Chapter 1

Introduction

1 Introduction

1.1 Background

Panama District in the republic of Panama has a population of about 700 thousand and covers an area of about 2,500 square kilometers as of year 2000.

Solid waste management (SWM) in Panama District was under the jurisdiction of the Panamanian government and transferred to Municipality of Panama in 1999. However, the municipality had not formulated a concrete basic plan for SWM due to lack of human resources. Thus, the waste management system had still to be established.

The present SWM in the Municipality of Panama stresses only on daily collection of mixed waste from the urban area. As economy grows and society changes in the future, the following concepts will become more important:

- Reduction of waste amount and resource conservation
- Efficient operation of Municipal Solid Waste Management (MSWM)

At present, there is no intermediate treatment system established such as material recovery and incineration in the municipality of Panama. The waste generated from the municipality is collected and transported to Cerro Patacon, a sanitary landfill located in the same municipality, as well as waste from the municipality of San Miguelito (population 300 thousand) and the neighboring areas.

However, there are problems. Industrial and medical waste is also disposed in this landfill without treatment and around four hundred waste pickers live on the waste. Besides, some wastes that are not collected are often dumped besides roads and into rivers that finally flow into Panama Gulf, which is causing serious environmental problems.

Under these circumstances, recognizing the necessity of overall waste management including enlightenment of community people's consciousness, the Panama municipality requested 'the Study on Solid Waste Management Plan for Municipality of Panama in the Republic of Panama' (hereinafter referred to as "the Study") to the government of Japan in August 2000.

In response to the request, the government of Japan dispatched the Preparatory Study Team in August 2001 and the team signed and exchanged the scope of work.

JICA appointed Kokusai Kogyo Co., Ltd. as the consultant of the Study.

1.2 Objectives of the Study

1.2.1 Objectives of the Study

The Study has the following three objectives:

- Formulation of a Master Plan on solid waste management in the municipality of Panama targeting the year 2015
- Implementation of Feasibility Study for selected priority project(s)
- Technology transfer to the counterpart personnel in the course of the Study

1.2.2 Study Area

The study covers the area under the jurisdiction of the municipality of Panama, but not covers the municipality of San Miguelito and other municipal areas that avail themselves of Cerro Patacon Final Disposal Site. However, it was carried out to collect data and to estimate waste amount of those municipalities, in order to attain the objectives mentioned above.

1.2.3 Solid Waste to be Covered Under the Study

This study covers municipal solid waste, industrial waste and medical waste. However, the study on industrial and medical waste were carried out **NO** further than grasp of present condition and suggestion to find and handle problems in the master plan.

Municipal solid waste consists of:

- Household waste
- Commercial waste
- Institutional waste
- Market waste
- Road sweeping waste

1.2.4 Target Years

Target years set in the Study are as follows.

i) Master Plan 2015

ii) Selected Priority Projects

The Final Disposal Project

- Phase I 2006 to 2008(operation)
- Phase II 2008 to 2010(ditto)
- Phase III 2010 to 2011 (ditto)
- Phase IV 2012 to 2015 (ditto)

The Transfer and Transport Project

- Phase I 2005 to 2007
- Phase II from 2008

1.3 Key Assumptions

The following assumptions are used in this Study.

a. Population

Table 1-1: Population Forecast

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

b. Economic Growth

Table 1-2: Projection of GDP Growth Rate

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

c. Waste Amount

Table 1-3: Forecast of Waste Generation Amount

unit : ton/day

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

d. Waste Composition

Table 1-4: Waste Composition of Panama Municipality

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

Source: Results of WACS in this study

1.4 Work Schedule of the Study

The Study consisted of the following two phases.

Phase I: Formulation of Master Plan

Phase II: Feasibility Study on Priority Project(s) and implementation of Pilot Project(s)

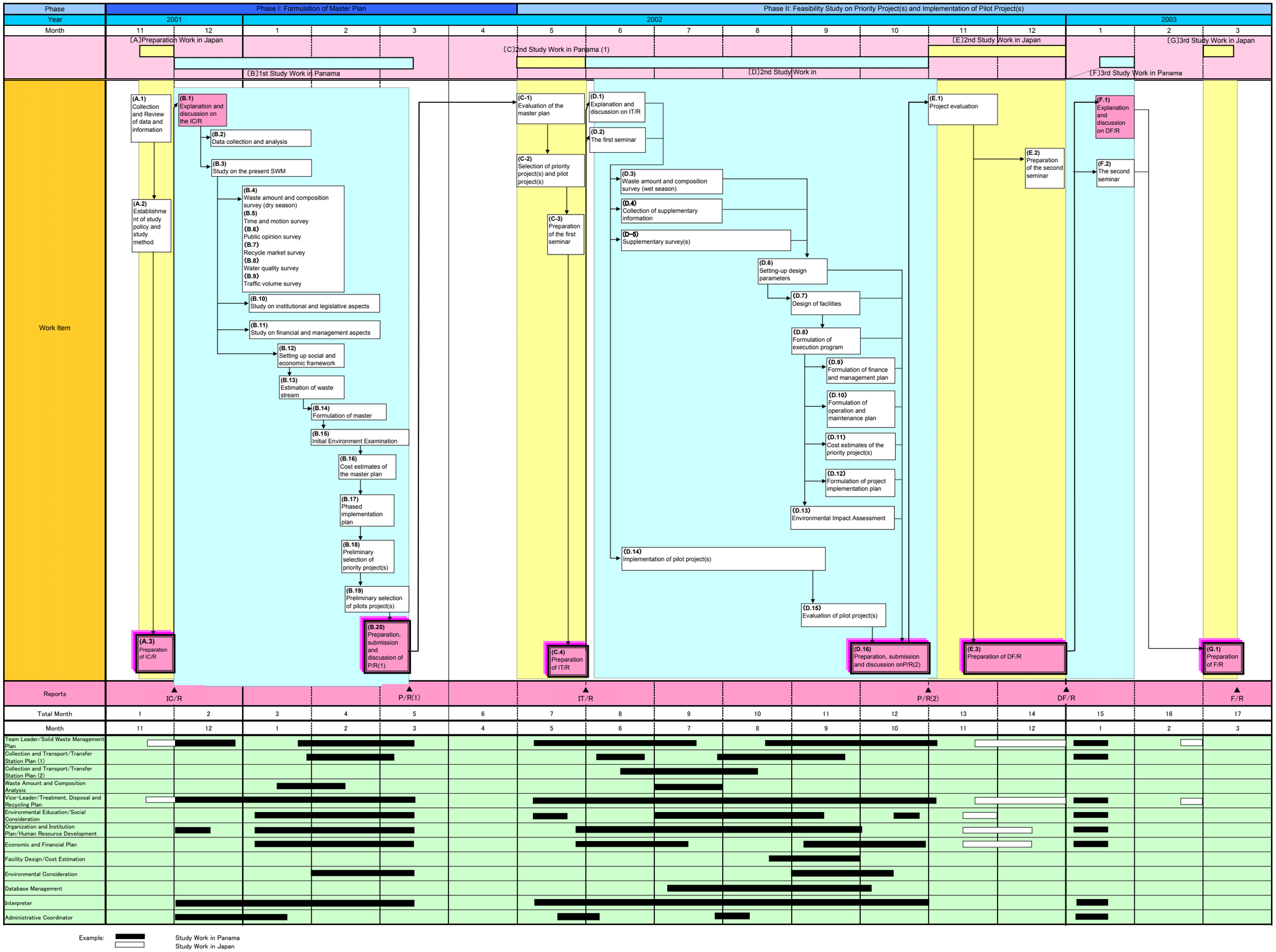


Figure 1-1: Overall Study Work Flow

1.5 Organization of the Study and the Assignment of the Study Team

On the basis of the Scope of Work and the Minutes of Meeting signed by both the Panamanian side and the Japanese side in the course of the Preparatory Study; the Municipality of Panama is the counterpart agency and the coordinating body in relation with other governmental and non-governmental organizations, it organized a counterpart team consisting of appropriate role and number of personnel corresponding to the experts of the Study Team, and it arranged the Steering Committee on the times of submissions of IC/R, P/R(1), IT/R, P/R(2) and DF/R.

The Advisory Committee organized by JICA provided JICA with the necessary advice.

1.5.1 Organizational Structure of the Study

The figure below schematizes the organizational structure of the Study.

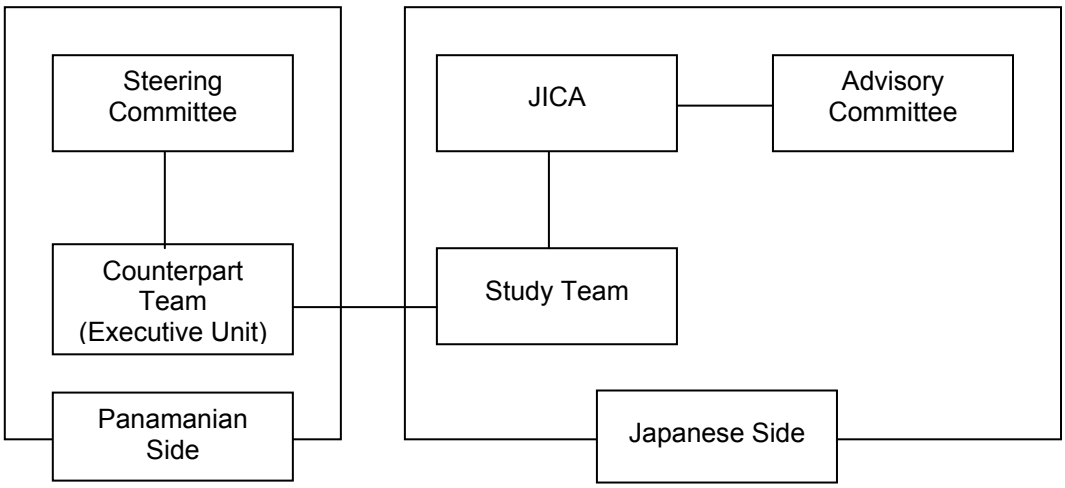


Figure 1-2: Organizational Structure of the Study

1.5.2 Members of the Study Team

The following are the members of the Study Team.

