Chapter 4

Current Situation of Municipal Solid Waste Management

4 Current Situation of Municipal Solid Waste Management

4.1 Service Coverage and Hygiene Conditions

Results of Public Opinion Survey (POS) shows that about 90% 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. This is a strong point of the city. However, quality of collection service seems to be uneven, as the results of POS show, i.e., 12% of samples has once a week collection service and 25% has twice a week.

As the city is kept clean, it is conjectured that number of cases of diseases related to waste is not so many. Cases of dengue that is thought to be related to waste are less than 10 cases in 8 corregimientos, between 10 and 50 cases in 8 corregimientos and 392 cases in Pacora in 2001[1].

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 first important step was to identify an alternative place for the disposal of solid wastes coming from the districts of Panama and San Miguelito, as the Panama Viejo dumping site was widely protested against by the neighbors of that place.

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.

The Ministry of Planning and Economic Policies and the National Environmental Commission took over the process to develop the Mocambo (nowadays Cerro Patacon) sanitary landfill studies. The latter are concluded in the first semester of 1987.

[1] Departamento de Control de Vectores y Zoonosis, MINSA

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. In "Stage II" impermeable membranes are used to protect the groundwater, leachate is collected and they are taken to a group of stabilization ponds for their treatment, and biogas is gathered by means of a piping system inserted in the mass of the wastes and evacuated towards the atmosphere.

The DIMA expands its operational ambit as the land properties and facilities of the Canal Zone are given back, as per the Torrijos – Carter treaty. Likewise, the DIMA receives the collection equipment that provided the service at the area mentioned above. Additionally, it takes charge of Mount Hope sanitary landfill that served the city of Colón.

During 15 years, the DIMA renders uninterrupted services to the three districts. On August 27th, 1999, the Legislative Assembly approved the Law No. 41, which creates the Urban and Domiciliary Cleansing Office (DIMAUD) for each of the municipalities of Panama, San Miguelito and Colón, and transfers the goods from the DIMA and the responsibility of the solid waste management at their respective districts.

As of the issuance of the above mentioned Law No. 41 dated August 27th, 1999, the municipality of Panama, through its Urban and Domiciliary Cleansing Office, has the exclusive responsibility of operating and exploiting the system, as well as administering Cerro Patacon sanitary landfill.

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)

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

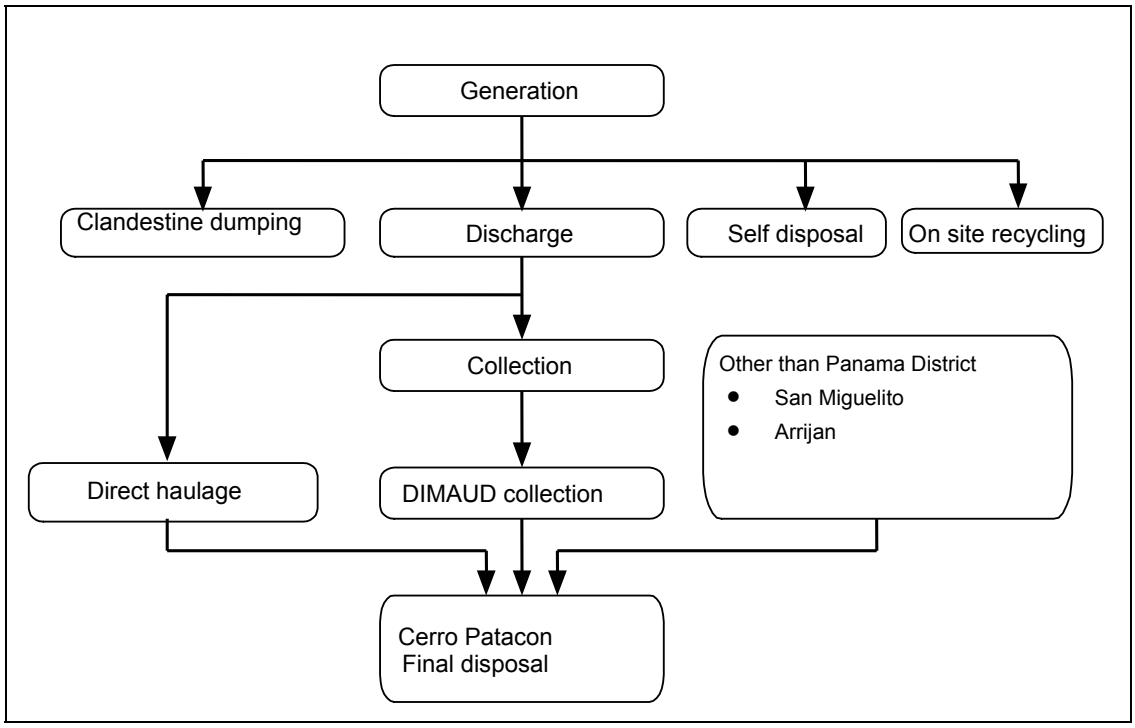


Figure 4-1: Concept of Present Waste Stream

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

4.3.2 Waste Generation Rate and Generation Amount

a. Waste Generation Rate

The study set up waste generation rates based on the results of WACS and data in Latin American countries (shown in Table 4-1 and Table 4-1).

Table 4-1: 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				
Commercial	Restaurant	g/employee/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

Table 4-2: Waste Generation Rate

Source		unit	Generation rate
Household waste	High income	g/person/day	898.3
	Middle income		655.8
	Low income		440.2
Commercial waste	Restaurant	g/employee/day	6,372.5
	Others		1,918.2
Institutional waste			200.6
Market waste			4,178.3
Street sweeping waste		g/m/day	15.9

a.1. Household Waste Generation Rate

WACS gave household waste generation rates by income level. Then, weighted average of them with taking into account population distribution by income level obtained by POS is regarded as waste generation rate for the whole households. The table below presents the results of the calculation.

Table 4-3: Household 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)**

b. Waste Generation and Disposal Amount

Waste generation amount is calculated based on the data of WACS, POS and statistics data such as population, number of employee of commercial and institutional entities. As for institutional waste, number of employees in institutions in Panama District was obtained by multiplying number of employees in institutions in the whole country by ratio of budgets between Panama Municipality and the whole municipalities (Panama Municipality's budget / the whole municipalities' budget = 49.5%), because no data of number of institutional employees in Panama District was found. Waste generation amount estimated is presented in Table 4-4.

The results of Public Opinion Survey say that collection coverage of household waste is 92 %. Table 4-5 shows 678.9 ton/day of collection amount of household, commercial, institutional and market wastes with taking into account the collection coverage.

Meanwhile, weighbridge data at the Cerro Patacon Landfill say that total waste disposal amount is 965 ton/day and disposal amount of household, commercial, institutional and market waste is 823.8 ton/day as shown in Table 4-6.

Table 4-4:Waste Generation Amount

Generation sources		unit	Generation rate	Number of person or employee	Waste generation amount (ton/day)
Household waste		g/person/day	590	744,448	439.2
Commercial waste	Restaurant	g/employee/day	6,372.5	16,695	106.4
	Others		1,918.2	60,282	115.6
Institutional waste			200.6	146,051	29.3
Market waste			4,178.3	5,634	23.5
Total					714.0

Table 4-5: Waste Collection Amount

Generation sources		unit	Waste generation amount (ton/day)	Collection ratio (%)	Waste collection amount (ton/day)
Household waste		g/person/day	439.2	92	404.1
Commercial waste	Restaurant	g/employee/day	106.4	100	106.4
	Others		115.6	100	115.6
Institutional waste			29.3	100	29.3
Market waste			23.5	100	23.5
Total			714.0	-	678.9

Table 4-6: Weighing Data at Cerro Patacon (August 2001 to July 2002)

Item	Waste amount (ton/day)
Domestic waste	691.7
Commercial and business entities	118.4
Market	13.7
Sub total	823.8
Street sweeping waste	8.4
Hospital waste including common waste	20.1
Large bulky waste / Chatarra	2.9
Small bulky waste / Despojos	8.8
Demolition waste / Caliche	96.3
Sewer sludge / Aguas negras	4.7
Total	**965.0**

As the tables above show, there is a difference of 144.9 ton/day of waste collected from households, commerce, industries and markets between estimated collection amount, 678.9 ton/day, and weighbridge data, 823.8 ton/day. The following facts are helpful to clarify the difference.

- At the Cerro Patacon Landfill, wastes are classified into three categories, i.e., households, commercial and business entities, and markets. However, this is not strictly carried out, as it is difficult to know sources of wastes correctly.
- There is no other landfill in the study area than the Cerro Patacon Landfill. All type of wastes generated in the study area will be brought to the landfill. Actually, it is observed that considerable amount of commercial and industrial (CI) wastes is contained in waste brought by collection vehicles from so-cold residential areas.
- A study[2] carried out by MEF in 1999 says that industrial waste amount generated in the study area was 159.6 ton/day (58,264.7 ton/year).

Consequently, it is estimated that the 144.9 ton/day would consist of industrial waste. The following figure schematizes the consideration mentioned above.

[2] Diagnosis, Master Plan and Evaluation of Alternatives for Private Sector Participation in Hazardous Waste Management, MEF, 1999

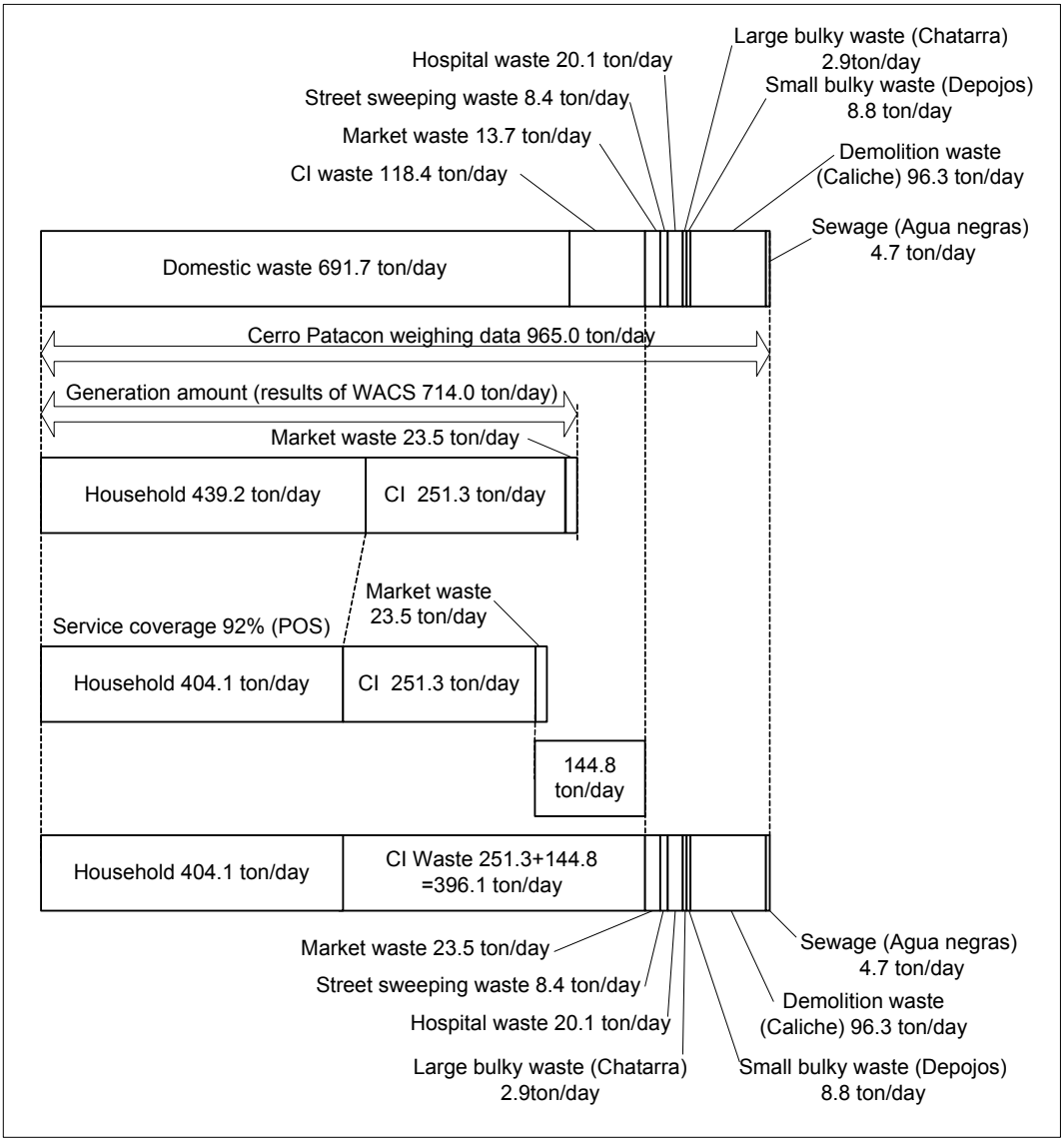


Figure 4-2: Estimated Waste Generation Sources in the Study Area

4.3.3 Waste Stream

Figure 4-3 shows a waste stream through out the whole year on the basis of the results described above.

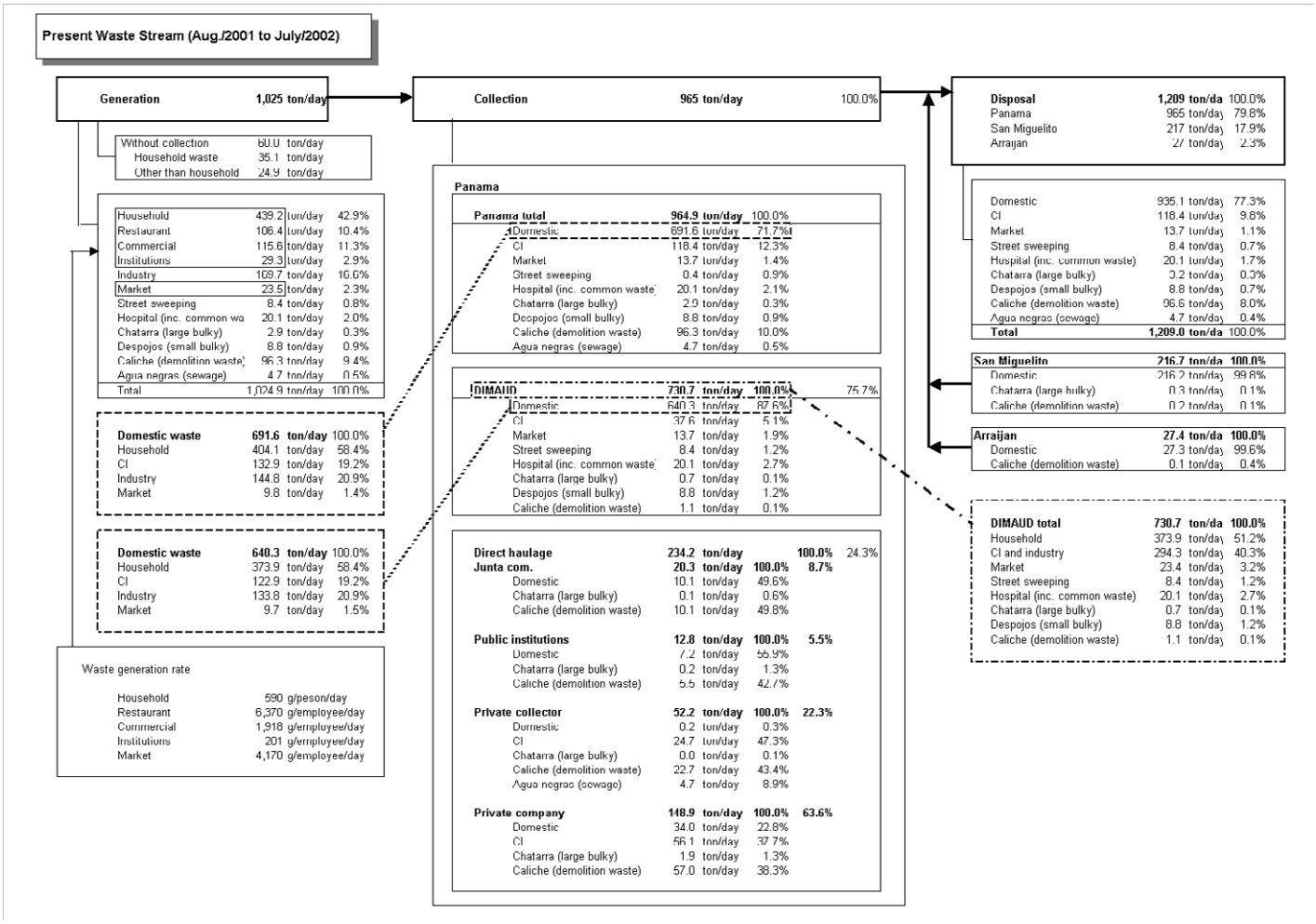


Figure 4-3: Current Waste Stream (daily average Aug.2001 to Jul. 2002)

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.

The use of tinaqueras to discharge waste produces many problems, especially bad odors which give an impression that wastes have not been collected because a lot of waste is found

scattered in the vicinity. Part of this waste is scattered by persons dedicated to recover valuable materials.

The users currently do not separate any type of waste; several categories of wastes are found in the bags, even those considered as hazardous.

The use of plastic bags and their discharge at any time of the day, lead to waste being scattered by animals or urban scavengers (*piedreros*). This situation also causes an adverse impact on the landscape and produces sanitary problems.

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.

All the waste is collected and disposed in the sanitary landfill or they are disposed illegally in several idle places or creeks.

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.

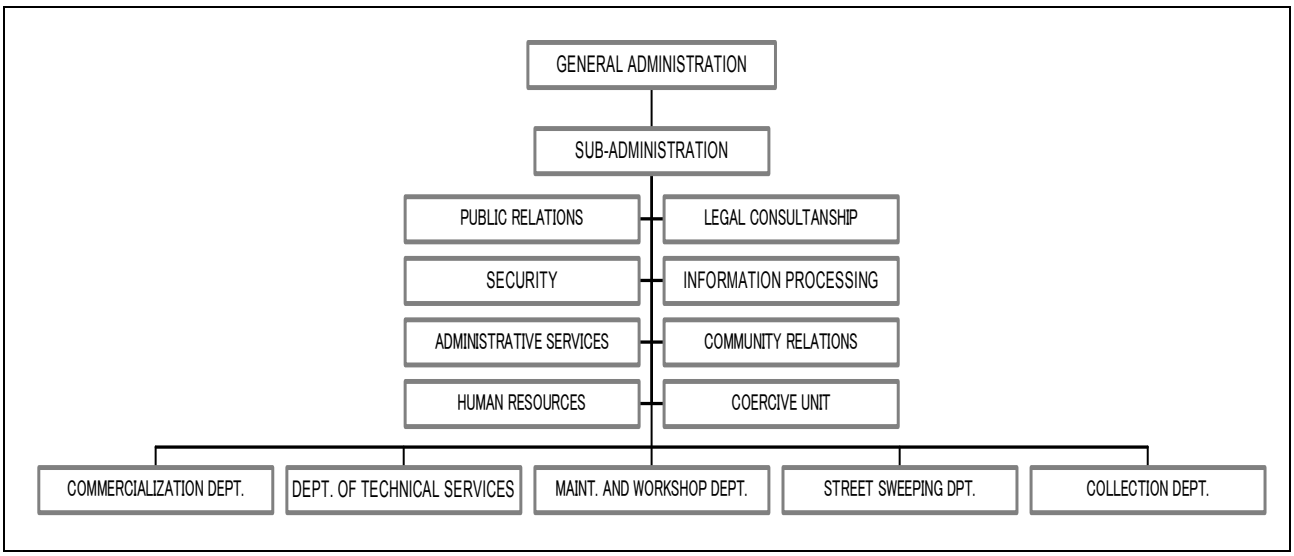


Figure 4-4: DIMAUD´s Organizational Flow Chart

This flowchart shows four levels: the first one is the Directive level; the second one is the coordination level which involves units of consultantship and administrative support; the

third one corresponds to the supervision which involves operative units, and the fourth one corresponds to execution which includes the corresponding work sections and areas.

The units found in the third level of the organization, which depends directly from the General Administration and Sub-administration are in charge to develop, supervise, and monitor operative activities which are required to provide an adequate urban and household cleansing service, final disposal, and to charge for these services. The activities developed by these departments require a strong coordination among them in order to maintain a continuous operation; this should be reflected in the efficiency of the service.

It is important to know the role of each department because there is a close relationship between the activities developed by each one of them; and generally, all these activities summed up make operative the service.

a.1. Description of the Operative Departments

The objectives, functions, and relationships of coordination of each one of the departments, defined by DIMAUD in the functions manual (November 2000) are presented in the following paragraphs.

a.1.1 Department of Technical Services

The department's main objective is to plan, execute, and control the activities related with the operation of projects and the sanitary landfill by guaranteeing the technical and administrative support for the fulfillment of these responsibilities.

This department has two sections called Project section and Sanitary landfill project.

This department is related horizontally with the comercialization, maintenance and workshops, street sweeping, and collection departments in different activities that are coordinated at the political directive level in the entity and for other common actions at the department levels.

a.1.2 Commercialization Department

Its main objective is to guarantee that income derived from services provided in the solid waste collection, final disposal, and usage of the landfill site is collected. Additionally, it should provide the customer with optimum conditions to make their transactions.

This department has two sections which correspond to Collection and Customer service.

This department should be coordinated with technical services, maintenance and workshops, street sweeping and collection departments regarding the common administrative activities undertaken by the entity.

a.1.3 Maintenance and Workshops Departments

The department´s main objective is to guarantee the preventive and corrective maintenance service to all vehicles in the entity´s fleet (light, medium, heavy-duty, and hydraulic) making sure that they are working adequately on a daily basis.

This department has the mechanical, preventive maintenance, and other maintenance service sections.

Relationships of Horizontal Coordination

This department has horizontal relationships with the technical services, commercialization, street sweeping and collection departments mainly in tasks related to the use of the fleet.

a.1.4 Collection Department

The department has the main objective to undertake the collection activities and to guarantee that the streets, avenues and other areas within all the corregimientos of the Panama District are kept clean.

This department has two sections A and B.

This department has relationships with the street sweeping, maintenance and workshops, technical services, and commercialization departments related to the support provided mutually during the execution of operative and administrative activities within the entity.

a.1.5 Street Sweeping

The department´s main objective is to undertake the street sweeping activities and guarantee that streets, avenues, and other areas in all corregimientos within the Panama District are kept clean.

It has two Sections: Nighttime street sweeping and Daytime street sweeping.

The department has relationships with the Collection, Maintenance and Workshops, Technical Services, and Commercialization Departments related to the support provided mutually during the execution of administrative and operative activities within the entity.

a.1.6 Analysis of the Structure

The Technical Services, Maintenance and Workshops, Collection, and Sweeping departments require to keep a direct contact with each other in order to provide efficiently the solid waste collection, sweeping, and final disposal services. The commercialization department´s work is more related to the accounting administrative activity; nonetheless, part of its work depends on the information generated at other departments.

However, notwithstanding the proposed organization, the current situation indicates that each department coordinates deficiently its activities with the other ones; reports are not exchanged among departments which leads in most cases to misinformation on the works they are undertaking. This situation has a direct impact on the quality and efficiency of the service.

This situation is evident between the collection, and maintenance and workshop departments. Neither of them have a program to coordinate their activities, as a result, several situations take place. Among the most important ones, there are:

- Misinformation in the collection department related to vehicles available to provide the service.
- The collection routing design does not allow enough time to undertake preventive maintenance in the fleet; this leads to provide only repair maintenance which consequently leads to damage on the vehicles.
- Because only repair maintenance is provided, it is not possible to have vehicles in reserve in case there is a failure within the route.

On the other hand, it is difficult to evaluate, in general, the service because there are not any daily or monthly activity reports.

a.2. Organization of the Collection Department

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.

All the required infrastructure (vehicles, equipment, personnel, etc.) to provide service to each area is physically located in Curundú depot (Curundú corregimiento) and Carrasquilla depot (San Francisco corregimiento).

The two Areas are divided in shifts: Area A Daytime shift, Area A Nighttime shift, Area B Daytime shift, and Area B Nighttime shift. Each collection shift has a chief which depends directly from the Collection chief.

Each one of the areas, previously mentioned, are divided into sectors which are also divided into collection routes. Each one of the sectors has a supervisor.

In addition to the two sections aforementioned, there is a third section which depends directly from the General Administration. This section is in charge of the trucks Roll on/Roll off type which operates totally independent from the other two sections.

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

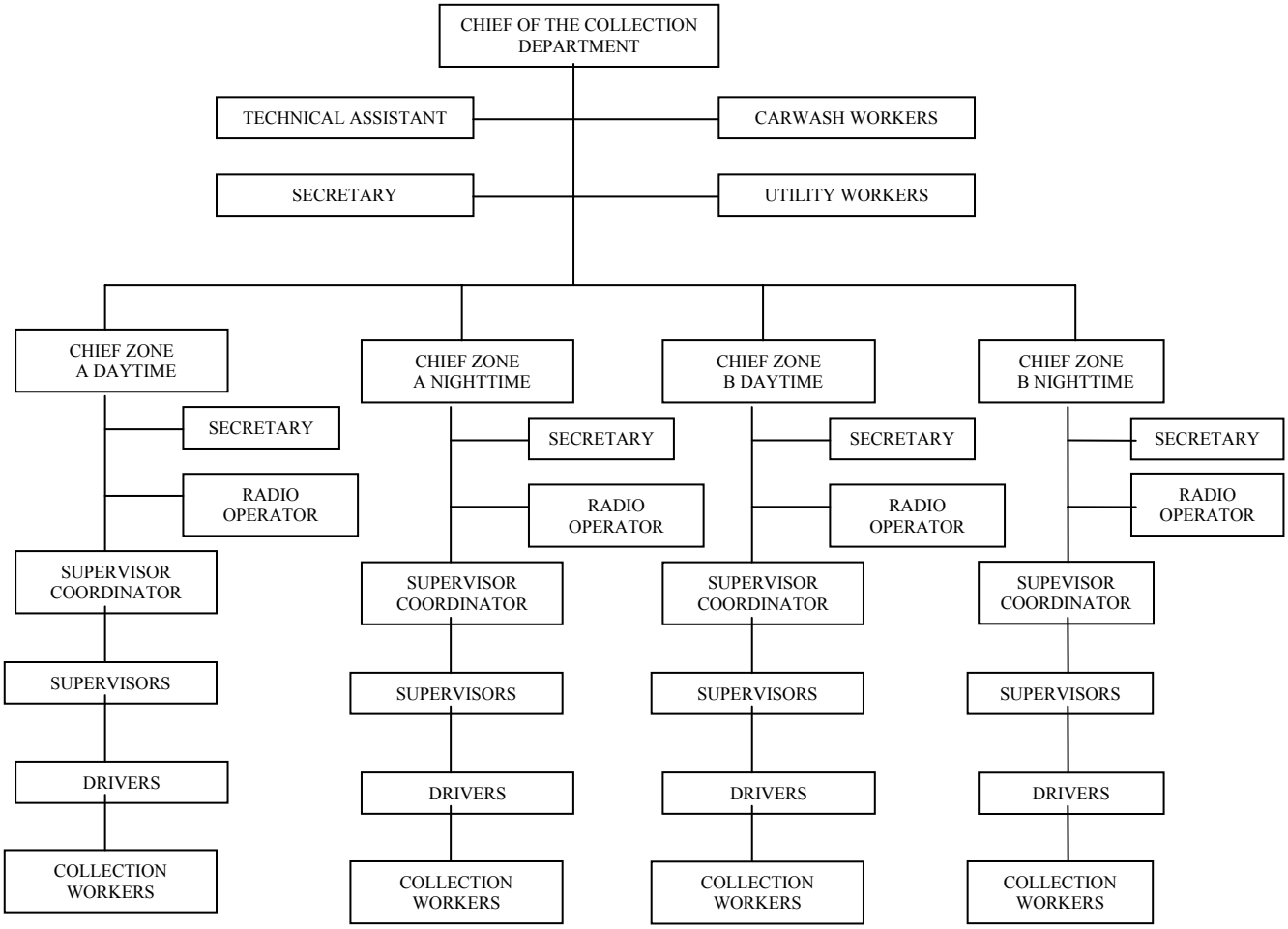


Figure 4-5: Collection Service Organizational Flow Chart

b. Personnel

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

Table 4-7: 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
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.

The workers were distributed according to the years they have worked for the institution as follows:

Table 4-8: 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%

More than 44% of collection workers and 34% of drivers with permanent contracts have more than 10 years of service in the institution. Most of the eventual workers have less than 2 years of service.

Those persons with eventual contracts have a higher employment turnover because they are always searching for new sources of employment.

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

c.1. Description of the Collection System

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.

These routes have generally been designed to conduct a daily waste collection, including Sundays; consequently, not too many routes have a frequency smaller than three times a week. This situation has caused that the collection service takes place during 7 days week; as a result, there is not a single spare day which is a common practice for services of this type (usually takes place between Monday and Saturday).

Currently, the collection service only considers three spare day which leads to have a total of 362 working days. On the other hand, the work schedule is distributed in 5 days a week with 8 effective hours per week, i.e., in a year, there are 260 working days that is equivalent to 71% of effective working days in the institution. As a result, there are 104 additional working days which represent an increment of personnel employed for this service.

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.

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. On the other hand, for a working week of 5 days a week, 1,4 of a crew is required to cover all seven days of the week (daily collection) which represents an increment of 16.6% in labor costs compared to a collection system based on 6 days a week.

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.

c.2. Estimate of the total number of hours of work per month per route

In addition to analyze the use of the fleet, the different routes have been studied with the purpose to define the real time used for the service and how this time affects the use of the resources.

For each one of the collection areas, the overtime hours where calculated per month per crew.Overtime hours are those worked after the regular eight hours per day per route.Overtime does not account for 7 days a week working periods, holidays or others because it is assumed that there are regular crews available for that type of situations.

The following graph shows the number of monthly overtime hours per Area and their percentage with respect to the total number of overtime hours.

