mainly found in markets are concrete container, metal container (2m³), and drum. Most of containers are placed in certain places under control of personnel of markets to avoid scavenging by waste pickers and animals.

Table 4-15: Storage and Discharge System in AMSS

Category	Storage	Discharge
Households	<ul style="list-style-type: none"> not unified but use of plastic bag is preferable. 	<ul style="list-style-type: none"> 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.)	<ul style="list-style-type: none"> use of plastic bag is major, but metal container and carton box are also used as container. 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> waste are normally stored in certain place(s) to avoid scavenging by waste pickers and animals. 	<ul style="list-style-type: none"> normally collection vehicle enter into the premises of market to collect

4.4.2 Collection and Haulage System

Figure 4-5 schematically shows collection and haulage system in AMSS, which can be divided into two areas; with municipalities' (municipal direct operation and private companies' operation with contract or authorization by municipalities) and without control (operation without contract or authorization by municipalities).

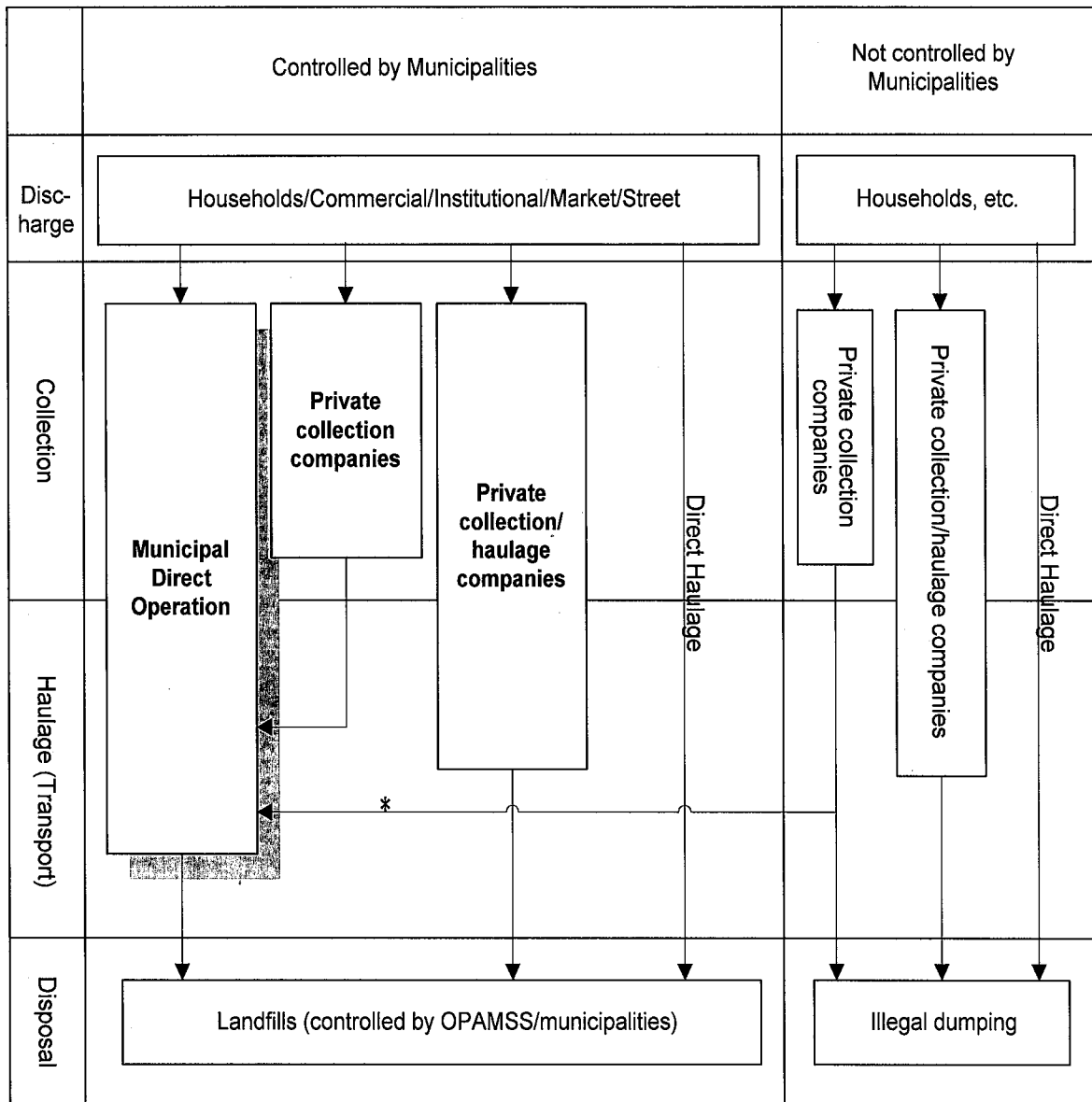


Figure 4-5: Collection and Haulage System in AMSS

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 2m³ metal containers that are compatible with 18yd³ and 25yd³

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.

Table 4-16: 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 4-17).

Table 4-17: 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 4-18). 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 4-19), the 18yd³ truck counts 76 (56.7%), the 16yd³ truck 34 (25.4%) and the 11yd³ truck 20 (14.9%). Those three types of vehicles are common in the Study Area.

Table 4-18: 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 4-19: 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.

Table 4-20: 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

Working Rate

Based on the weighbridges' data at Mariona in 1998, working rate of vehicles were analyzed. Table 4-21 clearly shows that the older vehicles, the lower working rate and vice versa. Table 4-22 presents working rate at each municipality.

