2.6.3 Roads and Traffic System

To improve the vehicular circulation a series of road works have been built, as the two corridors bounding the city, bridges in main roads and secondary roads in big urbanization's.

The main ports are USD (in Panama City) in the Pacific Ocean and Cristobal (in Colon) in the Caribbean Sea. Also, in 1994 a modern port of Manzanillo was inaugurated in the coastal area of the Caribbean Sea,

Regarding airport facilities, the main air terminal is Tocumen International Airport located at 20 km of Panama City; there is also an international airport in Colon.

2.6.4 Power Supply

The electric power service is one of the services that were privatized together with telephone service. 95% of Panama District is connected to the electricity services provided by Unión FENOSA-EDEMET EDECHI (Metro-Oeste Electrical Distribution Company).

2.6.5 Telephone, Internet and others

In Panama City there is a transnational company of telephone communication and 2 cellular telephone companies, several Internet service offices, 6 newspapers, 5 television stations and several radio stations.

2.6.6 Priority Ranking of Infrastructure Investment

Within the priorities of infrastructure investments of DIMAUD, the following can be mentioned:

- Transfer of the DIMAUD offices from current place in Carrasquilla to Cerro Patacon sanitary landfill site. It is expected that the project (about 7 million dollars) is financed through the National Bank. It is considered to begin the transfer in October 2003.
- The installation of transfer stations in Tocumen, Pedregal and Chilibre (under study).
- The exploitation of solid waste for energy recovery. At present, this project is under study, and three private companies from Holland, United States and Canada are interested in this project.
- Construction of an oxidation lagoon for leachate in Cerro Patacon sanitary landfill.
- Construction of fencing and internal roads inside Cerro Patacon sanitary landfill (the construction is foreseen to begin this year).

The Municipality of Panama has as priority the following work:

- Construction or purchase of a building to replace the Municipality offices from current place in EDEM building to a place between Colon and Avenue B.

3 Field Survey

3.1 Waste Amount and Composition Survey

Waste Amount and Composition Survey (WACS) is actually divided into two parts, i.e.,

- Waste Amount Survey, and
- Waste Composition Survey.

3.1.1 Samples

a. Waste Amount Survey

Table 3-1 shows the categories, the number of waste generation sources, the survey days and the number of samples in each category. The categories were 8, the waste generation sources were 80, and the total number of samples was 560 in respective seasons.

Table 3-1: Number of Sources and Samples

Category		Number of sources	Survey days	Number of samples
Residential	High	20	7	140
	Middle	20	7	140
	Low	20	7	140
Commercial	Restaurant	5	7	35
	Others	5	7	35
Institutional		5	7	35
Market		3	7	21
Street sweeping		2	7	14
Total		80	-	560

Households were categorized into 3 groups according to income level, i.e., high, middle, and low income, in order to reflect living conditions in the Study Area.

Table 3-2: Distribution of Sources (Households)

Income level	Name of Corregmiento
High Income	Paitilla, EL Cangrejo, Marbella, Curundu Altos
Middle Income	L. Cresta, Bethania, L.Radial, P.Lefevre
Low Income	Tocumen, Curundu, Chorrillo, Alc Diaz

Commercial entities were divided into two groups, i.e., restaurant and other, due to the difference of amount and character of waste generated from them. Schools, public institutions were chosen as waste generation sources of the institutional waste. Municipal markets (Mercado Municipal de San Felipe, Mercado Municipal de Abastos) were selected to obtain the market waste.

Manually swept streets were chosen as sources of street sweeping waste because the manual sweeping method dominates street sweeping in the Panama municipality.

b. Waste Composition Survey

Wastes of all 6 categories were subjects of bulk density, physical composition, three contents and chemical analyses. Table 3-3 shows the waste targeted and the number of samples.

Table 3-3: Number of Samples of Waste Composition Survey

Category		Samples (A)	Survey days (B)	Bulk density (A)×(B)	Physical composition (A)×(B)	Water content (A)×(B)	Chemical composition
Residential	High	1	3	3	3	3	1
	Middle	1	3	3	3	3	1
	Low	1	3	3	3	3	1
Commercial	Restaurant	1	3	3	3	3	1
	Others	1	3	3	3	3	1
Institutional		1	3	3	3	3	1
Market		1	3	3	3	3	1
Street sweeping		1	3	3	3	3	1
Collection Vehicle	Panama	3	3	9	9	9	3
	San Miguelito	1	3	3	3	3	1
	Arraijan	1	3	3	3	3	1
Total		-	-	39	39	39	13

3.1.2 Results

a. Waste Generation Rate

a.1 Household waste

It is not suitable to take mean values as representative values for waste generation rates, as the mean values vary widely with taking into account the 95 % confident interval as the following table shows.

Table 3-4: Results of Waste Generation Rate Survey

Category	Waste generation rate (g/person/day)
High income	635.5 to 898.3 (average 766.9)
Middle income	505.8 to 655.8 (average 580.8)
Low income	334.0 to 440.2 (average 387.1)

The following table compares the results of this survey and household waste generation rates of other Latin American countries. Household waste generation rates in those countries range between 500～700g/person/day.

Table 3-5: Comparison of Waste Generation Rate in Latin American Countries

Sources		unit	Municipality of PANMA by WACS	San Salvador / El Salvador [1]	Mexico[2] D.F/1998	Nicaragua principal cities[3] 1996	Nicaragua Managua[4] / 1995	Paraguay Asuncion[5] /1994
House hold	High income	g/person/ day	898.3(635.5 to 898.3)*	600	616	675	664	682
	Middle income		655.8(505.8 to 655.8)*	540				
	Low income		440.2(334.0 to 440.2)*	420				
Comm ercial	Restaurant	g/employ ee/day	6,373	NA	NA	NA	NA	NA
	Others		1,918	482	NA	1,676	NA	NA
Institutional			201	NA	NA	NA	NA	NA
Market			4,178	1,674	1,025	2,827	NA	NA
Street sweeping		g/m/day	16	198	NA	NA	50	NA

*: 95% reliable value, NA : not available

Source : [1] JICA study 2001, [2] JICA study 1999, [3] JICA study 1997, [4] JICA study 1995, [5] JICA study 1996

The following table shows a result of calculation of waste generation rate on the basis of the highest value of the 95% confident interval with taking into account population distribution by income level.

Table 3-6: Weighing Average of Waste Generation Rate

Income level	Share (%)	Generation rate (g/person/day)	Weighing average (g/person/day)
High income	11%	898.3	98.8
Muddle income	46%	655.8	301.7
Low income	43%	440.2	189.3
Total	100%		**590 (589.8)**

Although the waste generation rate of 590 g/person/day means the highest value obtained from the survey results, it is a reasonable value in comparison with ones of other Latin American counties. The IDB study concluded that waste generation rate of the metropolitan area (Panama, San Miguelito and Colon) was 620 g/person/day.

Consequently, the waste generation rate of 590 g/person/day is regarded as appropriate.

a.2 Commercial, Institutional, Market, Street Sweeping wastes

Results show that waste generation rate of commercial waste (restaurant) is about 6,370 g/employee/day, one of commercial waste (others) is about 1,920 g/employee/day, one of institutional waste is about 200 g/employee/day, market waste is about 4,180 g/employee/day and one of street sweeping waste is about 16 g/m/day. These waste generation rates vary widely depending on urban and industrial structures, then, it is not recommendable to estimate representative values by comparing them with data of other countries. Consequently, those waste generation rates obtained the survey results are directly used in the Study.

b. Waste Composition

b.1 Physical Composition (wet base)

Considerable portion of household waste is occupied with paper and plastics (about 65 to 70% in volume and 30-40% in weight at wet base).

Non-combustible items occupy about 11 to 16 % of waste from business establishments (commercial and institutional establishments). Meanwhile, non-combustible items are 8 to 10 % of household waste. Recyclable materials such as metals and glass occupy more than 10 to 16 % of waste from business establishments. In addition, a large amount of cardboards for transporting and storing products were found.

The table bellow presents waste composition in generation categories.

Table 3-7: Summary of Waste Composition

	Household			Commercial		Institutional	Market	Street Sweeping	Overall
	High income	Middle income	Low income	Restaurant	Others				
Waste amount (ton/day)	73.3	224.9	141	106.4	115.6	29.3	23.5	8.4	722.4
Kitchen Waste (%)	32.9%	53.3%	43.9%	46.4%	25.0%	14.0%	64.1%	14.8%	42.2%
Paper (%)	25.0%	20.3%	17.8%	32.7%	37.3%	58.7%	15.9%	24.6%	26.3%
Textile (%)	7.5%	3.3%	9.7%	1.5%	1.9%	0.7%	2.5%	3.5%	4.3%
Grass Wood (%)	9.5%	4.9%	4.5%	0.2%	2.5%	2.3%	2.3%	21.7%	4.2%
Plastic (%)	15.4%	9.5%	11.5%	8.1%	20.5%	8.4%	7.0%	16.7%	12.0%
Rubber Leather (%)	1.4%	0.1%	3.1%	0.0%	0.0%	0.0%	0.0%	1.3%	0.8%
Metal (%)	3.3%	3.3%	4.3%	1.9%	5.5%	9.1%	2.3%	2.4%	3.8%
Bottles Glass (%)	4.6%	5.0%	4.6%	9.3%	5.9%	6.8%	5.6%	6.3%	5.8%
Soil Stone (%)	0.4%	0.1%	0.4%	0.0%	0.9%	0.0%	0.0%	8.7%	0.4%
Others (%)	0.0%	0.3%	0.2%	0.0%	0.5%	0.2%	0.3%	0.0%	0.2%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

b.2 Water Content

Water content of household waste was about 50 to 60% in wet base as well as restaurant and market wastes. Meanwhile, water contents of commercial (others), institutional wastes were about 30%, restaurant, market were 63% and street sweeping waste was 42%.

c. Chemical Analysis

c.1 Three contents

Three contents (volatile matter, water and ash) of each category of waste were obtained from the chemical analysis, then, three contents for the whole waste generated in Panama Municipality were estimated with taking into account amount of waste generated from each category based on the WACS data. Consequently, the three contents of waste generated in Panama Municipality are regarded as follows.

- volatile matter (combustible matter) : 40%
- water contents : 53%
- ash contents : 7%

Table 3-8: Weighing Average of Three Contents for Combustible Matter

	Volatile matter (%)	Water contents (%)	Ash contents (%)	Total	Generation amount (ton/day)	Volatile matter (%)	Water contents (%)	Ash contents (%)
Household high income	42.4%	50.3%	7.2%	100.0%	73.3	4.3%	5.1%	0.7%
Household middle income	37.1%	57.5%	5.4%	100.0%	224.9	11.6%	17.9%	1.7%
Household low income	30.6%	60.1%	9.3%	100.0%	141.0	6.0%	11.7%	1.8%
Commercial/restaurant	32.1%	62.6%	5.3%	100.0%	106.4	4.7%	9.2%	0.8%
Commercial/others	59.4%	30.0%	10.5%	100.0%	115.6	9.5%	4.8%	1.7%
Institutional	63.2%	30.4%	6.4%	100.0%	29.3	2.6%	1.2%	0.3%
Market	32.6%	63.8%	3.6%	100.0%	23.5	1.1%	2.1%	0.1%
Street sweeping	43.0%	42.2%	14.9%	100.0%	8.4	0.5%	0.5%	0.2%
Total	-	-	-	-	722.4	40.3%	52.5%	7.3%

notes: Generation amount is based on WACS in the study, not correspondence with actual waste stream.

c.2 Elementary components and Calorific Value

Table 3-9 shows results of the elementary analysis.

Table 3-9: Results of Elementary Analysis

		Household			Restaurant	Commercial	Institution	Market	Street sweeping	Collection vehicle				
										Panama			San Miguelito	Arrijan
		High income	Middle income	Low income						High income	Middle income	Low income		
Dry season	Carbon	44.952%	44.761%	49.297%	52.690%	46.889%	48.200%	55.046%	44.439%	46.828%	46.054%	46.918%	46.070%	48.684%
	Hydrogen	6.513%	6.469%	6.485%	6.292%	6.252%	6.244%	5.939%	5.735%	6.013%	6.383%	6.335%	6.300%	6.384%
	Nitrogen	0.190%	0.236%	0.167%	0.211%	0.178%	0.181%	0.236%	0.145%	0.136%	0.091%	0.146%	0.193%	0.240%
	Sulfur	0.022%	0.027%	0.034%	0.035%	0.017%	0.019%	0.052%	0.024%	0.015%	0.021%	0.014%	0.019%	0.024%
	Oxygen	48.323%	48.507%	44.017%	40.772%	46.665%	45.356%	38.728%	49.657%	47.008%	47.450%	46.587%	47.418%	44.667%
	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Rain season	Carbon	46.734%	55.591%	61.104%	47.562%	56.519%	51.100%	45.732%	54.125%	55.514%	57.614%	56.112%	54.777%	53.543%
	Hydrogen	8.679%	8.391%	7.888%	7.567%	7.275%	6.674%	6.301%	9.637%	7.046%	7.343%	7.627%	8.107%	8.423%
	Nitrogen	0.286%	0.263%	0.278%	0.254%	0.179%	0.130%	0.147%	0.066%	0.137%	0.287%	0.177%	0.252%	0.271%
	Sulfur	0.087%	0.477%	0.087%	0.265%	0.060%	0.078%	0.044%	0.041%	0.047%	0.052%	0.076%	0.050%	0.064%
	Oxygen	44.214%	35.278%	30.643%	44.352%	35.966%	42.017%	47.776%	36.131%	37.256%	34.704%	36.008%	36.814%	37.699%
	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Average	Carbon	45.843%	50.176%	55.201%	50.126%	51.704%	49.650%	50.389%	49.282%	51.171%	51.834%	51.515%	50.423%	51.114%
	Hydrogen	7.596%	7.430%	7.187%	6.929%	6.763%	6.459%	6.120%	7.686%	6.530%	6.863%	6.981%	7.203%	7.403%
	Nitrogen	0.238%	0.249%	0.222%	0.232%	0.178%	0.156%	0.192%	0.105%	0.136%	0.189%	0.161%	0.222%	0.255%
	Sulfur	0.054%	0.252%	0.060%	0.150%	0.039%	0.048%	0.048%	0.033%	0.031%	0.037%	0.045%	0.035%	0.044%
	Oxygen	46.269%	41.893%	37.330%	42.562%	41.316%	43.687%	43.252%	42.894%	42.132%	41.077%	41.297%	42.116%	41.183%
	Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

The following formulas are in general proposed to estimate lower calorific value of waste from its elementary components.

Dulong formula $: Ho = 81C + 342.5(H - \frac{O}{8}) + 22.5S$

Scheurer-Kestner formula $: Ho = 81(C - 3 \times \frac{O}{4}) + 342.5H + 22.5S + 57 \times 2 \times \frac{O}{4}$

where *C: Carbon content (%)*

H: Hydrogen content (%)

O: Oxygen content (%)

S: Sulfur content (%)

Table 3-10 shows the lower calorific values of wastes based on the results of elementary analysis with the use of the above formulas.

Table 3-10: Comparison of Lower Calorific Value

unit kcal/kg

		Household			Restaurant	Commercial	Institution	Market	Street sweeping	Collection vehicle				
										Panama			Sam Miguelito	Arrijan
		High income	Middle income	Low income						High income	Middle income	Low income		
Dry season	Dulong (Hcvc)	3,803	3,765	4,331	4,678	3,942	4,101	4,836	3,438	3,840	3,886	3,976	3,860	4,218
	Scheurer-Kestner (Hcvc)	2,266	2,191	2,835	3,244	2,585	2,762	3,466	1,980	2,374	2,385	2,443	2,401	2,837
	Dulong (Ho)	1,786	1,540	1,771	1,853	2,747	2,818	1,991	1,963	1,934	1,914	1,621	2,139	2,569
	Scheurer-Kestner (Ho)	1,064	896	1,160	1,285	1,801	1,898	1,427	1,131	1,195	1,175	996	1,331	1,728
	Dulong (Hu)	1,116	836	1,066	1,151	2,227	2,293	1,317	1,396	1,311	1,265	924	1,531	1,990
	Scheurer-Kestner (Hu)	394	192	455	583	1281	1373	753	564	572	526	299	723	1149
	Measured	851	542	991	1,224	1,933	2,036	1,281	1,512	1,416	1,448	-284	1,322	1,871
Rain season	Dulong (Hcvc)	4,867	5,877	6,341	4,551	5,531	4,628	3,818	6,139	5,316	5,697	5,617	5,639	5,609
	Scheurer-Kestner (Hcvc)	3,318	4,445	4,997	2,953	4,314	3,335	2,207	4,721	3,906	4,336	4,241	4,199	4,061
	Dulong (Ho)	2,551	2,588	2,466	1,603	3,888	3,259	1,190	3,597	2,122	2,459	2,646	2,438	1,727
	Scheurer-Kestner (Ho)	1,739	1,957	1,944	1,040	3,032	2,349	688	2,767	1,559	1,872	1,998	1,816	1,250
	Dulong (Hu)	1,797	1,799	1,673	806	3,317	2,721	437	2,828	1,381	1,721	1,917	1,660	857
	Scheurer-Kestner (Hu)	985	1168	1151	243	2461	1811	-65	1998	818	1134	1269	1038	380
	Measured	1,524	1,430	1,297	783	2,798	2,825	625	1,554	1,409	1,280	1,502	1,288	286
Average	Dulong (Hcvc)	4,335	4,821	5,336	4,615	4,736	4,365	4,327	4,789	4,578	4,791	4,797	4,749	4,914
	Scheurer-Kestner (Hcvc)	2,792	3,318	3,916	3,098	3,449	3,049	2,837	3,351	3,140	3,360	3,342	3,300	3,449
	Dulong (Ho)	2,154	2,048	2,129	1,727	3,314	3,037	1,565	2,770	2,066	2,214	2,108	2,343	2,253
	Scheurer-Kestner (Ho)	1,387	1,409	1,562	1,159	2,414	2,121	1,026	1,938	1,417	1,553	1,469	1,628	1,581
	Dulong (Hu)	1,442	1,302	1,380	977	2,769	2,506	852	2,102	1,384	1,521	1,395	1,650	1,528
	Scheurer-Kestner (Hu)	675	663	813	409	1869	1590	313	1270	735	860	756	935	856
	Measured	1,188	986	1,144	1,004	2,366	2,431	953	1,533	1,413	1,364	609	1,305	1,079

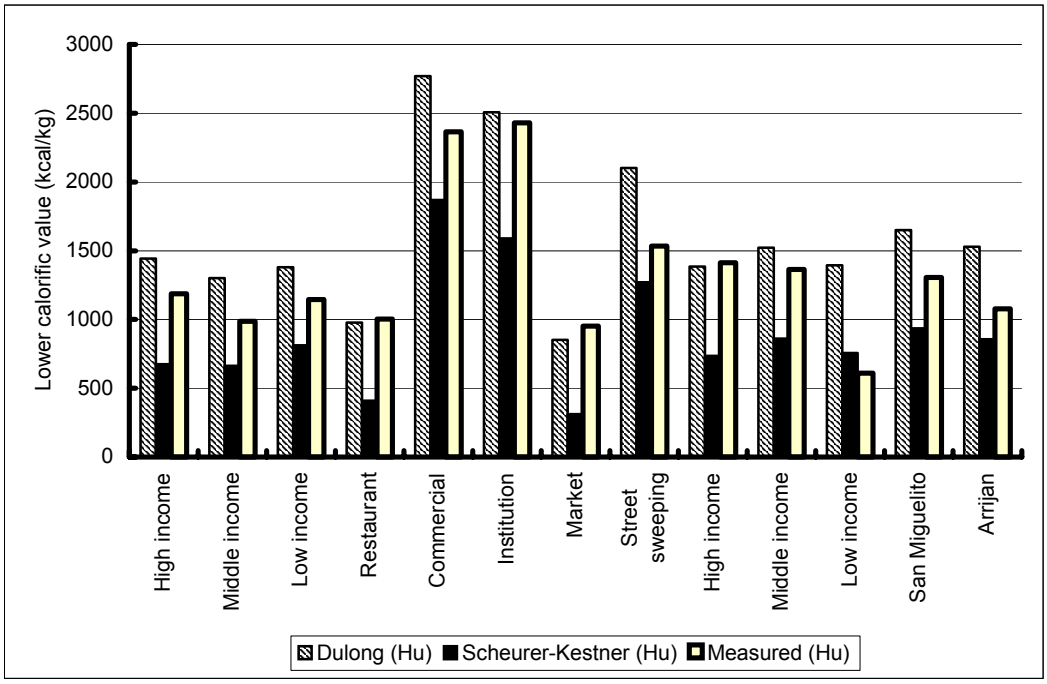

Figure 3-1: Comparison of Lower Calorific Value

According to the results of the calculation, it is found that lower calorific values obtained by various manners are distributed between 70 and 100% of values obtained by the Dulong Formula.

Lower calorific values of combustible matter vary between about 990 and 2,400 kcal/kg depending on waste generation sources. Table 3-11 shows a lower calorific value of the whole waste generated in Panama Municipality with taking into account non-combustible matter and waste amount from each generation source.

Table 3-11: Lower Calorific Value of Waste

	Lower calorific value (kcal/kg)	Non-combustible matter (%)	Combustible part (%)	Waste lower calorific value (kcal/kg)	Generation amount (ton/day)	Weighing average (kcal/kg)
Household high income	1,188	8.3%	91.7%	1,089	73.3	110
Household middle income	986	8.7%	91.3%	900	224.9	280
Household low income	1,144	9.5%	90.5%	1,035	141.0	202
Commercial/restaurant	1,004	11.2%	88.8%	892	106.4	131
Commercial/others	2,366	12.8%	87.2%	2,063	115.6	330
Institutional	2,431	16.1%	83.9%	2,040	29.3	83
Market	953	8.2%	91.8%	875	23.5	28
Street sweeping	1,533	17.4%	82.6%	1,266	8.4	15
Total	-	-	-	-	722.4	1,179

notes: Generation amount is based on WACS in the study, not correspondence with actual waste stream.