Assignment	Expert	Nationality
Team Leader /Solid Waste Management Plan	Hiroshi Kato	Japanese
Collection and Transport /Transfer Station Plan (1)	Ana Ximena Alegria Olivos	Chilean
Collection and Transport /Transfer Station Plan (2)	Carlos Eduardo Melendez Avalos	Salvadorian
Waste Amount Composition Analysis	Ken Kashima	Japanese
Vice-Leader /Treatment, Disposal and Recycling Plan	Ikuo Mori	Japanese
Environment Education /Social Consideration	Masaharu Kina	Japanses
Organization and Institution Plan /Human Resource Development	Victor Ojeda Rodriguez	Costa Rican
Economic and Financial Plan	Masaru Obara	Japanese
Facility Design/Cost Estimation	Osamu Nahata	Japanese
Environmental Consideration	Hortensia I. Broce	Panamanian
Database Management	Kunito Ishibasi	Paraguayan
Interpreter	Mario Valle	Salvadorian
Administrative Coordinator	Yumiko Asari	Japanese
Administrative Coordinator	Masahiko Takahasi	Japanese
Administrative Coordinator	Tomomi Kitajima	Japanese
Administrative Coordinator	Ryoichi Ogawa	Japanese

1.5.3 Member of the JICA Advisory Committee

The following are the members of the JICA Advisory Committee.

Assignment	Member	Position
Chairman	Hidetoshi Kitawaki	Toyo University
Member	Hiroto Komoda	Municipality of Fukuoka
	Ryoji Ijima	Municipality of Fukuoka

1.5.4 Members of the Counterpart Personnel

The following are the member of the counterpart personnel.

Assignment	Member
Leader	Mr. Mario Conte
Collection/Transport	Mr. Alvis Morales
Waste Amount/Waste Composition	Mr. Alonso Filós
Treatment/Disposal	Mr. Ricardo Garay
Recycling	Mr. Lorenzo Tejeira
Education/Public Communication	Mr. Frank Quintero
Sociology	Ms. Patsy Arcia
Organization Management	Mr. Amado Cantoral
Institution/Legislation	Mr. Erick Prado
Financial Management/Accounting	Mr. Franklin Alba
Environment	Mrs. Bethzaida Valverde
Urban Planning	Ms. Berta Donoso de Velasquez

1.5.5 Members of the Steering Committee

The following members participated the steering committee meetings during the Study.

Ministry of Economy and Finance
- Dr. Aurelio A. Mejía R. (Economic Assessor for the Minister)
- Ms. Daría Cohen de Ruiz (Chief of Department of Technical Cooperation, DCTI)
- Ms. Eira Rosas (Coordinator of Bilateral Cooperation, DCTI)

Ministry of Health
- Dr. José Alberto Arrocha (Advisor to the Minister)
- Mr. Raúl de Saint Malo Arias (National Director of International Affairs)
- Dr. Elda Velarde (Environmental Health General Sub-director)
- Mr. Felipe Castillo (Chief of External Cooperation)
- Ms. María Inés Esquivel (Chief of Department of Environmental Sanitary Quality)
- Ms. María E. Ulloa (Chief of Section of Non-hazardous Waste)

National Environmental Authority
- Ms. Rosario de Icaza (Chief of Direction of International Technical Cooperation)
- Mr. Rodolfo E. Batista S. (Chief of the Department of Environmental Control and Quality)
- Ms. Regina Logreira (Coordinator of Technical Cooperation, Direction of External Affairs)
- Mr. Denis González (National Direction for Environmental Evaluation and Regulation)
- Ms. Carmen Lay (Official for the Department of Environmental Control and Quality)

Municipality of Panama (Chairman)
- Mr. Juan Carlos Navarro (Mayor)
- Dr. Edgard Spence (Assessor for the Mayor on International Affairs)
- Mr. Pedro Castillo (Assistant for International Relations)
- Mr. Jorge Saenz (Director of DIMAUD)
- Mr. Emilio Palomeras (General Sub-director for DIMAUD)

Municipality of San Miguelito

Mr. Heraclio Barahona	(Vice-mayor)
Mr. Hernan Quintero	(Engineering)
Mr. Roberto García Fuentes	(Planning)
Mr. Javier Rodriguez	(Legal Department)
Mrs. Anielka Adames	(Institutional Image)

1.6 Technology Transfer

During the Study, the Study Team endeavored to transfer technology to the Panamanian side through the following activities.

Opportunities	Target	Contents	Frequency
On the Job Training	Counterpart	• Survey method • Analysis and evaluation method of survey results • Extraction of problems • Countermeasures • Planning and implementation of surveys • Planning, implementation and evaluation of pilot project(s)	Throughout the study.
Technology discussion	Counterpart	• Survey method, procedure, progress and results • Planning method • Formulation of alternative plans • Selection of a suitable plan • Project evaluation method • Introduction of Japan's and other countries' technology on solid waste management	Every two weeks
Report explanation meeting	Counterpart Steering committee member	• Planning, analysis of survey results and countermeasures at each stage.	At IC/R, P/R(1), IT/R, P/R(2), DF/R
Technology transfer seminar	Counterpart Steering committee member Community representative	• Raising recognition about present situation of solid waste management in Panama municipality and implementation of concrete countermeasures.	During the explanation of IT/R and DF/R
Counterpart training	Counterpart	• Visit to the institutions concerned with priority project(s) in Japan in order to raise recognition about effective institution management and its problems.	Once

Chapter 2

Profile of the Study Area

2 Profile of the Study Area

2.1 Natural Conditions

2.1.1 Location

Panama is located in the northern hemisphere, between Latitude north 7° 12' 07" and 9° 38' 46" between Longitude west 77° 09' 24" and 83° 03' 07". Panama spans as a land strip (approximately 225 km. wide) from east to west in the inter-tropical zone close to the Equator. Panama limits to the west with Costa Rica, to the east with Colombia, to the south with the Pacific Ocean, and to the north with the Atlantic Ocean. Panama has extensive coastlines of around 2,988.3 km long.[1].

The study area consists of the Panama District, which is located in the middle part of the Panama isthmus; the Panama District expands over the eastern side of the Panama canal.

2.1.2 Topography

The Panama Republic presents three morphostructural regions which are clearly defined from the perspective of topography, structure, and their geological history. These regions are a) Mountainous region, b) Hilly region, c) Lowlands and littoral plains[2]. Consequently, Panama is a country with sharp topographical contrasts which are characterized by a central mountainous region, commonly found in the Central American region, which descends toward both coast (Pacific and Atlantic). This pattern is accentuated due to the isthmus' narrowness. The main mountain ranges are Talamanca which runs from Costa Rica to Panama city's vicinity and San Blas which runs from Colon city (located in the Caribbean coast) to the Colombian border.

The study area also shows the three main morphostructural regions, mentioned previously, that shape its topography. The highest elevations are found in the north-northeast direction and descend to the Pacific coast; the urban area does not present sharp topographical contrast with elevations that range between 80 and 5 meters above sea level.

2.1.3 Climate

Table 2-1 shows the monthly average precipitation, temperature, wind velocity, and relative humidity during the last 5 years (1996-2000) in the area of Panama city, according to records from the meteorological station at Tocumen Airport.

[1] Panamá en cifras, Department of Statistics and Census
[2] Mapa Hidrogeológico de Panamá, Department of Hidrometeorology, 1999

Table 2-1: Climatic Parameters recorded at Tocumen Meteorological Station (1996-2000)

Concept/Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total (Ave.)
Average Monthly Rainfall (mm)	45.8	10.6	10.8	45.7	206.7	188.8	151.1	206	272.9	229.3	300.2	205.2	1,873.1
Average Monthly Temperature (^{o}C)	27.2	27.8	27.5	28.0	29.1	28.8	32.2	29.2	28.0	28.7	27.7	27.4	28.5
Average Monthly Wind Velocity (Knots)	8	10	9	8	7	7	6	7	7	6	7	9	8
Average Monthly Relative Humidity (%)	70	69	67	69	77	75	76	77	79	77	79	74	74

Source: Panamá en Cifras, Dirección de Estadísticas y Censo

2.1.4 Geological Conditions

The Republic of Panama is part of the geologic and geographic region called Costa Rica-Panama Isthmus. This region has limits to the west with the El Salvador-Nicaragua volcanic region and to the east with the Colombian Andes geological province.