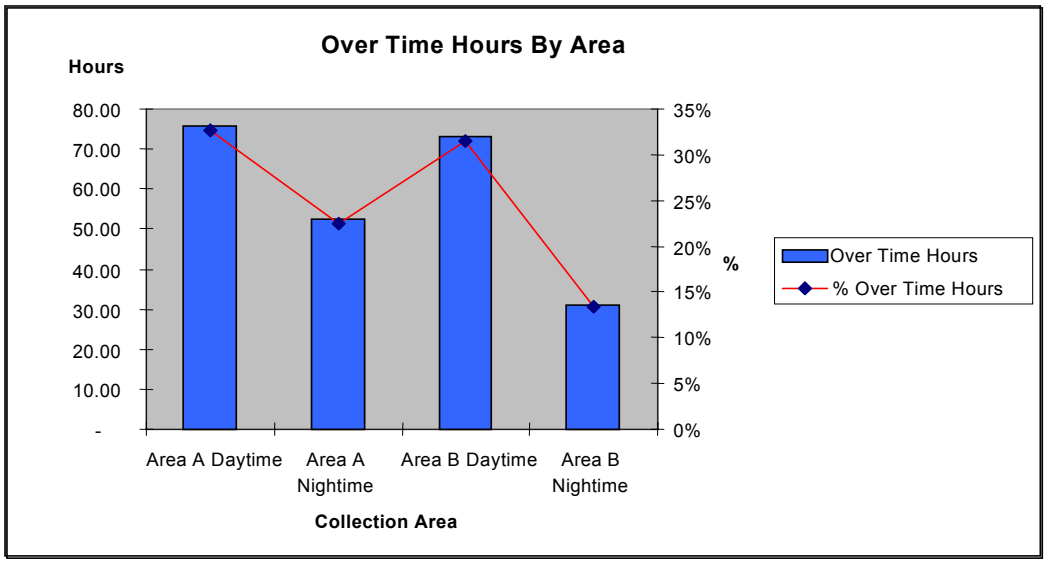


Figure 4-6: Overtime Hours per Collection Area

During the Daytime shifts more overtime hours take place (64% of the total of overtime hours) around 149 hrs./month.On the other hand, Nighttime Area B produces less overtime hours (13% of the total of overtime hours).

The total number of overtime hours generated is approximately 232 hrs./month, if the crew is made of 3 collection workers and 1 driver, the total number of overtime hours is 928.

d. Section of the Collection Areas

d.1. Description of the Collection Areas and Zones

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.

Each one of the areas is divided into two sections, reflecting the two work shifts; on the other hand, each section is divided into collection zones.

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

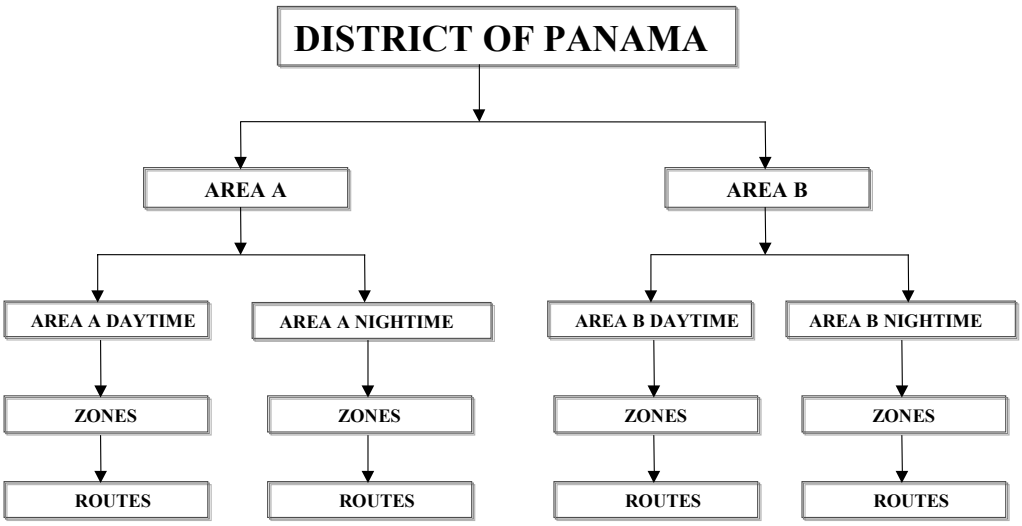


Figure 4-7: Collection Service Operative Flow Chart

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.

d.2. Definition of Routes

Route is defined as the path followed by the collection vehicle to service 100% the assigned area during a shift; more than a trip to the final disposal site can be made to cover all this area.A specific path with an initial point and a final point should define the route; it should also include all control points to verify how it is performing.

For Panama District, the route is only defined by the sector to be serviced.The path to service this sector is not defined; the driver truck is the person who mostly define the path; as a result, the path is constantly modified and it is difficult to control, specially, if more than one trip is made to the landfill site.

As it was mentioned previously, the collection by DIMAUD includes not only household waste, but also industrial, commercial, hospital, and institutional waste.In order to collect all these different types of waste, the collection department has defined specific routes which includes:

Residential collection route: these are routes that generally are named after the sector it serves; they are designed to collect all the household waste from residential areas.However, occasionally some commercial waste is also collected in the service area.Compactors are usually used in this type of routes.

Frontal 1 and Frontal 2: these are routes within area A that require collection of containers of 4, 6, and 8 $yd.^3$.These containers are placed in specific sites, mainly in Ancon corregimiento, and allow the storage of organic, vegetables, urban wastes.The collection frequency is daily and commonly during the daytime shift.

Special i: the routes called Special i are designed to collect specially commercial, industrial, and institutional waste.The routes are defined as a function of the premises and institutions to be serviced.Through these routes, wastes from workshops, universities, schools, commercial establishments, food industries, etc. are collected.The collection is made during the daytime shift with compactors and dump trucks.

Hospital i: these routes are designed specially to collect wastes from hospitals, clinics, and health centres.However, some commercial and restaurant waste is also collected.Waste from Hospitals consists mostly of household type waste (leftovers from dining-rooms, administrative activities, etc.); organic pathological waste should not be included (it is unknown whether it is also being disposed or not).It belongs to the Daytime shift.

Yellow Bags i: these are routes designed to collect street sweeping waste.The routes are defined based on the urban cleansing program; generally, it takes place during the Daytime shift.The type of waste is urban.

Franchise: these routes serve mostly food companies with several branches, e.g., hamburger joints, big restaurants, etc.The route takes place during the night shift to prevent scavengers from dispersing this waste.Generally, waste is collected from inside the premises; this increases the collection time.

Pueblos i: the route covers mainly two important malls and some industries.The type of waste is commercial; they are collected during the daytime shift.

Airport: this is a collection route that covers exclusively Tocumen international airport.The collection shift is during the Daytime.

Bulky waste: this route collects big size waste from public roads, e.g., electrical appliances, rubbish, vegetal waste, etc.Generally, these routes are serviced by dump trucks due to volume of the waste.Containers are also used for this purpose; they are located according to the information provided by the community and inspectors.These routes can cover more than one corregimiento per trip.

The collection service includes: 79 residential collection routes, 2 Frontal routes, 6 Special routes, 4 Hospital routes, 7 Yellow Bags routes, 2 Franchise routes, 2 Pueblos i routes, 1 airport route.

On the other hand, the average tons collected per trip are well below the loading capacity of the collection vehicle.Occasionally, there is more than one trip per route and for each trip the load does not reach 3 tons.If we assume the truck maximum loading capacity is 8 tons, one can conclude that the routes are not well designed and the collection efficiency is very low.

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.

Generally, wastes are stored in plastics bags which are 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. From the field trips, it was observed that residents discharge their wastes at any time of the day; this situation favours waste scattering by scavengers (persons and animals) along the public roads.This type of discharge is caused by an irregular service.

Collection is made with compactor trucks and a crew of 4 persons (1 driver and 3 assistants).

Occasionally, waste collection workers go inside the house to collect the waste; this situation delays unjustifiable the collection works.Additionally, it is common to find waste scattered after collection works; this takes place because collection workers do not clean wastes on the streets and near the bins or plastic bags, as a result, the service quality is negatively affected because the streets look dirty even after collection works took place.

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 $yd.^3$.

For the container type of collection, the accumulation of waste turns out to be more evident; many containers were observed at full or above capacity because, generally,a large amount of bulky waste is disposed in this type of containers.On the other hand, for many cases, the containers were observed empty or half full; nonetheless, waste was observed around the container.This is closely related to environmental education among residents.

Additionally, for this type of collection, waste collection workers do not clean the container´s surroundings, that reflects poorly on the community´s image and shows low service quality.

A few months ago, plastic containers started to be used in San Felipe corregimiento.This new system might be more efficient and might have a positive effect on the landscape compared to the use of metallic containers.Additionally, the plastic container might be easier to handle and easier to wash than the metallic container; because of the foregoing DIMAUD is exploring the possibility to add new plastic containers to the system.

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.

This collection is done independently from the collection routes already defined; it is planned based on requests by the community (specially low income sectors where security is a factor to be accounted for).

Generally, this system causes the most problems because their sides reach around 2 mts. high; this causes difficulties to the community when disposing its wastes.During the field trips, it was observed how inadequate this system might be; most of these type of containers where observed empty; however, waste was observed surrounding these containers.This waste remained around the container even after the containers were removed.

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.

Through these special assignments, the cleansing of specific areas is achieved, specially rural and low density areas; this improves overall sanitary conditions and minimize diseases produced by vectors.

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.

The Work Order (W.O) is a register document that the Collection Department has implemented to control the service; this W. O. allows to collect background data on each trip made by every truck during the shift. For every trip the W.O. registers date, area, assigned zone and route, time to enter and exit from discharging in the sanitary landfill, identification of the personnel assigned to the truck, tons collected by trip, background of the collection vehicle and observations. This W.O. is given to the driver by the supervisor at the beginning of the service shift. When the shift is finished, the driver returns the W.O. to the inspector.

A report is elaborated daily based on the W.O.; on this report, the number of trips, tons, number of personnel, and hours of work are registered. Every section submits, on a monthly basis, a similar report with the same information.

During the background data collection, it was confirmed that the sanitary landfill data is not kept according to codes, route number or name, waste origin, corregimiento, etc. Generally, this data is collected based on the individual criteria of the weighbridge operator; in many cases, this data is either incomplete or incorrect. Moreover, there are trips where the origin is not defined, in some cases, it was assumed that they belonged to DIMAUD. However, in some instances, it was not possible to define the origin. Additionally, there are records of the same truck with different numbers; this situation is due to the recent change of the internal number of the fleet; and it seems that neither the landfill personnel nor the drivers are aware of this change. Consequently, it is urgent to unify in the short term the criteria about the incoming vehicle data and to unify them with the collection department in order conduct easily and in short time the collection service control. Furthermore, it is necessary to report on a daily basis to the collection department about the incoming DIMAUD vehicles with the purpose to verify their background and be able to solve any discrepancy within 24 hours.

The register of incoming vehicles to the landfill site is a useful tool because not only allows to have the number of trips and tons collected, but it also helps to verify time elapsed within the sanitary landfill and between trips; additionally, this register can help to establish whether the wastes collected are originated from the established routes (type or origin of waste established through visual inspection).

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 4-9: 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. Efficiency indicator tables which were derived from Work Order Data are shown in the Data Book.

Once these indicators have been calculated, the average values were defined for each corregimiento. For those corregimientos with night-time and daytime collection, the indicators were defined for each situation because the traffic conditions change.

Regarding the Days of Work per Week indicator, it was confirmed that there is one corregimiento with real daily service (San Felipe). However, only the daytime shift has daily collection in San Felipe because the night-time shift has a collection service of 6 days per week.

All the corregimientos have a collection frequency larger than three times per week except San Martin which only has a frequency of two times per week. By analyzing each corregimiento, it can be determined that Llanos de Curundu route has only one day of service per week.

The previous values correspond to averages within a route. If the background information for each route is reviewed, it can be observed that there are sectors where there is not a definitive collection frequency pattern; consequently, the residents have some uncertainty regarding the waste discharge and, as a result, they tend to discharge the wastes in the public road at any time of the day.

Taking into account that the daily collection frequency is not followed as planned, the routes' collection frequency can be modified by considering a variation of daily collection (daily except on Sundays) or by considering a collection of three times per week. This new route design would reduce costs and would allow to keep a maintenance program for the fleet. Additionally, as the route design is closely followed, a better response from the service user will be received because the residents will have certainty that the service will be executed at the day and hour established.

The results show that most of the corregimientos have an average value of 5 to 6 tons per trip. The corregimientos of Pacora, San Martin, San Francisco, and Parque Lefevre have average values higher than 6 tons/trip which is shown mainly during November for three of the corregimientos

Closely reviewing the index value for each route, it can be observed that there are some routes with average values between 4 to 5 tons/trip. The values for Ancon where most of the waste is collected with dump truck are not included.

For the case of the indicator tons/man/day, 2.6 tons collected per man per shift was obtained as an average. There are many routes with values between 1 and 2 tons/man/day and the most critical route was Los Rios with 0.5 tons/man/day. The best performance was obtained in the Carrasquilla route with 4.5 tons/man/day.

It was verified that the crew is made up of three collection workers and one driver.

The mean values obtained per corregimiento for the last two indicators (tons collected versus hours of work and Hours of work/day) are shown in the following graphs.

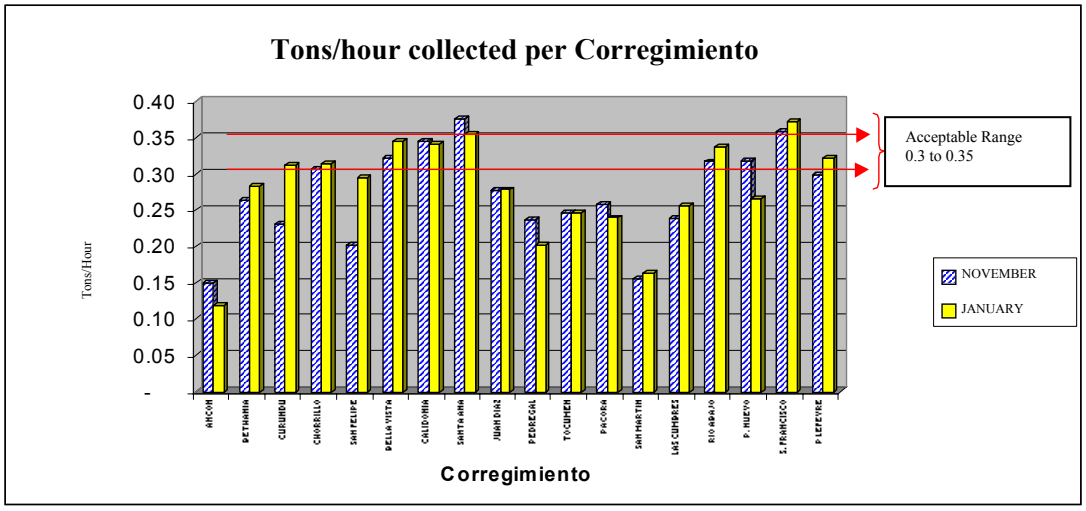


Figure 4-8: Tons/hour Collected per Corregimiento

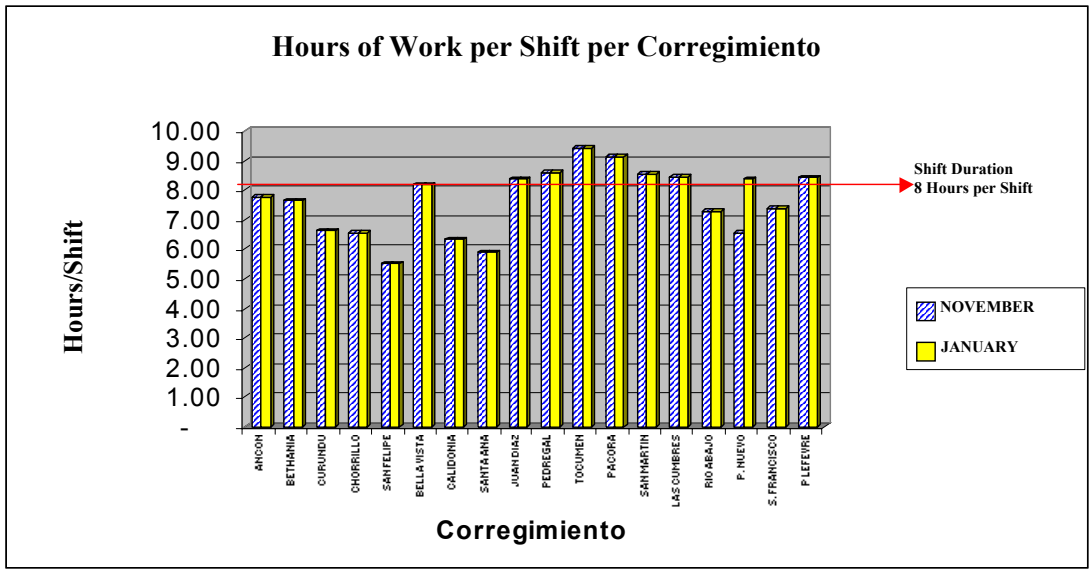


Figure 4-9: Hours of Work per Shift per Corregimiento

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.

f.3. Comments

The collection service is planned to service 18 corregimientos out of a total of 19 which make up the Panama District. In order to provide service, there are 103 routes which are distributed in three daily shifts.

The system design establishes 15 routes with collection service three times per week, and 88 routes with daily collection service, including Sundays.

The routes are defined by sectors and do not correspond to a specific path.

As a result of the study, it can be concluded that the service does not follow the program neither for the days scheduled nor for the hours. This situation becomes more critical in places where no container is located, but specially those places where large containers are placed (over 20 yd^3).

In spite of the fact that the planned frequencies are not followed, the service days are high. This figure is reflected when we evaluate the percentage of days serviced in each corregimiento. A 28% of corregimientos is serviced 7 days a week, 39% is serviced 6 days a week, and only 6% of the corregimientos is serviced less than three times per week.

It has also been established that there are an important number of vehicles being repaired. The most critical situation was registered in November when 43% of the fleet could not provide service; additionally, 19% of the remaining vehicles went to the landfill site less than 5 days. The condition of the trucks prevents the municipality to provide a service as planned, specially considering that they should work everyday during a month and three times a day.

The service shows important delays due to mechanical failures within the route. There are not either enough replacement vehicles; consequently, the collection can not be completed on occasions or the collection would continue after other truck has finished its assignment.

This previous condition would be improved in the short term because DIMAUD is considering to acquire 16 back loading compactor trucks (16 yd^3 capacity).

On the other hand, the routes would have to be redesigned because the trucks are currently making trips to the landfill site below capacity. This situation causes that more trips are made to the landfill site than necessary; consequently, less time is spent on collection works and also this leads to a deficient monitoring of the service. The routes can be expanded with a new design which would reduce the total number of routes and, consequently, the number of trucks. Additionally, the haulage time would be reduced because the number of trips would decrease. Lastly, the personnel can be controlled on the site to verify if they have fulfilled their duties.

The service control system undertaken by the collection department requires maintaining constant information with the sanitary landfill. This permanent exchange of communication would allow to check all the information related to tons, hours the trucks go into or exit the landfill site; specially, if we take into account that background information do not match today.

It is also important to review the service planning in order to maximize the use of resources. Currently, the service quality (from the user perspective) has improved. The community commonly express that a positive change has occurred; however, now it is vital to adjust the service to achieve better performances.

g. Haulage, Quantity and Characteristics of every vehicle

g.1. Background of the Fleet

DIMAUD has a fleet of 174 vehicles; among these vehicles, we can find the collection vehicles. The active equipment is the following:

Table 4-10: Active Equipment and Number of Units

Description	Number of units
PANEL	6
SWEEPER	2
SMALL BUS	2
MEDIUM VEHICLE	7
WATER TANK	1
COASTER	2
COMPACTOR	62
FRONTAL	9
CRANE	2
JEEP	1
MONTERO	1
MOTORCYCLE	2
PICK UP	44
EXCAVATOR	6
ROLL ON	2
SEDAN	4
DUMP-TRUCK	23

Note: This information reflects the situation up to March 2002

For the good development of the collection service, DIMAUD has a fleet of 62 back loading compactors, 9 front loading compactor, 26 dump-trucks, 2 roll-on roll-off trucks.

As support equipment, DIMAUD has six excavator which are used mostly for small dump sites; additionally, there are 2 cranes and pick-up vehicles for supervision.

In the Data Book, there are tables which show the characteristics of compactors and dump-trucks which are used for the service.

Summarizing, the collection department has the following compactor vehicles:

Table 4-11: Compactor Vehicles in the Collection Department

Name		Quantity	Year	Characteristics
Compactor	16 yd3	34	1999	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	16 yd3	13	1998	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	20yd3	8	1997	Backloading Heil F-4000, International chassis 4900, 3 axis.
Compactor	16 yd3	6	1998	Backloading EZ-Pack Peabody, Ford chassis F-800, 2 axis.
Frontal Compactor 25	25 yd3	4	1994	Frontal loading Demspter, Mack chassis RD600, 3 axis.
Compactor	16 yd3	4	1992	Backloading EZ-Pack Peabody, Ford chassis F-800, 2 axis.
Compactor	16 yd3	1	1994	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	11 yd3	1	1994	Backloading Heil F-4000, Ford chassis 800, 2 axis.
Compactor	16 yd3	2	1995	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	25 yd3	2	1996	Frontal loading EZ-Pack Front Loader, chassis Volvo Wx64, 3 axis.
Compactor	16 yd3	1	1996	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	16 yd3	1	1997	Backloading Heil F-4000, International chassis 4700, 2 ejes.
Compactor	36 yd3	2	2000	Frontal loading Mack chassis MR6885.
Compactor	11 yd3	1	2201	Backloading Heil F-4000, International chassis 4700, 2 axis.
Compactor	16 yd3	1	1997	Backloading Heil F-4000, International chassis 4700, 2 axis.

g.2. Operation Capability of Collection Vehicles

One of the vital aspects of the solid waste collection service is the vehicle condition and its operation capability. The service quality will be affected if the trucks are not available on time as required because the scheduled program already established can not be followed as planned. Other factor that can affect the service quality is the number of vehicles per fleet which should correspond to the number of routes and shifts during the day.

Generally, the collection systems consider the operation of vehicles to be done during two shifts in the day with 8 hours each shift. One day during the week is considered for preventive maintenance.

With the objective to know how the current collection fleet operates, an analysis of the condition and operation level for the equipment was done. In this analysis, it was verified the number of days the vehicle has operated in the two months of study; this information helps to measure the real number of vehicles that operate during a month, the percentage of trucks which have had failures, and the time that they require to be repaired.

On the other hand, an estimate of the fleet required for the service can be calculated with the amount of waste collected; this estimate can be compared to the current number.

The background information from the vehicle accessing to the landfill site was used. In this control, it is recorded the vehicle number, the time to enter the landfill site, the origin, and tons of waste transported.

The first step was to verify the number of vehicles that provided the service during the investigation period; this was done independently from the number of days of work. Based on the previous criteria, it was determined that during November only 56 vehicles worked (44 compactors and 12 dump-truck) which represent 57% of the fleet. During January, the number of vehicles that worked was 62 which represent 62% of the fleet.

It was also confirmed that from the total fleet which seems to be active, there are 10 dump-trucks and 8 compactors that do not appear to provide service during the two study months.

If the operative days are reviewed for each vehicle, we can verify that there is an important number of failures during the month; in fact, during November the average number of days of work was 19.8, in January this number decreased to 18.8.

In order to have a better understanding, the percentage distribution of vehicles as function of days of work was calculated. Seven time ranges were defined; the graph shows the results.

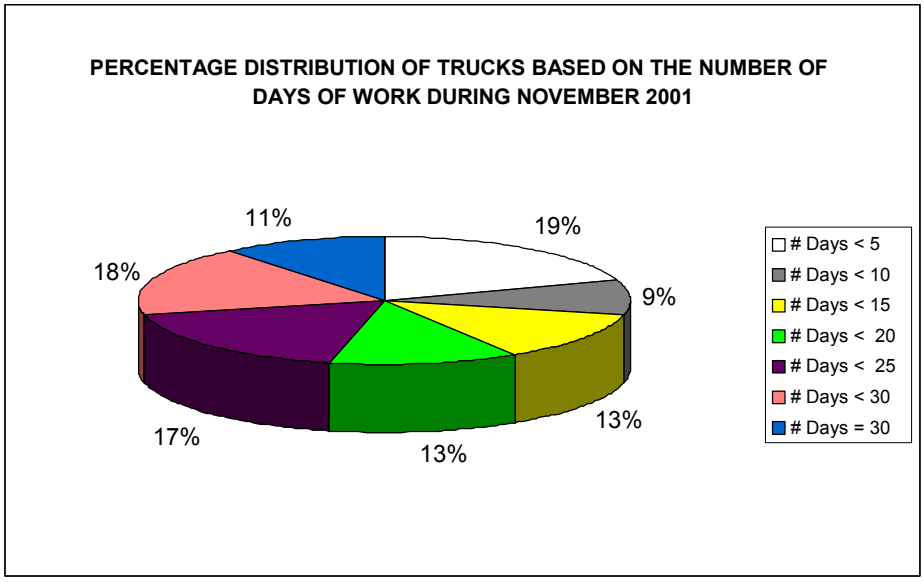


Figure 4-10: Percentage Distribution of Trucks Based on the Number of Days of Work During November 2001

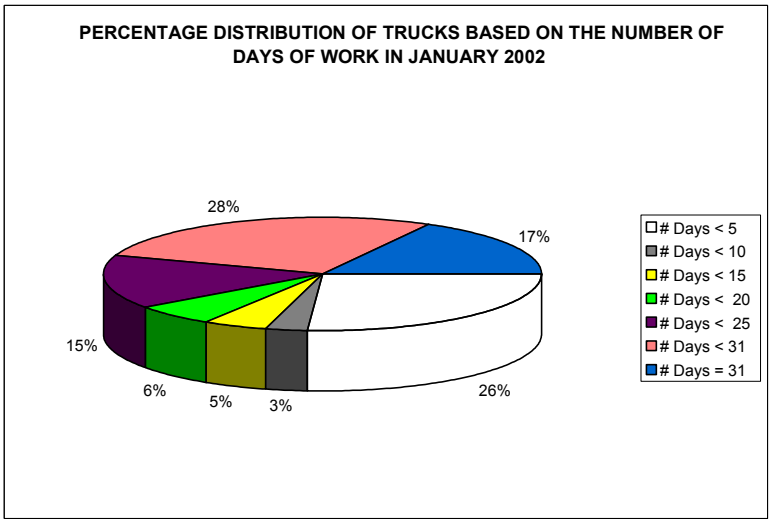


Figure 4-11: Percentage Distribution of Trucks Based on the Number of Days of Work During January 2002

In both graphs, the white color shows the percentage of vehicles that worked less than 5 days per month; this figure reaches 26% of the fleet in January. During this same period, it is shown the highest percentage of vehicles which worked continuously during a month; it is logic to assume that those vehicles which are not damaged should cover more routes.

Most of the vehicles have been manufactured in 1999, i.e., they do not have more than three years of operation. Consequently, these vehicles should not have important mechanical problems; generally, their service life is between 5 to 6 years considering two shifts per day.

h. 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 4-12: 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 4-13: 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.

Currently, no preventive maintenance program is taking place for the fleet. Most of the vehicles are working three shifts and they only have 3 hours a day to make preventive maintenance; however, this time is only used for repair maintenance. Additionally, occasionally a large number of vehicles in the fleet (higher than 40%) require to be fixed which reduce even more the time available to conduct preventive maintenance.

There is no preventive maintenance program and, consequently, attention is provided only when the vehicle has a failure.

Repair control is done through a private register which is elaborated for each vehicle when this one begins to operate.

Taking into account the workload that these vehicles have, they generally require to be repaired once a month. Currently, there is not a statistical control about how many times a vehicle has undergone repairs.

The time that for each repair varies, most of them are done within 24 to 48 hours. Major works which require spare parts not found in the warehouse will last as long as it takes to procure the spare parts which usually go through a long administrative process.

For periods with a heavy workload, DIMAUD has chosen to repair some vehicles outside the organization. This is done with the objective to reduce the repair time and meet the collection routes requirements.

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.

While the vehicle is being repaired, it is defined the spare parts that are required which are reflected on a ´request for materials and spare parts´ form which should be signed by the chief of mechanics and, subsequently, transferred to the warehouse.

With the purpose to keep a stock in the warehouse, the chief mechanic elaborates a request of materials and spare parts on a monthly, every three months, every six months or annual basis for those spare parts or materials which are more frequently used, such as, filters, starting motors, tires, coils, etc. These orders are repeated whenever the warehouse is running out of stock. Preferably, the orders are requested between periods no longer than every three months because the time it takes to arrive depends on the amount of the purchase.

Once the Purchase Order is authorized, it is returned to the Purchase Department and from this department it is sent to the Budget Department of the Panama Municipality in order to make its budgetary consolidation. Subsequently, the Purchase Order is sent to the Treasury Control Office which is located in the Panama Municipality.

In case the Auditing Office observes an error, the purchase order is returned to the Management Department of DIMAUD which transfers this purchase order to the responsible department.

In case it is required to acquire some piece urgently then petty cash under the Management Department can be used. A certain amount of money is assigned as petty cash.

Once the purchase is done, the materials are received by the warehouse. The warehouse sends daily reports to the General Direction and weekly to the Management Department with information on materials stored in the site.

Approximately, every six months an inventory is done in the warehouse; the inventory is made by the accounting office.

In the warehouse, there is also a register of the gas consumption.

If the failure is identified as not significant, then the vehicle is repaired on the site. Otherwise, the vehicle is taken to the shops by a crane if the vehicle can not be moved by its own means.

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 (See Chapter 3).

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 functions of this department include basically to undertake the street sweeping activities in order to guarantee that the streets, avenues, and other areas remain clean in the Corregimientos of Panama District.