The lower calorific value of about 1,180 kcal/kg (4,939 kj/kg) was obtained from the calculation above. It is similar to the lower calorific value of waste sampled from collection vehicles of Panama Municipality, about 1,130 kcal/kg (4,730 kj/kg).

The lower calorific value 1,179 kcal/kg was obtained based on proportion of estimated waste generation amount by sources acquired from the results of WACS. However, the waste stream analysis after-mentioned tells that there is difference in waste collection amount from the WACS. That is, in the waste stream analysis 832 ton/day is obtained as combustible waste subtracting amounts of hospital, bulky, demolition wastes and sewage sludge from total waste collection amount of 965 ton/day. Meanwhile, 687 ton/day can be acquired from the results of WACS by applying 92% of collection rate for household wastes. Here, there is a difference of 145 ton/day between them. Then, it is supposed that this 145 ton/day would come from business entities (institutional, commercial and industrial wastes). With taking into account the aforementioned, a lower calorific value of mixed waste collected from Panama District at present are considered in the following tables.

Table 3-12: Estimated Lower Calorific Value of Wastes from Institution and Business Entities

	Lower calorific value of combustible part (kcal/kg)	Non-combustible matter (%)	Combustible part (%)	Lower calorific value of waste (kcal/kg)	Generation amount (ton/day)	Weighing average of lower calorific value (kcal/kg)
Commercial/restaurant	1,004	11%	89%	892	106.4	378
Commercial/others	2,366	13%	87%	2,063	115.6	949
Institutional	2,431	16%	84%	2,040	29.3	238
Total	-	-	-	-	251.3	1,565

Table 3-13: Lower Calorific Value of Mixed Waste Collected

	Raw waste lower calorific value (kcal/kg)	Collection amount (ton/day)	Weighing average (kcal/kg)
Household high income	1,089	67.4	88
Household middle income	900	206.9	224
Household low income	1,035	129.7	161
Institution and business	1,565	396.1	745
Market	875	23.5	25
Street sweeping	1,266	8.4	13
Total	-	832.0	1,256

Table 3-14:Comparison of Waste Calorific Value

	Assumed waste amount (ton/day)	Weighing average of calorific value (kcal/kg)
Original WACS results	722.4	1,179
Collection vehicle by WACS	-	1,130
Mixed Waste Collected	832.0	1,256

The table above compares the lower calorific values resulted in the respective considerations. It can be said that lower calorific value of mixed waste collected in the Panama District is about 1,200 kcal/kg (5,024 kj/kg). This is around the lowest value where mixed waste could be burnable without auxiliary fuel. However, it should be noted that the samples contained in plastic bags were collected directly from the sources except the samples from the markets and the collection vehicles, then, those had not opportunities to be soaked with rain. No significant difference in water content between samples in dry season and in rain season proved this matter. In practice, waste has many chances to be wet in the rain season. Consequently, it can be said that lower calorific value of mixed waste collected will be lower than 1,200 kcal/kg with taking into account the pluvious climate of Panama District.

3.2 Time and Motion Survey

3.2.1 Objectives

The main objective of the survey is to have a better understanding of the current situation of waste collection and transport with the purpose to formulate an appropriate collection and transport plan through the use of indicators derived during this survey.

3.2.2 The Survey Schedule

The target vehicles were the most widely used vehicles by DIMAUD, the compactors of 11 and 16 yd^3.

From the discussion between the C/P and the Study Team the following routes were selected for the T&M field studies:

Table 3-15: Areas Selected for Time and Motion Survey

Target Area	Corregimiento	Location and Route1
Urban Area	• Bella Vista • Calidonia • Río Abajo	• Bella Vista (AN-3-05) • Marañón (AN-01-03) • Río Abajo (BD-06-01)
Old Section of the City	• San Felipe	• San Felipe (AD-03-03)
Village	• Pacora • Alcalde Díaz	• 24 de Diciembre, (BD-04-01) • La Cabima, (BD-05-05)
Area of Detached Houses	• Juan Díaz • Juan Díaz	• Don Bosco, (BN-03-02) • Radial, (BN-04-02)
Aggregated Residential Area	• Chorrillo • San Francisco	• Chorrillo (AD-03-01) • Punta Paitilla (BN-01-05)

[1] The routes are classified according to Section of the city (A or B), collection time (D for Daytime and N for Nighttime), zone, and route. For example, code No. BD-04-01 implies collection in section B during Daytime, zone 04, and route 01.

The following table shows the schedule followed by the study.

Table 3-16: Schedule for Time and Motion Survey

Route	Capacity of vehicle	No. of vehicle	Day	Time Period
• Punta Paitilla (BN 01-05)	16 yd^3	• 1926 • 1909 and 1929 • 1940	• Fri./18/Jan. • Sat./19/Jan. • Mon./21/Jan.	• 6:00 pm – 2:00 am • 6:00 pm – 2:00 am • 6:00 pm – 2:00 am
• Bella Vista (AN 03-05)	16 yd^3	• 239 (2956) • 1902 • 1902	• Sat./19/Jan. • Mon./21/Jan. • Tues./22/Jan.	• 6:00 pm – 2:00 am • 6:00 pm – 2:00 am • 6:00 pm – 2:00 am
• Rio Abajo (BD-06-01)	16 yd^3	• 1917 • 1917 • 1932 and 1933	• Sat./19/Jan. • Mon./21/Jan. • Wed./23/Jan.	• 12:00 noon–8:00 pm • 12:00 noon–8:00 pm • 12:00 noon–8:00 pm
• Marañon (AN 01-03)	16 yd^3	• 1905 • 240 (2957) • 333 (2967)	• Thu./24/Jan. • Sat./26/Jan. • Mon./28/Jan.	• 6:00 pm – 2:00 am • 6:00 pm – 2:00 am • 6:00 pm – 2:00 am
• San Felipe (AD 03-03)	11 yd^3	• 1903 • 1903 • 1903	• Fri./25/Jan. • Sat./26/Jan. • Mon./28/Jan.	• 6:00 am – 2:00 pm • 6:00 am – 2:00 pm • 6:00 am – 2:00 pm
• 24 de Diciembre (BD-04-01)	16 yd^3	• 1908 • 1931 • 1933	• Sat./26/Jan. • Mon./28/Jan. • Tue./29/Jan.	• 6:00 am – 2:00 pm • 6:00 am – 2:00 pm • 6:00 am – 2:00 pm
• Don Bosco (BN-03-02)	16 yd^3	• 1947 • 1938 • 1928	• Sat./26/Jan. • Mon./28/Jan. • Wed./30/Jan.	• 6:00 pm – 2:00 am • 6:00 pm – 2:00 am • 6:00 pm – 2:00 am
• Radial (BN-04-02)	16 yd^3	• 1932 • 1934 and 1908 • 1937	• Thu./31/Jan. • Sat./2/Feb. • Mon./4/Feb.	• 6:00 pm – 2:00 am • 6:00 pm – 2:00 am • 6:00 pm – 2:00 am
• La Cabima (BD-05-05)	16 yd^3	• 1929 • 1936 • 1936	• Fri./1/Feb. • Sat./2/Feb. • Mon./4/Feb.	• 6:00 am – 2:00 pm • 6:00 am – 2:00 pm • 6:00 am – 2:00 pm
• Chorrillo (AD 03-01)	16 yd^3	• 239 (2956) and 1907 • 239 (2956) • 239 (2956)	• Sat./2/Feb. • Mon./4/Feb. • Tue./5/Feb.	• 6:00 am – 2:00 pm • 6:00 am – 2:00 pm • 6:00 am – 2:00 pm

Note: Some days two trucks were used for the same route because the first one was damaged (e.g., Punta Paitilla on the 19th of January when 1909 and 1929 were utilized). The numbers that are shown in parentheses are alternative codes for the same truck.

3.2.3 Results

The results obtained in this study are compared with indicators suggested by CEPIS and previous studies in order to evaluate the collection service. CEPIS management tools are used by this study because they are derived from experiences in Latin America. They can be used as a starting point for comparison until indicators that suit better the conditions of Panama are developed.

a. Kg/Collection Time Indicator

This indicator reflects implicitly the type of infrastructure, population density, collection method, number of collection workers, vehicle characteristics, collection schedule, etc.[3] The results are shown in the following table.

Table 3-17: Comparative Table of Kg/Collection Time Indicator

	Kg/Collection Time (hrs) Indicator [a]
Type of Area	
Aggregated Residential	2,928
Detached Houses	1,798
Urban	2,369
Old Section of the city	1,749
Village	1,809
Total	2,242
Comparison	
San Salvador, small Compact.[b]	1,998
SUGGESTED RANGE BY CEPIS	2,300-2,600

[a] Includes only time t_3 or collection time
[b] The Study on Regional Solid Waste Management for San Salvador Metropolitan Area in the Republic of El Salvador, JICA, 2000

The highest performance for this indicator is found in the Aggregated Residential area and the lowest one in the Old Section of the City.

The Old Section of the City has an indicator that is lower than values found in other countries in the region and the value suggested by CEPIS. The performance indicator suggests that there is room to improve on the route design and schedule collection in the Old Section.

b. Kg/Trip Indicator

This indicator reflects if the routes have been designed properly and also helps to prevent overload on the vehicles.[4]

Table 3-18: Comparative Table of Kg/Trip Indicator

	Kg/Trip Indicator
Type of Area	
Aggregated Residential	4,826
Detached Houses	4,160
Urban	6,153
Old Section of the city	2,533
Village	4,973
Total	4,977
Comparison	
San Salvador, small Compact[a]	5,295
SUGGESTED RANGE BY CEPIS[a]	6,000-7,000 for 14 m^3 trucks
SUGGESTED RANGE BY CEPIS ADJUSTED	5,200-6,100 for 12 m^3 trucks 3,600-4,800 for 8 m^3 trucks

[a] The Study on Regional Solid Waste Management for San Salvador Metropolitan Area in the Republic of El Salvador, Kokusai Kogyo, 2000
[b] The suggested range is for 14 m^3 trucks

[3] Indicadores para el Gerenciamiento del Servicio de Limpieza Pública, CEPIS
[4] Indicadores para el Gerenciamiento del Servicio de Limpieza Pública, CEPIS

Generally, the indicator values fall below the recommended values; only the Urban area shows a value within the recommended CEPIS adjusted values. Low performance for this indicator could also be due to bulk density difference

c. Kg/Km of Collection Indicator

In this indicator, it is considered implicitly population density, collection method, storage, routing, frequency and number of workers.[5]

Table 3-19: Comparative Table of Kg./km. Indicator

	Kgs./km. Indicator
Type of Area	
Aggregated Residential	1,172
Detached Houses	488
Urban	659
Old Section of the city	311
Village	379
Total	611
Comparison	
San Salvador, small Compact.[a]	587-1,278
SUGGESTED RANGE BY CEPIS[B]	500-600

[a] The Study on Regional Solid Waste Management for San Salvador Metropolitan Area in the Republic of El Salvador, Kokusai Kogyo, 2000

[b] Suggested range for a population density of 16,345 pers./km.^{2}, service with 43% daily frequency and 57% every other day, 3 crew members, and collection on the curbside.

The population density factor is important for this indicator as it was for the Kg/hour indicator. However, this indicator also reflects the need to check collection frequency for less populated areas. Additionally, the Old Section of the City still follows the same pattern of low performance values.

d. Kg/Worker/Trip or Kg/Worker/hr Indicators

This indicator considers implicitly collection method, storage, age and physical fitness of collection workers, type of vehicles, and number of trips.[6]

[5] Indicadores para el Gerenciamiento del Servicio de Limpieza Pública, CEPIS
[6] Indicadores para el Gerenciamiento del Servicio de Limpieza Pública, CEPIS

Table 3-20: Comparative Table of Kg/Worker/Trip or Kg/Worker/hr Indicator

	Workers/trip	Kg/worker/trip	Kg/worker/hr.
Type of Area			
Aggregated Residential	3.0	1,608	976
Detached Houses	2.8	1,485	642
Urban	2.8	2,197	846
Old Section of the city	2.0	1,266	875
Village	2.7	1,832	667
Total	2.8	1,780	802
Comparison			
San Salvador, small Compact.[a]			587-1,278
SUGGESTED RANGE BY CEPIS[B]		2,250-2,500	

[a] The Study on Regional Solid Waste Management for San Salvador Metropolitan Area in the Republic of El Salvador, Kokusai Kogyo, 2000

[b] CEPIS suggests an indicator of 4.5 -5 tons/worker/day for a compactor of 14 m^3 and 2 trips/day

e. Kg/Total kilometers Indicator

This indicator considers implicitly population density, collection method, storage, frequency, routing, and crew number. Compared to the Kg/km of Collection indicator, the main difference might be defined by the distance to discharge (transfer station or sanitary landfill).[7]

Table 3-21: Comparative Table of Kgs/total kilometers Indicator

	Kgs./Total km. Indicator
Type of Area	
Aggregated Residential	122
Detached Houses	78
Urban	155
Old Section of the city	47
Village	69
Total	104
Comparison	
SUGGESTED RANGE BY CEPIS	100-150 Kgs./total kilometers

f. Comments

Overall, Aggregated Residential and Urban areas show higher performance; on the other hand, Detached Houses, Village, and Old Section of the City show the lowest performance. General comments by area are shown in the following paragraphs.

Aggregated residential area

The indicator values fall within the recommended values and usually are the highest among all the areas, except for the indicator Kgs/trip. Consequently, the performance is good overall, but there is room for improvement by reviewing the routes design and making sure the collection vehicles are used optimally.

[7] Indicadores para el Gerenciamiento del Servicio de Limpieza Pública, CEPIS

Detached Houses area

The indicators values are lower than recommended values. This is consistent with a disperse housing area with daily collection service, and located at a considerable distance from the disposal facility. The complete collection system should be reviewed (disposal type, collection schedule and frequency, equipment used, etc.).

Urban area

All the indicators´ values fall within the recommended values. Overall there is a good performance. The indicator closer to the lower limit of the recommended values is Kg/hours. As a result, additional improvement might be possible by reviewing the collection method (container, door to door, etc.) and schedule.

Old Section of the City

All indicators´ values, except Kg./worker/hr., are lower than recommended values. This is interesting considering that the Old Section of the City is more similar in characteristics to Aggregated Residential and Urban areas than Detached Houses and Village areas; however, the indicator values for the Old Section are closer to the former ones (Detached Houses and Village areas).

Consequently, all the collection system should be reviewed (disposal type, collection schedule and frequency, equipment used, etc.). Among the most interesting low indicator values is *Kgs./total kms*. because this area is not so distant from the disposal site; for this specific case, the value only emphasizes the small amount of waste hauled to a moderate distance for disposal.

Village area

This area has similar characteristics to the detached areas. The result is the same; the indicators´ values are generally lower than the recommended values.

3.3 Public Opinion Survey

3.3.1 Objectives

The survey aimed to clarify:

- present waste discharge conditions and manners,
- opinion of the residents and business establishments regarding solid waste management services, and
- their needs and demands to the services.

3.3.2 Number of Samples

384 households and 60 business establishments were chosen from all over the Study Area as samples.

a. Households

a.1 Sample Size

The number of samples required to make them represent the current population of 708,438 (in 2000) at more than 95% probability is 384. The survey took this sample size.

a.2 Selection of Samples

Samples were selected over the Study Area with taking into account distribution of income level (See Table 3-22) and population in each corregimiento (See Table 3-22).

Table 3-22: Distribution of Households according to Income Level

Income level	Ratio (%)
Low income (less than $480/month)	43
Middle income ($481-$2,200/mont)	46
High income (more than $2,200/month)	11
Total	100

Source: Contraloria General de la Republica, National Census of Population and Households 2000 (Panama District)

Table 3-23: Distribution of Samples (Household)

No.	Corregimiento	Nos. of Sample	Percent
1	San Felipe	5	1%
2	El Chorrillo	14	4%
3	Santa Ana	12	3%
4	Calidonia	12	3%
5	Curundu	10	3%
6	Betania	27	7%
7	Bella Vista	17	4%
8	Pueblo Nuevo	12	3%
9	San Francisco	22	6%
10	Parque Lefevre	22	6%
11	Rio Abajo	17	4%
12	Juan Diaz	45	12%
13	Pedregal	23	6%
14	Tocumen	42	11%
15	Pacora	29	8%
16	San Martin	0	0%
17	Las Cumbres	46	12%
18	Chilibre	22	6%
19	Ancon	7	2%
	Total	384	100%

b. Institutions

60 business establishments were selected as samples for the survey (See Table 3-24).

Table 3-24: Samples of Business Establishments

Category of Sample	Nos. of Sample
Market	5
University	2
Large scale office	20
Shop	20
Factory	10
General hospital	3
Total	60

3.3.3 Formulation of Questionnaire

The Study Team prepared the original questionnaire. Through discussion and consultation with the counterparts and a local contractor, which conducted this field survey, the draft questionnaire was modified and finalized to meet the actual conditions of the Study Area.

a. Residents

The questionnaire for households are consisted of 8 categories (55 questions):

b. Business Establishments

b.1 Markets, Universities, Large-scale offices and Shops

The questionnaire for markets, universities, large-scale offices and shops are consisted of 6 categories (38 questions):

b.2 Factories

The questionnaire for factories are consisted of 6 categories (40 questions):

b.3 Hospitals

The questionnaire for hospitals are consisted of 4categories (68 questions):

3.3.4 Results of the Survey

a. Household

Issues that must be noted out of the findings so far are the following.

- Major part of the residents do not have gardens (55%) or have small gardens that less than $100m^2$(35%). And only 13% make compost from their kitchen waste. Accordingly, a market of compost may be small at present and in the near future.
- Great number of the residents (92%) is covered with waste collection service. DIMAUD plays critical role in provision of the service (88% receive municipal waste collection service).
- DIMAUD tries to provide the residents with daily waste collection service. However, the results revealed that the whole residents do not necessarily receive such service. From this fact, it is conjectured that required capacity to conduct the daily waste collection service is beyond the present waste collection capacity of DIMAUD.
- Central, Southwestern and Reverted seem to receive higher quality of waste collection service than Eastern and Northern. Therefore, there would be a room to improve the service in the areas.
- The present tariff and billing system seem to be acceptable for the residents.
- The residents seem to be satisfied with the collection service and begin to be acquainted with necessity of recycling and resource conservation.

- The residents feel necessity of environmental education at schools and campaign to raise citizens' awareness on environment. Municipality is expected to act main role in the activities, and the residents have willingness to cooperate with such activities.

b. Business Establishments

b.1 Markets, Universities, Large-scale offices and Shops

From the results of the survey, the following can be said.

- Although many business establishments benefit from municipal waste collection service, private waste collection firms are also active. It may be necessary to make sure whether the private firms dispose of waste appropriately.
- Generally, the business establishments are in favor of recycling. However, most of them do not want to accept increase of collection fee due to introduction of recycling. Usually, recycling requires more cost. Therefore, certain activities to promote understanding about this matter will be necessary in the future.
- A recycling market exists at present. There would be a way to encourage recycling based on the market.

b.2 Factories

Although it is not able to generalize the results because number of samples was small, the following may be said.

- Some of private waste collection firms are working in a sector of industrial waste.
- Some factories control chemicals that they receive. However, many factories do not care about chemicals outgoing. A system to control movement of chemicals may be necessary in the future to preserve the environment.
- Generally, factories do not want to accept increase of collection fee due to introduction of recycling. However, a certain number of factories may accept if such increase is within 10%.
- Factories regard necessity of recycling and a campaign to encourage it. What is different from the residents' opinions is that factories do not regard communities as important in such campaign.

b.3 Hospitals

Every hospital has a training program for staffs about how to deal with medical waste, carries out separate storage by using special plastic bags and/or containers according to type of waste, and applies some treatment methods such as incineration, chemical disinfection and disinfection by autoclave.

Medical waste discharged from the hospitals are collected by DIMAUD and disposed of in Cerro Patacon landfill.

The results would not represent medical waste management in the study area, as number of samples was limited to three. However, it is conjectured that the hospitals being subjects to this survey would manage medical waste appropriately according to the information.

3.4 Recycle Market Survey

3.4.1 Objectives

The surveys investigated present markets and potential demands for recycled materials, that would be considered in the technical alternatives to be proposed in the M/P.

3.4.2 Samples

The survey carried out for 20 samples. Table 3-25 shows outline of surveyed samples.

Table 3-25: Outline of Samples

No.	Name of company	Main products
1	Bolsas y Cartuchos de Papel, S.A.	Recycledpaper
2	Fibras Panamá, S.A.	
3	Industrias Panameñas de Papel, S.A.	
4	Productos Universales de Papel, S.A.	
5	Reciclado de Panamá, S.A.	
6	Aluminio de Panamá, S.A.	Recycled metal
7	Compra y Venta de Metales	
8	Compra y Venta Tabasará, S.A.	
9	Forjas Técnicas, S.A. (FORJATEC)	
10	Fundidora Istmeña, S.A.	
11	Fundición Yisalex, S.A.	
12	Industrias de Reciclaje, S.A. (INDRESA)	
13	Metal Group Panamá, S.A.	
14	Procesos Ambientales, S.A.	
15	Reciclajes de Metales, S.A. (REIMSA)	
16	Recimetal Panamá, S.A.	
17	Vidrios Panameños, S.A.	Recycled glass
18	Constructora Vidriera, S.A. (COVISA)	
19	Eco Toner, S.A.	Others
20	Granja San Fernando	

3.4.3 Survey Item

The survey items are as follows.