The Panama District consists mainly of marine tertiary formation (central and south/south-east part of the District); it also consists of intrusive and extrusive rocks from the Miocene in both margins of the Panama canal. On the other hand, a volcanic and sedimentary basement is found in the north/northeast part of the District; additionally, volcanic rocks are located in the southeastern part of the District.[3]

Panama does not show as much seismic activity as Guatemala, El Salvador, Nicaragua, and Costa Rica. However, it has two zones of differentiated seismic activity; they are located in the southwestern part of Chiriqui province and the southwestern part of Darien

Around the final disposal site in Cerro Patacon, two regional faults are located. One of them is found nearby quarry ZP-1 which extends 2 km. to the northeast. The other fault runs parallel to the previous one separated by 1.5 km. to the southeast; it extends for 4 km. [4]

[3] Estructura Geológica, Tectónica y Morfología de América Central, Grabiel Dengo
[4] Estudio Identificación de sitios aptos para rellenos sanitarios ciudades de Panamá, Arraiján, Chorrera, Capira, y San Carlos, HidroGeo Servicios, Marzo, 2000

2.2 Socioeconomic Conditions

2.2.1 Macro-economy of the Country

a. Economically Active Population (EAP)

The Census of 2000 indicated a total population of 2,839,177 in the country, of which 1,161,612 as economically active population (EAP). The corresponding figures for Panama District were a total population of 708,438 and an EAP of 326,561.

Table 2-2: Economically Active Population (EAP)

Population	Country	Panama District
Total	2,839,177	708,438
Over 10 years old	2,216,191	578,700
EAP	1,161,612	326,561
Employed	1,010,837	282,601
Unemployed	150,775	43,960
Unemployment rate	13.0%	13.5%

Source: Censos Nacionales de Poblacion y Vivienda, 14 de mayo de 2000, Direccion de Estadistica y Censo, Panama

b. Gross Domestic Product (GDP)

During the 1995-1999 five-year period, total GDP of Panama measured in 1,982 USD grew 2.92% per year from 6,198 Million USD in 1995 to 7,157.7 Million USD in 1999. During the same period, the Panamanian per capita GDP, also measured in 1,982 USD, grew 1.58% per year, from U$2,356 in 1995 to U$2,548 in 1999, being unofficially estimated at U$2,571 in 2001. Total GDP grew fastest in 1997 at 4.5%, decreasing slightly to 4.1% in 1998, and 3.2% in 1999. The officially estimated preliminary growth rate was 2.9% in 2000, 1.8% in 2001, and the growth prospect for 2002 is 1.5%.

Table 2-3: Gross Domestic Product (GDP) Million USD

Economic Activity	1997	1998	1999
Primary sector	514.9	545.1	546.7
Secondary sector	1,230.4	1,263.6	1,326.5
Tertiary sector	4,912.2	5,124.2	5,284.5
GDP	6,657.5	6,932.9	7,157.7
GDP growth rate	4.5%	4.1%	3.2%
Per capita GDP	2,449.0	2,509.0	2,548.0
Per capita GDP growth rate	2.8%	2.4%	1.6%

Source: Informe del Contralor General de la Republica, 1 marzo 2000; Cuentas Nacionales 1989-1999, Direccion de Estadistica y Censo, Setiembre 2001, Panama

c. Manufacturing Industry

Manufacturing industry in the country in 1999 was classified into 40 types, comprising 883 firms, 37,931 employees, U$286,411,000 paid as salary, U$2,635,499,000 production value, and U$568,338,000 added value. The relative importance was ascertained by choosing manufacturing types that accounted for more than 5% of the total in terms of the following criteria: number of firms, number of employees, amount of salary paid, the value of production, and the added value.

Table 2-4: Manufacturing Industry in Panama, 1999

Criteria	Manufacturing Type
Number of firms	Bakery, apparel, printing, cement-lime-gypsum, metal works
Number of employees	Meat, dairy, bakery, apparel, plastics
Salary paid	Meat, dairy, bakery, oil refinery, plastics
Production value	Meat, dairy, milling, oil refinery
Added value	Meat, sugar, oil refinery, cement-lime-gypsum

Source: Industria Manufacturera, Direccion de Estadistica y Censo, Abril 2001, Panama

The above table indicates the importance of agriculture related industry (meat, dairy, bakery, milling, sugar), oil refinery, plastics, and construction (cement-lime-gypsum, metal works).

d. Construction

Total construction in the year 2000 amounted to U$332,662,506, of which 67% consisted of residential construction. Industrial construction amounted to less than 1%, but 93% of industrial construction took place in Panama District.

Table 2-5: Value of Construction in 2000 (USD)

Construction Type	Country	Panama District
Total	332,662,506	184,271,352
Residential	222,611,773	132,048,680
Commercial	89,163,667	32,724,398
Industrial	1,398,659	1,297,920
Others	19,488,407	18,200,353

Source: Industria Ano 2000, Direccion de Estadistica y Censo, Nov. 2001, Panama

e. Consumer Price Index (CPI)

CPI grew less than 1.5% per year during the last half of the 1990s. Sectors where CPI grew faster than the average growth rate were health care (more than 5%), education and public utilities (more than 3%).

Table 2-6: Consumer Price Index (CPI) (%)

Goods and Services	1997	1998	1999
Total	1.2	0.6	1.4
Food & beverage	0.7	0.4	0.2
Clothing	-2.0	1.3	0.4
Housing & public utilities	2.1	1.6	3.5
Furniture & house care	2.4	0.2	1.3
Health care	2.3	3.0	5.6
Transport & communication	2.2	-1.8	0.8
Entertainment & education	1.2	2.9	3.1
Others	1.2	0.4	-0.1

Source: Informe del Contralor General de la Republica, 1 marzo 2000

f. Public Sector Debt

Public sector debt in 1999 amounted to U$7,770 Million, of which 70% foreign debt and 30% domestic debt. Of foreign debt, 70% were of private sources (mostly bonds), 20% from multilateral organizations, and 10% from bilateral organizations. On the other hand, most domestic debt originated in public sources, namely, National Bank and Social Security. In 2001, public debt increased to U$8,183 Million, the foreign debt increasing its share to about 75%, or U$6,087 Million. A heated political debate is going on concerning the use of special funds (Fondo Fiduciario) to reduce the public sector debt.

Table 2-7: Public Sector Debt in 1999 (Million USD)

Sources	Total Public Sector	Central Government	Decentralized Sector
Total debt	7,770.9	7,566.6	204.3
Foreign debt	5,559.5	5,459.3	100.2
Multilateral organizations	1,157.0	1,097.6	59.4
Bilateral organizations	452.8	413.2	39.6
Private sources	3,949.7	3,948.5	1.2
Domestic debt	2,211.4	2,107.3	104.1
Private sources	653.9	651.7	2.2
Public sources	1,557.5	1,455.6	101.9

Source: Informe del Contralor General de la Republica, 1 marzo 2000

2.2.2 Regional Economy

a. Panama District EAP and Gross Regional Product (GRP)

As there are no officially published data on GRP, due consideration will be given to the little bit of existing data on regional economy, in an attempt to deduce the GRP of Panama District.

Of the EAP in the country, around 30% or 333,217 in 2001 were located in Panama District, according to the Household Survey of 2001. Further, employment data in Panama District in 2001 showed 2% in the primary sector, 20% in the secondary sector, and 78% in the tertiary sector. As expected, these data indicate employment in Panama District to be more skewed toward secondary and tertiary sectors.

Limited data available on regional economic activity confirm the above statement. Construction in Panama District in the year 2000 amounted to U$184,271,352, equivalent to 55% of the construction in the country. Although, 72% of construction in Panama District consisted of residential construction, 93% of the industrial construction of the country took place in Panama District.

Likewise, water consumption in Panama District in the year 2000 amounted to 42,969 million gallon, or 68% of the country. Further, a sector by sector comparison with water consumption of the country showed the predominance of Panama District, as it accounted for 68% of total consumption, 68% of residential consumption, 76% of commercial consumption, 77% of industrial consumption, and 63% of public sector consumption.

All the above data indicate the possibility of making assumptions on economic concentration in the Panama District.

Generally speaking, primary sector production around large urban areas is geared toward high valued perishables which should be produced near consumption centers, for example fresh vegetables. Accordingly, the assumption is that 10% of primary sector GDP is produced in Panama District.

The data on construction and water consumption suggest that secondary production is quite concentrated around the capital city. This might be especially true in the case of large scale production. However, small scale secondary sector production is likely to be scattered in the rest of the country. Therefore, the assumption is that 60% of secondary sector GDP is concentrated in Panama District.

The macroeconomic data indicate that Panama is a predominantly service economy. Commerce is the largest single component of GDP (around 20%), and Colon unquestionably plays the most important role in re-export activities. However, the other important components, financial intermediary (around 12% of GDP) and real estate rental (around 14% of GDP) are presumed to be centered in the capital city. Then, the assumption is that 70% of tertiary sector GDP is concentrated in Panama District.

The assumed economic concentration in Panama District results in a GRP amounting to U$4,538 Million, equivalent to 63.4% of GDP. The GRP sector distribution would be 1.3%

in the primary sector, 17.0% in the secondary sector, and 81.7% in the tertiary sector. The per capita production value of the EAP would be around U$13,500 in Panama District and U$3,500 in the rest of the country.

b. Consumer Price Index (CPI) in Panama District

The latest CPI data available for Panama District refers to June 2000 and June 2001 (Situacion Economica: Indice de Precios al por Mayor y al Consumidor, Segundo Trimestre de 2001, Direccion de Estadistica y Censo, Panama, Diciembre 2001). During the said period, the overall CPI in Panama City declined by 0.4% as a result of price decrease in food (-0.5%), and in transport and communications (-4.8%), which offset the price rise in clothing (4.6%), and in entertainment and education (2.6%).