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:

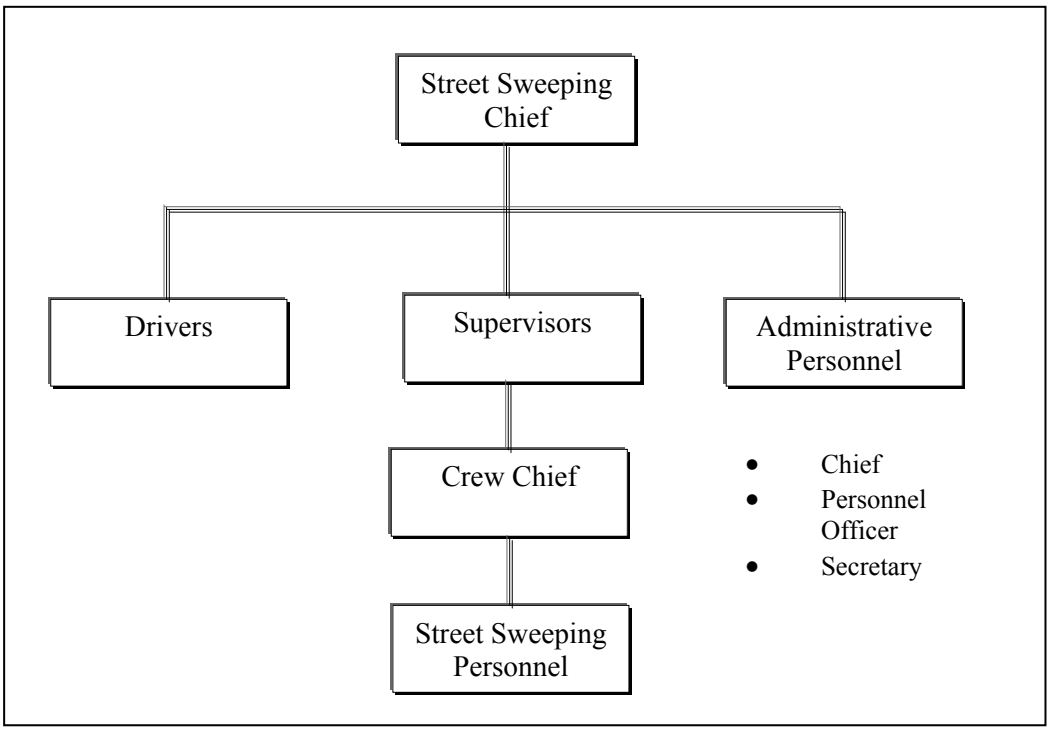


Figure 4-12: Organizational Structure of the Street Sweeping Department

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 4-15.

Table 4-14: 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
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 4-15: 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. Characteristics of the Routes

Routes per Corregimiento: Correspond to routes which are destined for street and avenue sweeping with daily frequency from Monday to Sunday. Generally, the main avenues are serviced every day; lateral roads are swept every other day alternatively.

Operativo$_i$: The Street Sweeping Department plans its *Operativos* every Saturday of every month; one specific Corregimiento is chosen and the volunteers and personnel from DIMAUD proceed to clean the public areas. The Street Sweeping Department begins to work in the *Operativo* Area on Wednesday and its tasks should finish on Saturday jointly with collection.

Main Roads: Corresponds to this road to cover the main roads of Panama District and it has a daily frequency.

Reverted Area: This route covers Ancon Corregimiento in one week. Consequently, the different areas which make up this Corregimiento are swept with a once a week frequency.

Support: Corresponds to the crew which is made up of male personnel because they undertake the heaviest tasks such as weeding out. This crew supports other crews as they are required.

a.3. Personnel in charge of service

The day-time section has a total of 336 workers as it is detailed in Table 4-16. On the other hand, the night-time section consists of the personnel that is shown in Table 4-17.

Table 4-16: 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 4-17: 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.

On the other hand, out of the total personnel that belongs to the daytime section, 86% is generally working, the rest of the workers are mostly on vacations (8%) or in compensatory payment (5%). The compensatory payment corresponds to the time off that the worker has as payment for overtime hours done by him/her.

a.4. Amount of Wastes Collected

The wastes derived from street sweeping are collected on a daily basis through the collection routes which are destined for that purpose. For those routes which correspond to the program of the *operativo*, the Street Sweeping Department reports every morning through fax to the Collection Department regarding the sectors that were served with the purpose that the collection department makes a plan to collect those bags.

The Street Sweeping Department does not have information related to the amount of wastes derived from street sweeping; consequently, in order to define a figure in this matter, it was

necessary to resort to data of entrance records from Cerro Patacon and the controls established through the Collection Department Work Orders.

According to the background information from Cerro Patacon, in November 2001, a total of 478.03 tons were collected and in January 2002 the total amount reached 596.27 tons; additionally, the data gathered shows that 609.37 and 840.42 tons were collected in November 2001 and January 2002 respectively.

Similar to the collection case, there is a discrepancy between the two types of control; the largest tonnage figure is produced by the Collection Department.

The street sweeping department does not have control over the kilometers that are swept, the percentage coverage per Corregimiento. The routes have not been drawn through a rational design which can help to evaluate them; constantly, the design is modified and this modification depends largely on the supervisor who is in charge of the work group.

a.5. Manner to Implement the Service

When the shift begins, each street sweeper is provided of his/her tools which commonly are made up of shovel, regular broom or large broom. The bags to store wastes are distributed directly by the crew chief on the site.

Street sweepers do not have a car to transport and install the bags with wastes; consequently, it should be done manually.

Once the tools are distributed, they are transported by the personnel to the corresponding work place. This is done by buses or pick ups.

On the route site, each worker is assigned a task which consists of certain amount of meters that they should sweep. In the routes, the street sweeping tasks cover the area between the construction line and the road; however, the workers also sweep the parking areas and surrounding areas to the *tinaqueras* which are found in their path.

As the street sweeping continues collecting wastes, he/she would place the bags which are already full on the sideway after the bag has been closed; this bag is subsequently collected by the collection truck.

a.6. Service Analysis

Some street sweeping routes were analyzed with the purpose to know the performance of the street sweepers. For the daytime section, routes 3, 4, and 5 were studied and it was determined performance indicators between 0.45 and 1.96 km/street sweeper/day for an average of 1.3 km/street sweeper/day. For the night-time section, the routes Presidency and

Santa Ana were analyzed and performance indicators between 1.2 and 1.52 km/street sweeper/day were obtained; for this last case, an average of 1.34 km/street sweeper/day was obtained. Meanwhile, the average performance value for Latin-American cities is 1.8 km/street sweeper/day.

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

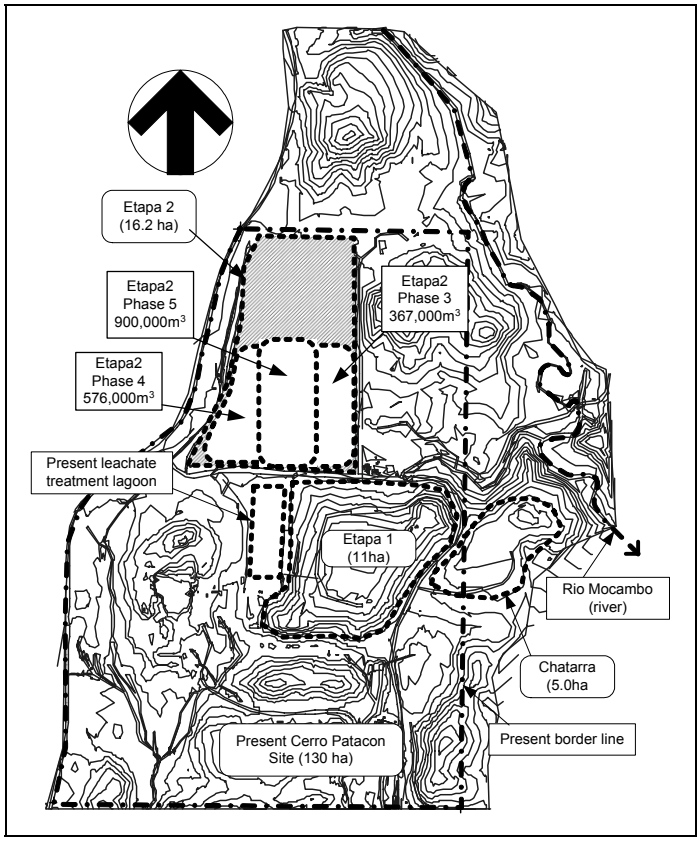
The final disposal site for solid waste in Panama Municipality is located in Cerro Patacon. This final disposal site is consisted of a part for inorganic waste and a part for organic waste. The part of organic waste is divided into two, i.e., 'Etapa I' that was used from June 1985 to June 1995 and 'Etapa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

Table 4-18: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	-	[3]3,541,918 m^3	-	Synthesis liner	Lagoon

[3] 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

Etapa II has certain environmental impact mitigation measures such as liner, gas extraction facilities and a series of lagoons for leachate treatment. However, there is a room to improve, e.g., pumps to lift up leachate to the lagoons are under repair and the leachate is discharged to a nearby river without treatment.



Meanwhile, the part for inorganic waste that does not have liner and leachate collection facilities receives scrapped personal computers, home electric appliances, empty cans of paints, scrapped gas cylinders and so forth. Then, it generates leachate that goes to Cardenas River directly. Taking into account type of waste disposed of, the part gives a larger impact on the surroundings than the part for organic waste.

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. (Annex H Landfill)

Table 4-19: 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

4.4.6 Other SWM Activities (NGO, community groups)

In the Country, there are several non governmental organizations (NGOs) that develop actions on environment.

The main activities of these NGOs are summarized next:

- Organization of seminars and conferences related to environmental sector.
- Ecological projects and recycling.

a. ANCON

The National Association for Nature Conservation (ANCON) is an non governmental organization founded in 1985 by a group of prominent businessmen, scientific and community leaders.

ANCON makes emphasis mainly on environmental education at schools, which makes students notice a importance of a harmonised relationship between the human being and the environment based on the understanding of natural processes and the sustainable resource management.

ANCON concentrates efforts on the community development programs and in the search of solutions for the marginal communities, through training and agroforestal extension, giving cultivation alternatives using established models in agroforestal demonstrative properties of Panama Canal hydrographic basin and other country zones.

b. APRONAD

The Association for Promotion of New Alternatives of Development (APRONAD) is an non governmental organization that promotes strategies of sustainable local development, the creation of new employment sources and the generation of revenues, by means of finding new alternatives and profitable investments for urban and rural communities.

c. CEASPA

CEASPA (Center of Studies and Panamanian Social Action) is a non-profit association created in 1977. This association works for the sustainable human development and improvement of the democracy through the civic “empoderamiento” and participation of diverse sectors of the society.

d. FAS-Panama

FAS Panama is an NGO and non-profit organization that provides the promotion and execution of sustainable human development projects. Founded by a group of young

professionals and university students that look for to contribute in the solution of the problems that the Panamanian youth lives.

This organization also carries out multiple activities as seminars, chats, and consultantships in the integral SWM and other topics of environmental nature. These actions are focused so much to government organizations as to private companies, schools, universities and the community, trying to aware these groups on the domestic environmental problem and the form how they can contribute to the solution of the problems.

FAS-Panama advises to 4 schools in Recycling Projects where students and teachers participate.

4.5 Institutional and Financial System

4.5.1 Institutional System for SWM

a. Organization of the Public Sector in the Republic of Panama

The sovereign power emanates only from the people, pursuant to the political constitution, by means of three state powers: the legislative branch, the executive branch and the judiciary branch, each one of which act independently from each other, yet maintain a harmonious cooperation.

It also has six additional independent bodies with the following duties: The *Contraloría General de la República* [Comptrollership General's Office of the Republic; auditing of public funds], *Ministerio Público* [Prosecutor's Office; defense of the state's, municipalities and citizens' interests], *Ente Regulador de los Servicios Públicos* [Regulating Entity of Public Services; proper rendering of public services] and the *Tribunal Electoral* [Electoral Court] and the *Fiscalía Electoral* [Electoral Auditors' Office] (oversee the liberty, integrity and efficacy of the people's suffrage).

Two additional independent stand out as well: the *Comisión de Libre Competencia y Asuntos del Consumidor* [Free Competition and Consumer Affairs Commission; allows free competition, battles monopoly and orientates the consumer] and the *Superintendencia de Bancos* [Bank's Superintendence Office; regulates the nation's banking system].

b. Legislative Body

The legislative branch is constituted by an association known as the Legislative Assembly, a professionalized body formed by seventy two (72) legislators, elected by popular voting for a five (5) year period that represent the electoral circuits outlined by law; and the Permanent Commissions established by the Organic Regulation of the Internal System.

The main activity of this body is the issuance of the required laws for the compliance of the aims and the exercise of the State's functions as laid out in the Political Constitution. In addition to the legislative functions, it also has judicial duties, such as getting acquaintance of accusations or claims against the President of the Republic, judges from the Supreme Court or members of the Legislative Assembly, who can be judged by this entity.

c. Executive Body

It is constituted by the President of the Republic and the State Ministers. The main functions of the Executive power are the planning, guidance, programming, directing, execution, control and evaluation of a set of activities encompassing economic, social, infrastructure (garbage and waste treatment, among others), politics and sovereignty.

To carry out its duties, the Executive branch has two main structures: the Central Government and Decentralized Institutions.

The Central Government area is constituted by the Presidency of the Republic, the Cabinet Council, the Advisory Commissions of the Executive Power, and the eleven (11) ministries. National public policies are dictated in this area.

The area of Decentralized Institutions is formed by all the autonomous and decentralized public institutions, public companies and financial mediators, which are responsible for the execution of governmental functions in accordance with the policies outlined.

Both areas develop programs, projects and also render public services.

d. Province System

Government

Provinces are political divisions constituted by the territory allocated to them by the laws and are the limitation areas for the governments. The governor is the representative from the Executive Power at his/her respective province, and has the responsibility of inspecting and coordinating the duties of public entities; likewise, he/she is the maximum authority within the province and head of police matters. The legal background of governments is outlined by the 1972 Political Constitution of the Republic and its reforms.

Provincial Council

A consultation body for the governor of the province, the provincial authorities and national authorities in general. Once the recommendations from provincial councils are approved by the Executive Body, their compliance will become compulsory. The provincial council has the power to forward bills.

The *Corregimiento* representatives (being the *corregimiento* the smallest political territorial unit) for the respective province (with opinion and voting), the governor, the district Mayor and the councilmen (opinion only) are members of the provincial council. The legal background for the provincial council is outlined by the 1972 Political Constitution of the Republic and its reformations.

e. Municipal System

The municipality is the community's autonomous and political organization within a district. The municipal organization will be democratic and will function in accordance with the administrative nature of the local government. Its main duty is to foster the development of the community and the achievement of social well-being.

Municipal Council

Each district has an assembly known as the Municipal Council, which is formed by all the *Corregimiento* representatives and, such being the case, by the councilmen at those districts with less than five *corregimientos*. The municipal council regulates the juridical life of municipalities by means of enforceable agreements and resolutions within the respective district.

Exclusive Jurisdictional Functions

To formulate, together with the Mayor and the participation and advise from the Ministry of Economy and Finance, the development policies for the districts and *corregimientos*, among others, that can be related to the current study: to create municipal or mixed enterprises to exploit goods and services; to foster the formalization of contracts with public or private entities to create municipal or mixed enterprises, with the aim of exploiting goods and services; to set taxes, contributions, duties, fees and rates; to authorize and approve the formalization of contracts on concessions and other means to render municipal public services; to establish and regulate the urban and domestic cleansing service of the villages, and provide the means to utilize the waste and residues; to pronounce measures to protect and preserve the environment.

District's City Hall

Its main functions related to the current study: to lead and coordinate the waste collection works in the district; to oversee the maintenance and improvement of the physical working conditions with respect to infrastructure, equipment and working materials; to establish, coordinate and guide municipal public services; to collaborate in the protection of the environment.

***Corregiduría* (Police Station)**

It is the minor police entity for the local government and headquarters for the *Corregidor* (police commissioner). Its purpose is to preserve the public order by supporting civil and police duties undertaken by the district's Mayor.

It oversees the compliance with the sanity and ornament in the *corregimiento*.

The police commissioner is the police chief, member of the communal board and representative of the Executive branch in the *corregimiento*. One of his main attributions is to support the communal board to preserve the environment.

f. Institutions with Jurisdiction in SWM

The following are state institutions with competency in Solid Waste Management.

f.1. Central Government

f.1.1 Ministry of Health

Purpose

To develop the health guidelines by means of the outlining and execution of health policies and strategies, and to carry out the actions for the rendering of services to the population and the environment; to prevent, remedy, repair and rehabilitate the people's and environmental health, as well as their promotion surveillance and regulation.

Principal Functions Associated with SWM

To formulate, coordinate, lead and execute the policies and activities from the Health Sector at a national level; to constantly update the set of laws that regulate the activities of the health sector and oversee its inter and intra-institutional relations.

Functions of the Administrative Units Entailed to SWM

International Affairs

To act as a means for the development of health policies for the Ministry of Health and the health sector; to serve as a link between the relations or communications with international organizations and countries, in order to channel resources and information for the benefit of the country.

National Policies Office of the Health Sector

To ensure the formulation and evaluation of public policies and health strategies for the people and the environment, with the participation of all the levels within the organization, of

public, private, inter-sector and external sector institutions, the community and NGOs that shape the National Health System.

General Health Office

To elaborate the regulations and juridical and technical procedures for the development of programs from the National Health System for the population and the environment; to supervise and assess the compliance of population and environmental sanitary regulations.

It has the following administrative units to develop its duties: General Assistant Offices of Population's Health and Environmental Health.

General Assistant Office of Environmental Health

To direct and elaborate all the juridical and technical regulations and procedures for the development of integral environmental health programs through the entire National Health System; to review, update and permanently validate the technical and juridical regulations and procedures for the development of environmental health activities and programs, based on scientific evidence; to oversee and assess the compliance with the existing environmental health regulations; to establish the surveillance systems of protection factors and physical, chemical, biological, psychosocial and cultural risks to achieve effective sanitary interventions in the natural and social environment in which population dwells.

To fulfill its functions, it has the following administrative units: Vector and Animal-transmitted Disease (*Zoonosis*) Control Departments; Quality of Water; and Sanitary Quality of Environment.

f.1.2 Ministry of Economy and Finance

Purpose

To integrate and develop the duties related to public investing, budget, public revenues and national treasury, public credit and modernization of the state, which will ease the formulation and adoption of economic, financial and social policies, as per the reality of the country, that drive the country's social and economic development to the maximum extent.

Principal Functions Associated with SWM

To formulate initiatives in regards to economic policies; to schedule public investments and social strategies; to modernize the state.

Functions of the Administrative Units Entailed to SWM

Department of Technical International Cooperation

To identify, pursuant to public institution requirements, the need for external technical cooperation; to set up a multi-annual technical cooperation program, according to the priorities set forth by national and sector development plans; to arrange the provision of technical cooperation and recommend top priorities in agreement with the National Development Plan and/or governmental programs.

Technical Unit of Public Policies

To work as a liaison among the Ministry, the international financial institutions and international cooperation organizations for the follow-up of targets and actions of the country's Economic Program.

Coordinating Unit for the Privatization Process

To coordinate and follow up the different stages of the privatization process and make recommendations to top levels on interesting issues of the process; to coordinate the diverse national and international public acts that convey the transferal of goods or services to the private sector, in accordance with the regulations set forth by the Fiscal Code and the respective set of laws.

Office of Social Policies

To prepare and promote surveys, analysis and research that prepare the grounds for the formulation of governmental policies linked with social development and arrangement; to propose managing modalities and strategies that render the implementation of social policies feasible.

To conduct its functions, it has the following administrative units: Assistant Office of Social Policies, Research and Social Studies Departments; Social Policies and Coordination; Social Information and Evaluation; and Strategic Social Administration.

General Cadastre Office

To conduct the cadastre study of the entire territory of the Republic and oversee its maintenance and updating; to make an inventory and appraisal of all the real estate, regardless of its nature and definition. Among its administrative units, it has an Appraisal and Cartography Department.

f.1.3 Ministry of Public Works

Purpose

To develop the programs and implement the construction and maintenance policies of the nation's public works and ground transportation.

Principal Functions Associated with SWM

To exercise the administration, coordination, supervision and execution of policies, plans, programs and budgets aimed at the construction and housekeeping of public works and the Ground Transportation Plan at a national level.

f.1.4 Housing Ministry

Purpose

To establish, coordinate and ensure the execution of the housing and urban development policies at a national level, with the purpose of providing this right to the entire population, especially low-income sectors.

Principal Functions Associated with SWM

To lay out develop policies, plans, regulations and actions that foster and/or ease the development of housing projects and to regulate urban development.

Functions of the Administrative Units Entailed to SWM

General Office of Urban Development

To propose laws and regulations on urban development and housing; to recommend the approval of housing and urban development plans in the country, both private and public; to prepare the plans for the harmonious and methodical development of the country's urban centers.

Among its administrative units we have the following: Assistance Office of Urbanism; Metropolitan Area Department; Human Settlements and Environment Department.

f.1.5 Ministry of Education

Purpose

To lead the country's educational policies as from an updating process that guarantees the articulation of the educational system; to achieve increasingly quality and fairness levels, with the objective of driving the harmonious and integral development level of the pupil within the society and in a physical, intellectual, moral, aesthetical and civil aspect, so that the student receives the appropriate training and a finds a useful job for his/her own interest and for the benefit of all.

Principal Functions Associated with SWM

To establish, organize, execute and oversee the activities related to the different educational levels by means of plans outlined in tandem with the institutions related to this field.

To drive an education modernizing process with a participative, coordinated, integral, progressive approach and with a vision into the future, so that the articulation between education and the society can happen in multiple ways.

Functions of the Administrative Units Entailed to SWM

National Office of Community Education and Parents

To promote the participation of the community, governmental institutions and NGOs in the educational duties; to coordinate social-economic, educative and communal activities of parents' associations, federations and confederations.

Office of Student Affairs

To achieve the development of cultural, sport, leisure and social activities that allow for a greater participation of the pupil.

National Office of Environmental Education

To provide guidance by means of seminars-workshops to the teachers, environmental and regional coordinators and provincial and national supervisors, on the importance of educational development; to advise, coordinate and supervise the compliance with Law No. 10 of Environmental Education; to participate in the decision-making process on the environmental issues that takes place at the Directive Boards with the participation of state institutions representatives, which aim at the protection, evaluation and conservation of environmental patrimony and actions.

Televisora Educativa Canal 11 (Channel 11 Educational Television)

To plan, produce and broadcast TV programs with an educational, cultural and scientific approach; to develop long-distance educational projects, along with the corresponding teaching and curricular units from the Ministry of Education, University of Panama, private and international organizations.

f.1.6 Ministry of Commerce and Industries

Purpose

To promote, coordinate, develop and execute the policies outlined for the industry, trade, insurance, securities, finance, resource exploitation, hydrocarbons and foreign trade subjects.

Principal Functions Associated with SWM

To plan, organize, coordinate, lead and control the activities related to the formulation and execution of government policies for the creation, development and expansion of industries in the country.

f.1.7 Ministry of Work and Labor Development

Purpose

To set the guidelines of labor policies and serve the social issues in the Republic; to foster harmonious relations between capital and work; to provide guidance, so that the employer-employee relations are solved pursuant to the most appropriate legal procedures and to promote the creation of productive and well-paid employment.

Principal Functions Associated with SWM

To plan, lead and control the development of the state's labor and social policies; to study and resolve the issues related to the work and labor security fields; to establish regulations for the strengthening and coordination of labor union policies, and to oversee the enforcement of constitutional laws and legal provisions that rule this subject.

f.2. Decentralized Institutions

f.2.1 Panama's Inter-Oceanic Region Authority

Purpose

That Reverted Property be gradually incorporated back to the nation's integral development; to exclusively exercise the custody, exploitation and administration of Reverted Property within the national guidelines and policies set forth by the State, in accordance with the General Plan and partial development plans approved in the future for their improved utilization, and in coordination with the State's competent bodies.

Principal Functions Associated with SWM

To outline the General Plan and adopt it as the fundamental guide for its administrative functions; to plan, coordinate and decide on the execution of specific strategies, programs and projects for the use, conservation and development of Reverted Property; to oversee that the appropriate policies for the conservation, protection and improvement of Panama Canal's hydrographical basin be adopted and executed, in such a way that potable water supply is guaranteed for the metropolitan region and for the Canal's efficient operation.

f.2.2 Panama's Maritime Authority

Purpose

To manage, promote, regulate, project and execute the policies, strategies, regulations, plans and programs directly or indirectly related or linked with the functioning and development of the Maritime sector; to perform as the Republic's supreme maritime authority to exercise the rights and enforce the responsibilities of the Panamanian State within the framework of the United Nations' Convention on Maritime Law, 1982, (MARPOL), and other laws and regulations in force.

Principal Functions Associated with SWM

To manage, conserve, retrieve and exploit marine and coastal resources; to coordinate, along with the National Maritime Service, the compliance with national legislation regarding maritime space and domestic waters of the country.

f.2.3 National Environment Authority

Purpose

To ensure the compliance and enforcement of environmental laws, regulations and national policies

Principal Functions Associated with SWM

To formulate and implement governmental policies, strategies and programs for the environment and the use of natural resources; to dictate regulations for emissions, absorption, procedures and products, along with the respective authorities for each case; to evaluate environmental impact studies.

Functions of the Administrative Units Entailed to SWM

National Environment Council

It is formed by three Ministers of State, appointed by the President of the Republic.

To recommend the national environment policy and the sustainable use of natural resources; to foster and support the National Environment Authority in the coordination of the Environment's Inter-institutional System for the execution of the nation's environment policy and sustainable development; to collaborate in the incorporation of the environmental issue within the context of public policies, in coordination with the National Council of Sustainable Development.

National Consultative Commission of the Environment

It will be integrated by no more than fifteen members representing the government, the civil society and the provinces.

A consultative body for the National Environment Authority for decision making with national and inter-sector importance; it will also be able to issue recommendations to the National Environment Council.

Environment Regional and District Consultative Commissions, with participation from the Civil Society

These commissions are integrated as follows:

- Provincial: By the governor, who chairs it; by the Technical Council, representatives of the Provincial Coordination Council and by civil society representatives in the area.
- Regional: By the representative of the General Indigenous Congress, the representative from the Regional Coordination Council, the Technical Council and by civil society representatives in the area.
- District: By the Mayor, who chairs it; by representatives of the Municipal Council and by civil society representatives in the area.

To analyze the environmental topics and make remarks, recommendations and proposals from the Regional Environment Administrator.

f.2.4 Institute of National Aqueducts and Sewerages

Purpose

To trim down morbidity and mortality rates of water-related diseases, thus improving the health, well-being and progress levels in the country, through the rendering of potable water services and the innocuous collection and disposal of wastewaters.

Principal Functions Associated with SWM

To plan, investigate, lay out, lead, build, inspect, operate and provide maintenance to all the items related to potable water and sewerage in the Republic; to advise the remaining bodies of the State and control all the activities related to the potable water services and collection and treatment of wastewaters.

f.2.5 National Institute of Professional Formation

Purpose

To propitiate the worker's technical development without disregarding economic, social, cultural and human aspects, according to his/her skills and to the employment possibilities and productive occupations required by the national development process.

Principal Functions Associated with SWM

To contribute to the technical and human improvement of the workers, in a way that the quality of human resources can be improved and their life quality can also be increased; to propitiate and reach agreements, in tandem with the diverse enterprises, the formative actions being carried out through the use and mobilization of the existing installed capacity.

f.3. Independent Bodies

f.3.1 Regulating Entity of Public Services

Purpose

To regulate, control and audit the rendering of potable water, sanitary sewerage, telecommunications and electricity services; to enforce the regulations that guarantee the rendering of such services at reasonable rates and prices.

g. Summary of Main Competencies as per the Current Legal Framework

The table shows summary of main competencies as per 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

h. Summary of the Main Competencies linked with the Municipal Solid Waste Management and Hazardous Wastes

The table below shows 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. The Comptroller of the Republic closely supervises and controls the accounting of government offices, deciding the account under which a given cost or expenditure is to be registered. The process may distort the real cost structure of DIMAUD. The government accounting system is a rigid system that does not permit adaptation according to the operating characteristic of each government office.

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. If the DIMAUD accountant wishes to calculate total cost per ton, he is forced to compute the relevant component costs by adding up accounts according to the assigned accounting code number. However, the assignment of these accounting code numbers may not respond precisely to the operating characteristic of DIMAUD. Rather, it is rigidly determined in the Government Accounting Manual so as to facilitate the budget control job of the Comptroller of the Republic.

In the process of choosing cost components according to the code numbers assigned to each account, there arise many chances for making mistakes. For instance, an estimation of the unit cost of solid waste disposal by DIMAUD in 2001 resulted in U$59.60 per ton, but it had a wide monthly variation, ranging from U$33.64 per ton in April to U$107.32 per ton in

December. This kind of wide variation in estimated unit cost makes one suspect of some kind of error. The cost estimate could be more accurate if precise waste collection records were available, but the unit cost estimation was based on assumed tonnage of collected solid waste.A more worrisome point was the fact that the unit cost of landfill activity in May gave a negative figure, which obviously contained errors in the input of component costs.

b. Financial System

b.1. DIMAUD Tariff

The present tariff or user charges of DIMAUD were set by Executive Decree 165 of August 26th 1999, which can be summarized as follows.

Table 4-20: DIMAUD Tariff Structure

User Category	User Sub-category	Tariff Type	Tariff (USD)
High Income Residence (over U$2,500)	Detached house	Fixed	U$.11.50/mo.
	Apartment	Fixed	U$.10.30/mo.
	Condominium	Fixed	U$.10.30/mo.
Middle Income Residence (U$600-U$2,500)	Detached house	Fixed	U$.7.50/mo.
	Apartment	Fixed	U$.7.20/mo.
	Condominium	Fixed	U$.7.20/mo.
Low Income Residence (U$100-U$600)	Detached house	Fixed	U$.5.60/mo.
	Apartment	Fixed	U$.5.00/mo.
	Condominium	Fixed	U$.5.60/mo.
	Rented room	Fixed	U$2.50/mo.
	Marginal house	Fixed	U$.1.75/mo.
Service, up to 5 employees	By type of activity	Fixed	U$.15.00/mo. to U$.67.76/mo.
Retailers, under 5 employees	By type of activity	Fixed	U$.20.00/mo. to U$.68.21/mo.
Commerce, over 5 employees	By type of activity	Fixed	U$.20.00/mo. to U$.140.57/mo.
Wholesaler	By type of activity	Fixed	U$.55.00/mo. to U$.140.00/mo.
Hotels and Restaurants	By type of activity	Fixed	U$.30.00/mo. to U$.655.76/mo.
Industry		Unit based	U$.14.30/cubic yard
Special Service	Rental back-loading container	Unit based	U$.70.00/mo.
	Rental front-loading container	Unit based	U$.90.00/mo.
	Disposal of trees	Unit based	U$.8.00/ton
	Disposal of debris	Unit based	U$.8.00/ton
	Disposal of scrap	Unit based	U$.5.00/ton
Landfill	Own waste	Unit based	U$.17.00/ton
	Private waste collection service	Unit based	U$.30.00/ton
	Scrap	Unit based	U$.5.00/ton

Source: Executive Decree 165, August 26th 1999

b.2. 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 4-21:: 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

According to the table above, collection by IDAAN in 2001 amounted to U$.12,020,492.76 out of U$.15,410,204.68 billing, giving a 78% collection rate.DIMAUD paid U$120,830.94 to IDAAN for this service. However, DIMAUD income from service charges is more than the amount billed by IDAAN. This is because DIMAUD collects directly from the government, and DIMAUD is trying to get the government to increase every year the budgeted solid waste disposal charges corresponding to different government offices. Also, DIMAUD undertakes own collection on billing made by IDAAN.