- General information of company (number of employee, type of company, established year, annual sales amount, main products or services)
- Major products and shipping item
- Profile of the major client (size of company, sales price and amount, etc.)
- Profile of the major supplier (type of supplier, type of material, original cost, supply amount)
- Processing method
- Opinion (cooperation of recycle activities, trend of production amount, etc.)

3.4.4 Results of the Survey

a. Recycling system

In Panama an ample variety of materials are recovered: aluminum tins, aluminum radiators, radiators of a metal mixture, bronze radiators, aluminum scrap, copper, bronze, batteries, cardboard, paper (of colors and target), newspapers, plastic, glass, fabric, and other waste that can be repaired and be sold.

These recovery materials is mainly from:

- the street waste picker ,
- waste picker at Cerro Patacon final disposal site and
- others recycle activities.

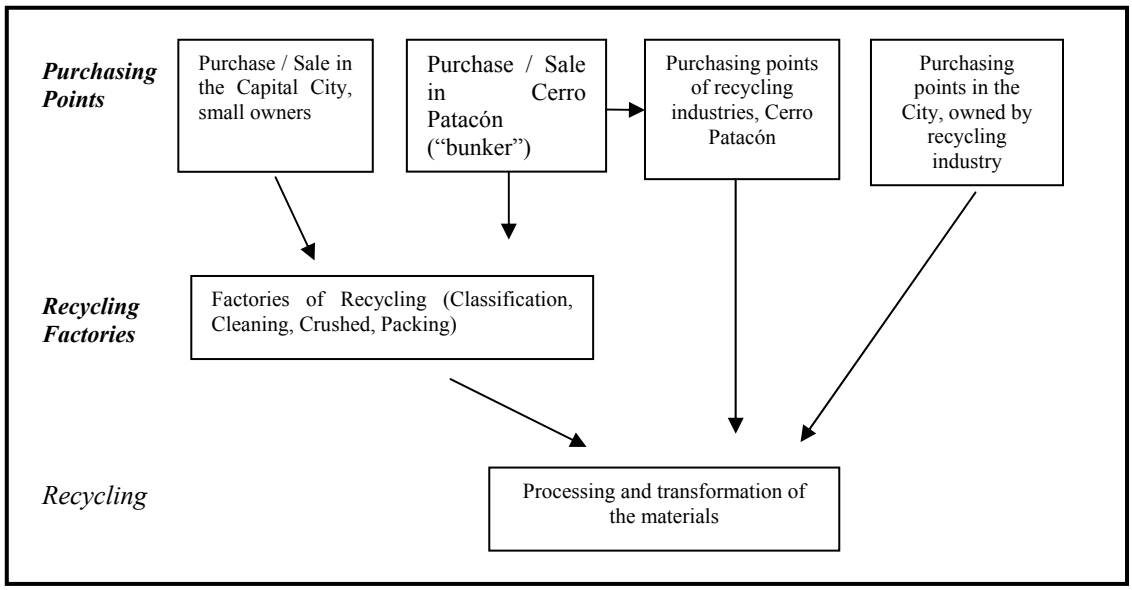

Figure 3-2: Recycling Structure in the Study Area

b. Findings

Currently, the public sector is not involved in the recycling activity in Panama municipality. Collections of materials generated from the urban area are performed by street waste picker s and waste-pickers in the town and the final disposal site respectively. Then, intermediaries buy those materials and sell to recycling companies who add more value on the materials by selecting, washing and crushing. The recycling companies sell off the materials to the final buyers such as manufacturers.

This recycling activity is commonly seen both in developing and developed countries. As long as people can manage to live on the activity, a recycle market is spontaneously formed although security and sanitary problems of waste-pickers and street waste picker s who directly collect materials remain. However, as economy grows and people's income level increases, this activity gradually loses its attraction.

Actually, in developed countries holding high economic levels, this activity is not practiced because other works with the same labor bring much higher income. This phenomenon gradually occurs as economy and society develop. However, from the point of view of resource preservation and waste reduction, recycling activity is necessary. Therefore, when those performances of street waste picker s and waste-pickers become inactive, positive intervention by the public sector will then be in demand in the recycling activity.

3.5 Water Quality Survey

3.5.1 Objectives

The objectives of the survey are the following.

- to investigate the present situation of environmental impacts, which are caused by leachate generated from Cerro Patacon Final Disposal Site,
- to analyze causes of problems if those are found, and
- to consider counter measures against the problems in the M/P.

3.5.2 Survey Schedule

a. Number of Samples and Sampling Points

Number of samples was 9 in total. The number of samples and sampling points shows below.

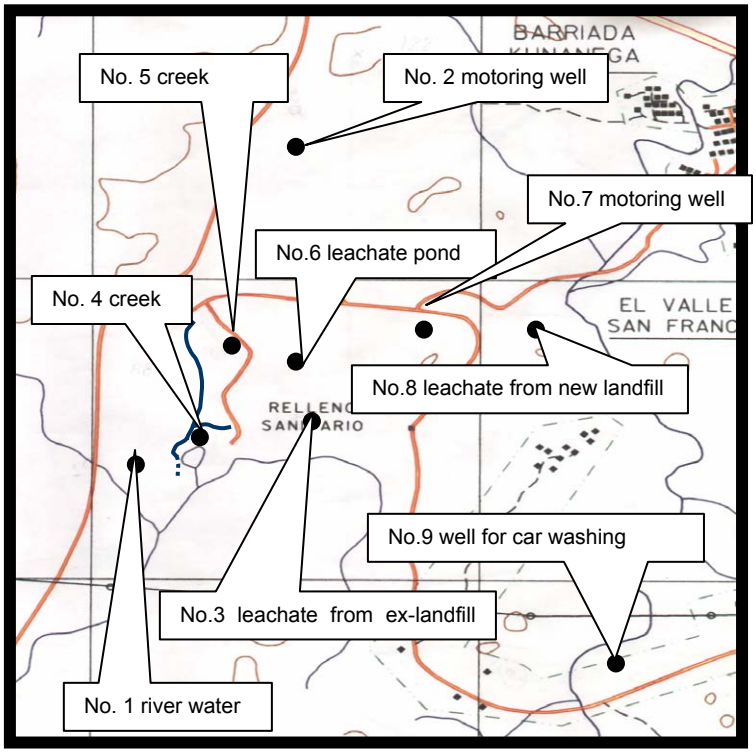

Figure 3-3: Location of Sampling Point

Table 3-26: Outline of the Sampling Point

Place of Sampling		Sampling Point	Coordinate
Leachate	Leacheate from the old dumping site	No.3	09º 03.06 North / 0.79º 33.99 West
	Leacheate discharge (actual)	No.8	09º 023.29 North / 0.79º 33.87 West
	Discharge from the oxidation pond	No.6	09º 03.19 North / 0.79º 34.02 West
River in which treated leachate is discharged	River in which the Leacheate is discharged (upper stream of the discharge point)	No.5	09º 03.17 North / 0.79º 34.04 West
	River in which the Leacheate is discharged (down stream of the discharge point)	No.4	09º 03.07 North / 0.79º 34.04 West
Natural River	Natural River close to Cerro Patacon's landfill site that flows from the Metropolitan Natural Park	No.1	09º 02.99 North / 0.79º 34.29 West
Groundwater	Car washing well	No.9	09º 02.74 North / 0.79º 33.81 West
	Monitoring Well, upper stream of the landfill	No.2	09º 03.53 North / 0.79º 34.02 West
	Monitoring Well, down stream of the landfill	No.7	09º 03.53 North / 0.79º 34.02 West

b. Construction of Monitoring Well

Before sampling, two monitoring well were constructed at upstream and downstream of the current landfill respectively on January 24 and 25, 2002.

Diameter of the wells are 6 inches, depths are around 10 m respectively.

3.5.3 Survey Record

Results of the water quality analysis shows below table.

Table 3-27: Results of Waste Quality Analysis

Item	Unit	Leachate			River water			Groundwater		
		Ex-landfill	Present landfill	Pond	Discharge point		Natural	Car wash	Upper	Down
					Upper	Down				
		No.3	No.8	No.6	No.5	No.4	No.1	No.9	No.2	No.7
Flow Volume	L/seg	0.00003	0.32	-	0.4	0.4	0.8	-	<0.1	0.95
Groundwater level	m	-	-	-	-	-	-	-	0.52	3.0
pH		6.9	6.9	9.6	6.8	6.7	7.0	7.7	7.1	6.9
Temperature	ºC	27.5	34.4	28.9	25.3	28.3	25.0	28.3	28.9	29.9
Conductivity	µS/cm	4130	9120	1255	1172	2140	287	696	1070	4590
Suspended Solids	mg/L	227.2	42	84.4	3.6	38.8	0.8	5.2	30.8	31.6
Turbidity	NTU	321	89.2	164	4.06	46.9	1.1	6.0	20.4	13.5
Color	PtCo	1638	1858	108	35	76	6	0	1	98
Alkalinity	mg/L	453	3192	199	434	440	140	313	302	735
Oil Content	mg/L	1181.0	28.0	434.0	36.0	13.0	14.0	17.0	2.0	35.0
Fecal Coliforms	cfu/100ml	12500	4750	6	20500	2400	520	0	95	30500
Total Coliforms	cfu/100ml	19500	51000	22	54000	5650	755	0	285	250000
BOD_5	mg/L	32.0	762.1	15.7	6.1	36.3	20.5	0	6.8	22.9

Item	Unit	Leachate			River water			Groundwater		
		Ex-landfill	Present landfill	Pond	Discharge point		Natural	Car wash	Upper	Down
					Upper	Down				
		No.3	No.8	No.6	No.5	No.4	No.1	No.9	No.2	No.7
COD	mg/L	35.4	1009	20.9	4	54	25	0	0	37.5
Ammonia Nitrogen	mg/L	33.0	491.4	<5.0	8.1	7.8	<5.0	<5.0	<5.0	7.1
Total Nitrogen	mg/L	35.4	495.0	<5.0	9.0	8.2	<5.0	<5.0	<5.0	8.5
Na^+	mg/L	445.0	490	191.2	82.5	99.0	16.4	111.9	68.0	109.4
Ca^{2+}	mg/L	78.9	245.0	10.8	49.4	69.5	13.7	20.7	69	362.5
HCO_3^-	mg/L	553.8	3895.3	181.8	529.7	536.6	170.8	330.9	346.5	896.9
SiO_2	mg/L	31.8	40.9	17.7	29.5	55.7	50.5	50.6	31.3	83.6
Cl^-	mg/L	691.3	1181.7	254.1	141.8	336.8	53.2	59.1	100.4	756.3
P	mg/L	620.0	5616.0	365.0	35.0	194.0	79.0	25.0	37.0	92.0
Cd^{2+}	mg/L	0.018	0.035	0.008	0.010	0.017	0.005	0.012	0.008	0.035
CN^-	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pb	mg/L	0.35	0.30	0.26	0.24	0.35	0.21	0.22	0.33	0.23
Cr	mg/L	0.0021	0.0054	0.0030	0.0036	0.0018	0.0027	0.0024	0.0021	0.0017
Cr^{6+}	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
As	mg/L	0.0046	0.0021	0.0022	0.0033	0.0026	0.0024	0.0030	0.0048	0.0177
Hg	mg/L	0.0010	0.0011	0.0005	<0.0002	<0.0002	<0.0002	0.0010	<0.0002	0.0010
Cu	mg/L	0.262	0.038	0.013	0.015	0.025	0.022	0.025	0.020	0.047
Zn	mg/L	0.117	0.587	0.030	0.042	0.040	0.032	0.443	0.033	0.065
Fe	mg/L	15.720	8.195	0.113	0.420	7.890	0.115	0.063	0.552	0.595
Mn	mg/L	6.272	4.830	0.220	2.987	1.643	0.062	1.272	0.405	3.930
PCB's Aroclor 1016	µg/L	19.9	21.6	ND	ND	ND	ND	ND	ND	ND
PCB's Aroclor 1260	µg/L	41.5	24.8	ND	ND	ND	ND	ND	ND	ND

3.5.4 Findings

The survey was conducted only once in the dry season. The results obtained through this survey would be too limited to conclude the whole characteristics of water quality in this region. However, some environmental pollution was recognized at the river into which the groundwater and the leachate form Cello Patacon are flowing. This highly indicates the effect of the Cello Patacon Final Disposal Site.

a. Leachate

Sampling points for the leachate are No.3, 8 and 6. No.6 is the leachate pond. Since the leachate had not been supplied into the pond due to disorder of the pump, the leachate pond was left as a static pool during the survey. Therefore, No.6 did not really show the characteristics of leachate.

No.8 showed an appropriate water quality as leachate from the final disposal site. It is remarkable that some organic chlorine compound which seems to be PCB was detected at No.3 and 8. The origin is indistinct but is thought to attribute to buried materials. In this survey, PCB was detected only from leachate so that groundwater and surface water might be

judged free from PCB. However, we cannot jump into a conclusion with this only one survey. Therefore, continuous observation will be needed in future.

b. River Water

Measurement of river water was attempted at three points. One is where there seems to be no effect of the Final Disposal Site (No.1). The other two points were at upper and down streams of the leachate pond outlet. The results at the down stream showed increases of;

- BOD and COD, indicators of organic pollution
- Chlorine ion concentration that seems to attribute to the leachate

These results, although the leachate pond is not currently functioning, are probably caused by sedimentation of pollutants at the riverbed after long-time discharge of leachate into the river. Additionally, a spring of water which presumably originates in Phase I discharges into the creek which might also contribute to water quality deterioration.

c. Groundwater

Groundwater samples were obtained from a well for car washing (No.9) and from two observation wells sunk at the upper and down streams of a reclaimed land which is currently under construction (No.2 and 7 respectively).

Well No.9 showed clean and normal water quality of the survey area. At well No.2 showed almost normal quality with some colon bacillus. On the other hand, well No.7 showed a high concentration of chlorine ion and many colon bacillus. Especially, chlorine ion is one of indicators of water pollution by leachate, so that well No.7 indicates a possibility of leachate contamination.

3.6 Traffic Volume Survey

3.6.1 Objectives

Traffic congestion is one of major problems, which Panama Municipality faces at present. It is said that the congestion decreases waste collection and transport work efficiency. Therefore, this traffic survey aims at investigating how the traffic congestion would affect the present transport work with quantified data. Results and findings will be good references for planning the transport system.

3.6.2 Survey Schedule

The survey was carried out at the intersection of Via Ricardo J. Alfaro and Ave. La Paz, Via Transistmica in Victoriano Lorenzo and Via Jose A. Arango in Santa Marta as follows.

- Intersection of Via Ricardo J. Alfaro and Ave. La Paz:

  25 Friday, 26 Saturday and 27 Sunday, January 2002 for 24 hours respectively

- Via Transistmica in Victoriano Lorenzo:

  1 Friday, 2 Saturday and 3 Sunday, February 2002 for 24 hours respectively

- Via Jose A. Arango in Santa Marta:

  2 Saturday, 3 Sunday and 4 Monday, February 2002 for 24 hours respectively

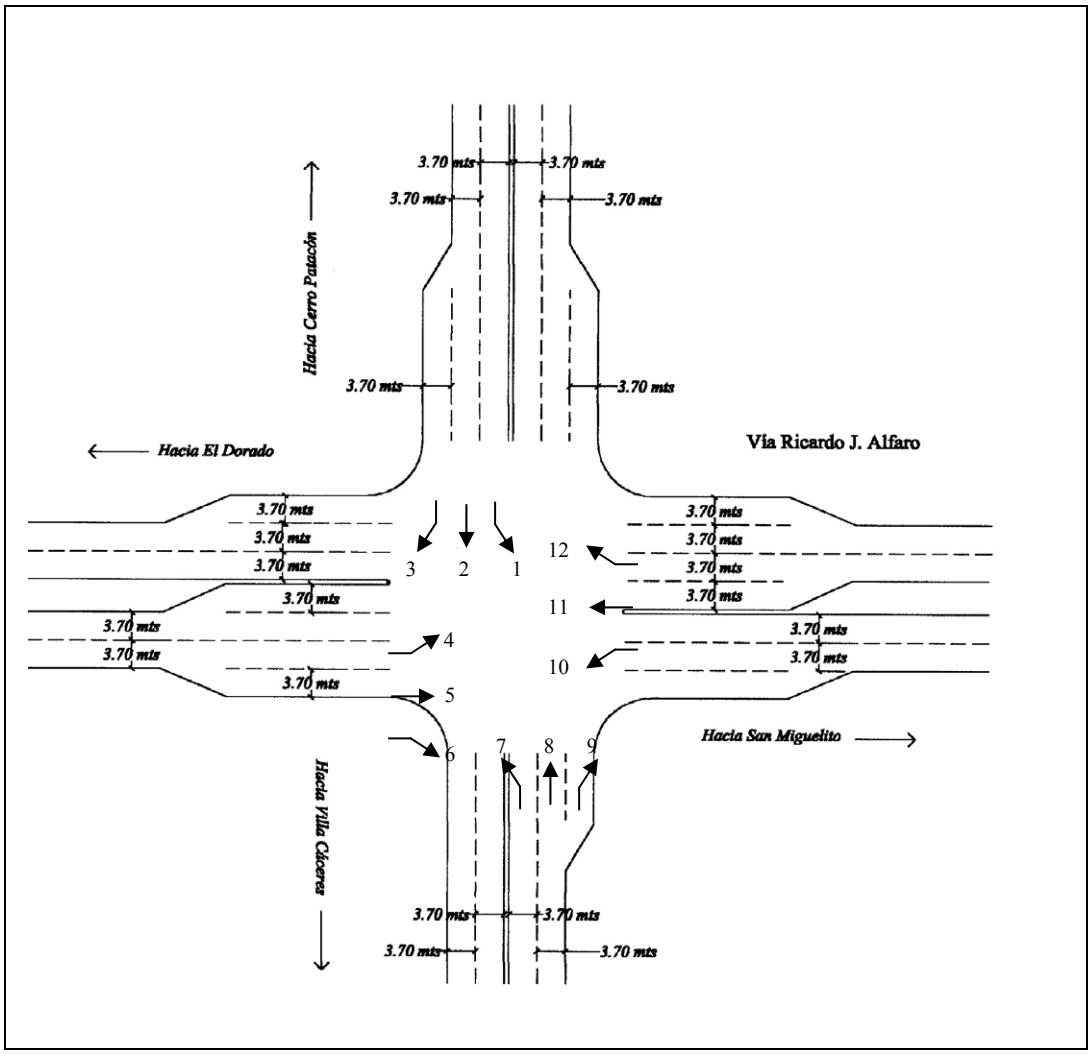

Figure 3-4: Intersection of Via Ricardo J. Alfaro and Ave. La Paz

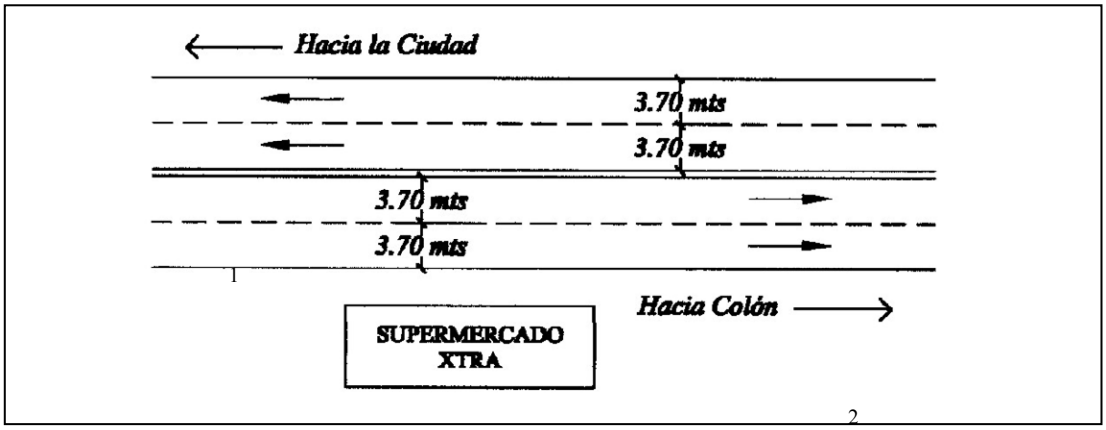

Figure 3-5: Via Transistmica

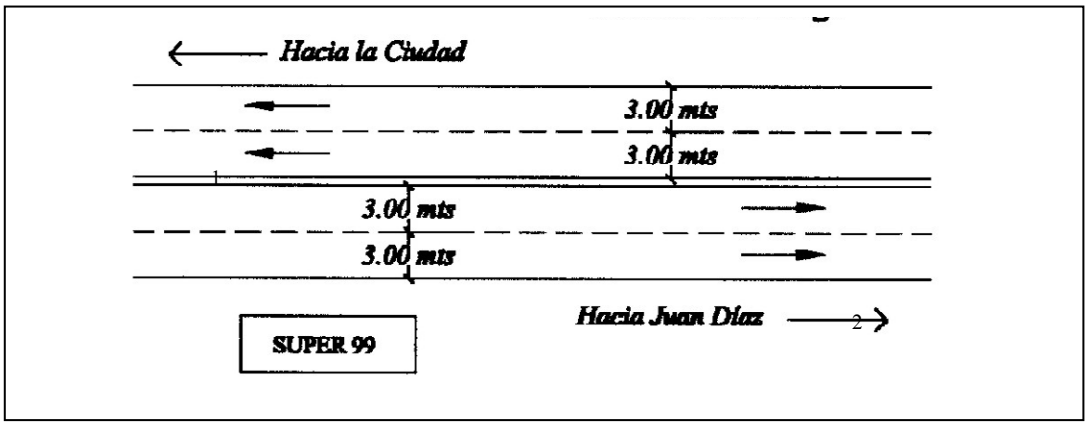

Figure 3-6: Via Jose A. Arango

3.6.3 Results

This survey targeted major roads which the collection vehicles use everyday. All of them have the actual traffic volume exceeding the possible one during the daytime. Actually, traffic congestions are frequently seen.