2.2.3 Administration

The Public Power is exercised by the State through its three branches: the Legislative, Executive and Judicial powers, which act separately and with limitations, yet in harmonic collaboration.

It also has six 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).

As of the 80's, after the exhaustion of the "interventionist-State" model – which prevailed during the previous decades-, a two-way movement to reduce the governmental public functions begin; being one in the direction of privatization and the other one towards de-concentration and decentralization of activities towards the municipalities.

The municipality is the community's autonomous and political organization within a district. Its main duty is to foster the development of the community and the achievement of social well-being. Each district has an assembly known as the Municipal Council, which is formed by all the *Corregimiento* representatives. The municipal council regulates the juridical life of municipalities by means of enforceable agreements and resolutions within the respective district.

Each *Corregimiento* has a Communal Board that fosters the community's organization and actions to promote their social, economic, political and cultural development. They are bodies

that stand for the *Corregimiento* inhabitants, with juridical status conferred by the mayor by means of a resolution.

The *Corregimiento* representative acts as chairman, the *Corregidor* (police commissioner) and five representative citizens living within the *Corregimiento*, who will be assigned by the C*orregimiento* representative, are all members of the Communal Board.

2.2.4 Population

The last population census for Panama Republic was conducted in the year 2000. Table 2-8 shows comparatively the results with census made in 1960, 1970, 1980, 1990, and 2000. Arraijan and San Miguelito District are also included because their collection systems also dispose in Cerro Patacon final disposal site

Table 2-8: Comparative Population Results from 1960, 1970, 1980, 1990, and 2000 Census

	Years				
	1960	1970	1980	1990	2000
PANAMA DISTRICT	248,369	368,112	477,107	584,803	708,438
Southwestern Corregimientos					
San Felipe	12,466	14,145	11,696	10,282	6,928
El Chorrillo	28,577	27,834	25,145	20,488	22,632
Santa Ana	34,097	32,023	27,806	27,657	21,098
La Exposicion o Calidonia	51,395	44,875	28,602	23,974	19,729
Curundu	-	12,753	16,947	17,933	19,019
Ancon			6,401	11,518	11,169
Central Corregimientos					
Betania	15,615	37,271	43,981	46,611	44,409
Bella Vista	13,293	26,659	28,136	24,986	28,421
Pueblo Nuevo	16,832	19,376	21,105	21,289	18,161
San Francisco	24,068	35,995	34,962	34,262	35,751
Parque Lefevre	18,449	31,165	34,128	38,163	37,136
Rio Abajo	18,862	27,353	31,989	33,155	28,714
Northern and Eastern Corregimientos					
Juan Diaz	7,553	24,719	51,944	73,809	88,165
Pedregal	7,162	14,536	32,731	40,896	45,801
Chilibre			18,168	27,135	40,475
Las Cumbres		13,238	31,495	56,547	92,519
Pacora			8,184	26,587	61,549
San Martin			1,925	2,479	3,575
Tocumen		6,170	21,762	47,032	83,187
SAN MIGUELITO DISTRICT	12,927	68,400	156,611	243,025	293,745
Amelia D. de Icaza					38,522
Belisario Porras					49,802
Jose Espinar					35,301
Mateo Iturralde					12,607
Victoriano Lorenzo					17,328
Arnulfo Arias (1)					30,502
Belisario Frias (1)					46,794
Omar Torrijos (1)					37,650
Rufina Alfaro (1)					25,239
ARRAIJAN DISTRICT		19,347	37,186	61,849	149,918
Arraijan (Cabecera)		8,432	16,272	24,665	64,772

	Years				
	1960	1970	1980	1990	2000
Juan Demostenes Arosemena		3,440	8,525	13,418	24,792
Nuevo Emperador		1,688	1,926	2,319	2,765
Santa Clara		1,109	1,169	1,422	1,744
Veracruz		2,358	5,287	8,224	16,748
Vista Alegre		2,320	4,007	11,801	39,097

Note: The results from census´60, ´70, ´80, and ´90 are not broken down by corregimientos for San Miguelito because those corregimientos marked as (1) are corregimientos recently created by the Law 21 of June 27th, 2000.

2.2.5 Education

The education system in Panama comprises the pre-elementary school, primary school, secondary school, and college/university studies. At present, there are about 357,000 registered primary students from first to sixth years. The 6 years of the secondary education are divided into first cycle (junior high school, 3 years) and second cycle (high school, 3 years) with approximately 207,000 students. The 6 years period of the primary school and the 3 years of junior high school are compulsories.

About 90% of the Panamanians are literate (urban 94%, rural 62% rural). The following table shows illiterate population figures of 10 years old and more in the country and in Panama District.

Table 2-9: Illiterate Population of 10 Years Old and More in Panama District

No.	Corregimiento	Population Total	Population of 10 years old and more			
			Population	With less than third level of primary school approved	Illiterate	Total (%)
	Country	2,839,177	2,216,191	230,938	168,140	7.6
1	San Felipe	6,928	5,878	228	127	2.2
2	El Chorrillo	22,632	18,207	512	271	1.5
3	Santa Ana	21,098	17,920	526	273	1.5
4	Calidonia	19,729	16,872	516	208	1.3
5	Curundú	19,019	14,408	1,031	539	3.8
6	Betania	44,409	39,887	572	242	0.6
7	Bella Vista	28,421	25,150	336	143	0.6
8	Pueblo Nuevo	18,161	15,794	353	143	0.9
9	San Francisco	35,751	30,981	579	177	0.6
10	Parque Lefevre	37,136	32,095	876	336	1.1
11	Río Abajo	28,714	24,638	903	543	2.2
12	Juan Díaz	88,165	74,458	1,678	581	0.8
13	Pedregal	45,801	36,369	1,658	660	1.8
14	Ancón	11,169	9,458	453	249	2.7
15	Chilibre	40,475	30,703	2,286	1,016	3.3
16	Las Cumbres	92,519	71,710	3,742	1,726	2.4
17	Pacora	61,549	47,138	3,611	1,758	3.7
18	San Martín	3,575	2,794	381	235	8.4
19	Tocumen	83,187	64,240	3,419	1,603	2.5
	Total	708,438	578,700	23,660	10,830	1.9

Source: Statistical and Census Office, National Censuses of Population and Housing 2,000. Edition, December 2001.

The plan and study programs for elementary school education, prepared by the Ministry of Education, and applied in the whole country starting from September 1993, has the purpose to provide the children "fundamental knowledge to understand the natural phenomena, in particular those that are related with the preservation of the health, environmental protection and the rational use of the natural resources.

2.2.6 Community Structure

Panama District is comprised by 19 corregimientos, which are mentioned next:

a. San Felipe

The corregimiento of San Felipe with an approximate population of 6,300 inhabitants (censuses of 2000) and an area of 0.5km^2, has characteristic of a colonial neighborhood with narrow and was declared World Heritage Area by the UNESCO, transforming the place into a special area.

b. El Chorrillo

The rehabilitation of the area of El Chorrillo, after its partial destruction during the invasion of 1989, has reduced the high prevalent densities by means of the construction of low-rise buildings.

c. Santa Ana

This area of restricted growth with a population of about 20,000 people is replacing the old wooden houses gradually for small apartment buildings. The suburb area, in the surroundings of Plaza Santa Ana, will become protected area by regulations of Historical Patrimony, to conform the group of Casco Viejo to San Felipe's neighborhood.

d. Calidonia

The transformation that took place in Caledonia, mainly from residential use to commercial use, it contributed in their population's marked descent, modified by an intensive use of existing residential areas in the corregimiento that maintains the low occupation densities (between the Central Avenue and Balboa Avenue especially toward Bella Vista area.

e. Curundú

The situation of the corregimiento of Curundu is one of most difficult in the metropolitan area of Panama, for the fact that two of its main neighborhoods (Hollywood and Viejo Veranillo that represent 40% of its population), they are located in flooding areas and they require urgent sanitation measures. These conditions force to maintain a restricted growth.

f. Betania

Betania is the only corregimiento of the central area, which has expansion areas (in its northeast end, toward San Miguelito). On the other hand, it has an important group of residential areas: El Dorado, Villa de las Fuentes, La Gloria, Altos de Betania, El Ingenio, developed in relatively low densities that can be considered similar to Bella Vista, although with a smaller intensity. In the vacant lands on the road Tumba Muerto, in La Loceria and in Loma de la Playa, are projected multifamily towers that will allow accommodating projected population's increment.

g. Bella Vista

The corregimiento of Bella Vista, has a population of 42,046 inhabitants and an area of 5.1 km^2. With heterogeneous characteristics and a medium-high living standard is observed in this corregimiento the best well being levels and high employment concentration. The corregimiento has many trade establishments, banks, high educational establishments (University of Panama, Inter-American University, Columbus University), hotels and others, transforming the corregimiento into a great generator of solid waste.

h. Pueblo Nuevo

This corregimiento takes its name from an old suburban settlement, has also been one of slow development process. There is a housing deficit due to deterioration and to be one of the old areas of the city. This deterioration is shown at tenancy houses. At present vast areas of vacant lands can be observed which are equal to 7% of their land area.