On the other hand, the Census of 2000 reported 180,474 dwellings in Panama District, of which 1,296 without water supply service. Then, IDAAN billing to 118,667 customers amounts to 66.2% of 179,178 dwellings with water supply service in Panama District, which implies a low billing rate. However, this is explained by the existence of multi-family buildings covered by a single contract. If DIMAUD estimate of 2,000 such contracts with an average of 15 dwellings are added, the resulting billing rate is 83%, thereby indicating that DIMAUD estimate of 85% coverage is correct.

b.3. 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.

The jump of 52.8% in income from "Households" between 2000 and 2001 can be explained by the fact that the 2000 figure was an estimate. It was necessary to make an estimate because when the service was transferred to DIMAUD in 1999, DIMA did not have the customers classified into different types, in addition to having Colon and San Miguelito included in the service.

Table 4-22: DIMAUD Income Report

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

According to Income Statement (Table B of Financial Statement), total expenditures amounted to U$21,754,547, of which U$10,531,322, equivalent to 48.4% as "Personnel Expenses". Other important expense items were "Service Provided by Third Party" amounting to U$5,154,376, or 23.7%, and "Operation Expenses" amounting to U$3,393,176, or 15.6%. Also included as an expense item was "Reserve Funds" amounting to U$2,046,390, equivalent to 9.4%. "Management Expenses" included a variety of expenses, among them the payment made by DIMAUD to IDAAN for billing services.

Table 4-23: DIMAUD Income Statement

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

4.5.3 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 4-24: DIMAUD Balance Sheet

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.

a. Fixed Assets

Fixed Assets include "Other Assets" for U$11,269,828, which is equivalent to "Provision for Bad/Doubtful Accounts" shown in Accounts Receivable.

b. Accounts Receivable

Accounts receivable showed a large increase (U$5.6Million in 2000 to U$10.5Million in 2001), one reason being the delayed transfers from IDAAN to DIMAUD. This is caused by the requirement that the transfer of large amounts must have the advance approval of the

Comptroller of the Republic, a quite time-consuming bureaucratic procedure. The delayed transfer of funds can reach as much as U$1,000.000. Also, large provisions were made for bad or doubtful accounts (U$11,269,828 in both 2000 and 2001), as shown in the following table.

Table 4-25: DIMAUD Accounts Receivable

Accounts Receivable	**2001**	**2000**
Accounts Receivable – Private Sector		
Households	18,084,858	13,545,808
Juridic person	2,058,153	2,048,859
User fee Cerro Patacon landfill	690,763	555,755
Total Receivables from Private Sector	**20,833,773**	**16,150,422**
Accounts Receivable – Public Sector		
Central government	382,479	355,975
Autonomous entities	142,392	129,456
Financial intermediary	227,761	149,231
Government corporations	108,604	93,209
Municipalities	50,593	17,354
Total Receivables from Public Sector	**911,829**	**745,225**
Total Accounts Receivable	**21,745,602**	**16,895,647**
Provision for Bad/Doubtful Accounts	11,269,828	11,269,828
Total Effective Accounts Receivable	**10,475,774**	**5,625,819**
Other Accounts Receivable		
Employees	12,036	6,470
Returned checks	4,211	3,324
Discounts	23,925	48,303
IDAAN	436,000	0
Municipality of Panama	2,603,232	0
Municipality of Colon	17,775	0
National Bank	98	0
Others	0	2,084,647
Total Other Accounts Receivable	**3,097,277**	**2,142,743**
Grand Total Accounts Receivable	13,573,051	7,768,562

Source: Informes Financieros Comparativos 2001-2000, Anexo-1, DIMAUD

Accounts Receivable from Employees refer to amounts owed by some employees who were found guilty of having caused damage to DIMAUD assets, and have the obligation to repair the damage. Accounts Receivable from Municipality of Panama refer to water consumed by the Municipality, which IDAAN deducts from bill collection done on behalf of DIMAUD, whereby DIMAUD has to recover the same amount from the Municipality. Accounts

Receivable from Municipality of Colon refer to fuel borrowed by Municipality of Colon from DIMAUD in 2000.

c. Accounts Payable

Accounts Payable also showed a large increase (U$1.5Million in 2000 to U$3.9Million in 2001), which was caused mostly by the rental of machinery and equipment for the operation of the landfill.

d. Liquidity Ratios

Current Ratio showed a large decrease but it is still adequate (7.7 in 2000 to 4.3 in 2001), and the same remark can be made about the Quick Ratio (6.4 in 2000 to 3.8 in 2001).

e. Support Documents

Inconsistent numbers were observed concerning income in 2001 between Income Statement (Table B) and Supporting Documents (Table F and Annex 7).

f. Cost of Service

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 4-26: 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.

g. 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.
- The delayed transfer from IDAAN is included in Accounts Receivable, despite being a revenue that only a technicality prevents it from being registered in accounting as income. The delayed transfer can sometimes reach U$1,000,000.
- The delayed transfer from IDAAN caused large ups and downs in monthly income (U$0.9Million to U$2.7Million in 2000, U$1.2Million to U$1.9Million in 2001).
- Subsidy from the Central Government (U$2Million in 2001) is earmarked U$91,715 per month for street sweeping and U$75,000 per month for Returned Area (Areas Revertidas).
- IDAAN charges DIMAUD for printing and delivery of bills, and for bill collected, depending on the geographic area and the type of bills (U$120,830 in 2001)
- IDAAN issues nearly 120,000 bills per month on behalf of DIMAUD, even in areas where IDAAN does not provide water service, which necessarily places DIMAUD in charge of collection.
- IDAAN normally collects from 70,000 service users, and DIMAUD collects from the remaining 50,000, of which 25,000 are hardly-paying customers in marginal areas.
- DIMAUD estimates the coverage of IDAAN to be around 85%, and the cost of billing/collection is considered low.

- A new water supply client is automatically added as DIMAUD client.
- Water supply is perceived as a social service that the government should provide because it is a vital need, and this perception makes it difficult to use service cut-off as a coercion instrument, despite provisions made in this regard by Decree Law 2 of January 7, 1997.
- DIMAUD expects to clear billing mistakes and fictitious accounts receivable in 2002, and from then on strive to keep accounts receivable proportionate with the billing growth.
- DIMAUD is in the process of differentiating between residential customers and business customers in the same building, who are currently being billed with the same tariff.
- DIMAUD is interested in directly controlling income from clear-cut commercial and industrial customers (independently located, without being combined with dwellings), as one source of stable monthly income. The other income sources under direct DIMAUD control would be the public sector (institutional) and Cerro Patacon sanitary landfill.
- Letters sent to late-paying service users, warning them that DIMAUD would proceed to collect through judicial means, are effective with middle income and commercial customers, who come to the office to pay before actually starting the judicial procedure. However, the same method would not be effective with hardly-paying residents of marginal areas.
- Adding waste collection fee on the property tax would not help to improve collection rate from hardly-paying customers in marginal areas. The reason is that dwellings costing less than U$20,000 are exempt from property tax by virtue of Law 100 of October 4th 1973, and most hardly-paying customers live in this type of houses in marginal areas.

4.5.4 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 4-27: 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.

Private vehicles that pay in cash, as they are given access into the facility, transport 2.4% of the total amount of waste allowed into Cerro Patacon.Private vehicles with credit (they are billed subsequently) transport 4.06% of the total.The combined weight of both sources added up to 5,565.71 tons (6.46% of the total).

These numbers suggest that solid waste amount from these private sector sources, taking into account those generators that use their own vehicle as well as those who hire private collectors, is less than the amount of waste transported by the private company that collects in San Miguelito.

Similarly, DIMAUD´s fee for companies that transport their own wastes is less than the fee for private companies that collect for a third party.

These private collection companies believe that this practice to have a final disposal service for free and the differentiated tariffs is discriminatory and affects negatively their interests because they can not compete under these circumstances.

They point out that under these conditions, some unscrupulous persons offer their collection services at a low price and discharge the waste collected in non-authorized locations.This situation violates existing regulations, affects the public health, and degrades the environment.

DIMAUD has to assume the cost for special operations dedicated to collect solid waste disposed illegally and keep clean the district.

Private entrepreneurs suggest that a register of collection operators should be initiated and the responsible authorities should investigate and punish, as it is established in the law, those who irresponsibly are harming the society as a whole.

These entrepreneurs are convinced that an effective regulation of collections services directed to the private sector would be convenient for the residents in the district, private sector, and DIMAUD.

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.

Currently, DIMAUD has a machinery rental contract for the operations at Cerro Patacon.

c. Recycling

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

The recycling sector has grown in the last ten years.Recycling materials have acquired added value in some cases; for example, there is a producer and exporter of packages for eggs that uses recycled material as raw material.Similarly, plastic has begun to be used as raw material to make new products.

Entrepreneurs in this sector are also initiating an association as a first important step directed to obtain the support of the state and the international cooperation.They estimate that they can achieve stability in the market and improve the working conditions and income of the primary recyclers.

They are convinced that the sector can achieve sustainable growth, based on statistics that reflect the tendency to include recycled materials in the national production, and the volume and value of the exportations.

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.

In this study, an investigation on the present conditions of waste-pickers was implemented in February 2002. The results are mentioned below.

4.6.1 History of waste-pickers in Panama

An interview survey was conducted by DIMAUD at Cerro Patacon in April 1995. At this time the number of waste-pickers was estimated approximately 300 from which 50 were children under 15 years old. Some of the population came from the previous disposal site, Panama Viejo Crematory.

After the investigation conducted in February this year, the population of waste-pickers is estimated between 450 to 500. The personnel of a private company that manage the landfill operation estimates that it reaches as high as 600 to 700 especially during specific periods such as those before school begins, Christmas and carnivals. Since there is not any kind of control or restriction policies to limit the access to the landfill, it is impossible to determine the exact number of west-pickers.

It is worth mentioning that many waste-pickers had been hired by DIMA, now called DIMAUD through years and vice versa, many ex-DIMAUD workers have now joined in the waste-picking activity.

4.6.2 General information

a. Sex and age

The data obtained during the investigation on west-pickers show that the proportion of men to the entire population is 83%. The majority of waste-pickers are concentrated in the age between 31-50 (61%).

b. Place of born

Most waste-pickers were born in Panama district (37%), followed by Darien (31%) and Veraguas (13%).

c. Previous occupation

The following occupations were identified within the waste-pickers; building workers (11%), domestic work (11%), ex-DIMAUD recollectors (11%), sailors (5%), waking sellers (5%),

masonry worker (4%), heavy truck driver (4%), welding worker (4%), security police (2%), driver (2%), baker (2%) and fumigator (2%).

d. Living condition

A high percentage of houses do not have electricity (44%), drinking water (46%) and sanitary (72%). In the same way, 50% has soil floor. Regarding the living period on their actual residence, most of the waste-pickers have between 5 to 10 years.

However, most waste-pickers buy water from the particular seller or other group go down to the stadium to fill some 5 gallon tanks.

Figure 4-13: View of "ranchitos" located in Cerro Patacon Landfill

The waste-pickers' houses in the landfill, called "ranchito", are mostly temporary buildings because they remove and relocate them as the landfill advances. However, there are permanent houses of some waste-pickers, too

e. Education

In general most waste-pickers complete elementary school. And there is a case of an ex-law student that was identified in the 1995 survey. 28% have incomplete elementary school (20% in 1984) against 39% with complete elementary school (26% in 1984), 11% have incomplete first half of secondary school (36% in 1984) against 9% with complete first half (2% en 1984), 2% with incomplete second half of secondary school (2% en 1984), 2% with incomplete university (1% en 1984) and 9% with no education (1% in 1984).

Comparing 1984 and 2002 surveys, the population in 1984 (38%) had more high school years than in year 2002 (22%).

4.6.3 Basic infrastructure within the landfill and close communities

a. Condition of the surrounding areas

There are two main routes to the landfill: one is Ricardo J. Alfaro Avenue, which is the main route and intersects with North Highway. The other is the route which intersects with a road to the lakes on the way to Paraiso Town in Ancon. Besides, by walking they can use a land route of Villa Cardenas that communicates with Las Cumbres, San Miguelito, Kunanega and

Valle de San Francisco. Also there are routes through Mocambo Arriba and Chivo Chivo. Villages closer to the landfill are: Kunanega, Valle de San Francisco, Villa Cardenas, Mocambo Arriba and Mocambo Abajo. Waste-pickers and buyeres in the landfill come from these four villages. The general basic conditions in these villages are summarized in Table 4-28.

Table 4-28: Basic Conditions of the Communities located around the Cerro Patacon Lanfill

Community	*Houses*[4]	*Habitants*	*School*	*Health Center*	*Electricity*	*Drinking water*	*Sewage systems*
Mocambo Arriba[5]	123	559	Yes	Yes	No	Yes[6]	No
Kunanega	97	851	Yes	Yes	Yes	Yes[7]	No
El Valle de San Francisco	86	86	No	No	No[8]	Yes, partial	No
Villa Cárdenas	13	27	Yes	No	Yes	No	No
Mocambo Abajo	174	660	No	No	No	No	No
Relleno sanitario	84 ranchitos	168	NA	NA	No	No	No
Total	407	1664	----	------	------	----	------

Source: FAS PANAMA, February 2002

b. Transportation

The transportation to the landfill depends on the buses or "chivas" that travel to Kunanega and Mocambo Arriba, which have a frequency of every 3 hours. However, large numbers of waste-pickers walk through the road close to the pre-cooperative or through Kunanega, which seems that they walk until the Transistmica Avenue to take a bus to Las Cumbres and San Miguelito.

Going to the final disposal site is a daily activity for many truck and lorry drivers from DIMAUD or others. And they are often pressed by some waste-pickers to take them in and out the landfill. Even the DIMAUD workers, especially those who cover the night turn have to take this way of transportation.

4.6.4 Working condition

a. Working section

Majority of waste-pickers work only in the organic site (74%).

[4] Data from the Houses and Population National Survey of May 2000.
[5] Mocambo Arriba is located within Las Cumbres, but there are 6 houses in Ancon.
[6] One of the residents commented that they have drinking water availability problems and that the aqueduct does not cover the whole community. The National Survey indicated that 42.73% have no drinking water.
[7] Provision Tank.
[8] The community had commonalty electricity but now cut off because of arrearage of electric fee. Now they are making new efforts to connect the electricity to houses.

b. Working days

According to the investigation, 73% of waste-pickers work more than 6 days per week. It is important to mention that the majority of the waste-pickers that lives in "ranchitos" in the landfill have continuous working periods that oscillate from 1 to 4 weeks. After that they go back to their permanent residences to have a rest, and then again come back to the landfill. On Sundays, most waste-pickers have rests.

c. Safety

Majority of waste-pickers use gloves made from hard cloths. The use of masks is very low with only 11% of waste-pickers. In the organic section, usage of tools is very low or null. On the other hand, 63% uses tools in the inorganic section due to the type of materials they picks. The tools which are frequently used are: chisels, mallets, screw drivers, monkey wrenches, pressure wrenches, knives, pincers, machetes and bags.

Regarding the problems waste-pickers face in the landfill, waste-pickers regard the work accidents most critical (44%), followed by fights and disputes (24%), illness (20%) and security (17%). Only 6% recognized drug as a problem. 30% answered no problem.

The awareness of safety among waste-pickers seems to be high. The most waste-pickers have their own personal protection and safety measures during the labor time. The internal security problems such as thefts and attacks within the landfill are indicative of the low police vigilance and ineffective access control.

4.6.5 Recovered material

a. Material type

Recovered materials in the landfill are enumerated below.

Aluminum cans, aluminum, bronze, cupper, lead, batteries, glass bottles, soft iron, white and color paper, newspaper, 5 galloon plastic tanks, bags, used cloth, food, wood, tires, car parts and electric appliances (used and damaged iron machines, microwave, and so on).

The data obtained both from organic and inorganic sites show similar type of materials to be recovered. Most waste-pickers collect metals (68% and 100% of waste-pickers in organic and inorganic sites, respectively), followed by paper (55% and 69%) and newspaper (23% and 22%).

b. Treatment of picked materials

Organic and inorganic materials

After accumulating a certain amount, they sell the materials to companies, intermediaries or classifiers-intermediaries in the landfill. Paper will also be sold to the classifier-intermediaries from Mocambo Arriba or the Pre-cooperative.

Clothes

Cloths are picked and classified in the ranchitos. They take the classified cloths to their homes to wash and sell to neighboring communities. This is mainly women's work.

Fabrics

Materials will be brought to ranchitos to clean (take out the zippers, knobs, and so on). Then, they wash in the river and dry the classified materials. After this procedure they use the materials in their houses making hammocks, mosquito nets, bed sheets and clothes. This activity is mainly performed by women and is for their own use or for their relatives. In this case there is not any direct income. They do this work every two months.

96% of waste-pickers clean materials in the ranchitos, while 4% brought them to their residences.

c. Solid waste carriage

87% of waste-pickers does not transfer the materials to other places but sell in the landfill and leave residual materials around ranchitos. 6% takes out the materials manually from the landfill. 6% uses transportation hired within the landfill. Those who transfer the materials burn or burry the residual materials at their residences.

d. Amount and price of materials

Survey results show that a significant amount of solid wastes are recovered by waste-pickers. For example, the average amounts of paper, metal and carton a waste-picker collects in a day are 86-100 lbs, 45-50 lbs and 200-1000 lbs, respectively.

The prices of materials recovered by waste-pickers have a direct relationship with the local and international market, which affects waste-pickers' daily income.

e. Income

According to the investigation conducted, 57% (44% in 1984, 63.3% in 1995) of picker-pickers earns U$. 10.00 or less per day, 26% (53% in 1984, 18.3% in 1995) between U$. 10 and 20 and 11% (3% in 1984, 7% in 1995) more than U$. 20.00. 6% (11.4% in 1995) does not receive any direct income. These figures indicate that after 18 years the average income of waste-pickers has decreased while their living standard has increased. This might

be caused by various reasons: on the one hand there is much more competition, and on the other hand, they spend less time to pick up solid wastes in comparison with the time they did in the previous Crematory. Finally, the sale price of paper has decreased by 72% (U$. 0.05 at present against U$. 0.18 in 1984).

80% of waste-pickers think that they have the same daily income in the rainy season as well as in the dry season, while 20% think more in dry season.

4.6.6 Possibility to change the present situation

Following questions were given to both waste-pickers and buyers.

A. Why are you doing this activity?

B. To improve your actual working conditions what would you prefer to do? (with options to choose)

C. What could you suggest to improve you current situation? (open question)

In the case of question A, 80% of waste-pickers referred to lack of employment, while many buyers had different answers “it is a good business”. For question B, 75% of waste-pickers answered “to get other job”, 16% “to improve current condition”, and 9% “working cooperatively”. In the case of buyers, 44% answered “to get other job”; 44% “to improve current working conditions” and; 12% “to join a cooperative”. Finally, the following answers were obtained from waste-pickers for question C.

- To be helped to get other permanent job
- To dress in uniforms
- To divide the working areas
- to have ID card
- to be supported by organizations
- to control the trading system

On the other hand, buyers suggestions were “improvement of vigilance and security” due to the frequent fights, attacks and thefts, followed by avoiding company’s monopoly (on paper), to have an special place outside the working area, to control buying hours and standardize the prices.

4.6.7 Recommendations by various groups

There have been many recommendations and suggestions from different groups and organizations that are involved in the waste management of the Cerro Patacon landfill (waste-pickers, DIMAUD personnel, classifiers, intermediaries, enterprises, interested institutions). The important thing is a dialogue and planning process with all involved groups such that a plan can be designed at a short, medium and long term to reconvert the waste picking activities in the landfill into feasible and agreed alternatives. Summary of recommendations are mentioned below.

a. For a short term plan

- To make a general survey to all waste-pickers and buyers, companies, "chicheros" and carriers to obtain data that help identify people and prohibit the access of unidentified persons. After this procedure there will be the first filter for children under 15 years old and fugitives. The access of drug sellers will also be limited and controlled.
- To request health assistants from the Public Health Center to conduct a periodical health check for waste-pickers.
- Workers in the landfill will wear uniforms. Each group has a specific color, so that waste-pickers, buyers and other traders can be easily identified.
- To establish weight control system to obtain statistic data of recovered solid waste by companies. It will help identify unauthorized buyers. This will also help to establish monthly fees accordingly to the profit made by each company and direct intermediary.
- To establish a security control plan within the landfill to avoid the access of unauthorized persons.
- To study the possibility of dividing the discharge area in two zones, such that waste-pickers and landfill operators can work in an alternate way.
- To provide containers to waste-pickers to make the collection activity effective.
- To establish time schedule for buying process.
- To remove the "ranchitos" built in the discharge and working area in each section and prohibit its construction. There are considerable waste-pickers who permanently live in the landfill. For the waste-pickers living permanently in the landfill, it will be necessary to find a solution probably with the help of ARI (for the land), MIVI (for the materials) and other institutions.

b. Middle and long term plan

- To improve the price control. It should be analyzed by the involved groups because some might feel unprotected while others trust.
- The problem of drug within the waste-pickers and buyers should be treated by a professional team.

4.7 Environmental Education

4.7.1 Environmental Education System

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.

The environmental law of ANAM, regarding environmental education (Law 41, Article 48) said: are duties of the State, to diffuse information or programs on environmental conservation and the sustainable uses of natural resources, as well as to promote educational and cultural activities of environmental nature, to contribute and supplement the civic and moral value with the Panamanian society. The communication media can offer cooperation to execute the projection of the present article. According to Article 49, ANAM will coordinates with the Ministry of Education (MEDUC), and will support, to fulfill the act of law 10 of 1992, specifically in the incorporation of Environmental Education in communities.

ANAM, through Law 41, recognizes the Environmental Education as one of the most important instruments for environmental management. Therefore, MEDUC and ANAM have united efforts for the production of Didactic Guides for Environmental Education, taking as target groups initial stage and primary level.

MEDUC, through Natural Sciencies and Social Studies subjects of the primary school, aspects related with natural resources are imparted, but in a very general way in 3rd and 5th school years. There are no specific environmental education programs.

4.7.2 Environmental Education Programs with Communities by Several Organizations

Many organizations provide the environmental education and encourage community participation related with solid waste management in Panama District and in the whole country, in such components as reduction of waste at generation source, recovery processes, and recycling. However, many lose continuity due to the lack of coordination among the main actors of the society (institutions, communities, NGOs, etc.), lack of human resources and economic or simply lack of enthusiasm or interest.

a. Ministry of Education (MEDUC)

The Environmental Education Office of the Ministry of Education presents a Didactic Guide of Environmental Education"Our life and waste" which contains methods of environmental conservation, especially through the appropriate waste management and reuse through recycling. The text was elaborated under the Program of Japanese Volunteers of Japan International Cooperation Agency.

b. Municipal Department for Urban and Household Cleansing (DIMUAD)

DIMAUD through Community Relations Unit with the support of other related offices has planned a serie of cleansing awareness activities and a recyclable material recovery activity in communities and schools of the capital district. It takes as beginning point the educational establishments (primary, secondary schools and at university level), Junta Communals, NOGs and others. Through the program it is expected a change of population's habits and attitudes on solid waste management, through training and orientation on the reduction of solid waste production and separation at generation source.

This activity program has a objective of validating a strategy for the promotion of an appropriate SWM, by means of waste separation at generation source and the environmental health based on the community health with a narrow relationship between DIMAUD and the community organizations.

The Public Relations Unit of DIMAUD carries out functions like diffusion of the different activities done by this department, orientation campaigns on the adequate disposal of solid waste at school, institution and community level, promotion of cleansing activities, etc.

Regarding preparation of educational programs on MSWM formulated by DIMAUD, there is not any specific program, monitoring and evaluation, since it offers information in a general way related to works carries out by DIMAUD, waste management, recycling, etc.

c. Non Governmental Organizations (NGOs)

Among the non-governmental organizations dedicated to the promotion of the environmental sanitation and social development the following can be mentioned:

- APROSAC (Association for Promotion of Environmental Sanitation) impels the community and municipal participation, micro and small company participation in the tourism sector and environmental management. Their short term goals are focused in creating micro-enterprises for waste management, based on the conceptual frame of "integral solid waste" considering waste reduction at source, recycling and final disposal.

- The projects of FAS (Social Action Foundation for Panama) concentrate on youths and in materials to recycle waste service and promotion of integrated projects for waste management in the rural areas of Panama.

- APRONAD (Association for Promotion of New Alternatives of Development) contributes to generate employment and to improve the quality of existing employment in communities of low resources. They cooperate in the improvement of the environment through an effective management of the productive processes and in to the rendering of services. They promotes new development alternatives that foment employment, generation of revenues, participation and environmental protection.

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:

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.

Chapter 5

Industrial Waste Management

5 Industrial Waste Management

5.1 Current Situation of Industrial Waste Management

5.1.1 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.

5.1.2 Quantification of Hazardous Industrial Waste

Hazardous waste generated in the country was quantified in the study on Diagnosis, Master Plan and Evaluation of Alternatives for Private Sector Participation in Hazardous Waste Management, MEF, 1999 shows quantification results corresponding to Panama District, by type of manufacturing industry according to Uniform National Industrial Classification of all Economic Activities, CINUTA.

Inert waste comprises 48.75% of total, waste from food industry 14.55% and waste from textile industry (apparel) 9.57%. These types of waste are regarded as non-hazardous and amount to 72.86% of total industrial waste.

The remaining 27.14%, equivalent to 15,812.72 ton/year, are: oil, acid, alkaly, solvent, recipients, paint and others, pesticide and organic and inorganic chemicals. These types of industrial waste are considered as hazardous.

5.1.3 Large Generators of Industrial Waste

In Panama Metropolitan Area (Districts of Panama, San Miguelito and Colon) in 1999, 132 industries were identified as potential generators of hazardous waste and were given high priority. Of these, the following are considered as large generators in Panama District.

Table 5-1: Quantification of Hazardous and Non-hazardous Industrial Waste by Group, Panama

Group	Non-Stable	Employments	Oils	Acids	Alkali	Solvents	Container	Paint/others	Plagic	Org. Chem.	Inorg.	Putrescible	Textile	Inert	Total
Food products	120	5,709	306.3		781.0							8,480.0		513.9	10,081.2
Beverage	11	1,101									4.6			110.1	114.7
Vehicle Chassis	4	122	73.1							3.7	7.3			36.6	120.7
Leather tannery	24	1,687	644.4								6.8			3,017.5	3,668.8
Edition and Printing	68	1,878	1,049.4			19.3		329.4		0.5	38.8			309.1	1,746.5
Manufacturing and Production of Paper	51	1,493			89.6			179.0						748.0	1,016.6
Optical Instr.	2	37	11.1								2.2			11.1	24.4
Games and toys	3	117				7.0		117.1						35.1	159.2
Wood and its products	47	1,852	72.1			22.6		223.5	0.6					370.4	689.2
Machines and Elect. Appliances.	9	196	16.9							0.8	68.4			354.1	440.2
Machines and Equipment	12	295	5.1			1.0		4.6			16.5			87.5	114.7
Metal products	97	2,393	1,134.6	915.8	415.7	1.5		48.2			597.6			3,388.1	6,501.5
Non-metallic Minerals	30	2,213									1,248.7			8,891.8	10,140.5
Other Manufacturing Industries	15	474				19.9		332.3		0.3				142.2	494.7
Parts and Vehicle pieces	13	140	42.0								8.4			42.0	92.4
Oil Refinery derived Products	5	489	392.2	233.4	932.8	32.6	93.5				372.9			980.9	3,038.3
Rubber and Leather Products	66	1,926	1,443.2			0.8								3,863.6	5,307.6
Chemical and pharmaceutical Products	61	1,978			2,200.6	30.0	99.3	57.1		5.0	720.5			3,967.9	7,080.3
Ship/Vessel Repairs	3	444				8.9		88.8						88.8	186.5
Tobacco	2	432	43.2			8.6								43.2	95.0
Garment and textile products	114	8,058	144.0		5.3			32.4					5,576.0	1,394.0	7,151.7
Total	757	33,034	5,377.7	1,149.3	4,424.9	152.2	192.8	1,412.4	0.6	10.2	3,092.7	8,480.0	5,576.0	28,396.0	58,264.7

Table 5-2: Large Potential Generators of Hazardous Industrial Waste in Panama District

	Name of the Company	Description of Activity
1.	Baterías Nacionales S.A	Chemical
2.	Xerox de Panamá S.A	Services
3.	3M de Panamá S.A	Services
4.	Petroterminal de Panamá S.A	Services
5.	Reconstructora de Frenos y Discos S.A	Minerals
6.	Fibropan S.A	Minerals
7.	Texaco Panamá S.A	Chemical
8.	Pinturas Sur de Panamá S.A	Paint
9.	Frenos y Embragues de Panamá S.A	Minerals
10.	Procesos y Análisis Metalúrgico S.A	Metals
11.	Fundición Centroamericana S.A	Metals
12.	Acero de Panamá S.A	Metals
13.	Esso Standard Oil S.	Chemical
14.	Insecticidas Superiores de Panamá S.A	Chemical
15.	Tabacalera Istmeña S.A	Tobacco
16.	Tabacalera Nacional S.A	Tobacco
17.	Tenería El Progreso S.A	Leather
18.	Tenería Tauro S.A	Leather
19.	Grupo Editorial Universal S.A	Services
20.	Corporación La Prensa S.A	Services
21.	Impresora Panamá S.A	Services
22.	Imprenta Edicano S.A	Services
23.	T – Shirts Interamericana S.A	Textiles
24.	Webforma de Panamá S.A	Paper
25.	Derivados de Pertóleo S.A	Chemical
26.	Asfaltos Panameños S.A	Chemical
27.	Metal Química S.A	Chemical
28.	Industrias Panan S.A	Chemical
29.	Sherwin Williams de Panamá S.A	Paint
30.	Fábrica de Pinturas Gliden S.A	Paint
31.	Laboratorio Prieto S.A	Chemical
32.	LAFSA	Chemical
33.	Nacional Química S.A	Chemical
34.	Aditivos de Panamá ADIPAN	Metals
35.	Plásticos Modernos S.A	Plastics
36.	Polymer Extrusión S.	Plastics
37.	Laboratorios Opticos Chevalier S.A	Services
38.	Galvanizadora Mecánica S.A	Metals
39.	Radiadores de Panamá S.A	Metals

5.1.4 Present Treatment and Disposal of Industrial Waste

Description of the present day management of potentially hazardous industrial waste will be easier by considering five sectors: medicine, solvent, motor oil, chemical products and paint.