Table 4-21: 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 4-22: 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., 11yd³ (8m³), 16 yd³ (12m³) and 18yd³ (14m³), were analyzed based on the data at Mariona in 1998. Table 4-23 shows considerably low productivity of the 16yd³-compactor truck compared with the other two compactors.

Table 4-23: 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 4-24: Productivity of 11yd³ 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 4-25: Productivity of 16yd³ 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 4-26: Productivity of 18yd³ 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

Compared with payload of the trucks, 4,500kg for the 11yd³-compactor and 7,500kg for the 18yd³-compactor, the average loads per trip of the vehicles are generally appropriate, although there are some unevenness among municipalities.

Table 4-27: Loading Condition of 11 yd³ 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 4-28: Loading Condition of 16 yd³ 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 4-29: Loading Condition of 18 yd³ 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 (18yd³) collects about 2,500 kg of waste per hour, and
- Small compactor truck (11yd³) 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 4-30).

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 4-31 shows average distance from each municipality to a disposal site.

Table 4-30: 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 4-31: 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 Martín 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 4-32: 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

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 16yd³ 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-enterprises⁵ located in six municipalities of AMSS, as shown in Table 4-33. 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.

⁵ Meléndez, *Microempresas y Cooperativas en Gestión de residuos Sólidos en EL Salvador*, 1996

Table 4-33: 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 4-34 shows next.

Table 4-34: 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.

Table 4-35: 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.

4.4.3 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 4-36.

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 4-36: Composting Plants in AMSS