i. San Francisco

In San Francisco, the creation of new profitable areas, with the use of the old Paitilla Airport lands and the gradual densification of San Francisco's neighborhood, will allow to absorb a growth that, as it is calculated, to double the current population toward the year 2020. This means that most of the residential area can remain with relatively low densities as shown at the moment.

j. Parque Lefevre

10% of Park Lefevre housings qualified as rent rooms are of masonry construction contrary to the rent rooms of other two corregimientos of Pueblo Nuevo and Rio Abajo where old wooden constructions prevails.

k. Rio Abajo

Rio Abajo houses one of most extensive barrio of the city, being one of the oldest, except Casco Viejo, presents the biggest housing proportion in deterioration. This situation has facilitated in the latest years the substitution, gradual and still slow, of the old wooden housings for small apartment buildings of more occupation density, tendency that will be accentuated in the future. The corregimiento also has an extensive area of vacant lands, along the Via Cincuentenario, between Via España and Domingo Díaz that will allow to build medium and high density residential complexes, which would facilitate to reach a projected population of 50,000 peoples by 2020 (according the Urban Development Plan).

l. Juan Díaz

Juan Diaz is one of the corregimientos with high potential growth, since it possesses abundant vacant lands and a road system, which is reinforced by the South Corridor that makes attractive its location in the city.

m. Pedregal

This corregimiento also has land in abundance, although it is gulch areas to the northeast of the city that have given place to semi-rural settlements of very low density. The growth of Pedregal is based in the development of new areas, with low densities, in the north sector. The second phase of the North Corridor link the buffer area of the corregimiento (San Martin, El Naranjal) with the rest of the city, what can give an additional incentive to the population of the area.

n. Ancón

Reverted area. This corregimiento that comprises the reverted area, has a population of 10,000 inhabitants.

o. Chilibre

This corregimiento, originally an articulate rural settlement to the old Canal Zone before the construction of the Transistmic Highway, still conserves rural characteristics (large land lots, low density) that goes disappearing because it is being absorbed by the City of Panama like one of its outlying neighborhoods. The fact that Chilibre is inside the hydrographic basin of the Canal makes that the future population should be limited, intensifying its use in the current area with low densities. This corregimiento is considered within the poor corregimientos of Panama District.

p. Las Cumbres

The area of Las Cumbres is characterized by its irregular topography, what explains the discontinuity of their urbanized areas and the current levels of low density. The corregimiento, however, still has expansion areas, particularly in its northeast sector, from Gonzalillo toward the area of Calzada Larga, where is projected a growth based mainly on the development of new areas and a bigger density of existing establishments. The corregimiento is qualified as semi-urban and rural with a strong pressure from the expansion of San Miguelito.

q. Pacora

The corregimiento of Pacora has an area of 479.4 km2 with rural area characteristics and a low socio-economic level. However, it is the corregimiento of high relative growth in the recent years. This phenomenon obeys the availability of abundant plane lands and of easy access. A tendency exists in this corregimiento to the dispersion.

r. San Martín

This corregimiento like Chilibre and Pacora show high poverty level, and consists essentially of rural population and it is one of the corregimientos of slow growth in the Study Area. Do not present difficulty in connection to its future population, since the residential land use projection for the year 2020 are considered less than 5,000 people, and the abundance of available lands guarantees completely this provision.

s. Tocumen

The corregimiento of Tocumen dates of 1950 and it is a continuation of the establishments settled down in the vicinities of Tocumen airport.

Tocumen, in the East side of the city, it has been a scenario of a growing process based in the autoconstruccion, conforming extensive settlements for low income peoples. With the improvement of the communication roads (Via Domingo Diaz, Inter-American Highway), the sector has begun to attract urbanization investments for medium income peoples. This tendency is reinforced with operation of the South and North corridors. This way takes advantage of two existing hints of Tocumen airport for activity localization purposes as processing export areas.

2.2.7 Poverty Conditions

According to the survey carried out by Social Political Bureau of the Ministry of Economy and Finances there are in Panama two poverty lines: extreme poverty and general poverty.

Extreme poverty level is defined as consumption level or annual per capita food expenses to satisfy the necessary daily minimum calories estimated at an average of 2,280 calories. The cost of this requirement, according to the Life Standard Survey data of 1997, fix the extreme poverty line at U$519 per person/year. People's with a total expense in consumption below this value are classified in extreme poverty or indigent.

General poverty level is defined as per capita food expenses to satisfy the daily minimum calories requirements (extreme poverty level) including an additional amount to cover service consumption and essential non food goods such as: housing, transport, education, health, clothing and home daily goods. The general poverty value was estimated at a consumption level of U$905 per person/year, that is to say U$75 a month per person.

Table 2-10: Poverty Main Indicators of Panama District

Corregimiento	General poverty (%)	Extreme poverty (%)
Distrito	18.10	7.81
Casco Viejo	28.05	14.48
San Felipe	11.76	5.88
El Chorrillo	41.76	20.00
Santa Ana	16.92	6.15
Calidonia o La Exposición	15.56	8.89
Curundú	50.00	32.35
Centro	5.57	2.30
Betania	0.00	0.00
Bella Vista	8.11	2,70
Pueblo Nuevo	2.86	0.00
San Francisco	5.00	1.67
Parque Lefevre	16.67	9.26
Río Abajo	1.67	0.00
Este	17.79	6.27
Juan Díaz	2.84	0.71
Pedregal	14.47	7.89
Tocumen	30.95	11.90
Pacora	31.82	7.95
San Martín	20.00	10.00
Noreste	26.49	11.89
Las Cumbres	21.97	9.85
Chilibre	37.74	16.98
Area Revertida	29.41	11.76
Ancón	29.41	11.76

Source: Living Level Survey, 1997 and National Censuses of Population and Housing. Prepared by Social Policy Department of the Ministry of Economy and Finance, 1999.

2.2.8 Public Health

Executive Organ presents in Health Policies and Strategies document, 2000 - 2004, the purposes and commitments, as well as, the policies and strategies for the health sector.

Among the policies, strategies and objectives/goals of the Ministry of Health can be mentioned the following policies I, III, IV and VI, which are related to solid waste management and described as follows:

a. Policy I

Promote a National Health Pact with a vision on health that all the Panamanians want in 2020

Strategies and Objectives / Goals

i. Establishing a consensus on development policy priorities for the production of population's health, environment, and National Health System.

- Develop a consensus on policies and models of sustainable management and provision of water services, sanitation, and waste disposal.

ii. Guiding health management according to a social agenda

- To incorporate the vision of the citizen's responsibility in their health and quality of life, of their family and their vicinity.

b. Policy II

Improve the regulatory framework on health, as mechanism that guarantees quality in the national health system and population's health protection levels and the environment.

Strategies and Objectives / Goals

1) Perfecting policies, laws, standards, and regulations in health field.

- Define policy and establish standards for water, sanitation, solid waste, air, and hazardous substances.

2) Coordinating sectors, intersector and others around high-priority topics

- Monitoring and coordination for water and sanitation subsector, housing sector, and others

3) Strengthening the capacity of MINSA as conductor of the health sector.

- Develop the capacity of MINSA in areas like environmental health, water, sanitation, food, medicines, investigation, technology, human resources and quality of services, among other aspects.

c. Policy III

To universalize and to improve access toward integral health programs and services with optimum levels, so that they reduce the breaches.

Improving the continuous access for population to ensure water, sanitation and appropriate waste management.

- To promote at national level decentralized environmental health programs, which include integral management of solid waste and wastewater, hazardous, and non hazardous waste.
- To reach intermunicipal agreements to achieve the development of sanitary landfills and water pipelines.
- To introduce new technology for the appropriate treatment of pollutant solid waste.

d. Policy IV

To guarantee a healthy environment improving surveillance system and risk factor control to the population's health

1) Perfecting the damages surveillance system and risk factors to the human health, labor, and social environment.

- Control infestation of transmitter vector of prioritized diseases
- To establish effective mechanisms for the control of urban plagues
- To develop environmental surveillance systems with emphasis in working environment, water, waste and residuals.

2) Implementing strategies and necessary coordination for the effective control of environmental risks that affects the population's health.

- To coordinate and implement policies and development strategies for drinking water services, sewerage system, collection and waste disposal, as well as those of environmental risk control for the population's health.
- To begin a Sanitation Plan of Panama Bay.

2.3 Urban Structure

2.3.1 Generalities

Panama city is limited naturally to the south by the Pacific Ocean and to the west by the canal itself. Consequently, its natural expansion is toward the north and east, as a result, the city expands from east to west along Via España, Transisthmic highway, and Via Ricardo J. Alfaro; by 1960 Corregimiento Pedregal is adhered to the city. Similarly, along the same Transithsmic highway there is an expansion to the north and important urban centers emerge, such as, Las Cumbres and Alcalde Díaz.[5]

2.3.2 Urban Plan

The Study area has three development plans:

- Regional Plan for Land Use: it focuses on the environmental resources of the Panama Canal watershed which are critical for its development
- General Plan for Land Use: it guides the development and maintenance of reverted areas, including its equipment
- Metropolitan Plan (Dames & Moore): it guides the growth of urban areas in the Atlantic and Pacific with the purpose to reach a sustainable use of land through the integrated use of the resources and controls of Panama canal and its watershed

The Urban Development Plan for the Metropolitan Areas in the Pacific and Atlantic (Dames & Moore, Inc.) is the most recent study conducted for the study area (December, 1997). This study foresees the creation of four development nodes in the study area: Ancon west node would be defined by its potential as a center for air transportation (Howard Air Base); Ancon east node would be an educative and sport development center; Central node would be an international financial center which would include an insurance and reinsurance center; and the Tocumen node would be a center to promote enterprises in the Exportation Processing Zone which would serve as a counterbalance for the Central node.