The majority of collection vehicles also run in the daytime. They bring waste to Cerro Patacon Disposal Site mainly between 10 am and 6 pm that overlaps the time zone of traffic congestion. Then, it is conjectured that the waste transport efficiency is lowered.

At present, direct transport method is applied where collection vehicles collect waste and transport it to a final disposal site by own means. Under this method, daytime collection work cannot avoid the traffic congestion. Especially, it is conjectured that collection works in the north and east where are far from Cerro Patacon Final Disposal Site are facing inefficiency of both transport and collection works.

Consequently, it will be recommended to consider increasing the efficiency of transport and collection by introduction of transfer transport which can move the transport works from daytime to nighttime.

4 Current Situation of Municipal Solid Waste Management

4.1 Service Coverage and Hygiene Conditions

Results of Public Opinion Survey (POS) shows that about 92% of citizens enjoy the benefits of waste collection service. More than 50 % of them receive it three times a week and more. As these figures shows, the city is kept clean.

4.2 History of Municipal Solid Waste Management

In 1984, a bill to create an autonomous entity to be in charge of the solid waste management in the metropolitan region was presented for the consideration of the Legislative Assembly.

By means of the Law No. 41 date November 8th, 1984, the *Dirección Metropolitana de Aseo* (Metropolitan Cleaning Office, or DIMA) is created, which takes over the waste management systems for the districts of Panama, San Miguelito and Colón.

The main purposes for the DIMA are the planning, research, direction, inspection, operation and exploitation of the services.

The site where Cerro Patacon sanitary landfill lies today was then chosen, and the discharge operations begin in June 1985. In that same year, Panama Viejo dumping site was closed.

Between June 1985 and June 1995, wastes are disposed of in the denominated “Stage I” of the sanitary landfill, at the entrance of the site; later on, the “Stage II” is developed by phases.

4.3 Waste Stream

4.3.1 Concept of Waste Stream

The present waste stream in the Study Area is 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)

4.3.2 Waste Stream

Figure 4-1 shows a waste stream through out the whole year on the basis of the results described above.

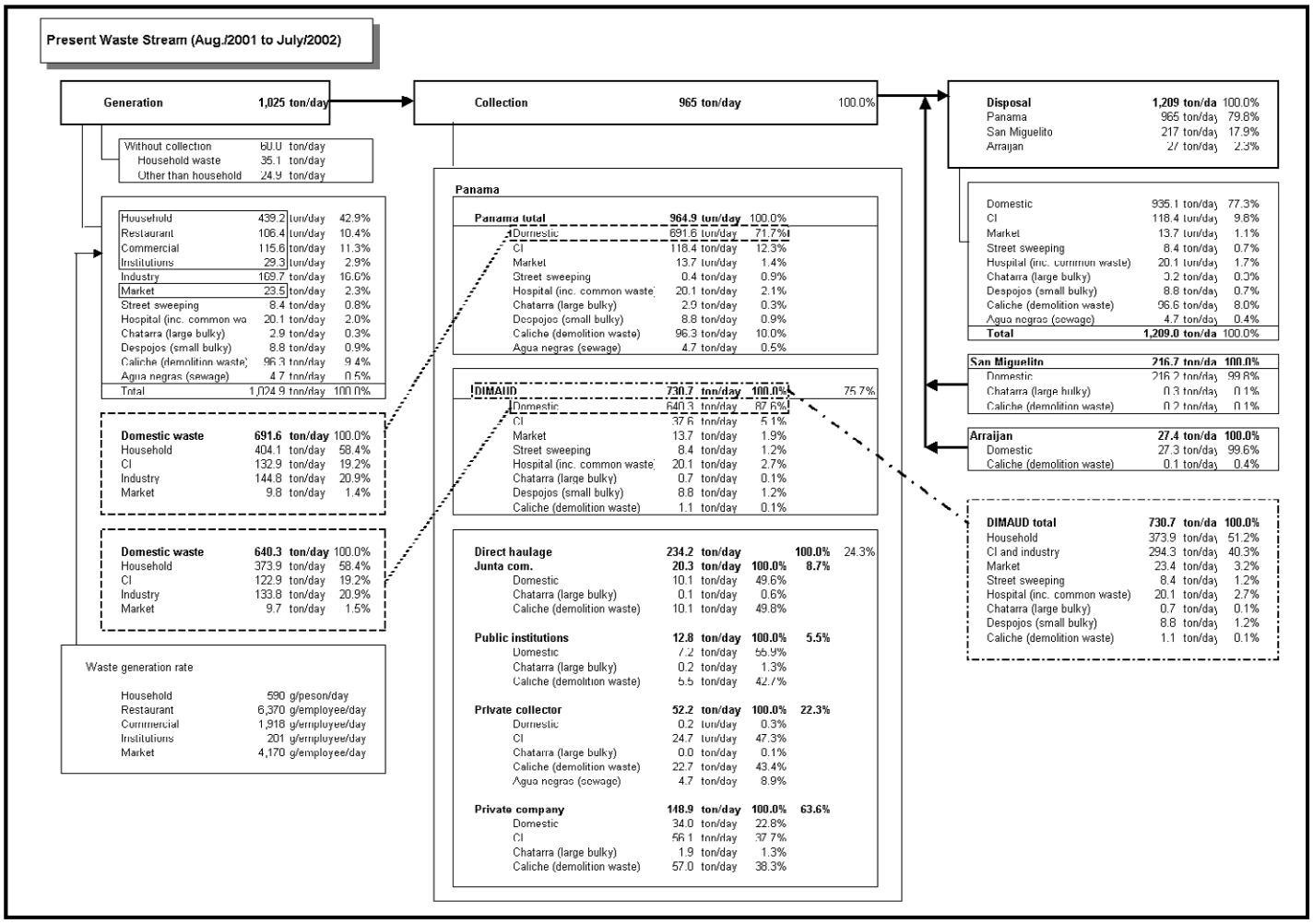

Figure 4-1: Current Waste Stream (daily average Aug.2001 to Jul. 2002)

4.4 Technical System

4.4.1 Discharge and Storage System

Currently, the handling of residential solid waste is done in plastic bags that are generally placed in *tinaqueras* (metallic baskets lifted above ground located near the sidewalks or the houses). Additionally, plastic or metallic bins are used to store the wastes; among them, there are full or cut in half 55 gallons drums.

Storage in public roads is done through metallic containers (2 and 8 yd^3) installed by DIMAUD; users usually deposit their waste in plastic bags inside the container. Commonly, in places where these types of containers are located, a lot of bulky waste is also

disposed (electrical appliances, mattresses, construction materials, etc.). In many cases, the containers are empty; however, a lot of waste is disposed around them.

4.4.2 Collection and Haulage System

a. Generalities about the Organization of the Haulage and Collection Systems

The Municipal Department of Urban and Household Cleansing of the Panama District (DIMAUD) operates with the following organizational structure, according to the manual of functions of November 2001 which generally is satisfied.

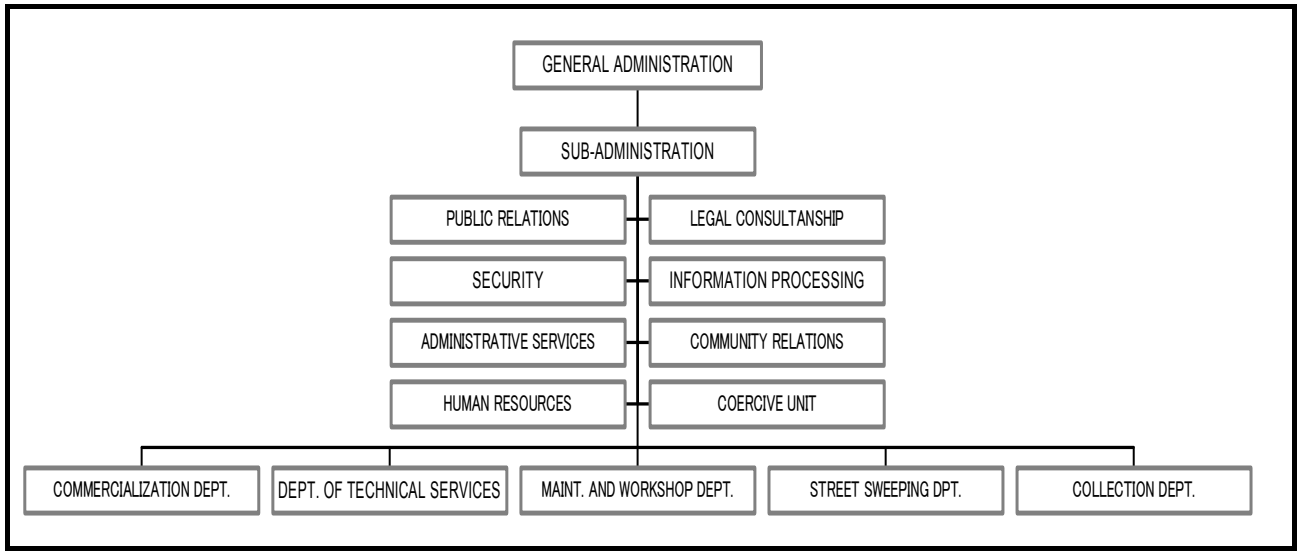

Figure 4-2: DIMAUD´s Organizational Chart

The collection department has been organized according to the current operation service. Consequently, there are two well-defined collection areas (A and B). Both sections depend directly from the Collection Department through the collection chief.

The following organizational chart shows the current organization in the collection department.

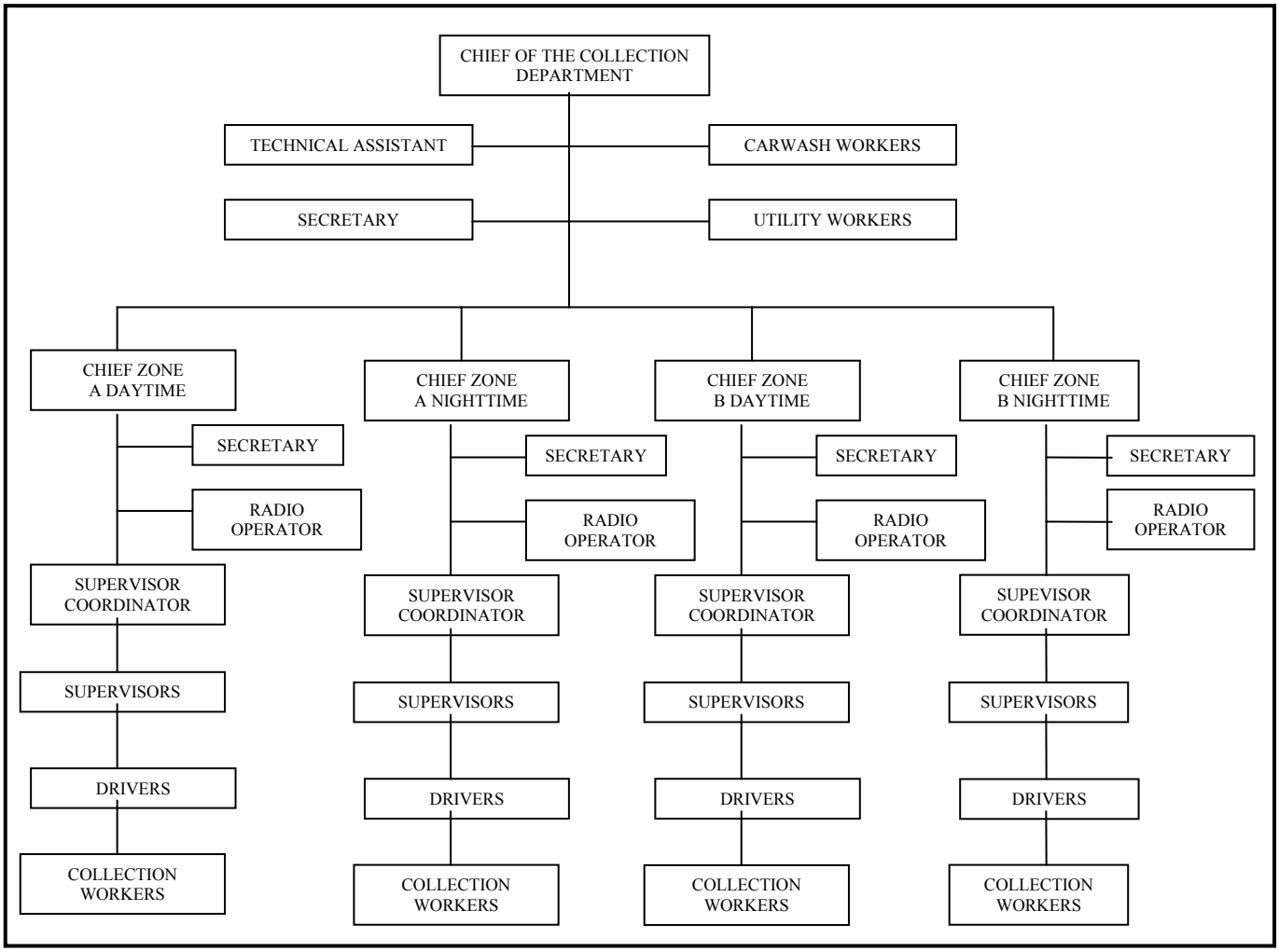

Figure 4-3: Collection Service Organizational Chart

b. Personnel

The collection department has a total of 804 workers which are distributed as follows

Table 4-1: Workers Distribution per Shift

Position	Zone A Daytime	Zone B Nighttime	Zone B Daytime	Zone B Nighttime	Total
Chief of Department	1				1
Chief of Zone	1	1	1	1	4
Technical Assistant	1				1
Department Secretary	1				1
Supervisor coordinator	1	1	1	1	4
Supervisors	10	4	12	6	32
Radio-operators	1	1	1	1	4
Administrative secretary	1	1	1	1	4
Drivers	46	23	88	31	188
Collection workers	148	64	232	104	548
Utility workers	6				6
Carwash workers	11				11
Total personnel per Area	228	95	336	145	804

Among this personnel, it is included the relief personnel.

b.1 Personnel Characteristics

Most of the workers assigned to the collection department have permanent contracts (67% of drivers and 65% of collection workers). On the other hand, drivers with eventual contract have an average of 0,5 years working for the institution; those workers with permanent contract have an average of 7,3 years working for the entity.

Table 4-2: Percentage of Workers by Range of Years of Service

Years of Service	Driver		Collection Workers	
	Eventual	Permanent	Eventual	Permanent
0 to 2 years	84%	3%	89%	11%
2 to 5 years	16%	23%	11%	21%
5 to 10 years	0%	40%	0%	24%
10 to 20 years	0%	16%	0%	20%
20 to 30 years	0%	13%	0%	21%
More than 30 years	0%	5%	0%	3%
Percentage per type of contract	33%	67%	35%	65%

c. Work System (Shifts, Work Schedule, Days Worked per Month)

The collection system that currently is performed by DIMAUD includes the collection of household, urban, commercial, and institutional waste; this work is done on a daily basis through different routes that cover most of the Panama District.

The collection service is designed based on Daytime and Nighttime shifts. The Daytime shift is made of two type of schedules that cover a total of 16 hours. The Nighttime shift is made of a single schedule which cover only 8 hours. The table shows the work shift.

Table 4-3: Work System

Shift	Type	Schedule
Daytime	Daytime	06:00 to 14:00 hrs.
	Noon time	12:00 to 20:00 hrs.
Nighttime	Nighttime	18:00 to 02:00 hrs.

In general, the collection vehicles work three types of shifts which results in only 4 available hours to make the preventive maintenance for all the fleet.

For every collection vehicle, there are usually 1 driver and 3 collection workers, which generally work 8 hours a day

In November 2001, a total of 56 vehicles operated; however, only 11% of them kept operating continuously during the whole month, i.e., 7 vehicles. A total of 14.496 tons were collected during November 2001. On the other hand, in January 2002, the total number of

vehicles was increased to 62; however, only 31% of them kept working continuously during the month, i.e., 20 vehicles. A total of 19.920 tons were collected during January 2002.

d. Section of the Collection Areas

The collection service is directed to collect the household, urban, commercial, and institutional solid wastes that are the responsibility of DIMAUD.The service is divided into two large areas ¨Area A¨ and ¨Area B¨ which cover most of Panama District; the service collects from 18 corregimientos out of a total of 19 corregimientos.

Area A has its headquarters in Curundu, beginning from January 2002 it serves 8 corregimientos.The service area has a total of 173,405 persons and a surface of 683 km^2.The total amount of waste collected is 7,300 ton/month.

Area B has its headquarters in Carrasquilla, San Francisco corregimiento.Area B´s infrastructure is larger than Area A´s, consequently, Area B´s serve 10 corregimientos.The population served is 494,558 and the surface is 900 kms^2.Currently, 10,400 tons/month of waste is collected in that area.

Collection zones are made of collection routes.The following diagram shows the operative organization of the collection service.

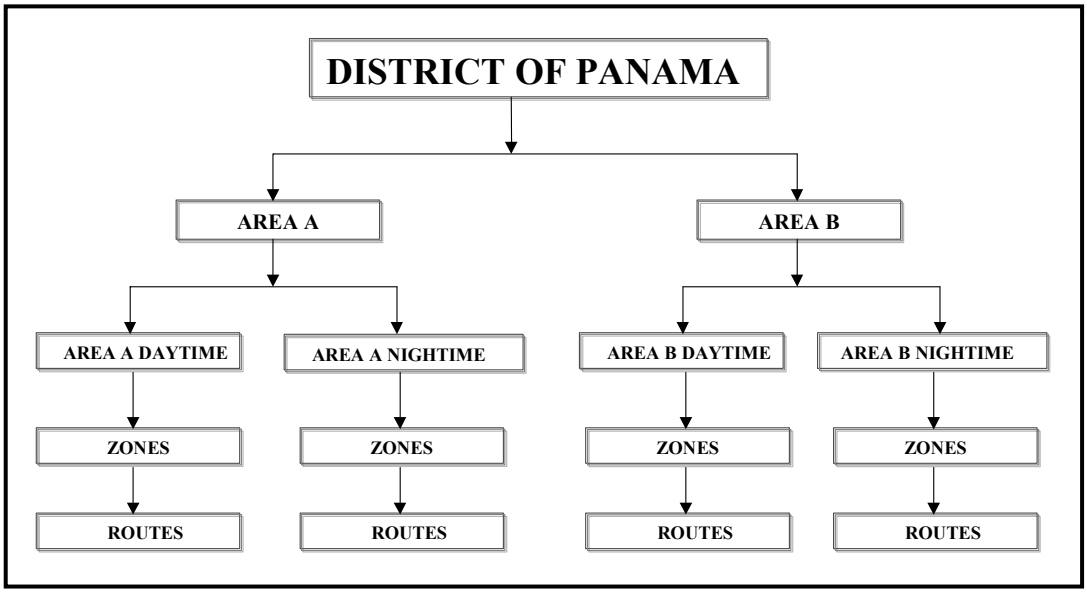

Figure 4-4: Collection Service Operative Flow Chart

Daytime area A has 7 zones; each one has a maximum of 7 routes; nighttime area A has a total of 3 zones, each one of them with 5 collection routes.

Daytime area B has a total of 7 zones with 7 routes each one; nighttime area B has a total of 4 zones, each one of them with 4 collection routes.

e. Collection Method

e.1 Collection Method within the Routes

Currently, there are three collection methods used by DIMAUD within the routes; they are the following:

- Collection Door to Door
- Collection Point to Point
- Mixed Collection

Door to door collection is done in most routes and where the collection truck can access without inconvenient.If the collection truck can not access easily, then the customer takes the wastes in bags to the nearest collection point.

Collection point to point is done mostly through metallic containers that are collected by frontal or rear loading trucks.In the first case, the truck is equipped with a lifter for containers; in the second case, a hook has been adapted to lift the container that is not the most adequate system to load them.The containers capacity varies from 2 to 8 $yd.^3$.

Mixed collection consists of door-to-door and point-to-point collection; this collection is preferably done in areas where both one floor and multilevel residential constructions are found.This system is also used in sectors where narrow streets are also found and collection vehicles are unable to access the houses.

e.2 Special Collection

Large Capacity Containers

There is another point-to-point collection system which consists of large capacity containers of 20 to 30 yd^3 which are lifted by roll-on/roll-off trucks.

It is planned based on requests by the community (specially low income sectors where security is a factor to be accounted for).

For the Roll-on/Roll-off service, DIMAUD has two trucks and a total of 10 containers (9 containers of 30 yd^3 and 1 container of 20 yd^3).

Special Assignments (Operativos)

The collection department plans special assignments (*operativos*) during the year; the main objective is to eliminate illegal dumpsites, cleansing in rivers and creeks, cut any overgrowth, and cleansing of public roads.

Planning for these special assignments is done with several weeks in advance and their undertakings involve many weeks, but focusing on specific days.

The special assignments are undertaken in all corregimientos in the Panama District and human and material resources from DIMAUD are used.

f. Analysis of Collection Service

f.1 Control on Register Information

Background data from the sanitary landfill (incoming trucks) and from the Collection Department was gathered with the purpose to know how the Collection Service takes place in the Panama District. For the sanitary landfill case, the background data gathered through the software working in conjunction with the weighbridge was used; on the other hand, data was obtained from the daily and monthly reports of the Work Orders that the Collection Department manages.