Quantification results show that around 16,000 ton per year of potentially hazarodous waste is generated in Panama District. According to the Safety Office of Firefighters of Panama, there are about 100 persons or small and medium size companies that provide collection and transportation service of this waste. No regulation exists for this type of transport, despite the latent risk to public health and safety, or to the environment.

As the market is not regulated, no registered data is available on waste generators, transport operators, or those working on material recovery from this waste. Likewise, places where the transport operators discharge this type of waste are unknown.

Also unknown are the companies that treat their waste before final disposal. There are only a handful of companies recovering material from this type of waste. Derivados de Petróleo S.A and Eco Klean S.A treat used motor oil to utilize it as alternative fuel. Procesos y Análisis Metalúrgicos S.A, recovers lead from car batteries, selling part to Panamanian battery manufacturers and exporting the rest.

It was found that waste liquid and sludge are discharged into the sewer system, as well as into the course of rivers crossing the District. As a result, environmental deterioration has worsened, especially affecting Panama Bay.

No strict control is conducted in Cerro Patacón sanitary landfill on the characteristics of waste brought in by private vehicles.

5.1.5 Control and Supervision System

a. Legal framework for the control and supervision of industrial waste

Legislation and competent authority are established in General Environmental Law No. 41 of July 1, 1998 (LEGA), which creates the National Environmental Authority as the State autonomous entity to direct matters concerning natural resources and the environment.

LEGA recognizes the Ministry of Health as the authority in charge to regulate, watch, control and sanction all matters related to guaranteeing human health. It establishes the duties of the

State, through competent authorities, to regulate and control the differentiated management of waste, be it household, industrial or hazardous, in all stages. Likewise, it establishes duties to take measures to ensure management of potentially hazardous substance without endangering human health and the environment, which will require registration prior to commercial distribution or use.

The competent authority can grant the right or permit, through contract, for the management and disposal of potentially hazardous substance, duly justified by pertinent studies. The right or permit can be granted to municipalities, provincial governments, board of trustees, foundations and private companies.

The Ministry of Health (MINSA) is the competent authority to administer, regulate, enforce and sanction the management of hazardous waste, and its effective or latent risk to human health. On the other hand, the National Environmental Authority (ANAM) is the leading State agency on matters pertaining to natural resources and the environment, has the right to formulate concerned policies, and shares with MINSA the regulation, enforcement and application of penalties in cases of lack of compliance.

MINSA is the competent authority concerning regulation, sale and storage of agricultural chemicals. MINSA regulates production and sale of 98 chemicals, and also those that cannot be used or sold in the country.

b. Institutional structure for the control and supervision of industrial waste

Within MINSA, there is a Section on Hazardous Substance and Waste, which is a fifth level unit and depends from the Department of Sanitary Quality of the Environment. This administrative unit implements the policy of MINSA, and is responsible for hazardous waste, as accorded by law. This unit receives the studies on environmental impact of new projects, reviews them to make recommendations, in accordance with the taxative list for Environmental Impact Evaluation Process.

5.1.6 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

5.2 Suggestions for the Present Management of Industrial Waste

5.2.1 Regulatory Framework

Under MINSA coordination, preparation is underway on the final version of a draft law on regulatory framework for hazardous waste management. This will guide and regulate management of hazardous waste generated within the country, and the transit of hazardous waste generated elsewhere. Its preparation, discussion and presentation to the legislative body is a commendable effort that deserves the public support.

The approval of this law, its passage, and its effective compliance, could guarantee a drastic reduction of hazardous waste hidden in municipal solid waste. Hazardous waste mixed in municipal solid waste poses health and safety risks to DIMAUD collection workers, and contributes to environmental degradation in Cerro Patacon sanitary landfill.

Only one comment is made concerning the draft law. The objective of the law, as stated in the draft, is to establish regulations for hazardous waste management, with the goal to prevent, mitigate, and control contamination, which will result in protection and recovery of environmental quality, protection of public health, and sustainable use of natural resources of the country.

Consideration is given to a number of modern concepts, contained in General Environmental Law, seeking compatibility between sustainable environment and economic development. The concepts are OBJECTIVE RESPONSIBILITY to assess environmental damage (*damage is presumed until proven otherwise*) and SOLIDARY RESPONSIBILITY (*all parties involved in an operation are equally responsible*). Both concepts will define and strengthen the competent aurhority, as well as providing more clarity to legal cases.

A management tool is introduced as **Operation Permit for Hazardous Waste Management**, which will be a specific and temporal requirement. To obtain the permit, the would-be-operator should comply with all the requirements set by the competent authority, and he should submit in advance a **Civil Responsibility Insurance against Damage to Third Party and the Environment.**

Hazardous waste will be classified based on a list provided by MINSA. Hazardous waste, if mixed in whatever proportion with non-hazardous waste, will make the whole classified as hazardous for all legal and regulation purposes. These proposed rules have a special importance in this project with DIMAUD.

Likewise, other management tools are proposed: **Declaration and Tracking System for Hazardous Waste and Residue, Management Plan for Hazardous Waste and Residue,**

and Contingency and Emergency Plans. In addition, MINSA will organize and make available the technical information on hazardous waste management to the Environmental Information System and to all economic agents. Together with ANAM, MINSA will propose incentive programs in support of economic agents, with emphasis on waste minimization and economic use.

The draft law establishes responsibilities of economic agents such as Generators, Receivers and Transport Operators.

Responsibility is established for environmental contamination caused by disposal of hazardous waste in the soil. The concepts of objective responsibility and solidary responsibility are applied in this case.

To comply with the LEGA provision on Objective Responsibility, a special fund will be created as **Fund for Remediation of Soil Contaminated by Disposal in Landfill (FRSC).** This fund will be capitalized with the mandatory contributions from users of the landfill.

Importers and exporters of products and residue that might generate hazardous waste, should request MINSA the corresponding permit. For issuing the permit, MINSA in coordination with competent authorities will set the requirements. These activities include pesticides, waste from ship operation or air transport.

The draft law establishes enforcement and application of penalties for non-compliance, and the appeals procedure.

5.2.2 Strengthening the Structure of the Competent Authority

Enforcement and technical assistance activities are conducted by MINSA, through the Section on Hazardous Substance and Waste, which together with the Section on Non-Hazardous Waste are in the fifth level within the organization structure.

Negative externalities generated by deficiency in waste management, hazardous and non-hazardous, and affecting public health and safety, make it necessary to recommend a higher hierarchy for the administrative units responsible for prevention, control and mitigation of the said effects.

Chapter 6

Medical Waste Management

6 Medical Waste Management

6.1 Current Situation of Medical Waste Management

6.1.1 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.

6.1.2 Quantification of MW

From the study carried out under ALA program (Regional Program on Medical Solid Waste ALA 91/33, Agreement between European Union and Central American Governments) it can be determined that the rate of hazardous waste generation in health establishments in Panama District was of 0.8/kg/bed.

In order to quantify hazardous waste from health establishment without beds, it can be considered that each ten-outpatient consultation generate the value of a hospital bed.

6.1.3 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

6.1.4 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:

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.

6.1.5 Control and Supervision System

a. Control and supervision legal framework for MW.

By means of the Executive Decree No. 111 of 23 June of 1999, the regulation is decreed. A regulation for solid waste management coming from medical establishments is established.

This Decree has its juridical base in the Article 106 of Policy Constitution; the Sanitary Code, the General Law of Environment. The Decree norm in effective forms the integral medical waste management.

MW is classifies as common, anatomopatologics, radioactive, chemical,

infectious, sharp and piercing materials, pharmacists, and, special

It adopts the procedures recommended in the Project ALA 91/33, regarding the recipients and their identification; and management in collection and in house collection process, temporary storage, treatment, collection and external haulage, and final waste disposal.

It determines that the infectious and anatopathologic waste, if they are not disposed in a special sanitary landfill, they should be treated before disposing in the sanitary landfill. The waste coming from the isolation pavilions and piercing materials, although they have been disinfected, it should be considered as dangerous and their manipulation and final disposal should be carried out in a special sanitary landfill. The pharmaceutical citotoxics should be treated with the methods prepared by the manufacturer or producer, through their manager or representative. It is described these Decree dispositions, since being in effect for approximately three years, it is not completed, as for the final disposal that is carrying out in the sanitary landfill Cerro Patacon.

On the other side, the Decree determines the procedures for the external haulage. It points out the characteristics that should complete the vehicles to transport MW considered as dangerous. Equally, the collection vehicles of DIMAUD that provides services to several public and private health establishments are very far from the established characteristics.

Equally, it points out the responsibility that involves the Medical or Administrative Director of the health establishment, as for the execution of the regulation, from the generation to the final disposal.

b. Institutional structure of control and supervision for MW

The existing regulatory scheme considers hospital waste as dangerous waste, following the classification of the Agreement of Basel.

As such, the control and supervision relapses in MINSA where is executed through the Section of Substances and Hazardous Waste.

It has been pointed out previously that this administrative unit is of the fifth level inside the structure of MINSA, this is, with little hierarchy, and reduced capacity to assist the supervision that requires the application of the Decree No. 111.

There is weakness in programs for personnel training in health establishments with regard to the MW management.

Knowledge on occupational accident and nosocomials disease statistics and their associated costs, related MW management, will be important.

6.1.6 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.

6.2 Suggestions for Present MW Management

6.2.1 Institutional enforcement of the competent authority

To strengthen the institutional capacity of MINSA, to assist their supervision responsibility and control, according to Decree No. 111 of June 23rd, 1999.

It is suggested, to endow a bigger hierarchy and resources to the section of Substances and Hazardous Waste; program of personnel training to build capacity to carry out their supervision work and control, and also, to conduct programs of trainers in MW management.

It is suggested, to provide a bigger hierarchy and resources to the section of Substances and Hazardous Waste; a program of personnel training to build capacity to carry out their supervision work and control, and also, to conduct programs of trainers in MW management.

6.2.2 Formation

To sensitize, qualify and train personnel of all level of health establishments of MINSA and private, in the observation of the procedures and practice of MW management, to prevent labor accidents, nosocomial diseases, the risks to the community in general, the environmental damage, and the associated costs to these events.

Of great utility they will be the procedures settled down in the Program ALA 91/33 and the didactic material produced.

To sensitize, to qualify and to train the personnel of all health establishment levels of MINSA and private, to prevent the work accidents, the nosocomial diseases, the risks to the community in general, the environmental damage, and the costs associated to these events.

Of great utility they will be the procedures settled down in the Program WING 91/33 and the didactic material that was produced.

6.2.3 Registration

It is suggested, to supplement the health establishment statistics keeping data on costs with labor accidents and nosocomial diseases. This information will be of great importance to evaluate the cost related with a MW deficit management.

Chapter 7

Pilot Projects

7 Pilot Projects

7.1 Collection Improvement

7.1.1 Outline

a. Background

Through the diagnostic of the collection service in the Panama District, it was established that even though the service has an extensive coverage, this service is not structured based on a rational design. Most of the service is programmed to serve with a frequency of 7 times per week. However, it is not always executed as planned. This situation has a direct effect on the costs and availability of vehicles because there is insufficient time to provide adequate maintenance to them.

Because there is not any rational design being applied, there is not any division of sectors nor have routes been diagrammed. Consequently, a low collection performance has been observed on the collection workers' part. Additionally, it has been observed, a low transport load per trip (taking into account the design load capacity of these vehicles). Over-time hours are also generated because the service cannot be completed within the 8 hours shift.

Moreover, there are not any procedures to control, to monitor and to evaluate the service which can help to define the flaws or low performances on time and can help to apply the corrective measures.

b. Objectives

Main Objectives

Because of the foregoing, a pilot project was planned which had the following main objective.

- 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.

Expected Outputs

Through the design and implementation of a rational collection plan, the following outputs are expected.

- New collection routes of the pilot project area are designed under the concept of maximizing the use of resources (human resources, equipment, and infrastructure in general).
- As part of the service design, the collection frequency is modified in such a way as to change it from a seven times a week frequency to three times per week frequency (from Monday to Saturday). This new frequency would allow having one day for maintenance of the collection fleet.
- Knowledge and experience are transferred to the technical, operative, and monitoring personnel of DIMAUD; in such a way as to achieve an adequate training that can allow the professionals to design and/or to optimize the routes, the operative personnel to be able to perform the service correctly and the monitoring personnel to be able to control the service effectively.

Regarding the procedures to establish monitoring and evaluation methods, the following outputs were expected.

- Procedures to gather information related to the development of the service are created.
- Service quality indicators are defined, which allow an evaluation of the service in a simple and easy manner.
- A reporting system between the collection department and other departments, which are involved directly in the collection service in order to coordinate and monitor the activities between them, is established.

Finally, the attainment of objectives and the experience obtained through the Pilot Project are included in a proceeding manual.

c. Selection of the Target Area

The selection of the target area was done jointly with the Counterpart team. The sector called San Pedro was selected for the pilot project. The area is located in Juan Diaz Corregimiento.

The selected area has the following characteristics:

- The service was programmed to consider a frequency of seven days per week. However, this frequency was not done all the time or, in some cases, the area was not covered completely. This was confirmed when we observed the area where wastes were scattered on the streets, containers were filled up to their capacities and unexpected large number of bags and recipients full of wastes were placed in front of the houses, while in the nearby streets the wastes have been collected.

- There are detached houses areas and aggregated areas; consequently, the collection is done door to door, point to point, and a mixed of both types.
- The area is predominantly residential; however, there are small commercial and industrial sectors.
- There are a variety of socio-economical strata which is reflected on the type of houses, population density, and road structure.
- There are a large number of streets and passages that are not accessible for the collection vehicles.
- The area has steep slopes and flat zones.

The area selected includes 20 residential sectors with a total of 12,000 persons and 2,940 houses which are based on a projection for 2002 taking into account the population growth rate obtained from the General Controller Office of the Panama Republic, Department of Statistics and Census. Table 7-1 details the information by residential sectors.

Table 7-1: Number of Houses and Residents in the Pilot Project Area

Residential Sector	Projection for 2002	
	Nos. of Houses	Nos. of Persons
El Sitio	139	457
Residencial Bernal	23	88
Bosques del Hipódromo	11	42
San Cristóbal	635	2816
Altos del Complejo	98	421
La Cantera	24	100
San Pedro	538	2344
San Pedro 2	398	1475
Altos del Hipódromo	281	1073
Los Almendros	93	347
El Nance	65	249
Urb. Nuevo Hipódromo	149	669
Urb. Altos de San Pedro	150	565
Urb. El Guayacán	55	222
Urb. El Laurel	37	151
Villa Venus 2	55	216
Villa Venus	79	344
Urb. Camino Real	17	57
Villa Inés	62	256
Santa Pera	31	108
Total	2,940	12,000

Source: General Controller Office of the Panama Republic, Department of Statistics and Census, modified.

d. Project Design Matrix

Project Design Matrix was formulated in order to clarify purpose, expected outputs, activities and necessary inputs as shown in Table 7-2.

Table 7-2: Project Design Matrix of the Pilot Project of Collection Improvement

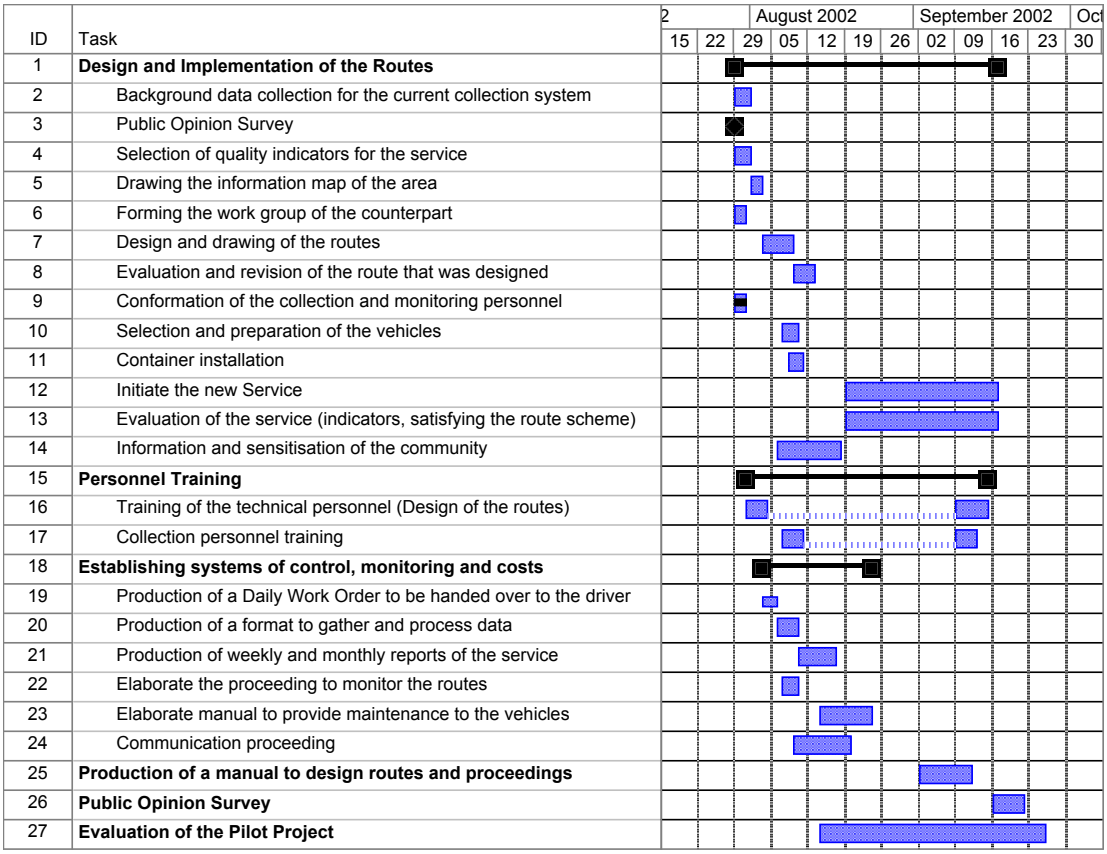
Narrative Summary	Objectively verifiable indicators	Means of Verification	Important Assumptions
Overall goal Collection Efficiency is improved in Panama District			
Project purpose To improve the efficiency of Waste Collection in San Pedro	The service is provided with the frequency and schedule established. 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	
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 Implementation Method

a. Work Schedule

The pilot project was executed during the period between July 29 and September 15, 2002. Previous to this period, some activities took place; these activities were directed mainly to obtain field information (Public Opinion Survey) and to procure equipment for the service.

The following figure shows the work schedule of the Pilot Project.



ID	Task
1	**Design and Implementation of the Routes**
2	Background data collection for the current collection system
3	Public Opinion Survey
4	Selection of quality indicators for the service
5	Drawing the information map of the area
6	Forming the work group of the counterpart
7	Design and drawing of the routes
8	Evaluation and revision of the route that was designed
9	Conformation of the collection and monitoring personnel
10	Selection and preparation of the vehicles
11	Container installation
12	Initiate the new Service
13	Evaluation of the service (indicators, satisfying the route scheme)
14	Information and sensitisation of the community
15	**Personnel Training**
16	Training of the technical personnel (Design of the routes)
17	Collection personnel training
18	**Establishing systems of control, monitoring and costs**
19	Production of a Daily Work Order to be handed over to the driver
20	Production of a format to gather and process data
21	Production of weekly and monthly reports of the service
22	Elaborate the proceeding to monitor the routes
23	Elaborate manual to provide maintenance to the vehicles
24	Communication proceeding
25	**Production of a manual to design routes and proceedings**
26	**Public Opinion Survey**
27	**Evaluation of the Pilot Project**

Figure 7-1: Work-Schedule of the Pilot Project

b. Implementation Method

b.1. Diagnostic of the Route

During the first week of the pilot project, the counterpart was instructed about the indicators which are generally used to evaluate the collection service[1]. Subsequently, taking into account the data which can possibly be gathered, the following indicators were selected for the experiment.

[1] Indicadores para el Gerenciamiento del Servicio de Limpieza Pública. OPS/CEPIS/PUB/01-72

Table 7-3: Indicators to Evaluate the Collection Service

Indicator	Formula	Unit
Tons/collection time	Tons collected per month / Collection Time during a month	Ton/Collect. hr
Tons/paid hours	Tons collected per month / Hours paid per month (Assist.+Driver)	Ton/paid hr
Tons/worked hours	Tons collected per month / Total hours worked per sector per month	Ton/worked hr
Tons/trip	Tons collected per month / Number of trips per month	Ton/trip
Tons/Assistant/day	Tons collected per month / Number of effective assistants per month	Ton/assist./day
Kilogram/Kilometer per sector	Tons collected per month x 1000 / Distance covered per sector in a month (km)	Kg/km sector
Kilogram/total kilometers covered in a month	Tons collected per month x 1000 / Total length covered in a month (km)	Kg/total km
Fuel Performance	Distance covered in a month (km) / Amount of fuel per month (gallon)	Km/gl

Based on the background information from May, June, July, and August, the indicators for the current route were calculated by using the calculation format Optimizaruta. The data obtained was compared with an acceptable range defined in a document "Indicators for the Management of Public Cleansing" OPS/CEPIS/PUB/01.72[2]. The following table shows the values for these indicators.

Table 7-4: Performance of the Collection Service before the Pilot Project

Indicator	Unit	May	June	July	August	CEPIS Reference
Tons vs Collection Hours	Ton/Collect. hr	-	-	2.28	1.93	2.3 a 2.6
Tons vs Paid Hours	Ton/paid hr	0.29	0.30	0.30	0.28	0.30 a 0.35
Tons vs Worked Hours	Ton/work. hr	1.20	1.27	1.33	1.24	-
Tons/trip	Ton/viaje	4.98	5.74	6.26	5.98	-
Tons/assistant/day	Ton/assist./day	3.29	3.64	3.23	3.47	4.5 a 5.0
Kilogram/kilometer sector	Kg/km sector	-	-	-	587.58	500 a 600
Kilogram/total kilometer	Kg/km total	-	-	-	128.21	100 a 150
Fuel Performance	Km/Gl	-	-	-	5.79	8 a 11

Note: The indicators for August are calculated based on 17 days of work.

As the previous table shows, only the indicators kilogram/kilometer-sector and kilogram/total kilometer fell within an acceptable range. The rest of indicators were below the minimum. Consequently, it was concluded that the route should be optimized. The indicator Tons vs. worked hours does not have any reference value; however, it was calculated with the purpose to use it as a comparative value during the pilot project development.

[2] See Manual of Proceeding to Optimize the Route

Once the comparison had been established, the average values were regarded as baseline data. Additionally, the optimum indicator values were defined as shown in Table 7-5. These values would serve to diagnose and to evaluate the routes.

Table 7-5: Indicators for Collection Work

Type of Collection (Urban Zone)	Acceptable Range	Optimum Value
Tons vs. Total Collection Time (door to door or mixed, 3 assistants)	2.3 to 2.6 ton/hour	2.45 ton/ hour
Tons vs. Total Collection Time (point to point, containers, 3 assistants)	2.8 to 3.2 ton/ hour	3.0 ton/ hour
Tons vs. Total Paid Hour	0.30 to 0.35 ton/hour	0.33 ton/hour
Tons per trip vs. maximum payload	-	0.9 to 1.05
Tons vs. nos. of assistances	4.5 to 5 ton/assist./day	4.5 ton/assist./day
Fuel consumption	The indicator value should be established according to the characteristics of the collection vehicle which should be defined by the manufacturer; it has been fixed as 7 km/gal for this specific case	

b.2. Route Design

The route design included the following activities.

i. Training of the technical personnel

ii. Division in Sectors

iii. Drawing route on a Map

iv. Verification of the Route

v. Training of the operative personnel

Before the pilot project implementation initiated, the counterpart nominated the professionals and personnel who would participate directly in this experience. This nomination was done based on requirements from the Study Team which are the following.

Collection and Monitoring Personnel:

- To have worked at least three years in the entity
- The health condition should correspond to the work which is being executed
- Between 25 and 45 years old
- Proved responsibility in the workplace
- No alcohol nor drug problems
- Respectful of the regulations and his/her superiors
- Preferably to have worked in the pilot project area

Technical Personnel

- To have knowledge regarding the current collection service
- To be involved with the current control systems of the collection service
- To have participated or have knowledge of the system which has been used to program the current routes

Based on the previous requirements, the counterpart selected the following personnel.

- 2 Collection Technicians
- 1 Computer Science Technician
- 1 Chief Coordinator
- 1 Supervisor Coordinator
- Supervisors
- Drivers
- Collection Workers

b.2.1 Training of the Technical Personnel

Before the collection routes were designed, the technical personnel were trained about the design procedures. The training process included the following.

- Calculation procedure to define the waste generation; the production during normal and peak days according to the collection frequency
- Proceedings to calculate indicators
- Calculation proceedings to define the number of sectors and sub-sectors
- Calculation proceedings to verify the number of tons which are transported by truck during a shift based on the time and motion register
- Proceedings to define the limits of Sectors and Sub-sectors
- Proceedings to draw the routes on a map; regulations to draw the routes
- Proceedings to verify the routes
- Proceedings to implement the route
- Method to evaluate the routes

The training was done simultaneously to the activities related to the management and analysis of the collected information, calculation of indicators, and the design of routes. Subsequently, this was reinforced each week after the implementation of the new routes.

The training also included the proceedings related to the management of information and operation of calculation formats.

b.2.2 Division of Sectors

The first design phase of the new routes corresponded to the division of sectors; the following conditions were established to undertake the service:

Collection frequency	3 times per week
Collection vehicle payload	8.5 tons
Number of trips per shift	2
Number of days worked during the week	6

Subsequently, the amount of waste collected monthly was calculated. This amount corresponds exclusively to household waste taking into account that industrial wastes should be handled separately. In order to calculate the amount of waste to be collected, the waste from industries (calculated beforehand) was subtracted to the average value of tons collected monthly. Once the design tonnage was defined, the amount of waste collected during the maximum accumulation days and on normal days was calculated. The calculations were done for a complete sector or residential area. For the latter case, the generation was defined based on a per capita generation which was obtained from the monthly generation and the number of persons per sector.

The generation results correspond to:

Total average production per month	290 Ton/month
Total average production per week	66.9 Ton/week
Industrial production per week	13.2 Ton/week
Production in the Residential Sector	53.7 Ton/week
Production Per Capita	0.64 Kg/per/day

Table 7-6: Waste Generation Amount in the Pilot Project Area

Residential Sector	Residents Year 2002	Weekly Generation	Generation on a Peak Day	Generation on a Normal Day
	Nos.	Tons/week	Tons/day	Tons/day
El Sitio	457	2.0	0.9	0.6
Residencial Bernal	88	0.4	0.2	0.1
Bosques del Hipódromo	42	0.2	0.1	0.1
San Cristóbal	2,817	12.6	5.4	3.6
Altos del Complejo	421	1.9	0.8	0.5
La Cantera	100	0.4	0.2	0.1
San Pedro	2,344	10.5	4.5	3.0
San Pedro 2	1,475	6.6	2.8	1.9
Altos del Hipódromo	1,074	4.8	2.1	1.4
Los Almendros	347	1.6	0.7	0.4
El Nance	249	1.1	0.5	0.3
Urb. Nuevo Hipódromo	669	3.0	1.3	0.9
Urb. Altos de San Pedro	565	2.5	1.1	0.7
Urb. El Guayacan	222	1.0	0.4	0.3
Urb. El Laurel	151	0.7	0.3	0.2
Villa Venus 2	216	1.0	0.4	0.3

Residential Sector	Residents Year 2002	Weekly Generation	Generation on a Peak Day	Generation on a Normal Day
	Nos.	Tons/week	Tons/day	Tons/day
Villa Venus	344	1.5	0.7	0.4
Urb. Camino Real	57	0.3	0.1	0.1
Villa Inés	256	1.1	0.5	0.3
Santa Pera	108	0.5	0.2	0.1
Grand Total	12,001	53.7	23.0	15.3

The number of sub-sectors was calculated taking into account.