Municipality /items	Description
<p>San Salvador</p> <p>Biginning:</p> <p>Name and address:</p> <p>Operator:</p> <p>Source:</p> <p>Input and out put:</p> <p>Chemical characteristic</p> <p>Operation process:</p> <p>Sale price, and main buyers</p>	<p>August 1997</p> <p>Cantón el Angel, colonia Santa Carlota N°2. municipio de Apopa, sobre calle que conduce de Apopa a Nejapa.</p> <p>Gerencia de Empresas e inversiones Municipales. Y Gerencia de Saneamiento Ambiental</p> <p>Waste coming from Markets, mainly from the wholesale market, Tiendona.</p> <p>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)</p> <p>C/N ratio = 3.78 PH = 8.30 Total nitrogen = 1.55% Phosphorous = 0.90% P₂O₅ = 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)</p> <p>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,</p> <p>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</p> <p>40.00 colones the 100 pounds (45.4 kg). Main buyers are NGO environmentalists, High demand in the rain season</p>
<p>Mejicanos</p> <p>Biginning:</p> <p>Name and address:</p> <p>Operator:</p> <p>Source:</p> <p>Input and out put:</p>	<p>June 1998</p> <p>Colony Zacamil, terminal of buses route 44</p> <p>Microempresa (Cooperative of Recolectores ABAZAC)-foundation ABA</p> <p>Waste coming from Markets, livestock manure from Mexicano slaughterhouse, sawdust from carpentries, etc.</p> <p>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). Output: They obtained a produccion 1,100 pounds (0.5 ton) (4.4% yeild)</p>

Municipality /items	Description
<p>Operation process:</p> <p>Sale price, and main buyers</p>	<p>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, turning is every 8 days, Taking temperature once per week, registered maximum temperature 50°C 3 employees are working</p> <p>35.00 and 40.00 colones per 100 pounds (45.4 kg) Main buyers are NGOs environmentalists, High demand in the rain season</p>
<p>Ilopango</p> <p>Biginning:</p> <p>Name and address:</p> <p>Operator:</p> <p>Source:</p> <p>Input and out put:</p> <p>Chemical characteristic</p> <p>Operation process:</p> <p>Sale price, and main buyers</p>	<p>March 1999</p> <p>Cantón Shangallo, calle a Asino, Antiguo botadero de Ilopango</p> <p>Fundación ABA</p> <p>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.</p> <p>Between March and December of 1999.</p> <p>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 kg/day)) Output: 50,000 pounds (22.4 ton) of compost (17.99% yield)</p> <p>C/N ratio = 7.13 PH in H₂O = 7.7 volatile compounds = 30.40% Nitrogen = 2.37% Phosphorous = 0.912% P₂O₅ = 2.090% Potassium = 0.616% Potassium in K₂O = 0.742% Analysis; February 4 the 2000 by the laboratory of PROCAFE, heavy materials were not analyzed.</p> <p>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.</p> <p>40.00 colones the 100 pounds (45.4 kg). Main buyers are NGO environmentalists, High demand in the rain season</p>

4.4.4 Street Sweeping System

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

Table 4-37 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 4-37: 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 4-38: Length of Street Sweeping by Mechanical Sweeper

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

Table 4-39: 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

4.4.5 Final Disposal System

4.4.5.1 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 4-40: 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: Departamento de Informática, OPAMSS.

4.4.5.2 Transport Distance to Final Disposal Site

a. San Martin and Tonacatepeque

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.

b. 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.

c. 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.