In order to verify if collection control data is similar from the two sources (weighbridge data and W.O. derived data), the tons and number of trips for November 2001 and January 2002 were established.

The following table summarizes the controls for each one of the corregimientos.

Table 4-4: Tons and Trips derived from the Collection Department and Landfill Data for November 2001 and January 2002

Corregimiento	Tons				N° Trips			
	Collection Control		Landfill Control		Collection Control		Landfill Control	
	November	January	November	January	November	January	November	January
ANCON	440.31	421.88	427.22	455.32	135	135	127	147
BETHANIA	1202.62	1199.38	1195.15	1692.62	205	231	223	343
CURUNDU	324.53	345.80	440.57	397.74	67	119	99	89
CHORRILLO	615.15	686.13	637.78	789.89	124	81	130	160
SAN FELIPE	267.01	447.45	397.67	390.94	73	103	101	87
BELLAVISTA	1355.51	789.47	1396.84	1527.27	244	145	253	285
CALIDONIA	907.84	973.44	1034.77	1083.55	172	194	207	222
SANTA ANA	505.64	582.51	491.58	597.18	46	115	94	116
JUAN DIAZ	1764.61	2137.51	1699.35	2179.93	321	428	311	429
PEDREGAL	584.22	506.70	650.27	687.50	111	134	122	145
TOCUMEN	1123.36	1172.61	1245.41	1208.16	202	241	222	251
PACORA	526.77	548.46	586.28	602.30	78	109	100	128
SAN MARTIN	42.30	50.14			8	8		
LAS CUMBRES	840.28	1032.14	918.68	1099.19	166	217	170	228
RIO ABAJO	405.34	506.99	471.44	443.91	77	91	89	84
PUEBLO NUEVO	577.18	790.70	551.59	687.14	108	151	99	127
SAN FRANCISCO	1278.44	1480.44	1279.52	1512.10	189	260	222	285
P LEFEVRE	1114.88	1179.72	1176.87	1429.74	174	224	205	269
GRAND TOTAL	13875.99	14851.47	14600.99	16784.50	2590	2997	2774	3395

The data analyzed reflects only the routes, it has not been included the contribution from rented vehicles or other services. The figures between the Collection Control and the Landfill Control should be equal. Consequently, it is clear that the controls are not being kept correctly and this can interfere in the evaluation of the service (for instance, San Martin route is not reflected in the Landfill control). Moreover, this situation can have a strong impact on the costs and income.

It is evident that it is required as soon as possible to establish a coordination between the sanitary landfill and the collection department with the purpose to control effectively the amount of wastes collected. Additionally, it is required to modify the monitoring of the service and the work order formats; this should be done jointly with the personnel training which is responsible to reflect this information on the formats.

f.2 Collection Routes Analysis

The collection routes performance was analyzed from the daily and monthly reports obtained from the W.O. Control Efficiency Indicators were defined for both November 2001 and January 2002

The indicator hours of work/shift shows that 38% of corregimientos have more than 8 hours of work per shift during November 2001, this percentage increased to 43% in January 2002 which represents an increment of overtime hours. If both indicators are analyzed, it can be concluded that the collection workers have a low performance regarding tons collected, however, they have to work more hours than those defined in a regular shift. This situation leads to an increment of labor costs due, in first place, to the inability of the collection workers to collect the amount of waste typically collected under normal conditions. Additionally, if we consider that the crew has to follow a work plan which is not completely satisfied during the regular shift; they have to compensate this situation with overtime hours. The current situation might be improved by designing new routes with fixed paths, but this measure has to be done in conjunction with more monitoring of the tasks performed by collection workers and drivers.

g. Maintenance of Collection Vehicles

Maintenance labors are done in the operational centers in Curundu and Carrasquilla where a Maintenance and Shops Department exists and its function is to guarantee preventive and corrective maintenance of the whole vehicle fleet (light, medium, heavy, and hydraulic) which belongs to DIMAUD in order to ensure that they function correctly on a daily basis.

This maintenance and Shops Department is organized in three sections which are Mechanical, Preventive Maintenance, and other Maintenance Services.

The Mechanical section has three units; each one of them in charge of maintenance and repair of heavy equipment, light equipment, and vehicle maintenance. This section is managed by the Chief of Mechanics.

The mechanical section works 24 hours a day which has been divided in three shifts of 8 hours as the following table shows.

Table 4-5: Shifts and Schedule for the Mechanical Section

Shift	Schedule
Daytime	07:00 to 15:00 hours
Noon time	15:00 to 23:00 hours
Night-time	23:00 to 07:00 hours

The repair and maintenance works are done by the following personnel:

Table 4-6: Personnel in Charge of the Repair and Maintenance Works

Position	Number of persons in Carrasquilla	Number of persons in Curundú
Mechanics	26	9
Assistants of Mechanics	23	7
Welder operators	8	4
Greasing personnel	9	4
Electromechanics	6	3
Assistants of Electromechanics	3	3
Personnel in charge to Vulcanize	15	7
Sheet Metal Worker	2	4
Lathe operator	3	2
Lathe operator assistant	2	3
Data collector	2	
Radio operator	1	
Crane	4	
Buyer of parts	1	
Supervisor	1	
Total	106	46

Most of the personnel is concentrated in the daytime shift with 61 workers, the Noon shift has 30 workers, and the night-time shift has 11 workers.

The Maintenance and Shops Department keeps only a stock of oils, greases, and lubricants. All the elements required to maintain the fleet are requested to the Warehouse which is the unit that manages all the materials needed to repair the vehicles.

4.4.3 Processing, Treatment and Recycling System

At present, there is neither formal intermediate treatment nor formal recycling system in Panama District. Waste collected in a manner of mixed collection goes to Cerro Patacon final disposal site directly and is disposed of there.

However, there exists informal material recovery system. Waste-pickers recover recyclable materials on the streets and Cerro Patacon landfill. According to the results of Recycle Market Survey, there are some recycling companies and Cerro Patacon is a major source of recyclable materials for such companies. Processed materials are mainly exported to USA, Costa Rica, Colombia, Asian Countries and others.

4.4.4 Street Sweeping System

With the purpose to keep the streets and avenues clean in the Panama District, DIMAUD conducts the manual and mechanical street sweeping program.

The responsibility to undertake manual street sweeping falls with the Street Sweeping Department which depends directly of the Director Office.

The mechanical street sweeping is under the responsibility of Area A of the Collection Department.

a. Manual Street Sweeping

In order to develop street sweeping, the Street Sweeping Department has organized the tasks according the work shift when the service takes place. Two sections are considered, one for the day time and another one for the night-time.

Shift	Work period	Schedule
Daytime	A	06:00 a 14:00
	B	09:00 a 15:00
	C	12:00 a 17:00
Night-time	A	16:00 a 22:30
	B	22:30 a 04:00

Not all the work periods last 8 hours, this is due to some personnel who does not have the required physical conditions to develop this type of work; consequently, physical wear down is reduced by decreasing working hours per day.

Each section has a street sweeping chief, administrative personnel chief, crew chief, and street sweeping personnel who are distributed according to the following figure:

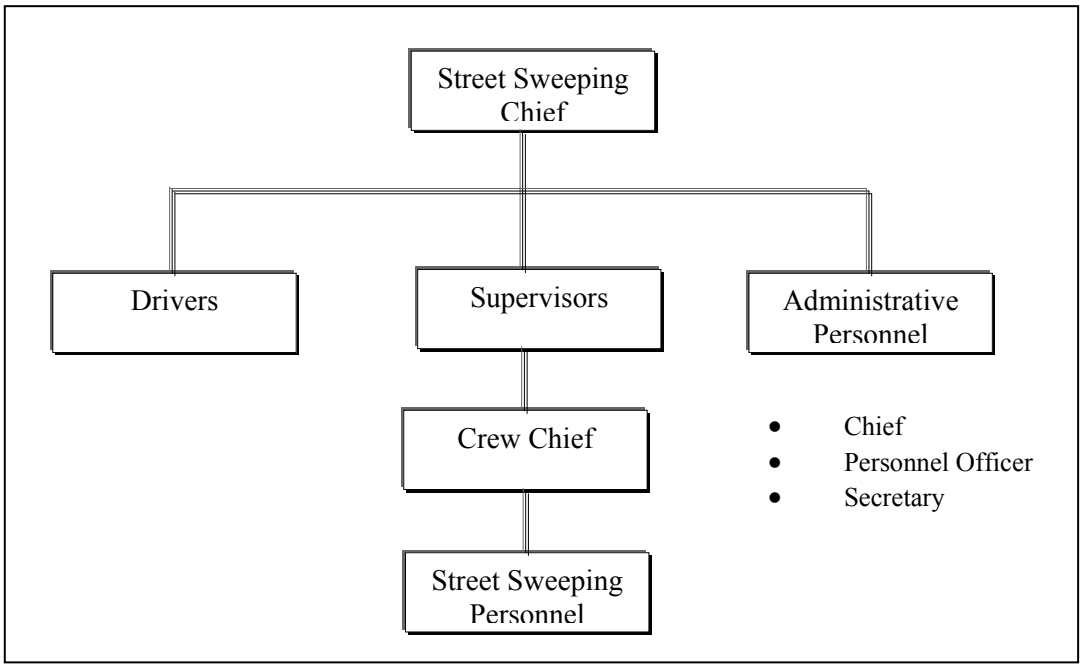

Figure 4-5: Organizational Structure of the Street Sweeping Department

a.1 Frequency of the Service Areas

The service area for the Daytime covers 19 routes which are detailed in the following table. The night-time shift street sweeping service covers 14 routes in six corregimientos as shown in Table 4-8.

Table 4-7: Daytime Shift Street Sweeping Service

Route	Service Area	Shift – Working Days	N° of Supervisors	N° of Street Sweepers
1 A	San Felipe Corregimiento	Shift A from Monday to Sunday	1	12
1-B	San Felipe Corregimiento	Shift C from Monday to Sunday	1	8
2	Corregimiento Calidonia	Shift B from Monday to Sunday	1	8
3	Corregimiento de Santa Ana	Shift B from Monday to Sunday	1	10
4	Corregimiento de El Chorrillo	Shift A from Monday to Sunday	1	12
5	Corregimiento de Calidonia	Shift B from Monday to Sunday	1	12
6	Corregimiento de Bellavista	Shift A from Monday to Friday	1	10
7	Corregimiento de Bellavista – San Francisco	Shift A, the main routes from Monday to Friday, secondary streets from Monday to Friday with a frequency of twice per week.	2	32
8	Work group which replace the personnel in other routes during their days off.	Shift A from Thursday to Monday	2	36
9	Group which works from Wednesday to Saturday in the Operativos which are planned by the Collection Department. On Sunday, this personnel replace personnel from other routes. On Sunday, this group replaces the personnel of route 10.	Shift A from Wednesday to Sunday	2	20
10	Río Abajo, Pueblo Nuevo, Parque Lefevre, and Bethania Corregimientos	Shift A, Main road from Monday to Sunday, secondary roads from Monday to Friday.	3	42

Route	Service Area	Shift – Working Days	N° of Supervisors	N° of Street Sweepers
11	The Group which supports route 9 on Monday, Tuesday, and Wednesday. On Saturday and Sunday, the group conducts street sweeping in España Ave., Calle 50, and Balboa Ave., all the main roads.	Shift A from Saturday to Wednesday	1	10
12	Calidonia and Curundú Corregimientos	Shift B from Monday to Friday	1	10
13	Replacement personnel on routes 1 and 4	Shift C	1	8
14	Reverted area: cleansing operativos are programmed by Area A of the Collection Department.	Shift A from Monday to Friday	1	8
15	Office and support cleansing	Shift A from Monday to Friday	1	35
16	Personnel who support the Operativos on Monday, Tuesday, Wednesday, and replace personnel from Group 2 and 10 on Saturday and Sunday.	Shift A from Saturday to Wednesday	1	8
17	Pacora Corregimiento	Shift A from Monday to Friday	1	5
18	Personnel in charge to support other routes weed out the area	Shift A from Monday to Friday	1	2

Table 4-8: Night-time Street Sweeping Shift

Route	Service Area	Shift – Working Days	N° of Supervisors	N° of Street Sweepers
1	Presidency Sector	Shift A	1	4
2	Market Sector	Shift A	2	4
3	Santa Ana Peatonal Corregimiento	Shift A	1	4
4	Calidonia Corregimiento	Shift A	2	6
5	Santa Ana Parques Corregimiento	Shift A		2
6	Calidonia MarañónCorregimiento	Shift A	2	6
7	Santa Ana Corregimiento Street 16, 17 – Ancon Avenue – A Avenue	Shift A	2	6
8	Presidency Sector	Shift B	1	4
9	Market Sector	Shift B	2	4
10	Santa Ana Peatonal Corregimiento	Shift B	1	4
11	Calidonia Central and Perú Corregimiento	Shift B	2	6
12	Corregimiento Santa Ana Parques	Shift B		2
13	Calidonia MarañónCorregimiento	Shift B	2	6
14	Santa Ana Corregimiento Street 16, 17 – Ancón Avenue– A Avenue	Shift B	2	6

a.2 Personnel in charge of service

The day-time section has a total of 336 workers as it is detailed in Table 4-9. On the other hand, the night-time section consists of the personnel that is shown in

Table 4-10.

Table 4-9: Number of Personnel in the Street Sweeping Department (Day-time)

Position	N° workers
Section Chief	1
Administrative Area	12
Supervisors	3
Crew Chief	24
Drivers	10
Street Sweepers	286
Total	336

Table 4-10: Number of Personnel in the Street Sweeping Department (Night-time)

Position	N° of workers
Section Chief	1
Administrative Area	5
Supervisors	37
Drivers	10
Street Sweepers	130
Tool Responsible	13
Total	196

Out of the total, 96% has permanent contract and has an average working period of 5 years. Among the street sweepers, 83% has a permanent contract and has an average working period of 5 years.

b. Mechanical Street Sweeping

According to what DIMAUD informs, mechanical street sweeping is done in the District. There are two mechanical street sweepers which conduct mostly the street sweeping on bridges; however, this could not be confirmed on the field.

According to information provided, the planning of the tasks for mechanical street sweeping is done by Section A chief. The program includes a total of 7 operative days per week; they cover a total of 8 working hours per day.

4.4.5 Final Disposal System

a. Outline of the Cerro Patacon Landfill Site

The final disposal site for solid waste in Panama Municipality is located in Cerro Patacon. This final disposal site is consisted of a part for inorganic waste and a part for organic waste. The part of organic waste is divided into two, i.e., 'Etapa I' that was used from June 1985 to June 1995 and 'Etapa II' that has been operated from July 1995 up to now. The table bellows summaries the final disposal site.

Table 4-11:Outline of Cerro Patacon Landfill Site

	Operation period		Landfill capacity	Disposed amount	Liner system	Leachate treatment system
	From	To				
Etapa I	June/1985	June/1995	1,998,002 m^3	2,327,400 ton	clay	lagoon
Etapa II	July/1995	-	[8]3,541,918 m^3	-	Synthesis liner	Lagoon

[8] Diagnóstico, Plan Maestro, Caracterización de Activos y Evaluación de Alternativas de Participación del Sector Privado para el Manejo de los Desechos Sólidos en el Area Metropolitana, Colón, Areas Revertidas y Panamá Oeste
INFORME DE AVANCE, DIAGNOSTICO, JOBEFRA SANIPLAN, Noviembre 1999

b. Landfill Capacity

Etapa 2 of Cerro Patacon final disposal site are the operated landfill at present. Its remaining capacity is estimated as about 1,800,000m^3 as of the end of 2002. Then, it would be full within 3 to 4 years. Cerro Patacon final disposal site has a large area enough to expand the present landfill. Therefore, formulation of a plan to expand the landfill in the site is urgently necessary. Meanwhile, proper disposal of inorganic waste disposed of other area and medical waste is other urgent issue.

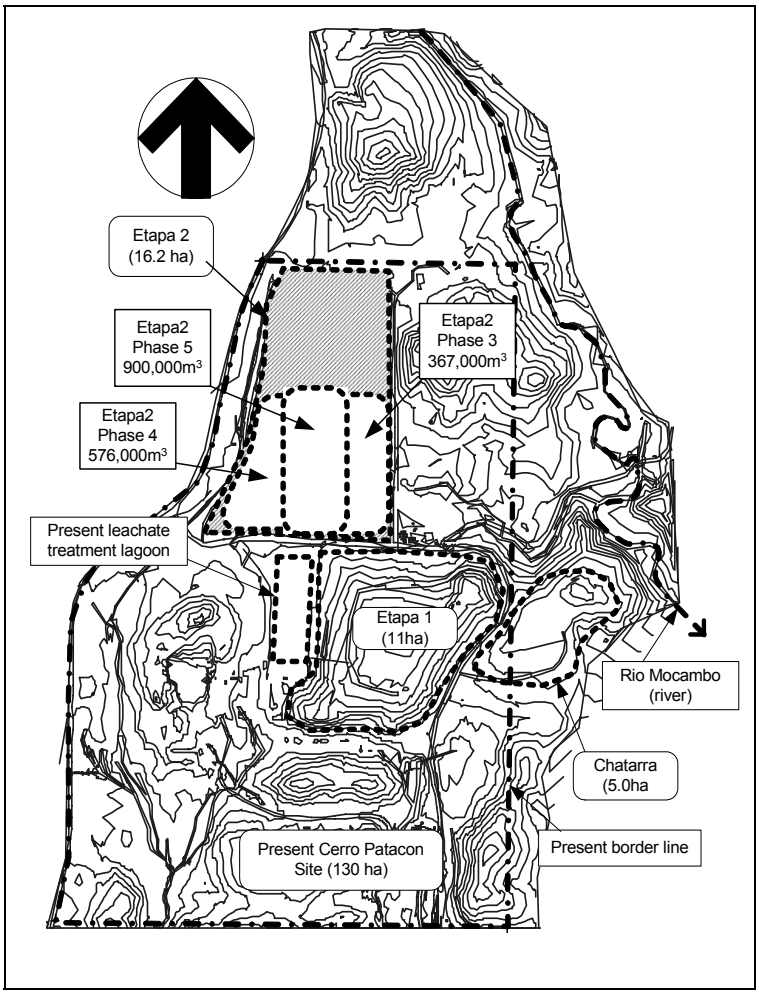

Figure 4-6: Layout of Landfill Site

Table 4-12: Remaining Landfill Capacity

Location	Volume (m^3)
Etapa 2, Phase 3	367,000
Etapa 2, Phase 4	576,000
Etapa 2, Phase 5	900,000

4.5 Institutional and Financial System

4.5.1 Institutional System for SWM

The table below shows the summary of current legal framework.

Table 4-13: Summary of Main Competencies as Per the Current Legal Framework

SUMMARY OF MAIN COMPETENCIES AS PER THE CURRENT LEGAL FRAMEWORK	
Ministry of Health	• In health matters, the State has to oversee for the population's health and fight transmittable diseases through environmental sanitation (Political Constitution Art. 105 and 106) • Public health engineering and cleansing of cities. (Sanitary Code Art. 201) • Sanitary activities regarding environment control are the following: collection and treatment of garbage, wastes and residues. • To study, formulate and execute the National Health Plan and supervise and assess all the activities conducted within the health sector. (Cabinet Decree No. 1 dated January 15th, 1969) • It is the authority in charge of regulating, overseeing, controlling and sanctioning everything linked with the assurance of human health (LEGA's Art. 56) • To regulate and control the differentiated management of household, industrial and hazardous wastes throughout its stages: generation, collection, haulage, recycling and final disposal. The State will outline the fees for such services. (LEGA's Art. 58) (the law does not establish who is the competent authority) • It is the sector's ruling body, and it has the responsibility and authority to opine, determine and make a decision onthe healthiness requirement) Art. 16 of Law No. 41 dated August 27th, 1999) • The authority in charge of regulating, promoting, evaluating and overseeing the management of solid wastes from health facilities (Executive Decree No. 111 dated June 29th, 1999)
National Environment Authority	All the regulations correspond to Law No. 41 dated July 1st, 1998 • The State's ruling entity in natural resources and environmental issues • Public institutions with environmental jurisdiction are obligated to coordinate, advise and execute their actions by sticking to the parameters outlined by the ANAM, by means of the Environment's Inter-institutional System. • To issue the resolutions and technical and administrative regulations for the execution of the environmental policy • To enforce the LEGA • To dictate the scope, guidelines and terms of reference for the environmental impact assessment and studies. To evaluate and approve the Sworn statements and issue the environmental resolutions that allow the beginning of projects. • To impose sanctions and fines
Municipal system	All the articles mentioned herein correspond to Law No. 106 dated October 8th, 1973, and modified by Law No. 52 dated December 12th, 1984 • To create municipal or mixed enterprises for the exploitation of goods and services. Art. 17 • To promote the formalization of contracts for the exploitation of goods and services. Art. 17 • To establish and regulate the cleaning and household service for their population. Art. 17 • To set and collect fees and rates over the rendering of the waste collection service. Art. 76
Municipality of Panama	All the articles mentioned herein correspond to Law No. 41 dated August 27th, 1999 • It is responsible for the direction, planning, researching, inspection, operation and exploitation of the services. Art. 2 • To set and collect reasonable rates and fees. Art. 4 • To formalize contracts regarding the urban cleansing and household services. Art. 6 • Management of Cerro Patacon sanitary landfill. Art. 6; it empowers the Mayor that manages a sanitary landfill to enter operation contracts of such landfills. Art. 8 • The collection and final disposal services are of a compulsory nature (Art. 21) and the DIMAUD is the competent authority to operate and exploit them (Art. 2). • To impose fines • To regulate the rendering of the urban cleansing and household services by means of decrees

The below table shows the main summary of the competencies linked with municipal solid waste management and hazardous wastes.