The following table shows the investments foreseen in the Metropolitan Plan in the area of Solid Waste Management.

[5] Plan Metropolitano, Dames & Moore

Table 2-11: Matrix of Key Projects for Solid Waste Management in the Study Area foreseen in the Metropolitan Plan

Area of Influence	Sector/ Sub-sector	Project	Justification	Investment (millions of USD)	Estimated execution Time (years)	Priority of Execution		
						1995 -2000	2001 -2005	2006 -2020
Coregimiento José Domingo Espinar, Belisario Porras, Integrated zone 4	Infrastruc./ Solid Waste	Transfer Station Las Cumbres (TELC)	Low capacity of DIMA* to service the area; to prevent illegal disposal	14.7	1		A	B
Corregimiento Pacora, San Martín, and Tocumen	Infrastruc./ Solid Waste	Transfer Station Tocumen (ETT)	DIMA* can not service area appropriately; too much distance to Cerro Patacon	17.3	1	A	A	B
Corregimiento Veracruz, western part of Ancón	Infrastruc./ Solid Waste	Transfer Station Howard (ETH)	Current system is adapted to Veracruz generation. Development projections in Howard and Kobbe indicate that the system should be reinforced.	14.3	1		A	B
Corregimiento Arraiján Cabecera, Juan Demóstenes Arosemena, Nuevo Emperador	Infrastruc./ Solid Waste	Transfer Station Arraiján (ETA)	A significant growth is projected in the area which would deteriorate the current situation .	10.0	1	A	A	B
Integrated zone 1, 2, 4, 5, Pacora, San Martín, Tocumen	Infrastruc./ Solid Waste	Cerro Patacón (Expansion)	It is the only Final Disp. Site in the metropolitan area. The development in the area creates a strong pressure on the landfill capacity.	149.6	2	A	A	B
Corregimiento Juan Díaz, José Domingo Espinar, 30% of Las Cumbres, Pedregal, Pacora, San Martín and Tocumen	Infrastruc./ Solid Waste	Sanitary landfill José D. Espinar (RSJDE)	The projection for 2020 shows that this area will have a high SW generation which should be serviced with appropriate technology	20.8	2			B
National level	Infrastruc./ Solid Waste	Sanitary education program	It is necessary to raise conciousness level of the residents regarding good cleansing habits	1.1	1	A	A	B
Metropolitan area	Infrastruc./ Solid Waste	Facility for separation and recycling program	Large quantity of waste can be recycled; additionally, there is great potential for employment generation	7.0	1		A	B

Source: Plan Metropolitano, Dames & Moore

* The service was provided by DIMA when the study was conducted

Note: The project priorities are shown as A, B, and C. Letter A represent essential projects which require to be executed in the corresponding execution phase. Priority B projects are important, but its execution in the proposed phase is not critical in the Plan. Priority C represents complementary projects to the Plan implementation. The investment amount is based on the assumption that there is an average generation of 0.7 kg./pers./day and proceeds mostly from residential areas.

2.3.3 Land Use

The categories established for land use and their representative Corregimientos are the following:

a. Urban Use

- Low density residential: San Francisco, Pueblo Nuevo, Betania, Parque Lefevre, Rio Abajo; and parts of Juan Diaz, Tocumen, Pedregal, Pacora, Chilibre, and Las Cumbres.
- High and medium density residential: Bella Vista, Curundú, San Felipe, Chorrillo, and Santa Ana
- Commercial/Services: Bella Vista, Betania, and mostly along corregimientos bordering Via Domingo Díaz, Jose Arango, and Via Simón Bolivar.
- Mixed: Calidonia, and Bella Vista.
- Institutional: parts of Parque Lefevre, Bella Vista, and Betania.
- Industrial: parts of Betania, Pedregal, and Chilibre
- Transport and communications: parts of Ancon and Tocumen; especially areas for national airport Marco A. Gelabert and Tocumen International airport
- Recreational and Green Areas: most of Ancon, parts of San Francisco and Juan Diaz.

b. Non-urban Use

Corregimientos Ancon, Chilibre, Las Cumbres, Pacora, Tocumen, Pedregal, and parts of Juan Diaz are included in this category.

c. Overlapping areas

Corregimientos Ancon (tourist and protected areas are found) and Parque Lefevre (mostly where Panama Viejo is found as a tourist attraction) are included in this category.

The urban area of Panama is made of approximately 57% residential areas, 18% commercial and residential areas, 10% commercial and industrial areas, and 15% public facilities.[6]

[6] Plan Metropolitano, Dames & Moore

2.3.4 Population Density

The following table shows population density in the study area. San Miguelito and Arraijan districts are included because their collection services also dispose in Cerro Patacon final disposal site.

Table 2-12: Population Density

Municipality, Corregimiento	Population 2000	Surface (Km.2)	Density (pers./km.2)
PANAMA DISTRICT	708,438	2560.8	276.6
Southwestern Corregimientos			
San Felipe	6,928	0.5	13,856.0
El Chorrillo	22,632	0.4	56,580.0
Santa Ana	21,098	1.3	16,229.2
La Exposicion o Calidonia	19,729	1.6	12,330.6
Curundu	19,019	1.1	17,290.0
Ancon	11,169	664.5	16.8
Central Corregimientos			
Betania	44,409	8.6	5,163.8
Bella Vista	28,421	5.1	5,572.7
Pueblo Nuevo	18,161	5.8	3,131.2
San Francisco	35,751	5.6	6,384.1
Parque Lefevre	37,136	6.2	5,989.7
Rio Abajo	28,714	6.3	4,557.8
Northern and Eastern Corregimientos			
Juan Diaz	88,165	35.6	2,476.5
Pedregal	45,801	28.4	1,612.7
Chilibre	40,475	978.0	41.4
Las Cumbres	92,519	106.0	872.8
Pacora	61,549	479.4	128.4
San Martin	3,575	134.0	26.7
Tocumen	83,187	92.4	900.3
SAN MIGUELITO DISTRICT	293,745	50.1	5,863.2
Amelia D. de Icaza	38,522	3.8	10,137.4
Belisario Porras	49,802	4.0	12,450.5
Jos・Espinar	35,301	7.1	4,972.0
Mateo Iturralde	12,607	1.0	12,607.0
Victoriano Lorenzo	17,328	2.0	8,664.0
Arnulfo Arias (1)	30,502	7.4	4,121.9
Belisario Frias (1)	46,794	4.3	10,882.3
Omar Torrijos (1)	37,650	11.0	3,422.7
Rufina Alfaro (1)	25,239	9.5	2,656.7
ARRIJAN DISTRICT	149,918	170.1	881.4
Arraijan (Cabecera)	64,772	53.4	1,213.0
Juan Demostenes Arosemena	24,792	48.3	513.3
Nuevo Emperador	2,765	24.4	113.3
Santa Clara	1,744	15.9	109.7
Veracruz	16,748	13.8	1,213.6
Vista Alegre	39,097	14.3	2,734.1

Source: Panama en cifras, Noviembre 2001

(1) Corregimientos created by the Law 21 of June 27th, 2000

2.3.5 Transportation

The study area has structures for sea, air, and terrestrial transport. Among the sea transport facilities, there are the Canal itself, and Balboa port.

Regarding air transport, the study area has Tocumen international airport and the airport for local flights Marcos A. Gelabert (better known as Albrook

The terrestrial transport consists of a railway system which connects mainly Panama with Colón. On the other hand, Panama city is crossed by the following main roads:

From east to west:

a) Ave. Balboa, Via Israel, Via Cincuentenario
b) Ave. Central, Via España, Via José Arango;
c) Vía Simón Bolívar (Transístmica);
d) Vía Ricardo J. Alfaro (Tumba Muerto), Vía Domingo Díaz

From north to south:

a) Calle Martín Sosa;
b) Ave. Manuel Espinoza B., Ave. Frederico Boyd;
c) Ave. Brazil; Ave. 12 de Octubre, Ave. Ernesto T. Lefevre y Ave. Cincuentenario

Additionally, two important roads (Corredor Norte and Corredor Sur) run from east to west. Those *Corredores* are the result of the implementation of the transportation master plan called ESTAMPA I and ESTAMPA II which were conducted by JICA.

2.4 Financial Conditions

2.4.1 Public Finance

a. Public Sector Budget

The Panamanian Public Sector encompasses General Government and Decentralized Institutions. General Government, in turn, is divided into Central Government and Local Government. On the other hand, Decentralized Institutions are classified into Financial Intermediaries, Autonomous Institutions and Non-Financial Government Corporations.

The budget of the Central Government amounted to some U$2,500 Million in 1999, with a surplus of some U$60 Million. Income of the Central Government originated 75% as current income and 25% as capital income. On the expenditure side, 86% was current expenses and 12% investment, as shown below.