- The number of sub-sectors is calculated for the maximum generation day
- Each sub-sector is defined for the area that a truck covers in a shift
- Peak day generation 23.0 Ton/day
- Generation on a normal day 15.3 Ton/day
- Collection vehicle capacity 8.5 Ton
- Number of trips per working day 2
- Number of eight-hours shift 1
- Number of days the sub-sector is serviced in a week 3
- Number of days worked in a week 6

$$N^o subsectores = \frac{Tons\ \ peak\ \ day}{Collection\ Capacity\ \ for\ \ one\ \ trip\ \ x\ \ N^o\ \ of\ \ trips\ \ per\ \ day} = 1.4 = 2$$

$$N^o\ \ of\ \ Subsectors\ \ Serviced\ \ by\ \ one\ \ truck = \frac{\left(N^o\ \ of\ \ days\ \ worked/week\right)\ x\ \ N^o\ 8hrs.\ Shifts}{N^o\ \ of\ \ days\ \ of\ \ service\ \ in\ \ the\ \ week\ per\ sector} = 2$$

$$N^o\ \ of\ \ Trucks = \frac{Total\ \ Number\ \ of\ \ Sub-sectors}{N^o\ \ of\ \ Sub-sectors\ \ Serviced\ \ by\ \ one\ \ truck} = 1$$

Consequently, the San Pedro sector includes 2 sub-sectors according to the following denomination

Sub-sector	Day of Service
1-1	Monday-Wednesday-Friday
1-2	Tuesday-Thursday-Saturday

After the sub-sectors have been defined, the total number of tons that can be collected during a working day was verified with taking into account the following

- Two peak days are generated during the week, one for each sub-sector (Monday and Tuesday); consequently, 11.5 tons/day can be collected.
- Non-collection time that had been found based on the existing data

Non-Collection Time

Time	Hours
Depot-Sector	0.38
Sector-Landfill	0.55
Landfill	0.52
Landfill-Sector	0.35
Landfill-Depot	0.42

Verification

Variable	Values	Unit
Tons to be collected/peak day	11.5	Tons/day
Collection Velocity	2.5	Tons/hour
Non-collection time 1st trip	1.8	Hour
Maximum Tonnage/1st trip	8.5	Tons/trip
Collection Time 1st trip	3.4	Hour
Total Time 1st trip	5.2	Hour
Remaining Time for 2nd trip	2.8	Hour
Non-collection time 2nd trip	1.5	Hour
Time available for collection in the 2nd trip	1.3	Hour
Tons to be collected in the 2nd trip	3.0	Tons/trip
Required collection time for 2nd trip	1.2	Hour
Total Tons which are collected in a working day	11.5	Tons/working day
Hours of work	7.9	Hour
Remaining time during the working day	0.1	Hour

It was confirmed that the total amount of tons which would be accumulated during the day of maximum generation could be collected in 8 hrs. Subsequently, it was defined the physical sub-division of the sub-sectors. A map at a scale 1:2000 was used for that purpose.

After the sub-sectors have been defined, the route was drawn on a map. The number and capacity of the containers were calculated. Their original locations remained unchanged. Figure 7-2 and Figure 7-3 show collection routes and location of the containers.

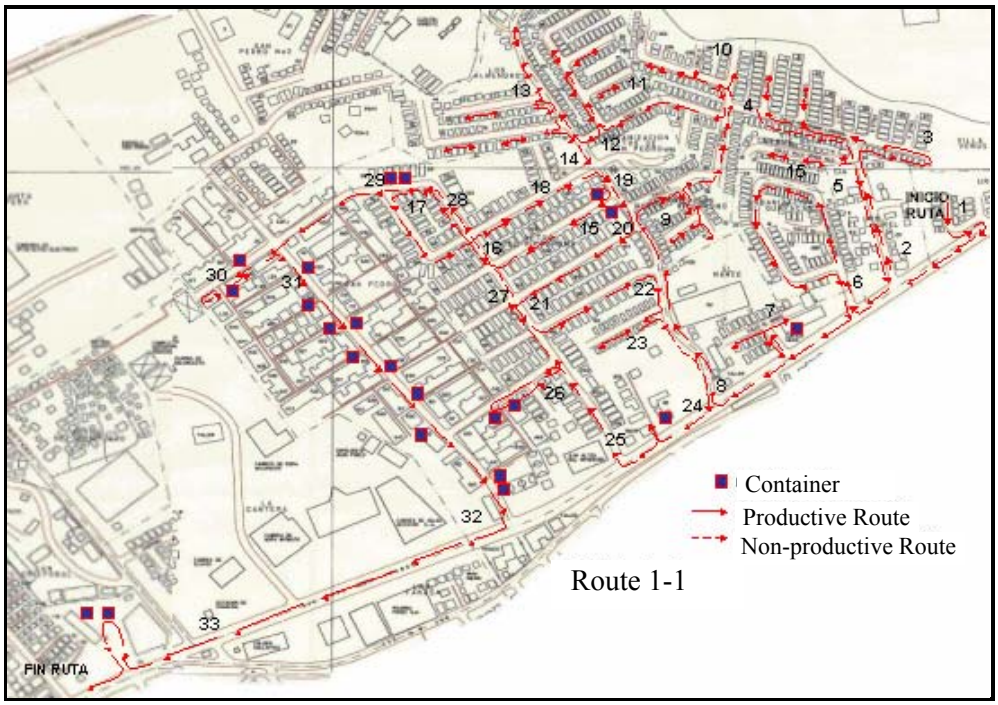


Figure 7-2: Designed Collection Route (1-1)

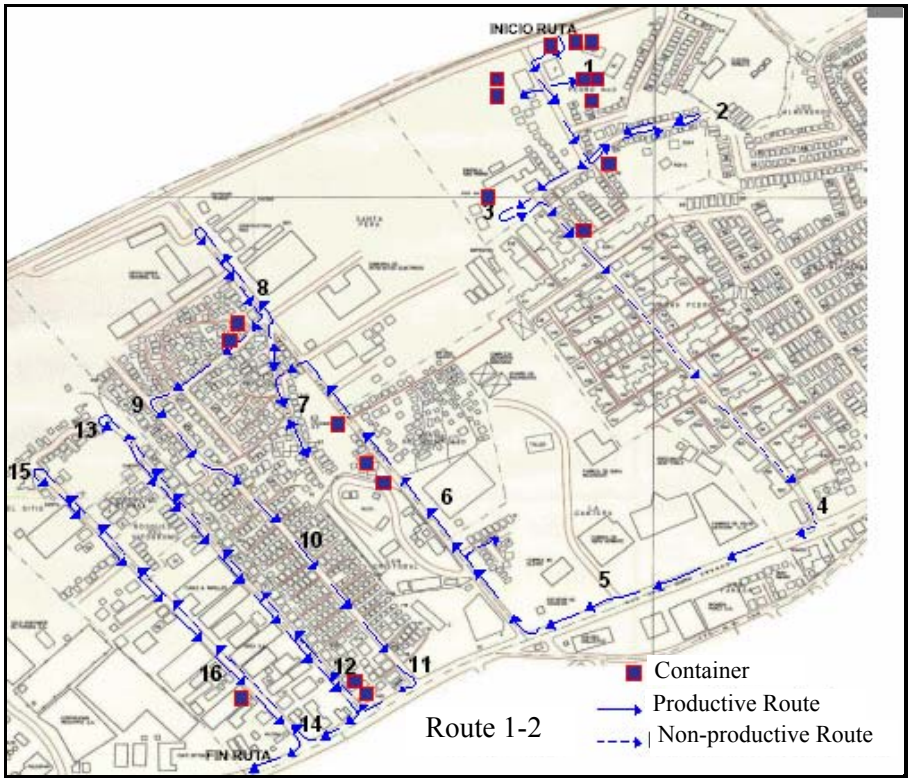


Figure 7-3: Designed Collection Route (1-2)

b.3. Implementation and monitoring of the routes

On August 19, the new collection service initiated. Everyday the time and distances were monitored for each one of the routes by using the new format of the Work Order.

- During the first week the time and motion data were taken jointly by the technical person and the driver. Subsequently, this task was done exclusively by the driver.
- In the first week new containers were added on locations where previously only baskets, called tinaqueras, had been placed previously. The use of these baskets had increased the collection time considerably.
- In the second week the industrial wastes which originally were excluded from the collection route, were added to the route. This decision was taken because DIMAUD did not have vehicles dedicated exclusively to collect industrial wastes. It was not necessary to design new routes because the industries are located within the routes already designed and the truck had capacity to transport them.
- Every week the routes were monitored by the technical personnel and the supervisors to confirm that the collection service is carried out as planned.
- The time and motion data was input daily to the calculation format called Optimizaruta and the results were evaluated.

7.1.3 Results

a. Administrative Findings

During the development of this pilot project, the following findings were obtained:

- It was unknown the number of clients who were served and the amount of waste which was generated in the residential areas. Similarly, it was also unknown how much of waste was generated from the industrial sector.
- The routes were defined by the drivers and occasionally they did not cover the complete area which was assigned to them.
- Industrial wastes collection was done every other day.
- No control is done over the time and motion on the route. Only the exit and entrance time to the depot (Carrasquilla) and the landfill were registered. Evaluations that relate

the time employed daily in the sector and the amount of tons collected were not either conducted.

- The collection department was not aware about the existence and use of indicators to evaluate the service.
- Collection is done on a daily basis, even though this collection often does not cover the area totally.
- The collection department ignores completely the use of resources and costs which are associated with the service because its main function is directed to provide a daily service as it is programmed and to respond timely to special situations which take place during the working hours and that are associated with complaints from the residents. DIMAUD ignores this information because every department in the institution works as an isolated unit which prevents the technical personnel from having information such as: fuel consumption, oil consumption, maintenance done to the vehicles, tire consumption, over-time paid to the personnel, distribution of uniforms, safety equipment, and tools, and the corresponding expenditures related to these activities. Consequently, it is difficult to evaluate the service from the technical and economical perspective.
- There is no coordination between the maintenance department and the collection department; this situation makes it difficult to implement a maintenance program for the fleet.
- The collection department is not involved on the control of overtime hours; moreover, the compensation hours which are given instead of overtime salary are not authorized nor monitored by this department. The human resources department defines the compensation time based on the attendance record of each worker; this situation is grave regarding the control of costs.
- Monitoring of the routes is not done on a daily basis. A complete and real monitoring by the supervisor was not observed to take place.

The previous findings can lead to infer that, in addition to optimize the design of the current routes, it is indispensable to modify the functional structure of DIMAUD in such a way as to achieve that all related departments can establish an adequate coordination among them.

b. Results of the Pilot Project

Table 7-7 presents comparison of indicators before and after the pilot project.

Table 7-7: Results of the Pilot Project

Indicators	units	Before	After	After/Before
Days of Work	Days/month	31	25	0.81
Tons collected per month	Tons/month	290.0	290.2	1.00
N° of trips per month	Trips/month	51	37	0.73
Collection kilometers per month	Km/month	449	300	0.67
Total Kilometers per month	Km/month	2061.0	1608.9	0.78
Collection Hours	Hr/month	139.5	112.2	0.80
Real Hours Worked per Route per Month	Hr/month	230.2	174.3	0.76
Hours paid to the driver	Hr/month	251.2	209.6	0.83
Hours paid to the collection worker	Hr/month	738	600	0.81
Fuel Consumption per month	Gl/month	356	269	0.76
Tons vs Collection Hour	Tons/hour	2.10	2.59	1.23
Tons vs Hours paid	Tons/hour	0.29	0.36	1.22
Tons vs Hours worked	Tons/hour	1.26	1.66	1.32
Tons/trip	Tons/trip	5.74	7.84	1.37
Tons/worker/day	Tons/worker/day	3.41	4.49	1.32
Kilogram/Kilometer/sector	Kg/km	587.58	967.27	1.65
Kilogram/Total kilometers	Kg/km	128.21	180.36	1.41
Fuel performance	Km/gal	5.80	5.98	1.03

b.1. Indicators

Indicators to monitor and evaluate the collection woks have been established in the pilot project. Table 7-8 and Table 7-9 shows values in the indicators before and after the pilot project.

Table 7-8: Indicator Values before and after the Pilot Project

Indicators	Before	After	Optimum	After/Before	After/Optimum
Tons vs. Collection Hours	2.1	2.6	2.5	24%	-4%
Tons vs. Paid Hours	0.29	0.36	0.33	24%	-9%
Tons vs. Worked Hours	1.3	1.7	-	31%	-
Tons per Trip vs. Designed Payload	0.8	0.9	0.9	13%	0%
Tons per Worker per Day	3.4	4.5	4.5	32%	0%
Fuel Consumption	5.8	6.0	7.0	3%	14%

Table 7-9: Waste Amount Collected per Travel Distance before and after the Pilot Project

Indicators	Before	After	Optimum	After/Before	After/Optimum
Kg/km/sector	587.6	967.3	600.0	65%	61%
Kg/total km	128.2	180.4	150.0	41%	20%

7.1.4 Evaluation and Conclusions

The results of the pilot project were evaluated as follows.

a. To improve the collection efficiency through the design and implementation of a rational collection plan.

In order to achieve the objective, three goals were proposed initially which include the design of optimum routes, modification of the frequency, and transfer of knowledge.

a.1. 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.

a.2. 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%.

a.3. The collection service has attained levels of efficiency and competitiveness

- Through the pilot project, competitive levels within the Latin American market could be attained. Performance levels were achieved within the optimum range which can ensure the effectiveness of the service. Values in the indicators obtained from the pilot project are higher than the initial values. These values also fall within the optimum range values as it is shown in the following paragraphs.

- The indicator of tons collected vs. collection time was increased in 23%. A monthly value of 2.6 tons/hr was obtained; the optimum range is found between 2.3 to 2.6 ton/hour.
- Tons collected vs. hours paid increased in 24%. The optimum range falls between 0.3 and 0.35 tons/hour. The value obtained for this parameter was 0.36 ton/hr.
- Tons vs. hours of work increased in 32%.
- The ratio of Tons/trip vs. payload capacity of the truck increased in 12%. The optimum value should be between 0.90 and 1.05. The value obtained was 0.92.
- The performance of the collection personnel increased in 32%. The optimum recommended value is between 4.5 and 5 ton/worker/day. Through the pilot project 4.5 was attained.
- The kilograms of wastes collected per kilometer of collection increased in 65%. The optimum range of reference lies between 500 and 600. Through the pilot project, this range was exceeded by obtaining a value of 967 kg/km/sector.
- The kilograms collected vs. the total distance traveled increased in 41%. A value of 180 kg/km was obtained. The optimum range lies between 100 and 150 kg/km.
- Fuel performance increased in 3% by attaining a value of 6 km/gl. It was not possible to attain the optimum range between 7 and 8 km/gl.

In addition to increase the efficiency of the service, its quality has improved as well. The days and hours of service have been closely observed and an optimum collection service has been provided. Moreover, after the service was provided no wastes scattered on the streets has been observed. These achievements can only be possible due to the constant participation of all the personnel who took part in the Pilot Project. They implemented what they learned through the training program and another goal of this project was attained as a result. An adequate route design and daily monitoring of the parameters by the technical personnel lead to required adjustments of the routes. A constant monitoring of the routes by the technical personnel and supervisors ensured that the routes´ design was followed as planned and also ensured that the service provided an adequate coverage. Finally, the correct implementation of the route and loading of wastes into the truck by the driver and collection workers had a positive effect in an increment of the performance and effectiveness of the service.

The previous results reflect a reduction of direct costs of the service. As it was calculated previously, the direct costs by the personnel as well as those derived from the collection

vehicle have experienced a reduction compared to the initial costs, as the following graphs shows.

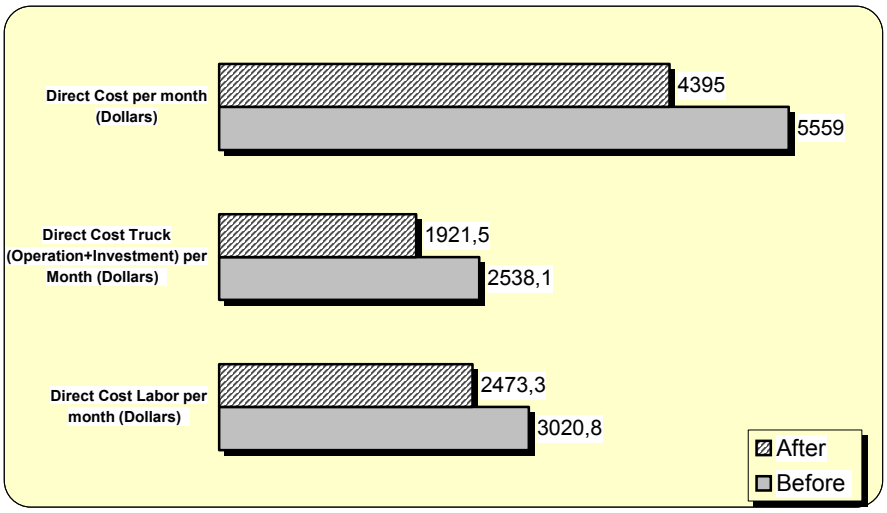


Figure 7-4: Direct Collection Costs before and after the Pilot Project

The pilot project managed to reduce the direct labor and vehicle costs in 21%. Before the Pilot Project's implementation the direct cost from this sector was 5,559 dollars/month. Subsequently, with the Pilot Project the cost went down to 4,395 dollars/month which represent savings of 13,967 dollars/year in one route. Currently, DIMAUD has 100 routes. If the previous result is generalized to the other routes then there could be savings of 1.4 millions of dollars per year.

The previous result leads us to conclude that DIMAUD's collection service can be improved considerably through a rational collection plan. This plan will not only allow to increase the efficiency and quality of the service, but also to reach an adequate competitive level which can help to reduce the costs.

b. To establish monitoring and evaluation methods for the collection service

Through this pilot project, the technical personnel were trained in identifying and gathering basic information which is necessary to evaluate the service.

In fact, as a result of the Pilot Project, a new Work Order format has been designed which allows monitoring the time and motion in the routes, fuel consumption, tons collected and identification of the operation and monitoring personnel.

Simultaneously to the elaboration of the new Work Order format, the technical personnel has started to implement a calculation format called Optimizaruta which represents a useful tool to calculate indicators and other variables which allow the evaluation of the service.

Now that the Pilot Project has finished, the professionals of the collection department are aware and knowledgeable on how to control the equipment and personnel performance, cost control and service quality.

Consequently, it is concluded that the personnel who participated in the Pilot Project is capable to expand this experience to other routes and to improve the collection service substantially.

During the development of this experience, it was confirmed that reports are not exchanged sufficiently among the different departments which could ensure an adequate and timely communication between them. This communication could lead to a control of resources and monitoring of parameters. In view of the foregoing, it is considered indispensable to establish in the short term a communication system between the departments.

Taking into account the results attained during the Pilot Project, from both the technical-economical and the client perspectives, it is concluded that the changes introduced during this Pilot Project were positive. Mainly because there were some doubts on the type of response from the population due to the implementation of the Pilot Project; the population was used to have a daily collection frequency. However, all the objectives were attained; moreover, the population is satisfied with the new frequency because it does not alter the service quality, on the contrary it has improved the service.

Finally, the results show that it is totally feasible to implement a route optimization program with the resources available in DIMAUD. As the result of this program, savings can be obtained in the short term and the client can be provided of a service of good quality and competitive.

7.1.5 Recommendations

In the following paragraphs, some recommendations are provided which can help to ensure continuity and to expand the Pilot Project.

It is advisable to maintain the monitoring of routes which have been optimized and input the data from this monitoring activities into the database in order to sustain the evaluation process which can help to compare the results between different periods (months, years, etc.) and to compare the indicators from the routes with optimum indicators.

It is recommended to implement as soon as possible the new format for Work Orders in order to have background information related to the time distribution in the routes and be able to conduct a diagnostic about them. However, the drivers should be trained in advance on how to fill them up.

It is also recommended to make an expansion program to optimize the routes which can be developed under a criteria of geographical expansion; priority should be given to those routes with lower performances. For example, for the case of the Pilot Project, the routes which have been optimized correspond to San Pedro sector; it is advisable that the following routes to be optimized are located in adjacent sectors to San Pedro; if there is more than one sector, then priority should be given to those which have lower performances.

Additionally, it is advisable to undertake the optimization of routes by following strictly the proceedings manual. Modifications should not be implemented during the monitoring process based on preliminary results because it will obstruct the data gathering process and the optimization itself.

Before the optimization of routes continue, it should be verified if there are any ICI´s in the sector and it should also be defined if these wastes will be managed separately or mixed with household wastes. In order to take a decision in this regard, it is advised to make a preliminary classification taking into account their characteristics and volume.

The collection and supervision personnel should be trained continuously; even if the routes have not been optimized yet.

It is recommended to implement as soon as possible a program of preventive maintenance of the fleet. The maintenance can be executed directly by DIMAUD or through external companies. It is important that the maintenance is executed according to the specifications of the manufacturer or truck dealer. Initially, this preventive maintenance can be done on the new trucks; other trucks can be incorporated gradually, an examination and general maintenance should be done beforehand.

It should be maintained the monitoring and evaluation of the routes which have been optimized. Any reduction on the efficiency or quality should be investigated immediately in order to prevent a return to preceding conditions.

It is recommended to implement as briefly as possible to exchange the reports among the departments in order to control adequately the service. It is advisable to manage at least the following information listed in Table 7-10 between the departments.

Table 7-10: Recommended Reporting Manners among the Departments in DIMAUD

From	To	Information	Frequency
Collection Department	Human Resources Department	Shifts and schedule of the personnel	Monthly
		Program of overtime hours derived from extraordinary works	Daily
		Approval of vacation requests and compensation time	Weekly if there are any
Human Resources Department	Collection Department	Hiring of new personnel	Daily
		Medical licenses	Daily
		Request to authorize compensation time and vacations	Weekly
		Occurrence of labor accidents	Daily
		Cessation of personnel	Daily
		Transfer of personnel	Daily
		Personnel Listing Report	Monthly
Collection Department	Maintenance Department	Hours/day worked per truck	Daily
		Hours/month worked per truck	Monthly
		Mechanical failure present on the route, daily	Daily
		Requirement of vehicles per working day	Weekly
		Fuel Consumption per truck	Monthly
Maintenance Department	Collection Department	Listing of trucks in working condition	Weekly
		Listing of trucks and date when they will receive preventive or repair maintenance; the replacement truck has to be defined	Weekly
		Vehicles which are not operating and their replacement due to mechanical failure	Daily
		Damage caused to the vehicles due to accidents and bad operation	Weekly
Collection Department	Management Control Department	Quality indicators per route	Monthly
		Tons collected per route	Monthly
		Identification of new routes	When it takes places
		Hours worked per truck	Monthly
		Fuel consumption per month per truck	Monthly
		Hours worked per month per worker	Monthly
Commercialization Department	Collection Department	Listing of new clients	When it takes place + Monthly Report
		Request of new containers	When it takes place
		Verification of complaints from the commercial area	When it takes place + Monthly Report
Collection Department	Commercialization Department	Listing of new clients according to field information	When it takes place + Monthly Report
		Report on the installation of containers	When it takes place + Monthly Report
		Listing of large generators	When it takes place + Monthly Report
		Modification on the type of waste that is being collected	When it takes place + Monthly Report
		Monthly listing of tons collected per ICI´s route	Monthly
Collection Department	Street Sweeping Department	Tons collected per street sweeping route	Weekly
		Program of Special Assignments (Operativo)	Monthly
Street Sweeping Department	Collection Department	Program for street sweeping and bags collection	Monthly
		Modifications of street sweeping routes	When it takes place + Monthly Report
Collection Department	Final Disposal Department	Identification of special wastes which are collected	Monthly
		Classification of wastes per route	Every time a route is created or modified
Final Disposal Department	Collection Department	Monthly Amount of Tons collected per truck per route	Monthly
		Identification of the vehicle, day and hour when it discharged wastes which are prohibited	When it takes place

7.2 Separation at the Source

7.2.1 Outline

a. Background

Separation of wastes at generation sources is crucial for introducing a recycling system in the future. However, there is no official separation system in Panama District at present. A kind of consensus had been made between the C/P and the S/T that municipal officers should know what the separation at the source is and what kind of problems might arise by the activities.

b. 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.

c. Selection of Target Group

Municipal officers of two municipal buildings were selected as target groups of this pilot project, i.e., DIMAUD, Carrasquilla, and Municipality, EDEM, because DIMAUD, Carrasquilla, is the headquarters of the SWM service provider and EDEM is a principal municipal building where most of municipal services are carried out and large number of personnel work.

c.1. Dirección Municipal de Aseo Urbano y Domiciliario (DIMAUD, Carrasquilla)

The main facilities of this organization are located in San Francisco Corregimiento, Avenida 1 C Sur, Carrasquilla.

The following are profile of the building.

- 36 office areas and complementary services
- 289 Permanent Officers, **PO** (they stay inside the office during the working hours).
- 171 Floating Officers, **FO** (They do not stay in their offices because their assignments are on the field).
- 15 Offices which recover the white paper, 41.67 % of the total by using two types of containers one (generally a box) for white paper and the other one for the rest.
- Waste collection inside the premises is done by General Services office (once a day) regularly during the morning.
- The facilities are distributed in just one level.

Level	Nos. of Offices	PO	FO	Offices which dispose their wastes in a mixed manner	Offices which Recover White Paper	Offices which separate Kitchen Waste	Offices which separate Paper and Food
1	36	289	171	21	15	None	None

- Special activities or complementary services regarding wastes generation are Barbershop, Clinics, Restaurants, and Computing services.

c.2. Municipality (EDEM)

These facilities harbor a large number of offices, where most of the sections of the Municipality operate, and where large number of visitors is serviced; it is located in Santa Ana Corregimiento, Avenida B and calle 15. It is better known as EDEM.

The following are profile of the building.

- 62 office areas and complementary services
- 677 Permanent Officers, (**PO**)
- 250 Floating Officers, (**FO**)
- The facilities are distributed in eight levels
- 15 offices recover white paper, 24.19% out of the total identified.
- 9 offices with independent containers for food wastes, 14.52% out of the total identified.
- 7 of the previous separate both white paper and food wastes,
- 45 offices store their wastes on a mixed manner, in just one container
- 17 use two containers for white paper or food wastes and the others.
- 7 offices use three containers: for white papers, food wastes and others.
- The distribution of offices, officers, and type of material being recovered was found as follows:

Level	Nos. of Offices	PO	FO	Offices depositing mixed wastes	Offices recovering White Paper	Offices separating Food Wastes	Offices separating Paper and Food Wastes
Ground level	15	188	107	12	3	1	1
1	1	13			1		
2	2	22	4	1	1		
3	12	73		12			
4	3	36	43	2	1	1	1
5	8	58	6	7	1		
6	13	127		7	6	3	3
7	8	160	63	4	2	4	2
Total	62	677	223	45	15	9	7

- Separate activities or complementary services in view of wastes generated are found in Clinics, restaurants, computing and printing centers.

d. 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 7-11.

Table 7-11: 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 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	**Inputs** Human Resources • One member of the S/T • Members of the C/P • NGO Materials • Containers • Equipment for the amount and composition survey • Materials for the educational campaign		• Employees in DIMAUD and EDEM accept that the separation introduced and participate the pilot project. **Preconditions** • JICA and the Panamanian side agree to conduct the pilot project.

7.2.2 Implementation Method

The pilot project is a combination of two aspects. One is technical aspect, i.e., amount and composition survey of recyclable materials. The other is social aspect, i.e., educational campaign for encouraging to separate waste and to inform how to do it. This section describes work schedule and method of implementation of the pilot project.

a. Work Schedule

The formulation of the implementation plan was developed jointly between the Panamanian C/P and the Study Team. The pilot project was implemented for about one month, from the 15th of July until the 16th of August, followed by analysis and evaluation.

The pilot project consisted of the following five stages.

1. Diagnosis of the current situation.
2. Planning
3. Preparation
4. Execution
5. Analysis and evaluation

a.1. Diagnosis of the current situation

To know the current conditions of the facilities and the operations that are done related to solid waste management, e.g., who is responsible to do collection, what type of containers are used for storage, location of the containers, when and how many times collection is done, after wastes are collected where they are disposed. All the previous information was required with the purpose to have a better idea about the internal flow of wastes and actors of this process. Additionally, it can give an idea on the impact that separate collection can have when it is implemented.

a.2. Planning

From the information obtained in the previous phase, the following four separation categories were defined:

- White paper
- Other recyclable materials
- Food wastes
- Others

The number of containers was calculated, taking into account the space available in the participants' offices and their availability in the market in number, sizes and quality. It was calculated one container per 10 officers. Additionally, the collection support equipment, number of persons who would be assigned, how to inform the participants, and evaluation methods were defined.

a.3. Preparation

As part of the preparation, an Opinion Survey was executed; containers were acquired; a flyer was produced; and instruction sheets were elaborated. Additionally, information to the officers was given through 24 times workshops, which were attended by 474 officers equivalent to 49% (474/966) of the permanent offices of the buildings.

a.4. Execution

After the preparation, separation at the source was implemented at the buildings. Data necessary to analyze and evaluate this pilot project was collected.

a.5. Analysis and Evaluation

Data and information were analyzed and validity of the separate collection for the M/P was evaluated.

Activities carried out in this pilot project are shown in the following table.

Table 7-12: Work Schedule of the Pilot Project of Separation at the Source

a.5.1 Period	Activity
24 Jun – 30 Jun	**Diagnosis of the current situation** • To obtain the number of offices, number of employees, storage system, collection frequency, and operation responsible
01 Jul – 07 Jul	**Planning** • To establish categories of waste for separation • To calculate the number of containers to be used for every facility • To elaborate an Opinion Survey before the implementation • To elaborate flyers • To elaborate instruction sheet showing the type of materials to be deposited • To elaborate a presentation with information for the officers of the project
08 Jul – 14 Jul	**Preparation** • To undertake the Opinion Survey before the implementation • To give informative talks to officers • To deliver the flyers • To purchase the containers and bags which were used during the project • To elaborate forms to obtain data • To define the methodology to be employed • To schedule the sampling • To initiate placing the containers, with the respective bags and posters with instructions where to place the materials
15 Jul - 21 Jul	**Execution** • Placing the containers was continued • Data collection initiated and adjustments were done to the formats • The methodology was adjusted • Information was processed
22 Jul – 28 Jul	**Execution** • Closure of the first week of data collection • Evaluation meeting • Data processing
29 Jul - 04 Aug	**Execution** • Closure of the second week of data collection • Evaluation meeting • Data processing
05 Aug – 11 Aug	**Execution** • Closure of the third week of data collection • Evaluation meeting • Data processing • Elaboration of a Opinion Survey to evaluate the project • Elaboration of the presentation of results for the workshop of participant officers • Workshop to present the results and to form a follow-up group in EDEM

a.5.1 Period	Activity
	• To initiate weight sampling of non-recyclables for a period of 8 days • To initiate obtaining volumes of recyclable materials, among the selected samples
12 Aug – 18 Aug	**Execution** • Closure of the fourth week of data collection • Opinion Survey to evaluate the project • Evaluation meeting • Data processing • To elaborate the presentation for the workshop of DIMAUD´s participant officers • Workshop to present results and to form a follow-up group • Finalization of weight sampling for non-recyclables • Finalization to obtain volumes of recyclables materials, among the selected samples • Workshop to form the follow-up group • Finalization of Data collection and closure of the fifth week
19 Aug – 25 Aug	**Analysis and evaluation**

b. Method of Amount and Composition Survey of Recyclable Materials

b.1. Separation Categories

Waste was mainly divided into two categories, i.e., 'Recyclable' and 'Non-recyclable'. As white papers were separated for recycling at both buildings before the pilot project, the recyclable materials were further divided into 'White Paper' and 'Other Recyclable Materials.' Consequently, the waste in the buildings was categorized as below.