Table 4-14: Summary of the Main Competencies linked with the Municipal Solid Waste Management and Hazardous Wastes

SUMMARY OF THE MAIN COMPETENCIES LINKED WITH THE MUNICIPAL SOLID WASTE MANAGEMENT AND HAZARDOUS WASTES			
ACTIVITY	MINSA	ANAM	MUNICIPALITY OF PANAMA
Outlining of policies	●	●	
Hazardous wastes	●	●	
Surveillance and controls	●	●	
Technical regulations	●	●	
Sanctions and fines	●	●	●
Operation and exploitation of the services			●
Fees and rates fixing			●
Regulation of the service			●

4.5.2 Financial and Accounting System

a. Accounting System

The present accounting system used by DIMAUD is mandatory for all government offices, and complies with the Government Accounting Manual (Manual General de Contabilidad Gubernamental) of 1993.

It can be seen that the present accounting system of DIMAUD is designed for budget control, and it is not well suited for cost accounting.

b. Financial System

b.1 Billing and Collection

DIMAUD inherited from DIMA the joint billing/collection system with IDAAN, the water supply company. Customers receive in one bill the amounts corresponding to water and solid waste disposal, but they have the option to pay both bills or either bill. As the bill is included in the water bill, users of solid waste disposal service may not feel compelled to pay the service charges. Billing and collection service provided by IDAAN to DIMAUD in 2001 can be summarized as follows.

Table 4-15:: Billing and Collection by IDAAN for DIMAUD in 2001

Month	Number of Bills	Amount of Bills (USD)	Collected Amount (USD)
January	111,385	1,293,123.51	947,097.06
February	112,279	1,304,888.25	762,981.11
March	113,401	1,341,984.88	1,123,566.60
April	113,699	1,389,118.91	919,210.54
May	114,744	1,425,740.51	1,139,503.11
June	115,111	1,432,036.25	1,053,989.59
July	116,020	1,423,232.29	1,025,582.28
August	116,024	1,423,317.14	1,161,723.13
September	116,369	1,436,288.39	929,673.14
October	117,253	1,423,276.65	881,505.82
November	118,041	1,445,163.82	944,825.65
December	118,667	1,468,018.96	1,130,834.73
Total	1,382,993	15,410,204.68	12,020,492.76

Source: DIMAUD Accounting and Commercial Departments

b.2 DIMAUD Income and Expenditures

According to DIMAUD Financial Statement, Annex-7 Income Report, total income in 2001 amounted to U$24,278,558, of which U$21,807,977 from service charges, U$2,000,580 subsidy from the Central Government, and U$460,251 from other sources. Revenue from households amounted to U$17,179,475, equivalent to 78.8% of total service charges, while user charges from sanitary landfill amounted to U$1,246,847. Revenue from juridic person, central government, autonomous entities and government corporations all added up to around 12% of total income.

Table 4-16: DIMAUD Income Report (USD)

Income Description	**2001**	**2000**
Service Charges		
Household	17,179,475	11,241,750
Juridic person	353,967	247,084
Central government	1,303,039	1,261,307
Autonomous entities	670,691	625,133
Financial intermediary	340,286	392,690
Special service	16,305	26,386
Government corporations	697,367	792,929
Cerro Patacon Landfill	1,246,847	1,391,514
Total Service Charges	**21,807,977**	**15,978,794**
Government Subsidy	2,000,580	2,283,349
Other Incomes	460,251	484,909
Income from Previous Years	9,750	0
Total Income	**24,278,558**	**18,747,051**

Source: Informes Financieros DIMAUD 2001-2000, Anexo 7

Table 4-17: DIMAUD Income and Expenditures (USD)

Income and Expenditures	2001	2000
Income		
Income from service	21,808,977	15,978,794
Other operational income	460,251	484,908
Total Income	22,269,228	16,463,702
Expenditures		
Personnel expenses	10,531,322	9,127,348
Operation expenses	3,393,176	2,100,771
Service by third party (Sub-contractor)	5,154,376	2,609,720
Management expenses	552,706	556,596
Reserve funds	2,046,390	1,465,628
Expenses of past years	76,577	51,557
Total Expenditures	21,754,547	15,911,620
Operating Income	514,681	552,083
Other expenses	9,750	393,463
Surplus before Subsidy	524,431	945,546
Subsidy	2,000,580	2,283,349
Surplus or Deficit	**2,525,011**	**3,228,895**

Source: Informes Financieros DIMAUD 2001-2000, Cuadro B

c. Financial System

As DIMAUD came into being when the service provided by DIMA was transferred to the Municipalities of Panama, San Miguelito and Colon by virtue of Law 41 of August 27th 1999, Financial Statements are available only for the years 2000 and 2001. The Balance Sheet is shown below.

Table 4-18: DIMAUD Balance Sheet (USD)

ASSETS and LIABILITIES	2001	2000
ASSETS		
Current Assets		
Cash and Bank	1,252,103	1,882,994
Commercial Accounts Receivable	10,475,774	5,625,819
Other Accounts Receivable	3,097,277	2,142,743
Inventory	1,933,455	1,959,367
Total Current Assets	16,758,608	11,610,922
Fixed Assets		
Land	3,549,435	3,549,435
Machinery and Equipment	4,176,204	4,886,024
Other Assets	11,269,828	0
Total Assets	**35,754,075**	**20,046,381**
LIABILITIES and EQUITY		
Current Liabilities		
Commercial Accounts Payable	3,639,348	1,295,892
Other Accounts Payable	221,218	217,123
Total Current Liabilities	3,860,566	1,513,015
Equity		
Public Equity (Capital)	26,574,299	15,304,471
Additional Public Equity	6,201	0
Accumulated Results	5,313,009	3,228,895
Total Equity	31,893,510	18,533,366
Total Liabilities and Equity	**35,754,075**	**20,046,381**

Source: Informes Financieros DIMAUD 2001-2000, Cuadro A

Analyses of DIMAUD Financial Statements 2000 and 2001 permit the following remarks.

Cost of service by "activity" (Administrative, Collection, Maintenance, Landfill, Street Sweeping, and Landscaping) was already available in DIMAUD. Unit cost per ton for 2001 was calculated by distributing administrative expenses to other activities proportionately with the corresponding labor costs, as shown in the table below.

Table 4-19: Unit Cost of DIMAUD Service

Activity	DIMAUD Cost (USD/year)	Distributed Cost (USD/yer)	Assumed Solid Waste (ton/year)	Unit Cost (USD/ton)
Administrative	3,935,387.98			
Collection	10,090,778.29	12,295,080.06	300,000	40.98
Maintenance	1,488,635.78	1,919,017.65		
Landfill	2,612,096.64	2,821,384.70	365,000	7.73
			411,000	6.86
Sweeping	3,047,337.99	4,138,754.27		
Landscaping	580,310.37	580,310.37		
Total	21,754,547.05	21,754,547.05	365,000	59.60
			411,000	52.93

Source: Informes Financieros Comparativos 2001-2000, Anexo 8, DIMAUD

- Total Cost: U$59.60/ton, assuming 1,000ton/day generation (365,000ton/year), but U$52.93/ton if the assumption is the total disposal amount of 411,000ton/year in Cerro Patacon landfill
- Collection Cost: U$40.98/ton, assuming 300,000ton/year collection
- Landfill Cost: U$7.73/ton, assuming 365,000ton/year final disposal, but U$6.86/ton if 411,000ton/year is assumed

Collection cost and total cost are high compared to referential parameters.

Administrative Expenses included most of clothing (pants, T-shirts, caps, shoes), which at least conceptually, should go to Collection Service and Street Sweeping. This remark is valid even after recognizing that "sweaters" (T-shirts) and caps included in Administrative Expenses were gifts to school children who were required to do community work in order to graduate, and many of them chose to get involved in solid waste management.

d. Commercial Aspects

IDAAN sends daily report to DIMAUD on the amount collected during the day, but the actual transfer of funds is not daily. The larger the amount to be transferred, the larger is the delay in fund transfer because it requires the prior approval of the Comptroller of the Republic. This means that the transfer does not follow the consecutive order of daily collection. One large collection (U$274,000) of early January 2002 was still not transferred on February 20th.

4.5.3 Private Sector

The private sector participates in collection, recycling, and final disposal areas.

a. Collection

During January 2002, private vehicles transported to Cerro Patacon sanitary landfill the following solid waste amounts.

The vehicles owned by a private company that services San Miguelito Municipality are also classified as private vehicles.

Table 4-20: Admission of private vehicles into Cerro Patacon sanitary landfill, January 2002

Source	Weight in tons	% of the total amount of waste transportedto Cerro Patacon	No. of trips	% of the total number of vehicles allowed into Cerro Patacon
Total amount of waste transported to Cerro Patacon	86,111.51	100	9,902	100
Private with credit	3,494.54	4.06	1,309	13.22
Private paying in cash	2,067.17	2.40	1,817	18.35
Sub total	5,565.71	6.46	3,126	31.57
San Miguelito	7,144.89	8.30	1,446	14.60
Total	12,710.60	14.76	4,572	46.17

The private company that services San Miguelito District deposits 8.3% of the total solid waste allowed into Cerro Patacon.DIMAUD does not bill for this final disposal service neither to San Miguelito nor the private company that collects in San Miguelito.

b. Final Disposal

The contract of operation by a private company of Cerro Patacon sanitary landfill still needs to be countersigned by the office of the Republic´s Controller.DIMAUD conducted a public bidding for that purpose.

c. Recycling

There is a marketing structure, partly formal and partly informal, consisting of street workers, collection workers, public and private employees, residents, waste picker in Cerro Patacon, purchaser points (in the city and Cerro Patacon), recycling shops, purchaser companies, processing and transforming companies, and exporters.

4.6 Social Aspects

Waste-pickers working under poor conditions in Cerro Patacon landfill count over 400. Improvement of waste-pickers' current situation is inevitable both for themselves and landfill operation. Previously various studies on waste-pickers were attempted at the landfill and a couple of studies help us establish some points of comparison with the present situation. For example, one is elaborated by DIMA in 1984, compiled by National Environment Commission in 1987 and the other is a survey executed by Patsy Arcia from DIMA within the scope of an international consulting job.

4.7 Environmental Education

The Ministry of Health (MINSA) is the authority in charge of standards, to watch over, to control and to sanction all relative aspects in order to guarantee the human health. Likewise, from the perspective of the environmental health it coordinates with the National Environmental Authority (ANAM), technical and administrative measures, so that the environmental alterations do not affect directly the human health.

MINSA has Integral Health Promoters that are volunteers elected by communities. Curriculum of Environmental Health responds to all programs that MINSA executes contains topics regarding water, control measures and surveillance of water, construction and uses of sanitary latrine and waste disposal.

MINSA will grant, in meritorious cases, environmental recognition for natural or juridical people who make efforts on environmental education.

4.8 Relevant Studies

During the last years, several national and international agencies have conducted studies related to the solid waste management in the study area.

The following table show some of those studies:

Table 4-21: Relevant Studies

Study	Scope
Study on Solid Waste Problematic in Panama, San Miguelito, and Colon cities Department of Cleansing. National Institute of Aqueducts and Sewage, 1982	Diagnostic of the situation; technical/economic feasibility; administrative restructuring. It is analyzed and designed a new organization oriented as an autonomous entity. In 1984, DIMA is created.
Studies on Sanitary Landfill in Mocambo. Ministry of Planning and Economic Policy. National Commission of the Environment, 1987	Directed to replace the old dumping site in Panama viejo. Selection of the site; structural studies; design; operative procedures; development plan. The results of this work serve as framework for the development of Cerro Patacon sanitary landfill.
Plan for Urban Development of the Metropolitan Areas in the Pacific and the Atlantic. Housing Ministry, 1997	Planning context; urban development plan; local action plan; proposal for institutional development; analysis of the client´s needs and design of the geographic information system. Tend to strengthen in the MIVI, the planning and regulation capacity for the urban development; it also includes proposals presented in the Conservation Plan of the Natural Resources in the Canal Basin (Regional Plan) and the General Plan for the Use, Conservation and Development of the Canal Area (General Plan)
Diagnostic, Master Plan, Characterization of Actives and Evaluation of Alternatives for the Participation of the Private Sector of the Solid Wastes in the Metropolitan Area, Colon, Reverted Areas, and Western Panama. Ministry of Economy and Finances, 2000	The government begins a process which intends to regulate the provision of the service for the solid waste management in the Great Metropolitan Area of Panama. Analysis and conclusions regarding the current situation of the services provided by DIMA, the participant institutions, the organization, the cost of the services, the organization affectivity and operation efficiency, available actives, market. The opinion of the clients is gathered, their availability and capacity to pay; a subsidy policy is design. A draft is written for a law on the Institutional and Regulatory framework.

5 Industrial Waste Management

5.1 Definition of Industrial Waste

Definition of industrial waste: Material generated by or remaining from production process and is not usable. (LEGA: General Environmental Law)

Also, LEGA defines Hazardous Waste as waste or residue that affects human health, including those classified as hazardous in international conventions ratified by the Republic of Panama, or in special law or regulation.

5.2 Key Issues

- To establish the regulatory framework to guide and regulate the hazardous waste management, in accordance with one of the main provisions of the Environmental General Law.
- To give more hierarchy and strength to the MINSA structure on hazardous waste

6 Medical Waste Management

6.1 Definition of Medical Waste (MW)

Medical waste is all those waste generated in the following health establishments:

a) Hospitals, Quantification of the DE clinics, medical centers, dental clinics, health centers, policlinics, and psychiatric clinics, psychiatric and geriatric houses, and other specialties of public and private sectors.

b) Autonomous institutes related with health.

c) Clinical laboratories, biochemical and biotechnology laboratories of public and private sectors.

d) Pathological anatomy departments, morgues and funeral and cremation houses.

e) Outpatient clinics, clinics, hospitals and veterinary laboratories.

f) Biomedical investigation centers, biotechnology and genetics

g) Any other establishment determined by the Ministry of Health.

The hospital waste are comprised by common waste (by nature is similar to the household waste) and medical hazardous waste.

6.2 Major MW generators

During 1998, the following occupation statistic of the main health establishments in Panama District was registered.

Table 6-1: Major Generators in Panama District. 1998

Health Establishment	Nos. of Beds	Patients/day
PUBLIC		
Metropolitan Hospital Complex. CSS	931	300,174
Children Hospital	393	142,309
National Psychiatric Hospital.	546	163,925
Santo Tomás Hospital	667	182,684
National Cancer Institute	127	33,206
“Hogar de la Esperanza” Hospital	48	12,560
Sub total		834,918
PRIVATE		76,187
Total		911,045

6.3 Current in House Management, Treatment, Haulage and Final Disposal of MW

For the present study, a survey in three district hospitals was carries out: One public and two privates, with a total of 1,100 beds. The results are described as follows:

Table 6-2: Results of the Study

Activity	Yes	No	Remarks
Separation	X		There are written instructions for separation and handling. Waste is separated into three categories: materials, which have had, contact with infectious patients; organic fabrics coming from surgery and childbirth; sharp and piercing materials (needles, surgical knifes, shaving blades, etc).
Packing and storing	X		Plastic bags of red color are used for packing in the first two categories, and plastic bins with cover or cardboard boxes, which are sealed. These recipients are deposited in a returnable plastic container of red color.
In house collection	X		The containers are collected twice a day. The collection of waste of outpatient consultation is carried out two to three times a day and is disposed in plastic bags of red color.
In house haulage	X		The recipients with red bags are moved from each generation area, using a cart and hauling to central storage area.
Central storage	X		The place is fenced and closed. One of the hospitals has a refrigerated space for pathological waste. The places are disinfected every day. In two hospitals there is additional place to store hazardous waste. There is free access for the collection vehicles.
Haulage (outside)	X		DIMAUD provide daily collection service.
Treatment		X	A hospital declares that incinerates its waste. The ashes are discharged with common waste. Two hospitals discharge its waste without treatment.
Final disposal	X		At Cerro Patacon sanitary landfill, DIMAUD collection trucks discharge the waste in a hole that previously had been prepared and covers immediately with other waste.

Although waste separation procedures and in house handling are carried out, haulage is made by vehicles, which do not have the characteristics for such a purpose. Disinfecting is not carried out before disposal in the sanitary landfill. In this landfill MW disposal does not fulfill the minimum protection standards for the health and safety of DIMAUD workers.

6.4 Key Issues

Weakness in the control capacity and supervision

- Low training of health establishment's personnel in the procedures and practice of MW management.
- Lack of information on labor accidents and nosocomial diseases.

7 Pilot Projects

7.1 Collection Improvement

7.1.1 Outline

a. Objectives

- To improve the efficiency of waste collection by means of design and implementation of a rational collection plan, and establishment of monitoring and evaluation methods of the collection service.

b. Project Design Matrix

Project Design Matrix was formulated in order to clarify purpose, expected outputs, activities and necessary inputs as shown in Table 7-1.

Table 7-1: Project Design Matrix of the Pilot Project of Collection Improvement

Narrative Summary	Objectively verifiable indicators	Means of Verification	Important Assumptions
Overall goal Collection Efficiency is improved in Panama District			
Project purpose To improve the efficiency of Waste Collection in San Pedro	The service is provided with the frequency and schedule established. Indicators showing collection efficiency is improved, e.g., ton/trip	Daily reports Indicators established through the pilot project	DIMAUD will take the Pilot Project as a base to apply its experiences in other Corregimientos of Panama. The personnel in charge of the pilot project remains in DIMAUD.
Output 1. A rational plan of collection is designed and implemented. 2. The personnel satisfies the work plan and the norms 3. The service is monitored according to a control program 4. The information records are kept up to date 5. The technical personnel are trained to design the routes.	1.1. Route Map Designed 1.2 Manual of Procedures 2.1 The pilot project area is covered with collection service established 3. Collection routes are monitored everyday. 4. Data is kept everyday. 5. 100% of the targeted personnel have received training.	This report This report Daily reports/monitoring report Monitoring report/ Record of the training evaluation Daily reports Records for the training evaluation	

Narrative Summary	Objectively verifiable indicators	Means of Verification	Important Assumptions
Activities 1.1 To produce a map of the area 1.2 To elaborate procedure manual 2.1 To train drivers and collection workers 2.2 To elaborate operation manual for collection 3.1 To elaborate monitoring program 3.2 To train monitoring personnel in conjunction with 2.1 4.1 To elaborate format to input data 4.2 To elaborate Daily Work Order to give it to the driver 5.1 To train technical personnel	Inputs Study Team Personnel 2 persons (1 person in charge and 1 assistant) Equipment 10 containers, 3 walkie-talkies, 2 odometers, 1 PC, 1 Set of Office 2000 software, 1 Printer Panamanian C/P Personnel 1 collection chief, 2 supervisors, 8 persons in the crew (two shifts). Equipment existing trucks in good condition (1 main, 1 reserve), maintenance facilities and equipment, project office Training The Panamanian C/P will receive training during the pilot projects		Residents agree with the implementation of the pilot project.

7.1.2 Evaluation and Conclusions

a. Optimization of Use of Collection Vehicles

The load being transported per trip has increased with respect to the maximum payload of the vehicle. The design of the routes have led to use 90% of the payload capacity of the truck, whereas previously only 82% was used (both values are monthly averages). The minimum values obtained before the pilot project represented 30% and 39% of the payload for the first and second trip respectively; whereas, for the pilot project these values increase to 63% and 75% respectively.

b. Increment of the efficiency on the collection service

The following has been achieved regarding collection efficiency.

- The total operation time of the vehicle was reduced in 24%.
- The hours which would be paid to the driver was reduced in 17%.
- The hours which would be paid to the collection worker was reduced in 19%.
- Fuel consumption was reduced in 24%
- The total distance traveled in one month was reduced in 22%.
- The collection distance was reduced in 33%.
- The number of trips in one month was reduced in 27%.
- **The pilot project managed to reduce the direct labor and vehicle costs in 21%.**

7.2 Separation at the Source

7.2.1 Outline

a. Objectives

This pilot project has the following objectives.

- To verify validity of separation at the source recommended in the Master Plan (M/P)
- To make this pilot project an origin of recycling activities
- Besides the objectives mentioned, to transfer knowledge and skills regarding separation to the Panamanian C/P and persons concerned is an important role of the pilot project.

b. Project Design Matrix

A Project Design Matrix was made in order to clarify purposes, inputs, expected outcomes and activities of the pilot project. It is shown in Table 7-2.

Table 7-2: Project Design Matrix of the Pilot Project of Separation at the Source

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal 1. Viable M/P is formulated 2. Separation at the source is expanded.	-	-	-
Project Purpose 1. Separation at the source is verified. 2. The pilot project becomes an origin of recycling activities.	1. Data and information obtained are analyzed and evaluated. 2. Recycling committee is established and the separate collection is continued.	1. Report of this study 2. Member list of the recycling committee and observation at each building	• The M/P is reviewed based on the results of the pilot project. • DIMAUD establishes a section to expand this pilot project to other institutions. • Other institutions understand necessity of recycling.
Outputs 1. Data and information regarding separation that is useful for reviewing the M/P are obtained. 2. Knowledge and skills regarding separation to the C/P and persons concerned are transferred. 3. Persons concerned are encouraged to conduct separate collection.	1. Amount and composition data for one month is obtained. 2.1. A large number of persons understand proper concept of recycling. 2.2. A large number of persons learn to separate materials properly. 3. A large number of persons are encouraged to continue the separate collection.	1. Record of the amount and composition survey 2.1. Results of Opinion survey 2.2. Record of the amount and composition survey 3. Results of the opinion survey	Decision makers in the municipality and DIMAUD do not oppose to the pilot project.
Activities 1.1. Introduce separate collection 1.2. Carry out amount and	**Inputs** Human Resources One member of the S/T		Employees in DIMAUD and EDEM accept that the separation introduced and participate the pilot project.