Table 2-13: Executed 1999 Budget of the Central Government

Income and Expenditures	Million USD	Composition (%)
Income		
Current Income	1,925.7	74.9
Tax Income	1,211.2	
Non-tax income	538.2	
Other current income	176.3	
Capital Income	644.5	25.1
Equity	32.3	
Domestic credit	220.4	
Foreign credit	384.8	
International organizations	70.0	
Bilateral agreements	14.2	
Foreign bonds	300.6	
Other capital income	7.0	
Total Current and Capital Income	2,570.2	100.0
Expenditures		
Working expenses	2,173.4	86.6
Operating expenses	821.7	
Personnel expenses	631.4	
Non-personnel expenses	113.6	
Materials & supplies	59.8	
Machinery & equipment	4.0	
Other expenses	12.8	
Transfer & subsidy	416.2	
Debt service	935.5	
Investment	303.6	12.1
Education insurance	32.4	1.3
Total Current and Capital Expenditures	2,509.4	100.0
Surplus	60.9	

Source: Informe del Contralor General de la Republica, 1 marzo 2000

The 1999 budget of the decentralized sector showed income of U$2,635.9 Million and expenditures of U$2,483.9 Million, with a surplus of U$152.0 Million. Within the Decentralized Sector, Social Security accounted for around 40% of the sector budget, and National Bank of Panama for about 20%. Regulatory Entity of Public Services (ERPS) and National Environmental Authority (ANAM), each accounted for less than 1%, while National Institute for Water and Sewerage (IDAAN) accounted for a little over 2%.

The payroll of the Public Sector in December 1999 numbered 131,300 employees (65% in the Central Government) who were paid U$76,637,000 (60% in the Central Government), resulting in an average monthly salary of U$584.

b. Budget of Municipal Government

The budget of all 68 municipalities in the country in 1999 amounted to U$69.9 Million, the municipalities in Panama Province comprising U$45.8 Million (65.5% of total). The municipal budget seems small when compared to the budget of the country, possibly due to the large number of decentralized institutions included in the general budget. Within Panama Province, the municipal budget of Panama City was the biggest with U$34.6 Million, while that of San Miguelito was second with U$4.8Million, and that of Arraijan was U$1.6Million.

Table 2-14: Municipal Budget of 1999 (Million USD)

Municipality	Authorized Budget
All Municipalities	69.9
Municipalities in Panama Province	45.8
Municipality of Panama	34.6
Municipality of San Miguelito	4.8
Municipality of Arraijan	1.6

Source: Informe del Contralor General de la Republica, 1 marzo 2000

c. Municipal Budget in Panama District

The 1999 authorized budget of Panama City was U$34.6Million, equivalent to 75.5% of the budget of municipalities in Panama Province, and 49.5% of the budget of all municipalities in the country.

Executed budget of 1999 in Panama City showed an income of U$38.1 Million and expenditures of U$26.4 Million. In Panama municipal budget, income from tax and fees amounted to 79% of total income, while personnel expenses accounted for 69% of total expenditures, as shown below.

Table 2-15: Income Statement 1999 of Panama City

Income and Expenditures	1999
Income	
Tax income	30,183,000
Non-tax income	7,915,000
Total Income	38,098,000
Expenditures	
Personnel	18,106,000
Operating expenses	3,654,000
Service by third party	2,339,000
Reserves	2,275,000
Total Expenditures	26,374,000
Other Income and Expenditures	-148,000
Operation Result before Contribution	11,576,000
Income from Previous Years	14,000
Contribution	-5,276,000
Surplus or Deficit	6,314,000

Source: Informe del Contralor General de la Republica, 1 marzo 2000

2.4.2 Taxation System and Public Utilities

a. Taxation System

Taxes are divided into direct tax and indirect tax. In Panama, the most important direct tax is income tax, comprising around 40% of tax revenues, and the most important indirect tax is import tax, comprising around 30% of tax revenues.

b. Public Utilities

The Census of 2000 indicates that there were 681,799 dwellings in the country, out of which 63,002 (9.2%) without water supply and 126,805 (18.6%) without electricity. The corresponding figures for Panama District were 187,729 dwellings, of which 2,558 (1.4%) without water supply and 4,343 (2.3%) without electricity.

Table 2-16: Houses without Electricity and without Water Supply

Dwellings	Country		Panama District	
	Number	%	Number	%
Total dwellings	681,799	100.0	187,729	100.0
Dwellings without electricity	126,805	18.6	4,343	2.3
Dwellings without water supply	63,002	9.2	2,558	1.4

Source: Censos Nacionales de Poblacion y Vivienda, 14 de mayo de 2000, Volumen I, Tomo I, Direccion de Estadistica y Censo, Diciembre 2001

b.1. Electricity

Three stages are clearly defined in electricity: generation, transmission, and distribution. There can be any number of electricity generators, as long as they are licensed by the Regulatory Entity of Public Services (ERSP). Transmission is monopolized by ETESA, a government corporation. Distribution is provided by regulated private companies: EDEMET and ELEKTRA in Panama District, and EDECHI.

- Empresa de Distribución Eléctrica Metro Oeste, S.A. (EDEMET), with concession area comprising western Panama City, western Panama Province, and the provinces of Coclé, Herrera, Los Santos and Veraguas.
- Elektra Noreste, S.A., (ELEKTRA), with concession area comprising eastern Panama city and Panama Province, Panama Gulf, Colon Province, as well as the isolated Darién and Kuna Yala.
- Empresa de Distribución Eléctrica Chiriquí S.A: (EDECHI), with concession areas in the Provinces of Chiriquí and Bocas del Toro. In addition, Bocas Fruit Company, generates electricity and sells it to the people of Changuinola, Guabito, Almirante and

Las Tablas in the Bocas del Toro Province, by virtue of a legal contract which authorizes the company to sell electricity without having a concession area for distribution.

In the year 2000, the number of clients was 513,638, of which 504,025 were served by the companies with concession for distribution. The remaining 9,613 were served by Bocas Fruit Company. The number of clients in 1999 was 485,051, which implied a growth of 5.9% in 2000, while the growth of 1999 over 1998 was 5.3%.

Sales by the three distribution companies in the year 2000 reached 3,796,770 MWh, equivalent to a 7.8 % growth over the previous year sale of 3,521,370 MWh. This growth rate was higher than the historical cumulative yearly growth rate of 5.7%.

EDEMET with 1,926,873 MWh accounted for 50% of total, followed by ELEKTRA with 1,553,950 MWh, or 41%, while EDECHI with 315,950 MWh accounted for 8% of total. Bocas Fruit Company accounted for 1%, or 40,000 MWh.

Electricity consumption in the country is concentrated in the cities of Panamá and Colón, and surrounding areas, which account for around 56% of the total population of the country. In addition, these are the areas with main commercial and industrial activities. Approximately 73% of electricity, or 2,761,644 MWh, is consumed in Panama, while Colón accounts for 310,229 MWh, or 8% of total electricity consumption of the country.

Electricity consumption in the country in the year 2000 showed the following distribution: 42% commercial, 29% residential, 16% public sector, and 13% industrial

Large consumers, defined as those consuming more than 500KW per site (Law 6 of February 3, 1997), have the option of bypassing the distribution companies to buy electricity directly from generating companies. Distribution companies try to keep large consumers by setting prices low, while generating companies try to entice large consumers with even lower prices. The goal of this policy is to stimulate competition and efficient operation.

b.1.1 Electricity tariff

The tariff structure of electricity distribution companies used to be classified as residential, commercial, industrial, and government. However, starting in 1998, electricity tariff is classified by consumption levels and voltage, as follows.

i. Tariff for Clients Connected to Low Voltage

These tariffs correspond to voltage of up to 600 volts, and are classified by consumption levels.

Simple Tariff (BTS): for clients whose demand is up to 10kW per month.

Tariff with Maximum Demand (BTD): for clients whose demand exceed 10kW per month.

Tariff per Hourly Block (BTH): for clients who request different prices depending on time of supply, peak or off-peak.

ii. Tariff for Clients Connected to Medium Voltage

These tariffs correspond to voltage of more than 600 volts and less than 115 kilovolts, and are classified as follows.

Tariff with Maximum Demand (MTD): for clients who request it.

Tariff per Hourly Block (MTH): for clients who request different prices depending on time of supply, peak or off-peak.

iii. Tariff for Clients Connected to High Voltage

These tariffs correspond to voltage of more than 115 kilovolts, and are classified as follows.

Tariff with Maximum Demand (ATD): for clients who request it.

Tariff per Hourly Block (ATH): for clients who request different prices depending on time of supply, peak or off-peak.