Table 7-13: Separation Categories

Category	Sub-category
Recyclable	White paper
	Other recyclable • Papers (color paper, magazines, newspapers, cardboard, folders) • Aluminum • Glass • Plastic
Non-recyclable	Food waste Others

Four types of containers were used depending on the separation category.

- White paper: carton box (existing)
- Other recyclable: plastic container (newly provided for the pilot project)
- Food waste: plastic container (existing)
- Others: plastic/metal container (existing)

b.2. Samples and Measurement

Only recyclable materials, i.e., white paper and other recyclable were subject to amount survey. Besides, the other recyclable materials were subject to composition survey. Those

were classified into sub-categories such as color paper, magazines, aluminum and plastic. Then, each sub-category was weighed.

Number of samples is shown in the table below.

Table 7-14: Measurement Items and Number of Samples of Separation at the Source

Place	Measurement Items	Material	1st week	2nd week	3rd week	4th week	5th week	Total
Carrasquilla	Amount	White Paper	33	33	33	33	33	165
		Other Recyclable	35	35	35	35	35	175
	Composition	Other Recyclable	5	5	5	5	5	25
EDEM	Amount	White Paper	55	55	55	55	55	275
		Other Recyclable	55	55	55	55	55	275
	Composition	Other Recyclable	13	13	13	13	13	65

c. Method of Educational Campaign

Basically, all persons who discharge waste at the buildings were subject to the educational campaign. However, ways of approach to them were different depending on type of persons. In order to evaluate the effect of the educational campaign as well as the implementation of the pilot project, opinion surveys were conducted before and after it.

Media	Target group
Workshop	Permanent officers
Flyer	Permanent officers and floating officers
Sign	Permanent officers, floating officers and visitors

c.1. Workshop

Two types of workshops were conducted before and the end of the pilot project. Objectives of the workshops were as follows.

c.1.1 Workshop before the pilot project

- To tell them importance and necessity of separation at the source,
- To inform about the objectives and procedures of the pilot project, and
- To motivate the personnel to participate actively on the pilot project.

c.1.2 Workshop at the end of the pilot project

- To train about recycling through an environmental educative video,
- To inform the participants of the progress of the pilot project,

- To know the opinions of the officers about the viability of a permanent program on separation which can be implemented by the officers and endorsed by the superior management, and
- To form the Recycling Committee for continuing the separate collection after the pilot project by themselves.

d. Delivery of Containers

Separation of Other Recyclable Materials was newly introduced by the pilot project. Containers (32 gallons, or 121.1 litters) for storing them were procured to the buildings.

7.2.3 Results

a. Amount and Composition Survey on Recyclable Materials

a.1. Amount of Recyclable Materials

a.1.1 White Paper

Amount of white paper measured at the both building are summarized in Table 7-15, Table 7-16 and Table 7-17. White papers measured at the first week included one that had been accumulated in the previous weeks. Therefore, the data of the first week was elided. Generation amount of the white paper in DIMAUD was 37.64 kg/week (5.38 kg/day) and one in EDEM was 46.86 kg/week (6.69 kg/day). The generation amount per permanent officer was 0.020 kg/pers./day in DIMAUD and 0.011 kg/pers./day in EDEM. Average of the generation rate of the two buildings were 0.014 kg/pers./day.

Table 7-15: Amount of White Paper at DIMAUD (Carrasquilla)

Unit: kg

Office	Nos. of offices	Week				Total	Average per week
		2	3	4	5		
Administrative office	33	51.60	22.00	26.48	30.16	130.24	32.56
Restaurant	1	9.87	0.20	-	-	10.07	2.52
Computer Center	1	5.22	1.50	3.06	0.45	10.23	2.56
Total	35	66.69	23.70	29.54	30.61	150.54	37.64
Average per office	-	1.91	0.68	0.84	0.87	-	-

Table 7-16: Amount of White Paper at Municipality (EDEM)

Unit: kg

Office	Nos. of offices	Week				Total	Average per week
		2	3	4	5		
Administrative office	52	44.57	55.93	34.28	25.54	160.32	40.08
Restaurant	1	-	-	-	-	0.00	0.00
Computer Center	1	3.12	4.37	6.97	2.52	16.98	4.25
Printing Shop	1	2.44	7.71	-	-	10.15	2.54
Total	55	50.13	68.01	41.25	28.06	187.45	46.86
Average per office	-	0.91	1.24	0.75	0.51	-	-

Table 7-17: Amount of White Paper per Permanent Officer

Unit: kg

Building	Nos. of officers	White paper per week	White paper per officer per week	White paper per officer per day
DIMAUD	265	37.64	0.142	0.020
Municipality	615	46.86	0.076	0.011
Average	440	42.25	0.096	0.014

a.1.2 Other Recyclable Materials

Amount of other recyclable material measured at the both buildings are summarized in Table 7-18, Table 7-19 and Table 7-20. Generation rates of Other Recyclable Materials per permanent officer were 0.039 kg/pers./day in DIMAUD and 0.027 kg/pers./day in EDEM. The average was 0.031 kg/pers./day.

Table 7-18: Amount of Other Recyclable Materials at DIMAUD (Carrasquilla)

Unit: kg

Office	Nos. of offices	Week				Total	Average per week
		2	3	4	5		
Administrative office	31	103.79	50.75	44.76	39.41	238.71	59.68
Restaurant	1	6.75	5.05	3.35	4.39	19.54	4.89
Computer Center	1	8.68	6.10	11.34	1.59	27.71	6.93
Total	33	119.22	61.90	59.45	45.39	285.96	71.49
Average per office	-	3.61	1.88	1.80	1.38	-	-

Table 7-19: Amount of Other Recyclable Materials at Municipality (EDEM)

Unit: kg

Office	Nos. of offices	Week				Total	Average per week
		2	3	4	5		
Administrative office	52	137.44	68.35	127.26	91.43	424.48	106.12
Restaurant	1	0.17	0.2	-	0.4	0.77	0.19
Computer Center	1	3.63	4.88	0.34	1.79	10.64	2.66
Printing Shop	1	13.32	1.05	16.22	0.54	31.13	7.78
Total	55	154.56	74.48	143.82	94.16	467.02	116.76
Average per office	-	2.81	1.35	2.61	1.71	-	-

Table 7-20: Amount of Other Recyclable Materials per Permanent Officer

Unit: kg

Building	Nos. of officers	Other recyclable per week	Other recyclable per officer per week	Other recyclable per officer per day
DIMAUD	265	71.49	0.270	0.039
Municipality	615	116.76	0.190	0.027
Average	440	94.13	0.214	0.031

a.2. Composition of Other Recyclable Materials

Table 7-21 and Table 7-22 show composition of Other Recyclable Materials in DIMAUD and Municipality respectively. Table 7-23 shows combined composition of the two buildings.

Papers such as color paper, newspaper and cardboard occupy major part of the compositions, about 60% in DIMAUD and about 90% in EDEM. Other materials shows lower portions, the composition rates of aluminum and glass together were 7.82% in DIMAUD and 4.38% in EDEM, the average was 6.04%.

For recycling, it is crucial that generators appropriately separate materials at the source. The item of others in the Other Recyclable Materials shows degree of appropriate separation manner. The others are non-recyclable materials. Those should not be put in the containers for the Other Recyclable Materials. The portion of the others is generally called as 'Impurity Rate.' The impurity rates were 11.57% in DIMAUD and 4.18% in EDEM. Compared each other, there may be a room to improve this value in DIMAUD.

Table 7-21: Composition of Other Recyclable Materials at DIMAUD (Carrasquilla)

Unit: kg

Type of material	Week				Total
	2nd	3rd	4th	5th	
Color paper	12.346	1.474	2.693	1.843	18.356
Magazine	8.789	0.000	0.000	0.227	9.016
Newspaper	1.361	1.786	0.369	1.786	5.302
Cardboard	3.558	2.920	6.691	2.029	15.198
Folders	1.162	0.407	0.539	0.162	2.270
Sub-total (paper)	27.216	6.587	10.292	6.047	50.142
Aluminum	0.198	0.241	0.113	0.170	0.722
Glass	1.177	0.397	2.693	0.369	4.636
Plastic	3.884	3.912	1.616	2.023	11.435
Others	3.058	2.481	1.843	0.779	8.161
Total	35.533	13.618	16.557	9.388	75.096

Unit: %

Type of material	Week				Average
	2nd	3rd	4th	5th	
Color paper	34.75	10.82	16.27	19.63	20.36
Magazine	24.73	0.00	0.00	2.42	6.79
Newspaper	3.83	13.11	2.23	19.02	9.55
Cardboard	10.01	21.44	40.40	21.61	23.36
Folders	3.27	2.99	3.26	1.73	2.81
Sub-total (paper)	76.59	48.36	62.16	64.41	62.87
Aluminum	0.56	1.77	0.68	1.81	1.21
Glass	3.31	2.92	16.27	3.93	6.61
Plastic	10.93	28.73	9.76	21.55	17.74
Others	8.61	18.22	11.13	8.30	11.57
Total	100.00	100.00	100.00	100.00	100.00

Table 7-22: Composition of Other Recyclable Materials at Municipality (EDEM)

Unit: kg

Type of material	Week				Total
	2nd	3rd	4th	5th	
Color paper	36.790	14.770	20.469	6.372	78.401
Magazine	3.686	0.397	0.255	0.085	4.423
Newspaper	2.637	10.135	2.552	1.871	17.195
Cardboard	2.322	4.830	2.608	3.147	12.907
Folders	2.424	0.454	0.709	1.786	5.373
Sub-total (paper)	47.859	30.586	26.593	13.261	118.299
Aluminum	0.204	0.170	0.085	0.142	0.601
Glass	4.564	0.241	1.616	0.123	6.544
Plastic	1.069	0.198	0.267	0.795	2.329
Others	1.316	1.014	0.210	1.673	4.213
Total	55.012	32.209	28.771	15.994	131.986

Unit: %

Type of material	Week				Average
	2nd	3rd	4th	5th	
Color paper	66.88	45.85	71.14	39.83	55.93
Magazine	6.70	1.23	0.89	0.53	2.34
Newspaper	4.79	31.47	8.87	11.70	14.21
Cardboard	4.22	15.00	9.06	19.68	11.99
Folders	4.41	1.41	2.46	11.17	4.86
Sub-total (paper)	87.00	94.96	92.42	82.91	89.33
Aluminum	0.37	0.53	0.30	0.89	0.52
Glass	8.30	0.75	5.62	0.77	3.86
Plastic	1.94	0.61	0.93	4.97	2.11
Others	2.39	3.15	0.73	10.46	4.18
Total	100.00	100.00	100.00	100.00	100.00

Table 7-23: Combined Composition of Other Recyclable Materials both DIMAUD (Carrasquilla) and Municipality (EDEM)

Type of material	Unit: kg/week			Unit: %		
	DIMAUD	EDEM	Total	DIMAUD	EDEM	Average
Color paper	18.356	78.401	96.757	20.36	55.93	46.72
Magazine	9.016	4.423	13.439	6.79	2.34	6.49
Newspaper	5.302	17.195	22.497	9.55	14.21	10.86
Cardboard	15.198	12.907	28.105	23.36	11.99	13.57
Folders	2.270	5.373	7.643	2.81	4.86	3.69
Subtotal (paper)	50.142	118.299	168.441	62.87	89.33	81.33
Aluminum	0.722	0.601	1.323	1.21	0.52	0.64
Glass	4.636	6.544	11.180	6.61	3.86	5.40
Plastic	11.435	2.329	13.764	17.74	2.11	6.65
Others	8.161	4.213	12.374	11.57	4.18	5.98
Total	75.096	131.986	207.082	100.00	100.00	100.00

a.3. Density

Density of other recyclable materials is measured once at the 5th week. The results are shown in Table 7-24.

Table 7-24: Density of Other Recyclable Material

Unit: kg/m^3

Type of material	Density
Color paper	118.43
Magazine	115.72
Newspaper	65.09
Cardboard	74.15
Folder	67.28
Aluminum	98.25
Glass	284.29
Plastic	51.84

According to George Tcobanoglous, Hilary Theisen and Samuel A. Vigil, in their book "Integrated Solid Waste Management", the following average in densities were reported.

Range of Densities
(Kilograms-cubic meters)

Material	Minimum	Maximum	Value Obtained
Paper	41	130	118.43
Cardboard	41	80	74.15
Aluminum	65	240	98.25
Glass	160	480	284.29
Plastic	41	130	51.84

b. Educational Campaign

As activities of the pilot project, workshops were held, leaflets were delivered and sings were put on the walls in order to deliver information how to separate materials as well as to tell the participants importance of recycling and to motivate them to actively participate and to continue the separation.

Workshops were held before the pilot project targeting all the permanent officers and at the end of it targeting selected permanent officers. One-hour workshops before the pilot project were carried out 24 times at DIMAUD and Municipality between July 9 and 12. Then, three-hour workshops at the end of the pilot project were held one time at Municipality and DIMAUD on August 8 and 13 respectively. Table 7-25 shows data about participation.

Table 7-25: Participation to Workshops

Workshop	Nos. of targeted officers	Nos. of participants	% of participation
Before	966	474	49.1
At End	83	67	80.7

c. Opinion Survey

An Opinion Survey was done to 149 officers, 46 from the DIMAUD and 103 from the Municipality before the pilot project and the other to 150 officers, 47 from DIMAUD and 103 from the Municipality at the end of the pilot project, as a basic principle, one sample at least was picked up from each office. The results were presented in Table 7-26 and Table 7-27. Some of important results were described in the following.

- Although only about 20 % of participants understood what is recycling appropriately, 90% become to have correct idea about it at the end of the pilot project.
- About 60% in EDEM showed unwillingness to the introduction of separation before the pilot project, however about 100% actually participated in the separation.
- Four separation categories were introduced in the pilot project. 90% both before and the end of the pilot project said that the categorization was appropriate.
- Regarding formulation of a recycling committee for continuation of the pilot project, 62% in DIMAUD and 85% in EDEM made affirmative answer before the pilot project. The portion was improved at the end of the pilot project to more than 90% in each building.
- Majority (75%) answered that the container used for the Other Recyclable Materials was appropriate.
- Almost all (about 100%) said that the municipality should support activities to continue and expand the separation at the source.

Table 7-26: Results of Opinion Survey before the Pilot Project

Question	Municipality	DIMUD
1 What do you understand for recycling?	20.39 % has a clear concept 66.02%, the concept is acceptable 13.59%, wrong concept	17.39%, has a clear concept 45.65%, has an acceptable concept 36.96%, wrong concept
2. Do you consider that it is necessary a recycling program within the municipality?	93.20%, Yes 3.88%, No 2.91%, Do not know	91.30%, Yes 4.35%, No 4.35%, Do not know
3. If the municipality were to introduce a system of separate collection of wastes would you	91.26%, Yes 6.80%, No	39.13%, Yes 58.70%, No

Question	Municipality	DIMUD
be interested in participating?	1.94%, Do not know	2.17%, Do not know
4. Would you be willing to separate in four parts?	88.35%, Yes 10.68%, No 0.97%, Do not know	91.30%, Yes 8.70%, No 0.00%, Do not know
5. If the answer to the previous question is NO, what are the reasons?	Out of the 10.68% who responded NO to the previous question: 0.98% Requires a lot of effort 0.98% Requires more containers 7.84% It is inconvenient for a normal activity of the office 90.20% Did not give any reason	Out of the 8.70% who responded NO to the previous question: 2.17% Requires a lot of effort 6.52% Requires more containers 91.30% It is not inconvenient for a normal activity of the office
6. In your department are paper wastes or other materials being separated?	36.89%, Yes 61.17%, No 1.94%, Do not know	45.65%, Yes 54.35%, No
7. What do you do with white paper waste that is recovered in your office?	12.62%, We sell it 5.83%, We donate it 81.55%, Others	36.96%, We sell it 10.87%, We donate it 52.17%, Others
8. Would you be willing to be part of a separation and recovery committee within the municipality?	62.14%, Yes 25.24%, No 6.80%, Do not know	84.78%, Yes 4.35%, No 10.87%, Do not know
9. What would be your main motivation if your answer was YES to the previous question?	Out of the 62.14% who answered YES to the previous question, 62.14%, Concern about the Environment 0.97%, Interest that the Sanitary landfill extends its service life 36.89%, My siblings encourage me to do it	Out of the 84.78% who answered YES to the previous question, 60.87%, Concern about the environment 2.17%, Interest that the Sanitary landfill extends its service life 36.96%, My siblings encourage me to do it

Table 7-27: Results of Opinion Survey at the end of Pilot Project

Question	Ans. %	DIMUD	Ans. %	Municipality
1 Among the different statements which one would better represent the concept of Recycling?	25.53	To reduce wastes as much as possible	11.65	To reduce waste as much as possible
	19.15	To separate used materials and prevent their disposal in order to sell them subsequently	18.45	To separate used materials and prevent their disposal in order to sell them subsequently
	46.81	The process to collect used materials to process them again and to elaborate new products	65.05	The process to collect used materials to process them again and to elaborate new products
	4.26	None of the previous	1.94	None of the previous
	4.26	Do not know / Did not respond	2.91	Do not know / Did not respond
2 Do you consider that recovery of materials contributes to.....	31.91	The conservation of natural resources	33.98	The conservation of natural resources
	19.15	To obtain additional income	24.27	To obtain additional income
	42.55	The two previous answers	37.86	The two previous answers
	2.13	Nothing	2.91	Nothing
	4.26	Do not know /Did not respond	0.97	Do not know / Did not respond
3 Did you participate actively in the project to separate wastes?	23.40	A lot	35.92	A lot
	46.81	Moderately	50.49	Moderately
	10.64	Little	11.65	Little
	8.51	Nothing	1.94	Nothing
	10.64	Do not know/ Did not respond	0.00	Do not know / Did not respond

Question	Ans. %	DIMUD	Ans. %	Municipality
4 Did your co-workers participate actively in the project?	31.91	Very actively	21.36	Very actively
	23.40	Actively	42.72	Actively
	38.30	Moderately	34.95	Moderately
	6.38	Little	0.97	Little
	0.00	Nothing	0.00	Nothing
5 Do you consider that it was achieved to recover all the materials that are produced in your office by following all the instructions in the separation project?	31.91	All of them	25.24	All of them
	27.66	Most of them	33.98	Most of them
	31.91	Moderately	36.89	Moderately
	8.51	Little	2.91	Little
	0.00	Nothing	0.97	Nothing
6 Do you believe that it is appropriate to separate the wastes and deposit them in four containers?	93.62	Yes	90.29	Yes
	4.26	No	9.71	No
	2.13	Do not know / Did not respond	0.00	Do not know / Did not respond
7 If the answer to the previous question was NO, why?	50.00	It is a lot of effort and the containers were too far	10.00	It is a lot of effort and the containers were too far
	50.00	The instruction flyers did not motivate	70.00	The instruction flyers did not motivate
		The large number of containers caused confusion	20.00	The large number of containers caused confusion
		Takes a lot of time out of the work schedule		Takes a lot of time out of the work schedule
		More containers should have been placed		More containers should have been placed
8 Do you consider that the containers used for other recyclable materials were the most adequate?	25.53	Very appropriates	18.45	Very appropriates
	51.06	Appropriates	58.25	Appropriates
	10.64	Regular	14.56	Regular
	10.64	Inappropriate	6.8	Inappropriate
	2.13	Do not know / Did not answer	1.94	Do not know / Did not answer
9 Did you have any problem to store the white paper?	12.77	The cardboard box was missing after the first two weeks	24.27	The cardboard box was missing after the first two weeks
	8.51	The cardboard box was missing after the first three weeks	3.88	The cardboard box was missing after the first three weeks
	19.15	Never had box, but we recovered the paper	10.68	Never had box, but we recovered the paper
	53.19	None	60.19	None
	6.38	Do not know / Did not answer	0.97	Does not know / Did not answer
10 Would you be willing to continue the separation if the project continues?	95.74	Yes	98.06	Yes
	2.13	No	1.94	No
	2.13	Do not know / Did not answer	0.00	Do not know / Did not answer
11 Do you believe that a committee to separate materials should be formed to continue the recovery of recyclable materials?	91.49	Yes	90.29	Yes
	6.38	No	5.83	No
	2.13	Do not know / Did not answer	3.88	Do not know / Did not answer
12 Do you consider that the Municipal authorities should support the continuity of this activity (separation) and promote them in the Communities?	95.74	Yes	99.03	Yes
	4.26	No	0.97	No
	0.00	Do not know / Did not answer	0.00	Do not know / Did not answer

7.2.4 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.

In order to make recycling activity feasible, large amount of materials has to be transported at a time for reducing the transportation cost. The generation rates of the white paper in the buildings are not so high. It should be stored for a certain period until its amount be enough to be attractive by a buyer. If the white paper is accumulated by 500 kg and is sold to a buyer, it takes about three months in DIMAUD and two and half months in EDEM. The price of the white paper is between US$0.18 and 0.26 per kg according to the Recycling Market Survey. 500 kg of white paper could be sold at between US$90 and 130.

Although the generation rate is likely to be different depending on types of business, the average obtained in the pilot project, 0.014 kg/pers./day (per permanent officer), could be a good indicator for other public institutions.

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

About 50% of target personnel (474/966) participated in the workshops that were held before the pilot project. Although the participation rate to the workshops was not so high, the results of the opinion survey show that considerably large number of personnel acquired correct knowledge about recycling at the end of the pilot project.

About 80% of target personnel (67/83) attended the workshops that were held at the end of the pilot project for aiming at encouraging continuation of the pilot project. Although the workshops targeted the selected personnel, considerably large number of personnel (more than 90%) was encouraged to continue the separation.

According to the mentioned above, it could be said that the integrated approach of educational campaign applied in this pilot project, i.e., holding workshops, delivering leaflets, putting signs, showing photos and videos, was quite effective to deliver the information and

to raise awareness of the participants on the separation and recycling. And participation itself was likely to be effective.

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. Method of Data and Information Gathering

Technical data and social information obtained through the pilot project are good enough to review the M/P. It can be said that the combination of different types of information makes us possible to profoundly consider the results.

e. Sustainability

All the activities were conducted together with the C/P and the NGO. Knowledge and skills how to introduce the separation, how to conduct the amount and composition survey and how to organize a recycling committee were transferred to them.

Meanwhile, considerably large number of personnel in the both buildings has understood the idea of separation and recycling properly and has been encouraged to continue the pilot project. Besides, a recycling committee has been formulated in DIMAUD at the end of August to continue and expand the pilot project.

Consequently, it can be said that the pilot project is ready to be an origin of recycling activities, as they have the knowledge, the skills, the experiences and the organization. It is expected that this will lead the expansion of the activity to the whole municipal buildings.

7.2.5 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. Background

The Cerro Patacon Landfill has some facilities necessary for a sanitary landfill, such as leachate collection facility and landfill gas removal facility. However, daily soil caver was not implemented and landfilling schedule was not established, then, the operation had a room to improve. Therefore, it was expected to demonstrate appropriate landfilling as well as to gather basic data to plan the landfill operation rationally.

Waste-pickers were practicing in the landfill. The landfill operation was often hampered by their activity. Meanwhile they exposed themselves to danger of accident with heavy equipment and collection vehicles. Therefore, a measure to improve the current situation was expected.

b. 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.

c. Selection of Target Area

The Cerro Patacon Landfill has mainly two areas for wastes called *organic waste* and *inorganic waste* respectively. The *organic waste* is that daily collected from households and business entities by ordinary collection works. The *inorganic waste* is bulky waste collected by special collection services and/or hauled by waste generators. The *organic waste* occupies most of the whole waste disposed in the Cerro Patacon Landfill. Therefore, it is first of all important to dispose the *organic waste* properly.

A new landfill operation method was introduced in a small scale, as it may bring about the mess to introduce the new method at once in a full scale.

d. Project Design Matrix

A Project Design Matrix PDM) was made in order to clarify purposes, outputs, activities and inputs of the pilot project. Table 7-28 shows the PDM and Figure 7-5 schematizes flow of the pilot project.

Table 7-28: 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 1. Landfill operation is carried out rationally and designedly in the pilot project area 2. The present situation regarding waste-picker is improved.	1. Landfill operation is carried out according to the method established. 2. Landfill operation and waste-pickers activities are separated.	1. Data recorded, observation of the operation 2. 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 1.1 Design a landfill operation method 1.2 Carry out the landfill operation method 1.3 Collect data and information to verify the validity of the method. 2. Design a rule to separate the waste-pickers' activities and the landfill operation	**Inputs** Human Resources • Members of the S/T • Members the C/P • NGO • Contractor Materials and Equipment • Heavy equipment • Soil • Equipment for measuring cells		• The Contractor of landfill operation agrees to conduct the pilot project. **Preconditions** • JICA and the Panamanian side agree to conduct the pilot project.

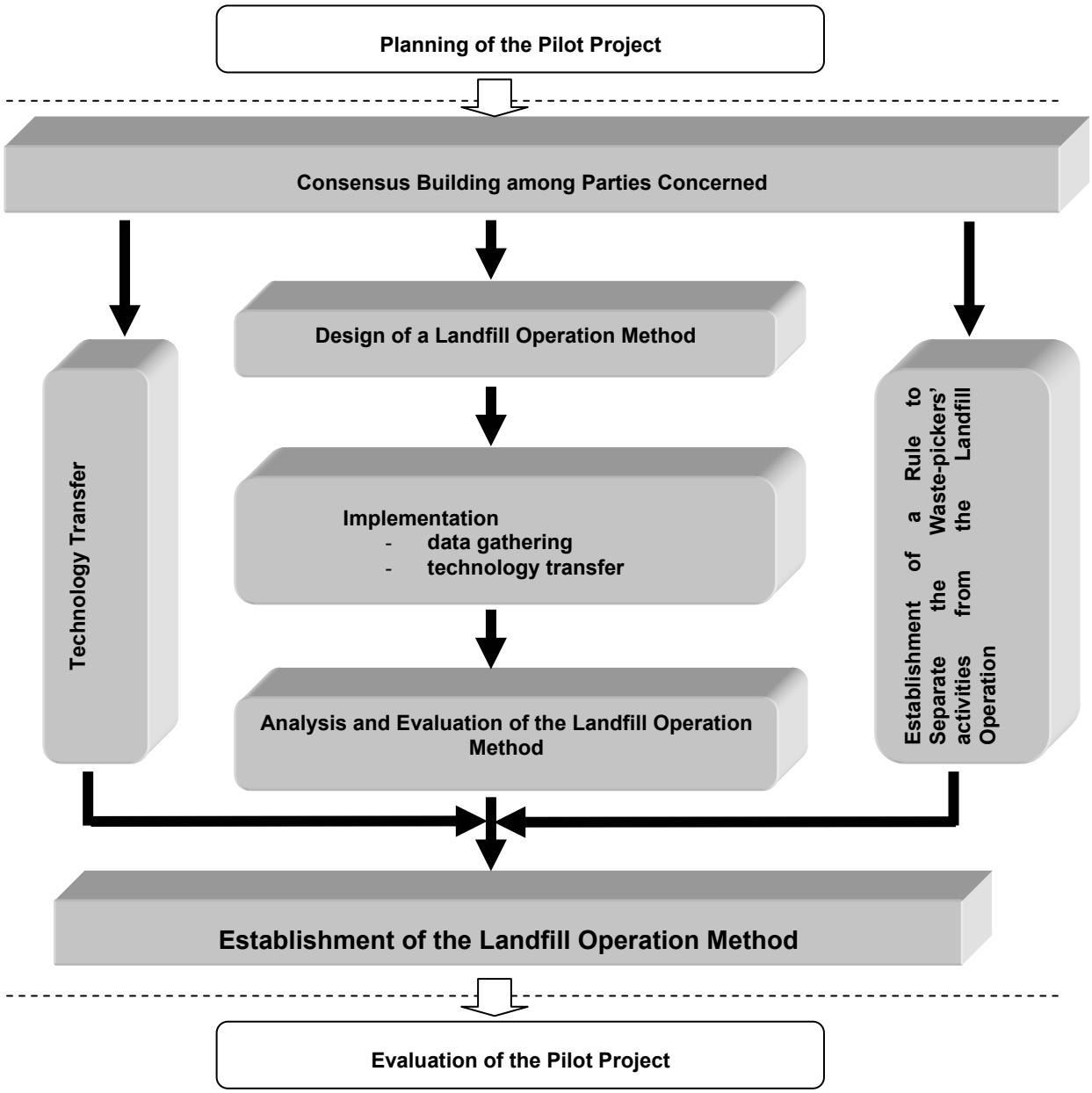


Figure 7-5: Flow of the Pilot Project

7.3.2 Implementation Method (Design of Landfill Operation Method)

A landfill operation method was designed at the end of July through discussions and consultations among the C/P, the contractor in charge of landfill operation and the S/T. Table 7-29 shows summary of the landfill operation method designed at the beginning the pilot project. Followed by the table, how the design has been set is discussed.

Table 7-29: Landfill Operation Method designed at the Beginning the Pilot Project

Items	Description
Heavy equipment 1. One Bulldozer, D7 class (28 ton) 2. Excavator 3. Dump truck	 for accumulation and compaction of waste for excavating soil and for making banks at edge for carrying soil
Performance capacity of bulldozer	55 m^3/hr
Bulk density of waste	Unloaded waste: 0.35 ton/m^3 Compacted waste: 0.70 ton/m^3
Waste amount received	20 ton/hr (120 ton/day, 24 units of 16-yd^3 compactors)
Operation hour 1. Receiving waste 2. Accumulating and compacting 3. Covering soil	From 8:00 to 17:00 (lunch time from 12:00 to 13:00) From 8:00 to 15:00 (6 hours) From 9:00 to 16:00 (6hours) From 16:00 to 17:00 (1 hour)
Dimension of cell	L x W x H = 10.0 x 10.0 x 2.0 m Volume; 200 m^3 Slope; 1 to 3
Soil cover	Thickness; 15 cm 34 m^3/day
Countermeasures to rainwater	Slope of surface of cells is 2.0%
Supervision	Define an area where waste is disposed of on the day Measure a cell after operation every day

a. Performance Capacity of Heavy Equipment

A D7 class bulldozer was supposed to use for the pilot project at first. The weight of the bulldozer was assumed about 28 tons according to the specification of CATERPILLAR. In order to estimate performance capacity of the bulldozer, Table 7-30 was used. The D7 was assumed 21-ton class bulldozer. Operating efficiency is depending on type of soil. As no operating efficiency is set for waste, it was assumed as 0.45 on the safe side. The distance of moving waste was assumed as short as 20 m. Consequently the performance capacity was set up as **55 m^3/h**.