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
composition survey 2.1. Hold workshops before the pilot project 2.2. Deliver leaflets 2.3. Put signs 2.4. Carry out on the job training 3. Hold workshops at the end of the pilot project	Members of the C/P NGO Materials Containers Equipment for the amount and composition survey Materials for the educational campaign		**Preconditions** JICA and the Panamanian side agree to conduct the pilot project.

7.2.2 Evaluation and Conclusion

a. White Paper

- As white paper had been separated in some offices before the pilot project, the personnel were open-minded to its separation. Besides, there are monetary incentives, as the price of white paper when it is sold is quite good. Continuation of separation of the white paper is recommendable.

b. Other Recyclable Materials

- Papers occupy major part of the compositions. Aluminium and glass were far less than the papers. To separate the materials other than papers is inefficient at present. Effort of separation shall concentrate on the papers.

c. Educational Campaign

- Degree of understanding of separation was different between the two buildings, as the impurity rates shows. This implies that manner of educational campaign needs to be adjusted depending on character of target group.

d. Recommendations

The following are recommendations to continue and expand the separation at the source.

- Expansion of the pilot project to other municipal buildings is recommendable.
- Separation of papers in public institutions is recommendable.
- Storage at the source needs to be considered carefully.
- Educational campaign shall be implemented with introduction of the separation.
- Educational campaign shall use various media, such as workshop, leaflet, sign and video, to bring good results effectively.
- Establishment of a recycling committee in each building is recommendable.

- The municipality shall authorize the activities of separation and the recycling committee.

7.3 Landfill Operation Improvement

7.3.1 Outline

a. Objectives

This pilot project has the following objectives.

- To establish a method to operate landfill rationally and designedly
- To establish a method to improve the present situation regarding waste-pickers

Besides the objectives mentioned, to transfer knowledge and skills regarding proper landfill operation to the Panamanian C/P and persons concerned was an important role of the pilot project.

b. Project Design Matrix

A Project Design Matrix PDM) was made in order to clarify purposes, outputs, activities and inputs of the pilot project. Table 7-3 shows the PDM of the pilot project.

Table 7-3: Project Design Matrix of the Pilot Project of Landfill Operation Improvement

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
Overall Goal Landfill operation is carried out rationally and designedly on full scale.	The whole *organic waste* landfill site is operated properly.	Data recorded, observation of the operation	-
Project Purpose Landfill operation is carried out rationally and designedly in the pilot project area The present situation regarding waste-picker is improved.	Landfill operation is carried out according to the method established. Landfill operation and waste-pickers activities are separated.	Data recorded, observation of the operation Observation of the operation	The landfill method established is expanded to full scale.
Outputs 1. A proper landfill operation method is established. 2. A rule to separate the waste-pickers' activities and the landfill operation is established.	1. There is a document to describe the method. 2. There is a document to describe the rule.	1. This report 2. This report	The C/P and the contractor learn the method. The C/P and the contractor understand the importance and necessity to operate the landfill properly.
Activities 1. Design a landfill operation	**Inputs**		The Contractor of landfill operation agrees to conduct the pilot project.

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumption
method 2. Carry out the landfill operation method 3. Collect data and information to verify the validity of the method. 4. Design a rule to separate the waste-pickers' activities and the landfill operation	Human Resources Members of the S/T Members the C/P NGO Contractor Materials and Equipment Heavy equipment Soil Equipment for measuring cells		**Preconditions** JICA and the Panamanian side agree to conduct the pilot project.

7.3.2 Results

The pilot project was implemented from the beginning to the end of August 2002, for about one month. In order to analyze and evaluate 1) performance capacity of bulldozer, 2) bulk density of waste after compaction, 3) required amount of cover soil and 4) operating efficiency of collection vehicle, the following data were gathered during this period. This section presents such data obtained.

- Waste amount disposed and number of collection vehicles
- Operating time of heavy equipment
- Finished dimension of cells
- Amount of cover soil
- Unloading time of collection vehicle

7.3.3 Evaluation and Conclusion of the Pilot Project

Valuable data were obtained through implementation of the pilot project. Those data were beneficial to formulate the Landfill Operation Method. It can be evaluated that the plan of data gathering and its implementation were appropriate. However, it is true that the data lacked coherence a little as some types of heavy equipment were used simultaneously for the same activity.

The pilot project was implemented mainly by the C/P under the guidance of the S/T. Several operators have learned to formulate cells appropriately. In this manner, the C/P and the contractor have understood what is the sanitary landfilling and learned skills to carry out landfilling appropriately, which will lead to full-scale operation of sanitary landfilling.

7.4 DIMAUD Management Improvement

7.4.1 Background

a. Objective

Preparation of a database to input all work orders on every SW collection route, according to the data collection form specifically designed in the Collection Improvement Pilot Project, which can permit computation of quantified indicators to be used in continuous monitoring and can indicate necessary improvements

b. Project Design Matrix

Table 7-4 shows the Project Design Matrix (PDM) of DIMAUD Management Improvement Pilot Project.

Table 7-4: Project Design Matrix of DIMAUD Management Improvement

Narrative Summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall Goal Collection works are improved through analysis and evaluation of indicators.	Improvement in indicators	Results of calculated indicators	Facilities to receive relevant data, input the data, compute the selected indicators, and submit the indicators to the top management and the offices involved, so as to serve as an instrument for management improvement.
Project Purpose Indicators regarding collection works are established and monitored.	1. Ton per trip 2. Ton per hour 3 Ton per worker 4. Fuel efficiency	Results of selected indicators, computed periodically	Collection and input of relevant data
Outputs 1. Preparation of database on indicators 2. Training of counterpart personnel to collect and input data, and to verify indicators	Set up of database program and input of collected data	Ability of counterpart personnel to effectively use the database	Continued support from the top management for the effective operation of the system
Activities 1.1 Analysis of the newly designed form for work order 1.2 Analysis of performance indicators to calculate 1.3 Design of the general database scheme 1.4 Set up, testing and operation of hardware 1.5 Training of necessary personnel 1.6 Data collection and input 1.7 Analysis and evaluation	**Inputs** JICA Personnel DIMAUD Personnel Equipment PC 1 unit PC software 1 set Printer 1 unit		**Pre-conditions** The necessary budget is secured for personnel and other necessary expenses

7.4.2 Results and Evaluation

Once all data is input, indicators can be obtained very flexibly for any length of time, daily, weekly or monthly, without being tied to the one-year analysis time-frame of COSEPRE. And when the operation indicators become available, cost indicators can be obtained by applying the price actually paid by DIMAUD for the different resources used.

The Collection Improvement Pilot Project trained the counterpart personnel to collect the required data and verify the performance indicators by collection route. Therefore, the counterpart personnel is capable of evaluating the results of performance indicators, and introduce the indicated improvement measures.

7.4.3 Recommendations

Information technology is quickly and constantly changing. Therefore, Collection Department with the support of the Computing Department will have to change the operating system, in order to update the database system.

The database was developed with Microsoft Access, and the Computing Department is capable of modifying the program when the need arises. Probably, information types will need to be modified or added, in order to obtain more specific reports to help implement constant monitoring and improvements.

The establishment of the database on indicators is expected to facilitate the effective utilization of COSEPRE, already installed in DIMAUD computer, when the COSEPRE requirement of annual data from all collection routes are input in the database.

7.5 Environmental Education

7.5.1 Outline

a. Objectives

The project pilot for environmental education within the framework of the Study has the following objectives.

- to raise public awareness concerning solid waste management
- to encourage public participation in solid waste minimization activities
- to reduce the load on the environment and to conserve natural resources

b. Project Design Matrix

A project Design Matrix was made in order to clarify purposes, inputs, expected outcomes, and activities of the pilot project. It is shown in the following Table

Table 7-5: Project Design Matrix for Environmental Education Pilot Project

Narrative summary	Objectively Verifiable Indicators	Means of Verification	Important Assumptions
Overall goal Viable M/P is formulated. Solid waste minimization. Conservation of natural resources.	Knowledge and interest about solid waste minimization aspects among students and residents of pilot project areas are increased.	-	-
Project purpose To promote public participation in waste minimization activities. The pilot project becomes an origin of solid waste minimization activities through recycling.	Environmental activities in the community, public opinions, analysis and evaluation. Environmental education program planned and continued by the C/P.	Report of this Study Program and record prepared by DIMAUD.	Revision of the M/P based on the results of the Pilot Project. DIMAUD establishes a unit to expand this pilot project to other schools and communities in Panama District. Schools and communities understand the necessity of solid waste minimization.
Outputs Communication between concerned institutions and offices within the Municipality for environmental education activities is improved. Knowledge and skills regarding environmental education given to the C/P, teachers, and persons concerned are transferred. Persons concerned are encouraged to conduct environmental education and recycling activities. Enforcement of school curriculum regarding environmental education on solid waste issues in the formal education.	Community Relations and Public Relation offices of DIMAUD will jointly work with other municipal offices and relevant institutions. A large number of persons understand the benefits of waste minimization. A large number of persons understand the proper concept of recycling. A large number of persons are encouraged to continue environmental education	Future programs of environmental education. Results of public opinion. Results of public opinion. Evaluation results.	Decision-makers in the Municipality and DIMAUD will assure the continuation of the program.
Activities Environmental education program. Formulate the program and train facilitators of the Municipality. Formulate a training program to teachers and residents. Prepare training tools and complementary materials.	Inputs Human resources One member of the S/T Members of the C/P NGO		The C/P of DIMAUD commits to carrying out the environmental education project pilot in schools and communities and to following-up the undertaken activities.
Implement the environmental education pilot project. Carry out meetings and mini-workshops with the community. Hold workshops with teachers. Start waste minimization activities through recycling.	Materials Educational guide Educational panels Educational video OHP Posters, leaflets, stickers, etc.		Preconditions JICA and the Panamanian side agree to conduct the pilot project.

7.5.2 Conclusion

Through the pilot project the environmental education is appreciated as vital and effective to bring about the changes of people's attitude for the environmentally sound SWM. All the sectors of the society should take actively part in the changes.

All workshops and activities carried out had the active participation of the C/P. The S/T showed complete and absolute satisfaction with the results of this training workshop and with the performance of the C/P.

The trial lessons can be evaluated that those are not only opportunities to deliver the information and knowledge informed at the workshops held by the C/P, but also opportunities where teachers and children demonstrate their creativity that may bring about innovation in the methodology of environmental education applied in the pilot project.

7.6 Public Relations Enhancement

7.6.1 Outline

a. Objective

The purpose of this pilot project is as follows:

- To establish a communications system for the solid waste management

The pilot project has two components to be tested:

- Use of the existing administrative arrangement
- Strengthening and expansion of the 800ASEO service.

Within this zone the Collection Improvement pilot project was also being developed.

b. Project Design Matrix

Table 7-6 and Table 7-7 display the Project Design Matrixes of the two components for the pilot project.

Table 7-6: Project Design Matrix of Use of the Existing Administrative Organization

Summary	Verification indicators	Means of verification	Important assumptions
Overall Goal Responsible participation from users in the rendering of the service, as well as a smooth and sustainable interaction among the mayor's office and the DIMAUD are achieved.	Percentage of houses that discharged their SW within the frequency and schedule programmed for the collection	Reports from DIMAUD's Customer Attention Unit and from the Cleansing and Ornate Committee.	
Project Purpose A communications system between the users of the service, the Mayor's office and the DIMAUD is established.	Percentage of total houses whose inhabitants are aware of and use the new communications system	Reports from the DIMAUD's Customer Attention unit and from the Cleansing and Ornate Committee	The Cleansing and Ornate Committee, the Mayor's Office and the DIMAUD are convinced that success in rendering the service relies on mutual participation and collaboration.
Output 1. The Cleansing and Ornate Committee of Juan Diaz's Communal Board is organized 2. Customer Attention Unit within DIMAUD's structure is organized.	1. Existence of the Cleaning and Ornate Committee of Juan Diaz's Communal Board 2. The Customer Attention unit is created within the DIMAUD's organizational structure.	1. Minutes of the meeting from the Communal Board of the *corregimiento*, which states the creation of the Cleaning and Ornate Committee 2. Note from DIMAUD's General manager which confirms approval of the Customer Attention Unit.	The members of the Communal Board accept to establish the Cleansing and Ornate Committee.
Activities 1. Within the project zone 1.1 Introduction of the project to the Communal Board 1.2 Creation of the Cleansing and Ornate Committee of the Communal Board 1.3 Organization of the Cleansing and Ornate Committees at a neighborhood level 2. At the DIMAUD 2.1 to set Customer Attention policies 2.2 Organization and training of the Customer Attention personnel 2.3 Organization of the Regional Network of Cleansing and Ornate	Input JICA Staff DIMAUD Staff Public Relations Community relations		There is the political will to involve the civil society to organize them for the improvement of the service Assumption The Communal Board is committed to organizing the Cleansing and Ornate Committee DIMAUD's top management agrees on the necessity of modifying the administrative structure

Table 7-7: Project Design Matrix of Improvement of the 800 ASEO Service

<table>
<tr><th>Summary</th><th>Verification indicators</th><th>Means of verification</th><th>Important assumptions</th></tr>
<tr><td>Overall Goal

1. The municipality of Panama and the users of the collection service interact between each other by utilizing the 800ASEO service
2. The DIMAUD uses the 800ASEO service to support the marketing of the new Special Collection service for ICI customers.</td><td>1. Number of people surveyed on the quality of the service.
2. Number of ICI customers contacted through the 800 ASEO service.</td><td>1. Monthly report on the control of activities of the 800 ASEO service for the Mayor’s Communications Office (D.C.A.) and for the DIMAUD’s Customer Attention unit.
2. Report from the Commercialization Department on the status of ICI customers.</td><td></td></tr>
<tr><td>Project Purpose

The 800ASEO service is expanded to a communications service that can be used to monitor and assess the collection service and for promotion</td><td>Percentage of users of the collection service contacted through the 800ASEO communication system.</td><td>Monthly report on the control of activities of the 800ASEO service.</td><td>Users exercise their right to receive an adequate and good quality of collection service.</td></tr>
<tr><td>Output

1. The 800ASEO system has been adequately enhanced and expanded and functions properly.</td><td>1. Number and reasons of the calls received and percentage of users at the target area that have used the 800ASEO system.</td><td>1. Daily report on the activities of the 800ASEO service to the Mayor’s Communications Office (DCA) and to the chieftainship of the Customer Attention unit.</td><td>Sustainable support from top management for the efficient functioning of the system</td></tr>
<tr><td rowspan="2">Activities

1. With the 800ASEO staff for the pilot project
1.1 Elaboration of a customer database with telephone service at the target area
1.2 Design of the telephone opinion survey
1.3 Expose the 800ASEO system to the users at the target area.
1.4 Conduct the opinion survey along with the pilot project of collection

2 With the DIMAUD
2.1 Rent and outfitting of the new premises for the 800ASEO system
2.2. Personnel training</td><td colspan="2" rowspan="2">Input

JICA
Staff
PC 1 unit
Software 1 set Office furniture
Printer 1 unit

DIMAUD
Staff
1 operator of the Informatics system
3 telephone operators/promoters
Telephone accessories
40 m^2 area of office</td><td>The Commercialization Department collaborates in the preparation of the customers’ database for target area</td></tr>
<tr><td>Assumptions

The Mayor’s Communications Office (DCA) and the DIMAUD agree to restructure the 800ASEO service to a communications system.
The required budget to pay the staff, outfitting of premises and telephone lines is allocated.</td></tr>
</table>

7.6.2 Evaluation and Conclusion

According to the strategy outlined by DIMAUD's General Management office, the first area to establish the communications system is Juan Díaz *corregimiento*.

The 800ASEO service has been strengthened with new premises and six telephone lines. The computer system donated by JICA is being utilized by the personnel allocated by the Municipality and by the DIMAUD, staff that was duly trained.

The 800ASEO service performs as the communication link between the Cleansing and Ornate Committees and the DIMAUD's Customer Attention Unit, allowing their interaction; it supports the Commercialization Department to enhance the customers' database; and it also conducts the opinion surveys on the quality of the service. It was a complete turnaround from the previous service, where only complaints were received and transferred for their immediate attention.

8 Setting up Planning Framework for the Master Plan

8.1 Social Framework

8.1.1 Population Forecast

Contraloria has not finished at present the projections for every District based on the updated figures from the 2000 census.

The results for the Panama, San Miguelito, and Arraijan District as a whole are shown in Table 8-1. The counterpart agreed to use this projection for the current study.

Table 8-1: Population Forecast

Year / Corregimiento	2000	2001	2002	2005	2010	2015
Distrito de Panam	**708,438**	**725,866**	**744,448**	**807,868**	**944,573**	**1,132,726**
San Felipe	6,928	6,660	6,402	5,687	4,668	3,832
El Chorrillo	22,632	22,858	23,087	23,787	25,000	26,276
Santa Ana	21,098	20,535	19,986	18,427	16,095	14,057
La Exposición o Calidonia	19,729	19,348	18,975	17,897	16,236	14,728
Curundú	19,019	19,131	19,244	19,586	20,171	20,773
Betania	44,409	44,195	43,981	43,347	42,311	41,300
Bella Vista	28,421	28,789	29,163	30,312	32,328	34,479
Pueblo Nuevo	18,161	17,875	17,593	16,774	15,493	14,309
San Francisco	35,751	35,903	36,056	36,520	37,305	38,107
Parque Lefevre	37,136	37,035	36,934	36,633	36,137	35,647
Río Abajo	28,714	28,304	27,900	26,722	24,868	23,143
Juan Díaz	88,165	89,746	91,355	96,358	105,313	115,100
Pedregal	45,801	46,323	46,850	48,470	51,294	54,283
Ancón	11,169	11,135	11,100	10,998	10,831	10,665
Chilibre	40,475	42,126	43,845	49,433	60,373	73,735
Las Cumbres	92,519	97,188	102,093	118,343	151,374	193,626
Pacora	61,549	66,939	72,800	93,648	142,486	216,795
San Martín	3,575	3,708	3,847	4,293	5,156	6,191
Tocumen	83,187	88,069	93,237	110,633	147,136	195,681
Distrito de San Miguelito	**293,745**	**299,366**	**305,095**	**322,946**	**355,050**	**390,346**
Arraijan	**149,918**	**163,797**	**178,961**	**233,407**	**363,392**	**565,764**

8.2 Economic Framework

The GDP growth projection can be made as forecast using growth data from past years, and varying the time period used as basis of forecast..

Table 8-2: Projection of GDP Growth Rate

Data Source	Forecast Base	Year	GDP Growth Rate (%)	Assumed GDP Growth Rate (%)
Real data		1996	2.8	
Real data		1997	4.5	
Real data		1998	4.1	
Real data		1999	3.2	
Real data		2000	2.9	
Preliminary		2001	1.8	
Official expectation		2002	1.5	
Forecast	1996-2000	2003	2.9	2.5
Forecast	2001-2003	2004	3.3	3.0
Forecast	2001-2004	2005	3.9	3.5
Forecast	2002-2005	2006	4.7	4.5
Forecast	2002-2006	2007	5.3	4.5
Forecast	1996-2007	2008	4.1	3.0
Forecast	1996-2008	2009	4.2	3.0
Forecast	1996-2009	2010	4.3	3.0
Forecast	1996-2010	2011	4.4	3.0
Forecast	1996-2011	2012	4.5	3.0
Forecast	1996-2012	2013	4.6	3.0
Forecast	1996-2013	2014	4.7	3.0
Forecast	1996-2014	2015	4.8	3.0

8.3 Forecast of Future Waste Amount and Composition

8.3.1 Waste Amount Forecast

a. Waste Generation Rate

The generation rate at each source is shown in Table 8-3.

Table 8-3: Waste Generation Rate

Source		unit	Generation rate
Household waste		g/person/day	590
Commercial waste	Restaurant	g/employee/day	6,373
	Others		1,918
Institutional waste			201
Market waste			4,178

b. Waste Generation Amount

The future waste amount is forecast by multiplying the waste generation rate listed in Table 8-3 by factors, such as population, employees and number of shops, etc.. The number of employees was estimated to increase in proportion to the GDP growth ratio. Table 8-4 shows waste generation amount forecast by 2015.

Table 8-4: Forecast of Waste Generation Amount

unit : ton/day

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Household waste	439.2	450.9	463.4	476.6	490.8	505.9	521.9	539.1	557.3	576.7	597.5	619.6	643.2	668.3
Restaurant waste	106.3	109	112.1	115.8	120.5	125.2	128.3	131.5	134.6	137.8	140.9	144.1	147.2	150.4
Commercial waste	115.6	118.5	121.9	125.9	131	136.1	139.5	143	146.4	149.8	153.2	156.6	160	163.5
Institutional waste	29.4	30.1	30.9	32	33.3	34.6	35.4	36.3	37.2	38	38.9	39.8	40.6	41.5
Industrial waste	169.7	173.9	179	185	192.6	200.2	205.3	210.4	215.5	220.6	225.7	230.8	235.9	241
Market waste	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5	23.5
Bulky waste	11.7	12.2	13.4	13.7	15.0	16.3	16.8	18.3	18.9	20.5	21.3	23.1	24.0	26.1
Street sweeping waste	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Hospital waste	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1	20.1
Demolition waste	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3	96.3
Sewage	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
Panama total	**1,024.9**	**1,047.6**	**1,073.7**	**1,102.0**	**1,136.2**	**1,171.3**	**1,200.2**	**1,231.6**	**1,262.9**	**1,296.4**	**1,330.5**	**1,367.0**	**1,403.9**	**1,443.8**
San Miguelito	216.6	226.4	237.3	250.0	265.3	281.1	293.6	306.6	320.3	334.0	348.1	363.0	378.0	393.5
Arraijan	27.4	30.7	34.4	39.0	44.4	50.4	56.3	63.2	70.5	79.0	88.1	98.6	110.3	122.8
Sub-total	**244.0**	**257.1**	**271.7**	**289.0**	**309.7**	**331.5**	**349.9**	**369.8**	**390.8**	**413.0**	**436.2**	**461.6**	**488.3**	**516.3**
Total	**1,268.9**	**1,304.7**	**1,345.4**	**1,391.0**	**1,445.9**	**1,502.8**	**1,550.1**	**1,601.4**	**1,653.7**	**1,709.4**	**1,766.7**	**1,828.6**	**1,892.2**	**1,960.1**

8.3.2 Waste Composition

The waste composition at source in Panama Municipality are similar to those in OECD countries. The waste composition in Panama Municipality, as well as the waste generation rate, turns out to be in the level of industrialized economies. Therefore, it can be estimated that the future waste composition remains same as that of today even taking the future economic growth into the consideration. Consequently in this M/P, the future waste composition is set as the present one.