4.4.5.3 Location of Existing Final Disposal Sites

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

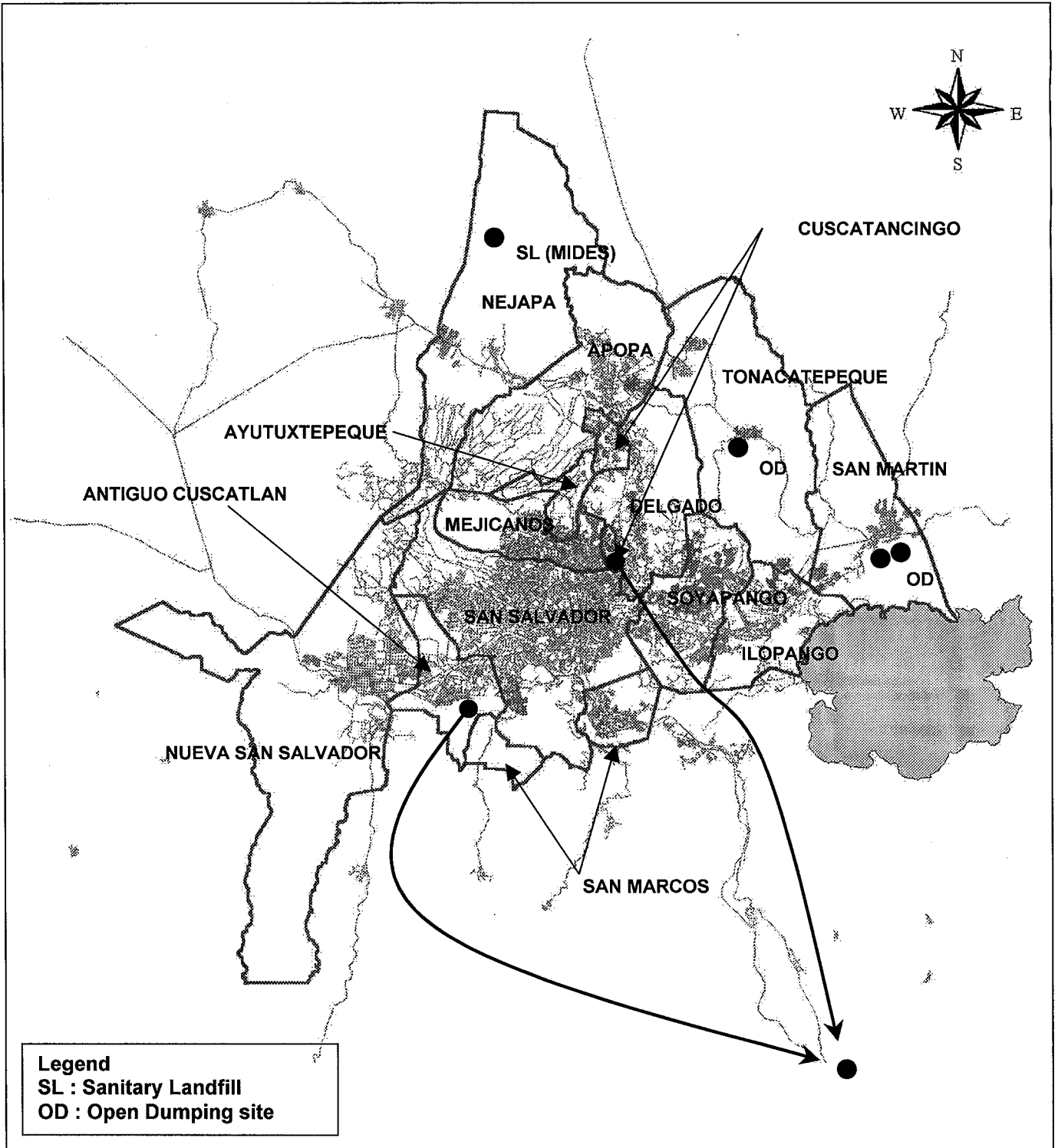


Figure 4-6: Locations of Existing Final Disposal Sites

4.4.5.4 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 4-41).

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 4-41: 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.

4.4.5.5 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 4-42: 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 1 st 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.

4.4.5.6 Landfill Management

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 4-43: 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 precautions management of final disposal system, MIDES Nejapa project plans to implement a set of precautions management, however, some of them such as groundwater monitoring are not practiced yet.

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

Table 4-44: 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 CH₄ and CO₂, because of the rise in pH within the landfill. An additional benefit of recycling is the recovery of landfill gas that contains CH₄.

Table 4-45: 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 20,000m²) 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.

4.4.6 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 4-46 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.

Table 4-46: 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	<ul style="list-style-type: none"> • 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)	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • "Recycling Hopes" Project (1998-99) 	Procomes e Intermon
Fundación Olof Palme ⁴	1988	5	Protection of victimized children	Markets, parks, streets, disposal site (Nejapa)	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 Apropriada

² Unidad Ecológica Salvadoreña

³ Asociación de Proyectos Comunales de el Salvador

⁴ Fundación Olof Palme