Table 7-30: Performance Capacity of Heavy Equipment

Unit: m^3/hr

Type	Operating efficiency	Dozing Distance (m)						
		20	30	40	50	60	70	80
15ton class bulldozer	0.45	34	26	22	19	16	14	13
	0.60	45	35	29	25	22	19	17
	0.70	52	41	34	29	25	22	20
21ton class bulldozer	0.45	55	43	35	30	26	23	21
	0.60	73	57	47	40	35	31	28
	0.70	85	67	55	47	41	36	32
32ton class bulldozer	0.45	91	72	59	51	44	39	35
	0.60	122	96	79	67	59	52	47
	0.70	142	112	92	79	68	61	54

1) Equation: 60 x (dozing amount/time) x operating efficiency / cycle time
2) Cycle time: 0.038 x dozing distance + 0.65
3) Operating efficiency: See the table below
4) Dozing amount: 15ton class 1.75m^3, 21ton class 2.85m^3, 32ton class 4.77m^3

Type of soil	Operating efficiency	
	Ground	Dig up
Sand	0.65	0.7
Sandy soil		
Gravel soil	0.55	0.6
Cohesive soil		
Gravel	0.4	0.45
Crushed rock	-	0.35

b. Bulk Density of Unloaded Waste

According to the Time and Motion Survey, average payload of 16yd^3 (12.2m^3) collection vehicle was about 5 ton. This leads to 0.41 ton/m^3 of bulk density of waste in vehicle. When the waste is unloaded on the ground, it will be loosed. Bulk density of waste after being unloaded is assumed as **0.35 ton/m^3**.

c. Operation Hour

Operation hour of the pilot project was set as Table 7-31 shows; waste was to be received for 6 hours, to be compacted for 6 hours, and to be covered for one hour.

Table 7-31: Operation Hour

Hour	Receiving	Compacting	Covering
8:00-9:00			
9:00-10:00			
10:00-11:00			
11:00-12:00			
12:00-13:00	Lunch Break		
13:00-14:00			
14:00-15:00			
15:00-16:00			
16:00-17:00			

d. Waste Disposal Amount

According to the above mentioned:

i. Waste disposal amount per hour is 20 ton/h.

$$55m^3/h \times 0.35ton/m^3 = 19.25ton/h \qquad say, \quad 20ton/h$$

ii. Waste disposal amount per day is 120 ton/day.

$$20ton/h \times 6hours = 120ton/day$$

iii. The amount is equivalent to 24 collection vehicles (16 yd^3).

$$120ton/day \div 5ton/vehicle = 24vehicles$$

e. Design of Cell Size

It is said that bulk density of compacted waste is between 550 and 1,200 lb/yd^3 (326 – 712 kg/m^3)[3]. The value was derived from waste in USA. Considering the nature of waste in developing countries, its bulk density was set as 700 kg/m^3 (0.7 ton/m^3). As the waste amount dealt with in a day was set as 120 ton, it would become 171 m^3.

$$120ton \div 0.7ton/m^3 = 171m^3$$

Amount of cover soil necessary is often said between tenth and fifth of waste amount. Various literatures recommend various thicknesses for daily cover soil, but it generally falls in between 15 and 30 cm. With taking into account the above mentioned, 20% (fifth) of waste volume was considered as cover soil amount. It becomes 34m^3. Bringing them together, the volume of cell is to be 205m^3.

$$171m^3 \times 20\% = 34m^3$$
$$171m^3 + 34m^3 = 205m^3$$

Considering area and slope for bulldozer' operation, the size of cell was set as follows.

- Length: 10m
- Width 10m
- Height: 2m
- Slope: 1:3

[3] George Tchobanogrous, Hilary Theisen and Samuel A. Vigil, 1993, Integrated Solid Waste Management, McGraw Hill

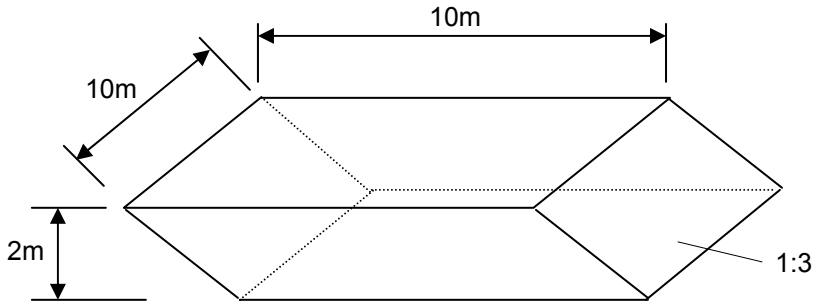


Figure 7-6: Dimension of Cell

f. Soil Cover

As mentioned above, amount of cover soil was set as 20% of waste volume, i.e., 34m^3. The area to be covered with soil everyday would be 226 m^2 according to the dimension of cell. These figures gave 15cm thickness of cover soil. This was in the range of recommended thickness of cover soil. Then, the thickness was judged as appropriate as daily cover soil.

$$10m \times 10m + 10m \times 6.3m \times 2 = 226m^2$$

$$34m^3 \div 226m^2 = 0.15m \quad (15cm)$$

g. Countermeasures to Rainwater

Rainfall at the Cerro Patacon Landfill is very intense and heavy. Therefore, it was designed to slope the surface of the cells at 2% and to make a bank with soil at edges. Besides, it was planed to begin the operation at the center of the landfill and to move to the edge in order to avoid that the operation area would be inundated. Numbers in Figure 7-7 (B: Landfilling Schedule) shows order of landfilling. 1 means the 1st day of operation, 2 is the 2nd day of operation in sequence.

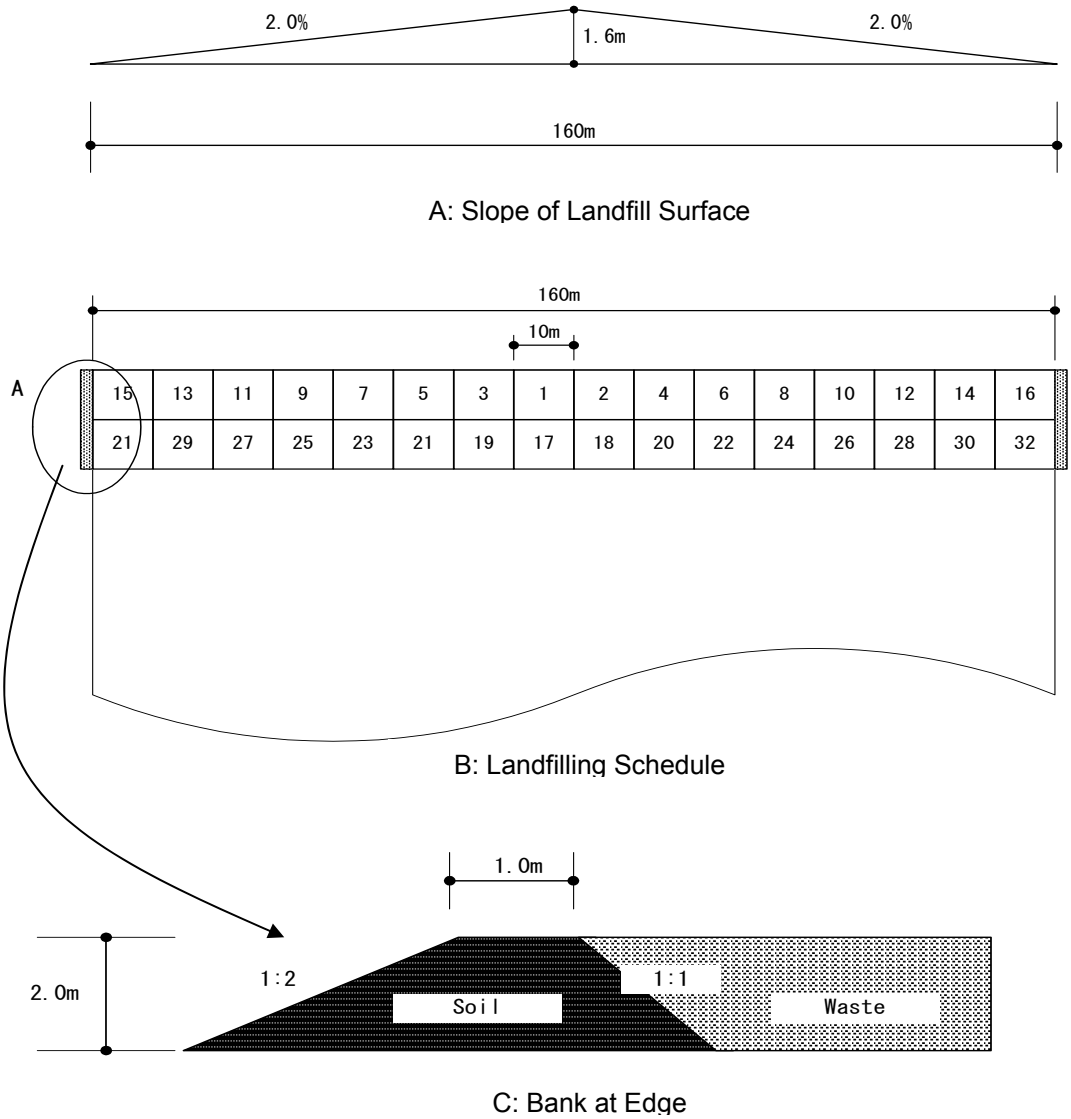


Figure 7-7: Consideration of Rainwater

7.3.3 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

a. Heavy Equipment used in the Pilot Project

At the beginning of the pilot project, a bulldozer of D7 was supposed to use. However, 3 types of heavy equipment were assigned eventually, because the D7 was damaged and could not be repaired, then alternate equipments were delivered. Equipments used in the pilot project were the following.

Table 7-32: Heavy Equipment used in the Pilot Project

Equipment	Type	Operating weight*
D8 (Caterpillar)	Bulldozer	About 37 ton
D65 (Komatsu)	Bulldozer	About 18 ton
D6R (Caterpillar)	Bulldozer	About 18 ton
CAT 815 (Caterpillar)	Compactor for road construction (soil)	About 20 ton

* According to specifications

b. Waste Amount Disposed

Waste amount disposed of during the pilot project is shown in Table 7-33. About 24 units of 16-yd^3 compactor trucks were received per day as planned. However, 36 units were accepted to dispose of in the last week to check if the heavy equipments were able to deal with larger amount of waste than planed.

Average waste amount brought by the 16-yd^3 compactor truck (5.4 ton/truck) was a little higher than expected (5.0 ton/truck).

Table 7-33: Waste Amount Disposed

Unit: ton/day

No.	Date	Waste (ton)	Nos. of vehicle	Waste (ton/vehicle)
1	8/ 5	149.91	27	5.6
2	6	136.35	24	5.7
3	7	127.38	25	5.1
4	8	128.86	24	5.4
5	9	148.00	24	6.2
6	12	131.04	24	5.5
7	13	134.82	24	5.6
8	14	128.55	26	4.9
9	16	128.96	24	5.4
10	19	89.38	17	5.3
11	21	116.84	23	5.1
12	22	146.48	25	5.9
13	23	125.06	24	5.2
14	26	181.17	36	5.0
15	27	199.27	36	5.5
16	28	123.00	24	5.1
17	29	201.86	36	5.6
Total		2,396.93	443	*5.4 (average)

c. Operating time of Heavy Equipment

As Table 7-34 shows, heavy equipment that was most used in the pilot project was D65P. The second one was D8L, the third one was CAT815 and the least used one was D6R. D8L was mostly used for compaction, because it was not suitable for the work of covering soil, as the pilot project area was too small for the large equipment. CAT815 was used only for the compaction together with bulldozer. It could not do the work of covering soil, as the tire is not designed for such work. D65P was the most suitable for use in the pilot project. It compacted waste well in a small area and covered waste with soil appropriately.

Table 7-34: Operating Time of Heavy Equipment (by type of equipment)

Unit: minute

Equip	Compaction	Soil cover	Idling	Total
D8L	1,369	218	1,036	2,623
	52.2%	8.3%	39.5%	100.0%
D65P	2,892	1,202	1,658	5,752
	50.3%	20.9%	28.8%	100.0%
D6R	0	62	0	62
	0.0%	100.0%	0.0%	100.0%
CAT815	642	0	791	1,433
	44.8%	0.0%	55.2%	100.0%
Total	4,903	1,482	3,485	9,870
	49.7%	15.0%	35.3%	100.0%

Table 7-35: Operating Time of Heavy Equipment (by day)

Unit: minute

No.	Date	Compaction	Soil cover	Idling	Total	Equip.
1	8/5	559	N/A	163	722	CAT815+D65P
2	6	516	35	403	954	CAT815+D65P
3	7	427	30	279	736	CAT815+D65P
4	8	428	24	471	923	CAT815+D65P
5	9	313	26	142	481	D65P
6	12	272	103	127	502	D65P+D8L
7	13	201	150	470	821	D65P+D8L
8	14	219	131	174	524	D65P+D8L
9	16	263	125	136	524	D65P+D8L
10	19	175	73	210	458	D65P+D6R
11	21	203	73	166	442	D65P
12	22	266	123	86	475	D65P+D8L
13	23	194	110	108	412	D65P+D8L
14	26	231	105	160	496	D65P+D8L
15	27	198	154	138	490	D65P+D8L
16	28	164	134	112	410	D65P
17	29	274	86	140	500	D65P
Total		4,903	1,482	3,485	9,870	

N/A: Not Available

d. Finished Dimension of Cell

As Table 7-36 shows, the average finished dimension of cells was almost according to plan (L x W x H = 10 x 10 x 2). For some days, heights showed considerably lower than the plan. This was due to height of the original level. In order to maintain the height of cells' surface, the height of cell was kept at lower than planned.

The average bulk density of waste after compaction, 0.755 ton/m^3, was higher than planned, 0.7 ton/m^3. The minimum bulk density was 0.546 ton/m^3 and the maximum was 0883 ton/m^3.

Table 7-36: Finished Dimension of Cells

No	Date	Dimension of Cell				Waste	
		Length (m)	Width (m)	Height (m)	Volume (m^3)	Amount (ton)	Density (ton/m^3)
1	8/5	9.50	10.00	2.08	197.60	149.91	0.759
2	6	8.85	9.00	1.96	156.11	136.35	0.873
3	7	8.20	9.15	2.13	159.81	127.38	0.797
4	8	8.70	9.70	1.99	167.94	128.86	0.767
5	9	9.50	10.00	2.00	190.00	148.00	0.779
6	12	7.00	10.00	2.14	149.80	131.04	0.875
7	13	8.00	9.50	2.01	152.76	134.82	0.883
8	14	9.20	10.00	1.79	164.68	128.55	0.781

9	16	9.20	10.30	1.89	179.10	128.96	0.720
10	19	9.10	11.60	1.55	163.62	89.38	0.546
11	21	7.10	9.70	2.13	146.69	116.84	0.797
12	22	8.60	10.40	2.00	178.88	146.48	0.819
13	23	10.75	10.90	1.92	224.98	125.06	0.556
14	26	14.00	10.33	1.80	260.39	181.17	0.696
15	27	14.53	9.90	1.65	237.35	199.27	0.840
16	28	16.60	9.37	1.33	206.87	123.00	0.595
Average		9.93	9.99	1.90	183.54	137.19	0.755

e. Cover Soil

The average soil amount used for covering waste, or 54.4 m^3, was considerably much more than planed, or 34 m^3. There is a large difference between the calculated thickness and the measured thickness as shown in Table 7-37. The measured thickness was obtained by subtracting the height measured before covering soil from the height measured after covering soil. Meanwhile, it was regarded the thickness of soil was sufficient from the observation during the pilot project, as the waste was properly covered with soil. According to the mentioned above, possible causes of the difference between the calculated thickness and the measured one are as follows.

- Actual height of cell without cover soil might be lower than one measured before covering soil, because the waste was further compacted during being covered with soil. Then, actual thickness of soil cover might be higher than the measured one.
- Some amount of soil was not carried to the area where the waste was covered with soil, as there was some distance between the area where soil was unloaded by trucks and the area where waste was disposed of.
- Operators of heavy equipment were not used to the operation manner applied to the pilot project. Waste was often tumbled and mixed with soil. This might reduce the thickness of cover soil.
- Soil amount was measured by counting number of buckets of the excavator. This measurement manner may contain a large degree of error.

Table 7-37: Cover Soil

No	Date	Area (m^2)	Soil (m^3)	Calculated thickness (cm)	Measured Thickness (cm)
1	8/5	223.17	59.6	27	14
2	6	190.21	87.9	46	4
3	7	191.81	57.3	30	5
4	8	200.1	41.3	21	11
5	9	218.24	42.8	20	7
6	12	184.96	39.8	22	10
7	13	187.15	56.6	30	10
8	14	200.6	37.5	19	6
9	16	211.22	61.9	29	11
10	19	206.95	45.1	22	NA
11	21	181.95	50.5	28	9
12	22	209.52	59.6	28	NA
13	23	248.53	56.6	23	13
14	26	283.07	55.8	20	13
15	27	271.23	59.6	22	3
16	28	264.69	58.9	22	8
Average		217.09	54.4	26	9

f. Unloading Time of Collection Vehicle

Table 7-38 and Table 7-39 show time spent for unloading waste from collection vehicles at the pilot project area and at Etapa I respectively. In the pilot project area, an area where waste should be disposed of was designated clearly everyday, the collection vehicles were guided by personnel on the site and there was no activity by the waste-pickers. In Etapa I, disposal areas were not clearly designated and many waste-pickers worked in the site. The difference between the average in the pilot project area, or 6 minutes, and one in Etapa I, or 10 minutes, may be due to the differences of situation on the sites.

Table 7-38: Discharge Time (Pilot Project Area)

Unit: Minute

No	Date	Nos. of vehicle	Discharge	Average
1	8/5	27	247	9
2	6	24	154	6
3	7	25	145	6
4	8	24	132	6
5	9	24	139	6
6	12	24	142	6
7	13	24	145	6
8	14	26	160	6
9	16	24	130	5
10	19	17	94	6
11	21	23	122	5
12	22	25	129	5
13	23	24	122	5
14	26	36	189	5
15	27	36	223	6
16	28	24	117	5
17	29	36	201	6
Total/Average		443	2,591	6

Table 7-39: Discharge Time (Etapa I)

Unit: Minute

No	Date	Nos. of vehicle	Discharge time	Average
1	5	22	232	11
2	6	124	1,260	10
3	7	112	1,078	10
4	8	104	983	9
5	9	100	1,161	12
6	12	120	1,167	10
7	13	123	1,320	11
8	14	138	1,531	11
9	16	113	1,053	9
10	19	127	1,058	8
11	21	120	1,351	11
12	22	124	1,202	10
13	23	132	1,297	10
14	26	88	874	10
15	27	111	1,089	10
16	28	109	1,129	10
17	29	99	1,013	10
Total/Average		1,866	18,798	10

7.3.4 Analysis and Evaluation of the Landfill Operation Method

a. Performance Capacity of Heavy Equipment

Days when only D65P worked were August 5, 11, 28 and 29 (See Table 7-40). The waste amount dealt with was in the range between 28 and 45 ton/hr that is equivalent to 80 and 129 m^3/hr of unloaded waste, when the bulk density is assumed 0.35 ton/m^3. The bulldozer showed much more performance capacity than expected (34 to 52 m^3/hr for 15 ton class bulldozer, See Table 7-30). Meanwhile, the bulk density of waste after being compacted by the D65P felled between 0.595 and 0.797 ton/m^3. The lowest bulk density 0.595 ton/m^3 was recorded at the highest waste amount dealt with. This may imply that 129m^3/hr of waste would be overload for D65P.

In the combination use of D65P and D8L, D8L was used mainly for compaction and D65P for covering soil. Therefore, it can be said that the waste amount dealt with reflects the performance capacity of D8L. The range of waste amount dealt with was between 28.9 and 60.4 ton/hr (83 to 173 m^3/hr) and the bulk density after compaction was between 0.556 and 0.883 ton/m^3. As 0.840 ton/m^3 of bulk density was recorded when the highest waste amount (173 m^3/hr) was dealt with the D8L may have more performance capacity than 173 m^3/hr.

Table 7-40: Performance Capacity of Heavy Equipment

No.	Date	Waste (ton/day) a	Operating time (min) b	Waste (ton/hr) a/(b/60)	Density (ton/m^3)	Equipment
1	8/5	149.91	559	16.1	0.759	CAT815+D65P
2	8/6	136.35	516	15.9	0.873	CAT815+D65P
3	8/7	127.38	427	17.9	0.797	CAT815+D65P
4	8/8	128.86	428	18.1	0.767	CAT815+D65P
5	8/9	148.00	313	28.4	0.779	D65P
6	8/12	131.04	272	28.9	0.875	D65P+D8L
7	8/13	134.82	201	40.2	0.883	D65P+D8L
8	8/14	128.55	219	35.2	0.781	D65P+D8L
9	8/16	128.96	263	29.4	0.720	D65P+D8L
10	8/19	89.38	175	30.6	0.546	D65P+D6R
11	8/21	116.84	203	34.5	0.797	D65P
12	8/22	146.48	266	33.0	0.819	D65P+D8L
13	8/23	125.06	194	38.7	0.556	D65P+D8L
14	8/26	181.17	231	47.1	0.696	D65P+D8L
15	8/27	199.27	198	60.4	0.840	D65P+D8L
16	8/28	123.00	164	45.0	0.595	D65P
17	8/29	201.86	274	44.2	N.A	D65P
Average		141.00	288	33.2	0.755	

b. Bulk Density of Waste after Compaction

Figure 7-8 shows that relation between bulk density of waste after compaction and time spent for compacting waste. Although the number of samples is small, the graph may imply the following.

- The maximum bulk density of waste after compaction will be around 0.8 ton/m^3. It would not exceed 0.9 ton/m^3.
- D8L will achieve the maximum bulk density immediately.
- D65P can achieve the planned bulk density, or 0.7 ton/m^3, with a little workload. It requires twice as the workload to realize the maximum density, 0.8 ton/m^3.

Consequently, it is recommendable for D65P to spend time to compact waste about two minutes per ton of waste, where the planned bulk density of 0.7 ton/m^3 will be achieved economically. Meanwhile, much less time for compaction shall be spent in case that D8L is used, i.e., one or less minute per ton of waste.

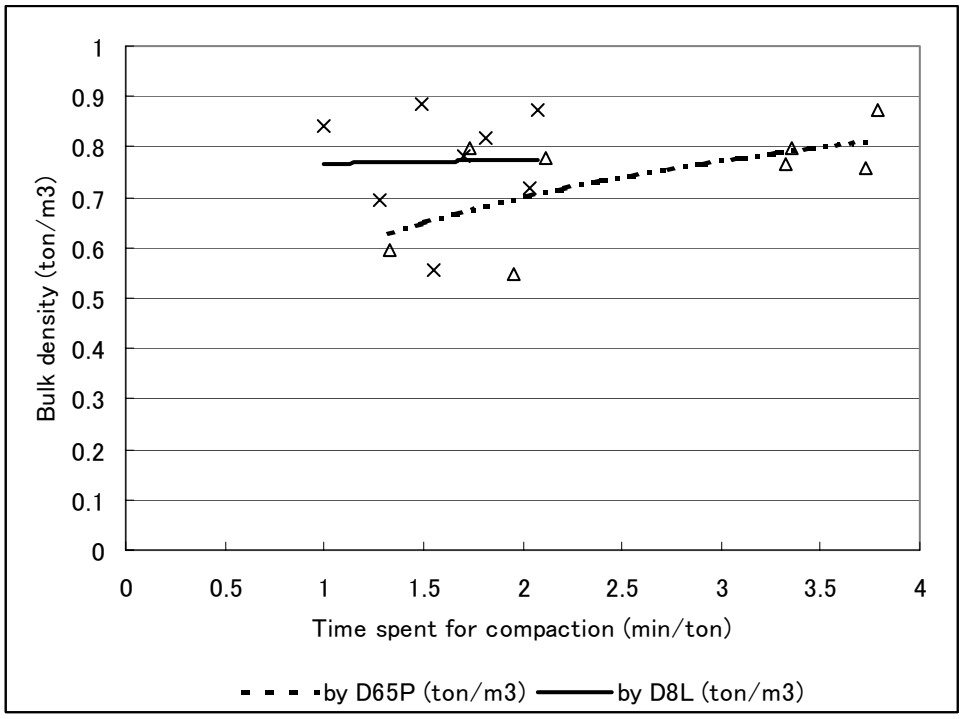


Figure 7-8: Relation between Density and Compaction Time

c. Required Amount of Cover Soil

As mentioned in the section of Implementation, soil amount that was actually used, 54.4 m^3 on the average, was much more than the planned, 34 m^3, i.e., 1.6 times as planned. The less amount of soil is used, the longer life of landfill is realized. The use of soil will be reduced by the following.

- Operators learn appropriate operation.
- Soil is put as close to the operation area as possible.
- Height of cell is increased up to 3 m, then, surface area is reduced in proportion to volume of waste.

d. Recommended Landfill Operation Method

Based on the implementation, analysis and evaluation of the landfill method designed at the beginning of the pilot project, a landfill operation method is recommended shown in Table 7-41.

Table 7-41: Recommended Landfill Operation Method

Items	Description
Heavy equipment 1. Bulldozer, D6 and D7 class 2. Bulldozer, D8 class 3. Excavator 4. Dump truck	 : for accumulating and compacting waste, and covering waste with soil : for accumulating and compacting waste : for excavating soil and for making banks at edge : for carrying soil
Performance capacity of bulldozer 1. D6 and D7 class 2. D8 class	Waste amount for compaction : 30 ton/hr (2 min/ton); D7 could deal with more than this. : 60 ton/hr (1 min/ton) Note; if distance between where waste is discharged and where waste is compacted is more than 20 m, the performance capacity will decrease.
Bulk density of waste 1. Unloaded waste 2. Compacted waste	 : 0.35 ton/m^3 : 0.70 ton/m^3
Dimension of cell 1. Length 2. Width 3. Height 4. Slope	 : More than 10.0 m : More than 10.0m : 2.0 to 3.0 m : 1 to 3
Soil cover 1. Thickness 2. Amount	 : 15 cm : 20 % of waste volume
Countermeasures to rainwater	Slope of surface of cells is 2.0%
Supervision	Define an area where waste is disposed of on the day Measure a cell after operation every day

7.3.5 Rule to Separate the Waste-pickers' Activities and the Landfill Operation

Objective of sanitary landfilling is to dispose waste sanitarily and quickly without giving serious negative impacts on the environment.

Waste picking is incompatible to the sanitary landfilling. Those should not be carried out coincidentally. Waste picking shall not be allowed from a viewpoint of appropriate landfill operation. The society should also not overlook the unsanitary, dangerous and atrocious activity of waste picking in the landfill. Therefore, it is expected that the waste picking in the landfill will be prohibited.

However, it is not undesirable that the waste picking in the landfill is definitely prohibited before the waste-pickers find alternative means of living, if the society considers the fact that the waste-pickers have earned their bread and butter by the activity. It is desirable that the prohibition of waste picking in the landfill carried out stepwise in parallel with the program to create job opportunity for the waste-pickers. In this regard, it is very important that the

organizations concerned participate in the program and carry out their responsibilities without shifting all responsibilities onto the landfill owner.

The society altogether should consult on the issue of waste-pickers. It will take a long time. However, the problem exists at present and measures to improve it are expected. The following are what are discussed and agreed by the C/P and the S/T.

- The operation area does not have fence to restrict access of unauthorized persons. This has made the situation uncontrolled.
- The fence will be constructed around Etapa II by December 2002.
- Waste-pickers will be checked at a gate and registered.
- Operation area and area for waste picking will be divided clearly to avoid accidents.

7.3.6 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.

One of important roles of pilot projects is to actually show expected outcome and to prod persons concerned to change for improvement. Through this pilot project, the C/P and the contractor have realized that they can implement the sanitary landfilling by themselves and what sort of effects it brings. It can be evaluated that the pilot project fully carried out the important role.

7.4 DIMAUD Management Improvement

7.4.1 Background

DIMAUD came into being when the responsibility for solid waste disposal services provided by DIMA was transferred to the municipalities of Panama, Colon and San Miguelito in 1999. According to the financial report, DIMAUD income exceeded expenditures in the years 2000

and 2001. The accounting system was the government accounting for budget control, rather than the cost accounting for cost control. This gave rise to a number of difficulties:

1. Data on operation and accounting made it possible to calculate the yearly total cost per ton, but the cost per ton by component activity was less reliable, as waste flow analysis and broken down cost figures were not readily available.

2. There was no monitoring system to evaluate operation/financial performance through the use of quantified indicators.

The shortage of detailed cost data and performance indicators possibly prevented DIMAUD from advancing more aggressively with implementation of improvement measures. The obvious adverse effect on DIMAUD finances suggested the need for the establishment of a system to register and allocate cost to appropriate component activities, which can also permit computation of quantified performance indicators.

CEPIS (Centro Panamericano de Ingenieria Sanitaria y Ciencias del Ambiente) has prepared COSEPRE ("Costo de Servicios Prestados" or "Cost of Services Provided") as a tool to keep all costs related to solid waste service, allocating each cost to the appropriate activity, and compute some quantified performance indicators. However, COSEPRE is designed for the service provider as a whole on the basis of one-year data, that is, the analysis time-frame is one year. In the case of DIMAUD, as Collection and Maintenance Costs comprised 53% of total cost in 2001, the Study Team considered as more appropriate to concentrate on the largest cost component, on the basis of a system that would permit cost control by SW collection route on daily basis. Then, management improvement would result from improving performance of the largest cost component.

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. Selection of Target Group

Due to the need of operation data, the target geographic area was chosen to be the same as the target area of the Collection Improvement Pilot Project. The target area was San Pedro 2 in Corregimiento Juan Diaz. The target area and the target group consisted of 2,940 households and business firms, and 12,000 residents.