Table 8-5: Waste Composition of Panama Municipality

Composition / Area	Paper and cardboard (%)	Plastics (%)	Glass (%)	Metal (%)	Food & garden waste, etc. (%)	Other (%)
Panama	25	17	6	4	46	2

Source: Results of WACS in this study

8.3.3 Future Waste Stream

Future waste stream shows below.

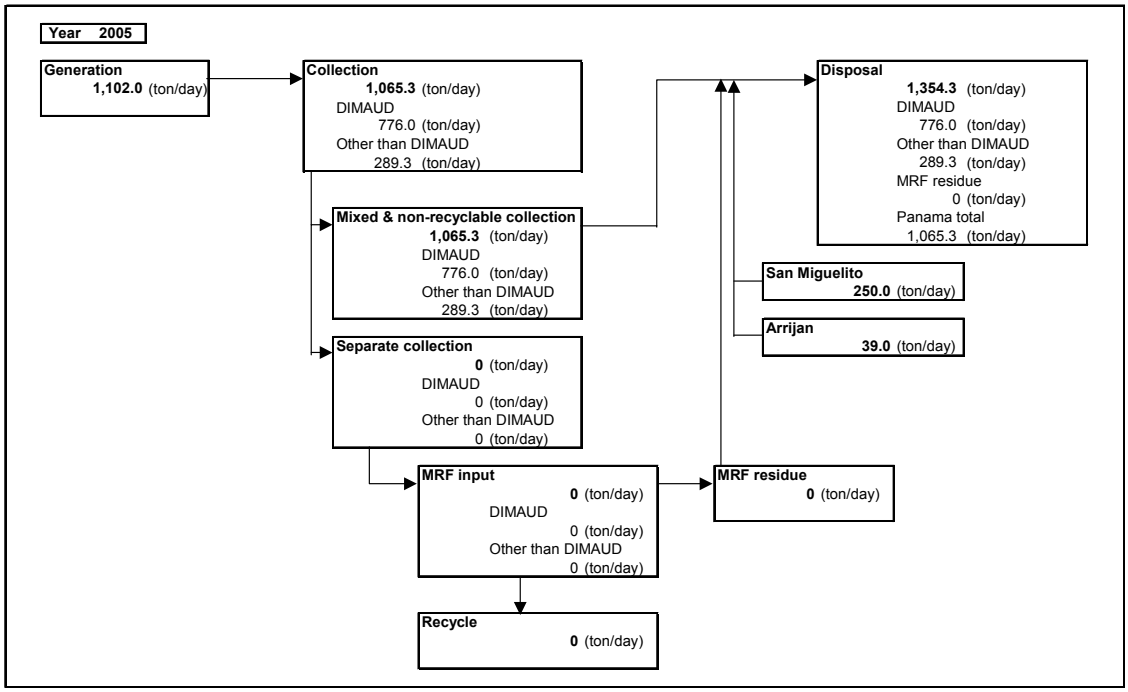

Figure 8-1: Waste Stream in 2005

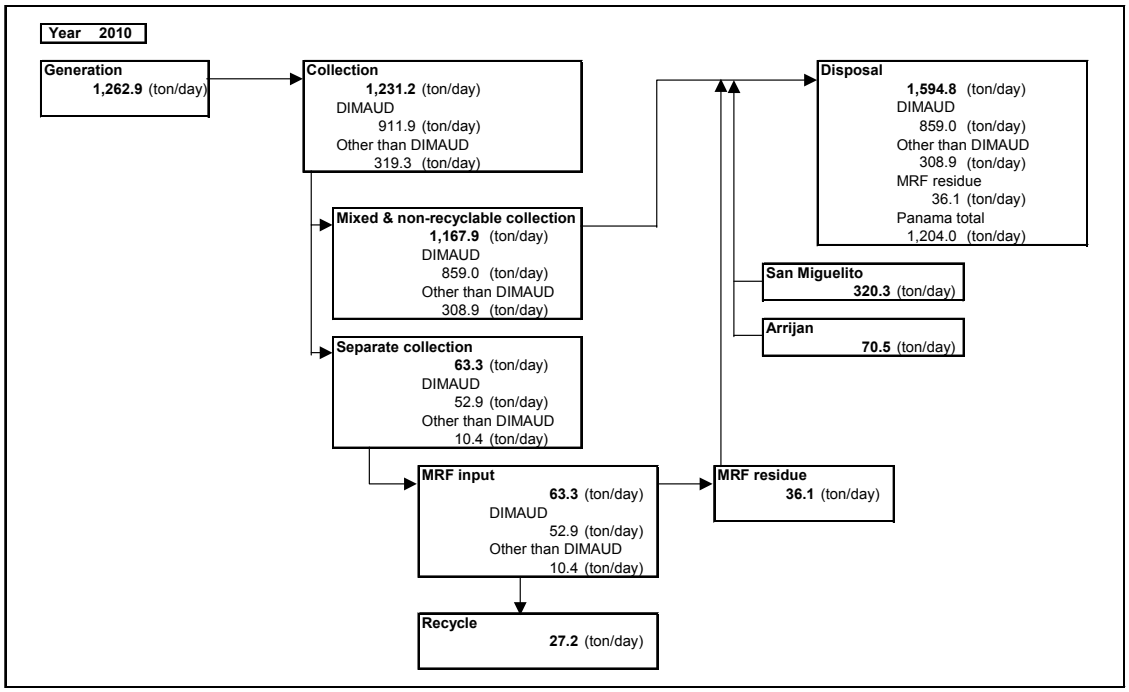

Figure 8-2: Waste stream in 2010

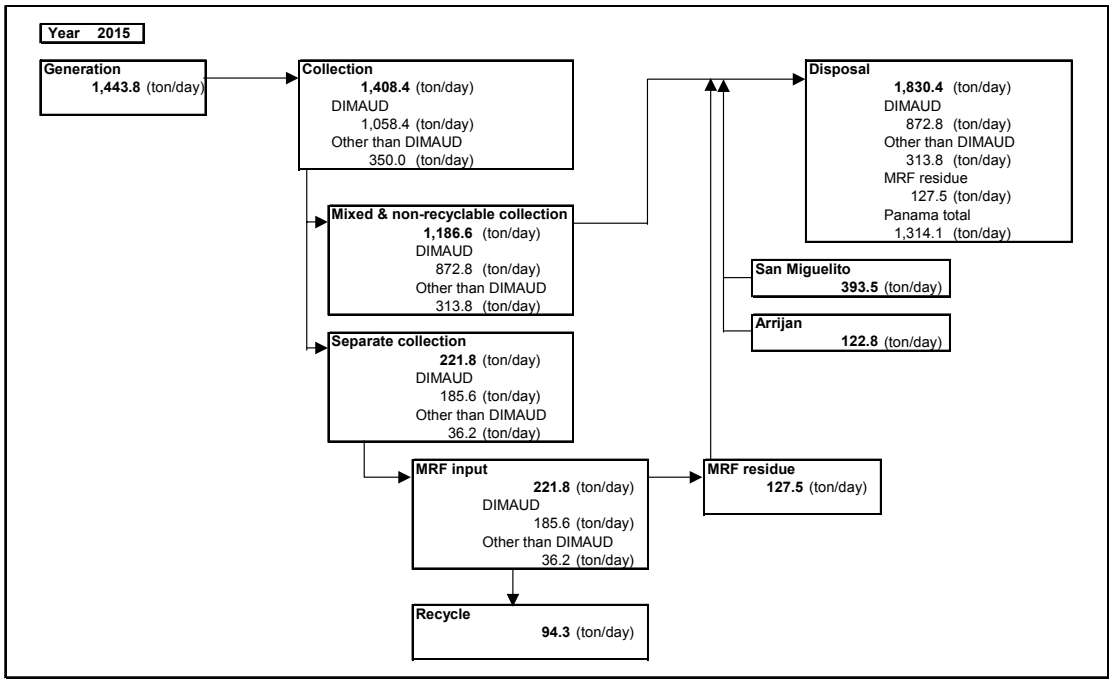

Figure 8-3: Waste Stream in 2015

9 Selection of an Optimum Technical System

9.1 Priority Ranking of Key Issues

On the basis of the current situation analysis, key issues, or the current problems to be solved and the new challenges, in the technical aspect were prioritised in view of urgency and importance, and those are presented in Table 9-1. This section discusses selection of an optimum technical system with taking into account the key issues.

Table 9-1:Priority Ranking of Key Issues

Item		First priority	Second priority	Third priority
Technical system	Discharge and storage system	Improvement discharge manner	Introduce separate collection	-
	Collection system	Basic database establishment and maintenance	-	-
		Improvement of collection efficiency	-	-
		Expansion of collection area	-	-
	Intermediate treatment system	Establishment of policy on intermediate treatment system	Examination material recovery system	Examination of incineration system
	Final disposal	Improvement of current landfill operation	-	-
		Improvement of leachate management	-	-
		Ensuring final disposal capacity by 2015 (expansion plan of Cerro Patacon)	-	-
	Waste minimization and resource conservation	Education program for encouraging waste minimization and recycling	Execution of recycling program	-

9.2 Overall System

The table below shows potential technical system alternatives that could be introduced in Panama Municipality. In the following, those alternatives are analyzed in views of technical practicability, waste reduction and costs. Then, an optimum alternative is recommended at the end.

Table 9-2: Comparison of Technical System Alternatives

Alternatives	Sub-categories	Discharge and storage/Collection			Intermediate treatment			Final disposal item
		Manner		Separation item	Facility	Recovery method	Recovery item	
		Mixed	Separate					
ALT1	Type 1	X		non	non	non	non	Whole waste
	Type 2	X		non	MRF	Manual sorting	Optionally (plastic. metals, glass & bottle)	Other than recovered item
ALT2	Type 1		X	Recyclable	MRF	Manual and mechanical sorting	Optionally (paper, plastic. metals, glass & bottle)	Residue of MRF
				Non-recyclable	non	non	non	Whole waste
	Type2		X	Organic	Composting	Composting	Organic matter (kitchen waste, Grass & wood)	Residue of composting
				Recyclable	MRF	Manual and mechanical sorting	Optionally (paper, plastic. metals, glass & bottle)	Residue of MRF
				Others	non	non	non	Whole waste
	Type3		X	Combustible	Incineration	Combustion	Thermal energy and/or power generation	Bottom and fly ash
				Non-combustible	MRF	Manual and mechanical sorting	Optionally (metals, glass & bottle)	Residue of MRF

notes : MRF : Material Recovery Facility

a. Reduction Effects

The table below shows reduction effects of alternatives based on the recovery and volume reduction ratios mentioned above.

Table 9-3:Reduction Effect of Final Disposal Amount (weight ton base)

Alternatives	Sub-categories	Discharge/collection		Intermediate treatment			Final disposal amount
				Facility	Input amount	Recovery amount	
		Collection item	Ratio				
ALT1	Type1	Mixed	100%	none	none	none	**100%**
	Type2	Mixed	100%	MRF	100%	5%	**95%**
ALT2	Type1	Non-recyclable	65%	none	none	none	65%
		Recyclable	35%	MRF	36%	14%	21%
						total	**86%**
	Type2	Organic	35%	Composting	35%	2.6% (compost)	7%
		Recyclable	35%	MRF	35%	14%	21%
		Others	30%	none	none	none	30%
						Total	**58%**
	Type3	Combustible	65%	Incineration	65%	Thermal energy / power generation	11%
		Non-combustible	35%	MRF	35%	14%	21%
		Others (bulky & hospital waste)	0.3%	none	none	none	0.3%
						Total	**32%**

assumptions

ALT1	Type2	recovery ratio at MRF is 10% (based on data of Mexico City)
ALT2	Type1	separation ratio at generation sources is 50%
		recovery items at MRF are paper, plastic, metal, and bottle and glass
		recovery ratio at MRF 60%
	Type2	separation ratio at generation sources is 50% for organic matter
		separation ratio at generation sources is 50% for recyclable matter
		compost production ratio is 10% of organic matter
		recovery ratio at MRF 60%
	Type3	separation ratio at generation sources are 80% for kitchen waste, textile, and grass & wood
		separation ratio at generation sources are 50% for other than above items
		waste reduction ratio of incineration is 10 % to combustible matter (kitchen waste, paper, textile, grass & wood, plastic and rubber & lather
		recovery ratio at MRF 60%

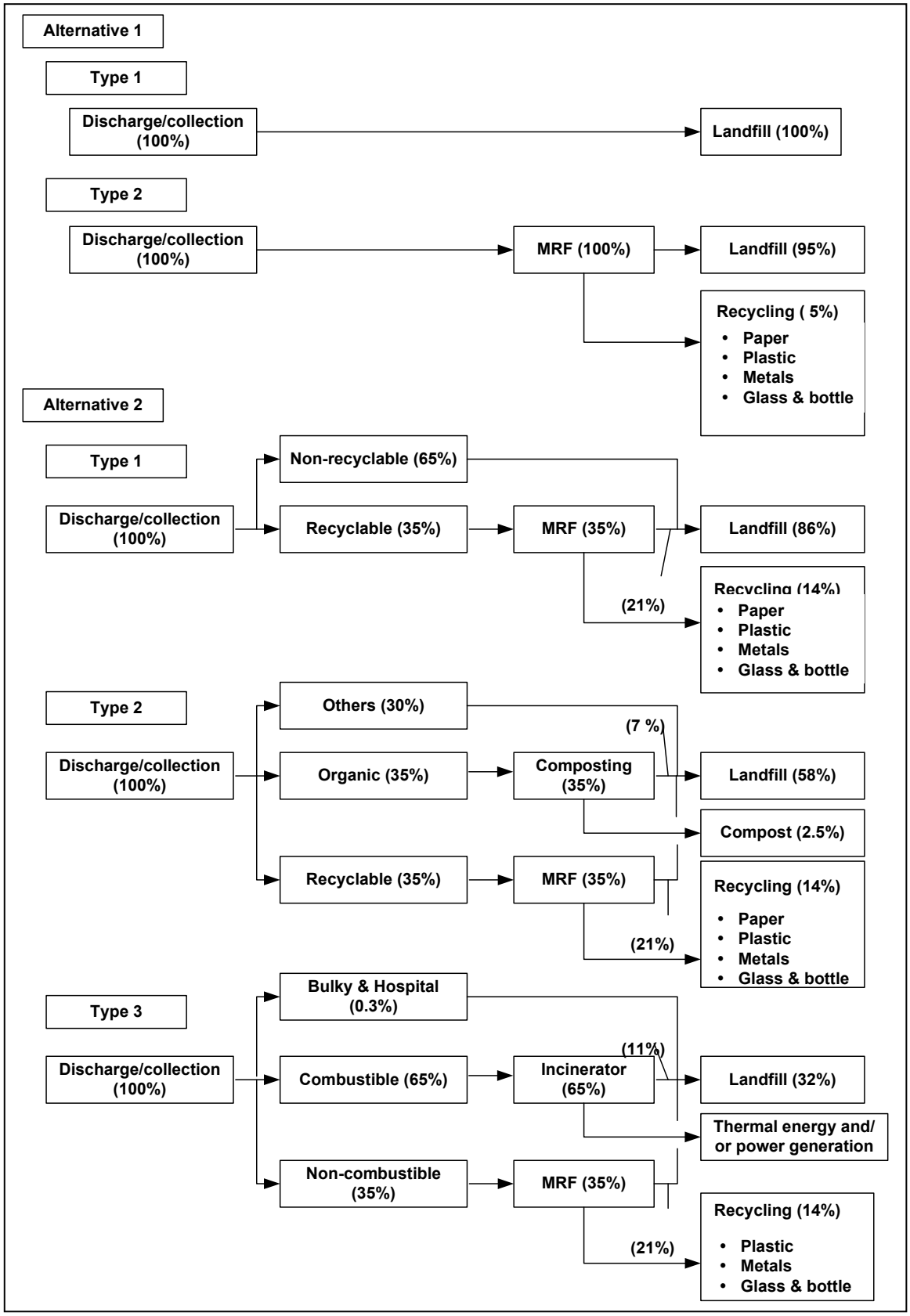

Figure 9-1: Flow Diagram of Alternatives

b. Cost Index

Cost index was devised and presented in Table 9-4, supposing that waste amount subjected is 1,000 ton/day. The index expresses increase of cost in percent with setting the present technical system's cost at 100%.

Table 9-4: Cost Index

Alternatives	Sub-categories	Item	Technical system					Total cost
			Collection	MRF	Composting	Incineration	Landfill	
AIT1	Type1	Landfill	80.4%	0.0%	0.0%	0.0%	19.6%	**100.0%**
	Type2	Landfill & MRF	80.4%	39.2%	0.0%	0.0%	18.6%	**138.2%**
ALT2	Type1	Landfill & MRF	160.8%	14.1%	0.0%	0.0%	16.7%	**191.6%**
	Type2	Landfill, Compost & MRF	241.2%	14.1%	16.7%	0.0%	11.4%	**283.3%**
	Type3	Landfill, Incineration & MRF	160.5%	14.0%	0.0%	125.5%	6.7%	**306.7%**

assumptions

MRF unit cost : U$20/ton (inc. construction, operation and maintenance cost, exc. land acquisition cost) (study team estimated referring composting costs)

Incineration unit cost : U$100/ton (inc. construction, operation and maintenance cost, exc. land acquisition cost)) (study team estimated referring incineration costs and dioxin treatment costs)

Composting unit cost : U$25/ton (inc. construction, operation and maintenance cost, exc. land acquisition cost) (average value of composting costs)

Landfill cost : U$10/ ton (inc. construction, operation and maintenance cost, exc. land acquisition cost)) (study team estimated referring sanitary landfill costs and present landfill unit cost of DIMAUD)

Management size : around 1,000 ton/day

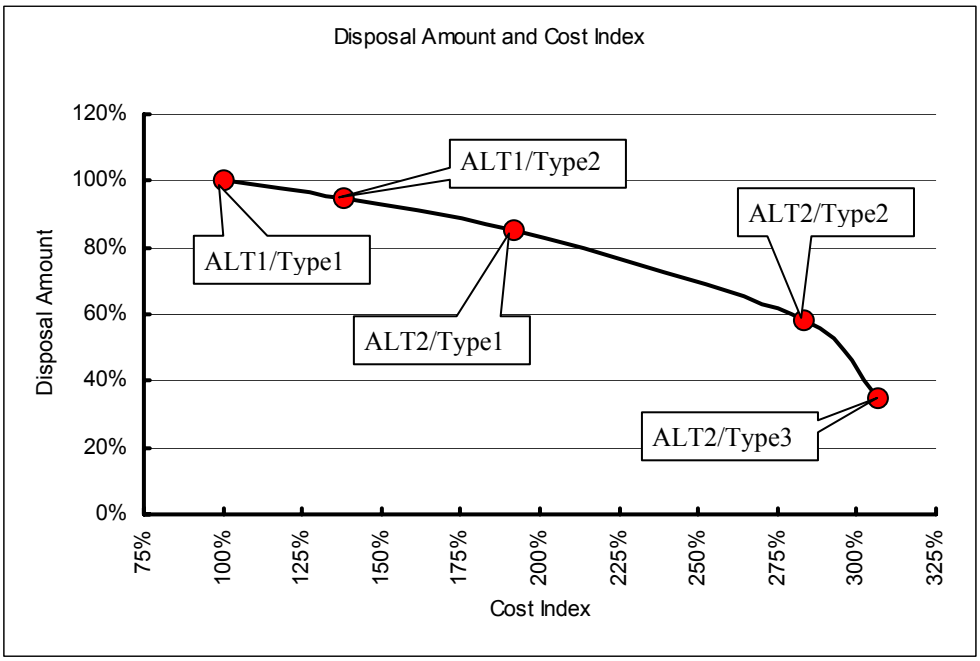

Figure 9-2: Relation Between Disposal Amount and Cost Index

Figure 9-2 schematizes Table 9-4. An important technical difference between ALT1 and ALT2 is the mixed collection or the separate collection. Comparing ALT1/Type2 and ALT1/Type1 on the assumption that separate collection is introduced in addition to the current mixed collection, i.e., frequencies of the current mixed collection will not change and further works for a new separate collection will be necessary,

- ALT1/Type2 achieves 5 % waste reduction by 38% of cost increase (5/138=0.036), and
- ALT2/Type1 attains 14% waste reduction by 91% of cost increase (14/191=0.073).

Therefore, it can be said that cost-effectiveness of ALT2/Type1 is twice as high as one of ALT1/Type2 (0.073/0.036=2.03), and introduction of MRF with separate collection will be more advantageous than one with mixed collection.