Table 2-17: Electricity Tariff, Second Half of 2000

Voltage	Unit	EDEMET	ELEKTRA	EDECHI
Tariff for Low Voltage				
SimpleTariff (BTS1): = o < 100 kWh				
Fixed charges for first 10kWh	U$/client/mo.	1.66	1.65	1.66
Additional charges: 11 to 100 kWh	U$/kWh	0.10823	0.10712	0.10623
Simple Tariff (BTS2): > 100 kWh				
Fixed charges for first 10kWh	U$/client/mo.	1.66	1.65	1.66
Additional charges: 11 to 100 kWh	U$/kWh	0.12492	0.11619	0.10623
Tariff with Maximum Demand (BTD)				
Fixed charges for first 10kWh	U$/client/mo.	3.04	3.02	3.04
Additional charges: 11 to 100 kWh	U$/kWh	0.08669	0.07784	0.07794
Charges for maximum demand	U$/kW/mo.	8.00	8.57	6.82
Tariff per Hourly Block (BTH)				
Fixed charges for first 10kWh	U$/client/mo.	4.06	4.03	4.05
Additional charges: 11 to 100 kWh	U$/kWh	0.08436	0.07784	0.07793
Charges for maximum demand peak	U$/kW/mo.	16.58	12.00	0.85
Charges for maximum demand off-peak	U$/kW/mo.	3.06	2.33	11.67
Tariff for Medium Voltage				
Tariff with Maximum Demand (MTD)				
Fixed charges	U$/client/mo.	6.09	5.04	5.07
Additional charges	U$/kWh	0.08105	0.07136	0.06189
Charges for maximum demand	U$/kW/mo.	9.99	9.07	1.27
Tariff per Hourly Block (MTH)				

Voltage	Unit	EDEMET	ELEKTRA	EDECHI
Fixed charges	U$/client/mo.	6.34	5.54	5.57
Additional charges	U$/kWh	0.08105	0.07136	0.06189
Charges for maximum demand peak	U$/kW/mo.	14.01	12.93	0.33
Charges for maximum demand off peak	U$/kW/mo.	1.21	1.11	2.31
Tariff for High Voltage				
Tariff with Maximum Demand (ATD)				
Fixed charges	U$/client/mo.	6.09	5.04	5.07
Additional charges	U$/kWh	0.06586	0.05528	0.04612
Charges for maximum demand	U$/kW/mo.	10.08	9.42	-0.30
Tariff per Hourly Block (ATH)				
Fixed charges	U$/client/mo.	6.34	5.54	5.57
Additional charges	U$/kWh	0.06586	0.05528	0.04612
Charges for maximum demand peak	U$/kW/mo.	12.39	11.55	-0.76
Charges for maximum demand off peak	U$/kW/mo.	0.64	0.46	0.12

Source: Ente Regulador de los Servicios Públicos

The following table shows income by distribution company and type of tariff for the year 2000.

Table 2-18: Income by Company and Tariff in 2000 (USD)

Tariff Type	EDEMET	ELEKTRA	EDECHI	TOTAL
BTS	98,217,621	72,775,379	16,495,216	187,488,216
BTD	112,153,924	66,169,862	10,887,174	189,210,960
BTH	17,503	344	0	17,847
MTD	19,218,435	27,640,047	3,529,050	50,387,532
ATD	0	2,328,089	0	2,328,089
TOTAL	229,607,483	168,913,721	30,911,440	429,432,644

Source: Ente Regulador de los Servicios Públicos

It can be seen that EDEMET accounted for 53.5% of income in 2000, ELEKTRA for 39.3%, and EDECHI for 7.2%. On the other hand, low voltage consumers comprised 87.7%, medium voltage consumers 11.7%, and high voltage consumers only 0.5%.

b.2. Water

Water consumption in the country in the year 2000 amounted to 62,807 million gallon, distributed in 73% residential, 15% commercial, 10% public sector and 2% industrial. Panama District accounted for nearly 70% of water consumption of the country.

ERSP has in its registry 9 providers of water supply and sewerage services, including Bocas Fruit Company, Municipality of Boquete, Water Committee of Gualaca, and a few urbanization and resort companies (Urbagona, Altos de Vistamares, Costa Esmeralda, Punta Chame Turistica). User charges vary from fixed monthly rates, regardless of water consumed, to charges that vary in relation to water quantity consumed.

The cut-off of water supply service as a coercion measure is contemplated in Decree Law 2 of January 7, 1997.

IDAAN Water Charges

IDAAN water charges have not varied for about 20 years. The following definitions apply to IDAAN.

- Minimum Consumption: fixed charges applied when consumption is lower than the minimum.
- Basic Consumption: charges applied to consumption restricted to 10,000 gallon/month.
- Additional Charges: charges applied to every 1,000 gal in excess of basic consumption.
- Tariff 20: charges applied to residential customers in Panama, Colon and Arraijan.
- Tariff 21: charges applied to residential, special and marginal areas in the country.
- Tariff 22: charges applied to residential customers in urban areas other than Panama, Colon, Arraijan.
- Tariff 23-24: charges applied to Commercial-Industrial customers.
- Tariff 25-26: charges applied to the government.

Table 2-19: IDAAN Fixed Charges by Customer Type

User Type	Charges	Monthly Water Consumption	Monthly Tariff
Residential Panama-Colon –Arraijan Tariff 20	Minimum	8,000 gal	U$ 6.40
	Basic	10,000 gal	U$ 8.00
Residential other urban areas Tariff 22	Minimum	8,000 gal	U$ 5.68
	Basic	10,000 gal	U$ 7.10
Special residential at national level Tariff 21	Minimum	6,000 gal	U$ 4.26
	Basic	10,000 gal	U$ 7.10
Commercial-Industrial Tariff 23-24	Basic	10,000 gal	U$11.50
Government Tariff 25-26	Basic	10,000 gal	U$ 8.00

Source: Ente Regulador de los Servicios Publicos

Differential Tariff: additional charges applied when consumption exceeds 10,000 gal/month (JD-1506 of Regulatory Entity, August 18, 1999)

Table 2-20: IDAAN Differential Tariff Applicable to Tariff 20

User Type	Monthly Consumption	Charges
Residential Panama, Colon, Arraijan Tariff 20	First 10,000 gal	U$ 8.00/month
	10,001 - 15,000 gal	U$ 1.36 per 1,000 gal
	15,001 - 20,000 gal	U$ 1.51 per 1,000 gal
	20,001 - 30,000 gal	U$ 1.62 per 1,000 gal
	30,001 - 50,000 gal	U$ 1.67 per 1,000 gal

Source: Ente Regulador de los Servicios Publicos

Table 2-21: IDAAN Differential Tariff Applicable to Tariff 21

User Type	Monthly Consumption	Charges
Special housing (marginal areas) Tariff 21	First 10,000 gal	U$ 7.10/month
	10,001 - 15,000 gal	U$ 1.36 per 1,000 gal
	15,001 - 20,000 gal	U$ 1.51 per 1,000 gal
	20,001 - 30,000 gal	U$ 1.62 per 1,000 gal
	30,001 - 50,000 gal	U$ 1.67 per 1,000 gal

Source: Ente Regulador de los Servicios Publicos

Table 2-22: IDAAN Differential Tariff Applicable to Tariff 22

User Type	Monthly Consumption	Charges
Other urban areas Tariff 22	First 10,000 gal	U$ 7.10/month
	10,001 - 15,000 gal	U$ 1.36 per 1,000 gal
	15,001 - 20,000 gal	U$ 1.51 per 1,000 gal
	20,001 - 30,000 gal	U$ 1.62 per 1,000 gal
	30,001 - 50,000 gal	U$ 1.67 per 1,000 gal

Source: Ente Regulador de los Servicios Publicos

Table 2-23: IDAAN Differential Tariff Applicable to Tariff 23-24

User Type	Monthly Consumption	Charges
Commercial-Industrial and High Consumption Residential and Government Tariff 23-24	First 10,000 gal	U$11.50/month
	10,001 - 100,000 gal	U$ 1.51 per 1,000 gal
	100,001 - 150,000 gal	U$ 1.70 per 1,000 gal
	150,001 - 200,000 gal	U$ 1.81 per 1,000 gal
	Over 200,000 gal	U$ 1.6225 per 1,000 gal

Source: Ente Regulador de los Servicios Publicos

Table 2-24: IDAAN Differential Tariff Applicable to Tariff 25-26

User Type	Monthly Consumption	Charges
Government Tariff 25-26	First 10,000 gal	U$ 8.00/month
	10,001 - 15,000 gal	U$ 1.36 per 1,000 gal
	15,001 - 20,000 gal	U$ 1.51 per 1,000 gal
	20,001 - 30,000 gal	U$ 1.62 per 1,000 gal
	30,001 - 100,000 gal	U$ 1.67 per 1,000 gal
	100,001 - 150,000 gal	U$ 1.70 per 1,000 gal
	Over 150,000 gal	Same as Tariff 23-24

Source: Ente Regulador de los Servicios Publicos

The above tables show that even though the IDAAN tariff structure has not changed for about 20 years, the introduction of "differential tariff" in August 1999 made it a progressive tariff. This means that high consumers pay more, which is a mechanism to encourage rational resource use and conservation.

2.5 Environmental Policy

2.5.1 General Review

a. The Constitution

The basis for environmental legislation and policies in the Republic of Panama is the country's Constitution, which was modified in 1972 and again in 1983. Articles 114 to 117 of this main statute relate to the quality of the environment, establishing that environmental protection is a responsibility of the State. Article 114 states that it "is a fundamental duty of the State to guarantee that the population lives in a healthy environment, free of contamination, where the air, water and food satisfy the requirements for the adequate development of human life." Similarly, Article 115 establishes that the "State and all inhabitants of the national territory have the duty of promoting social and economic development that prevents environmental contamination, maintains ecological equilibrium and avoids the destruction of ecosystems".

b. Earlier environmental legislation

Earlier environmental laws, dating from the 1960's, dealt primarily with the rational use and protection of natural resources, such as forests, fisheries and wildlife. Thus, in 1966 the first National Park was created in Altos de Campana, a National Water Commission was established to regulate the use of the waters and the Renewable Natural Resources Institutes was designated as responsible for the administration of forested lands.

c. Law 41 of July 1998

As concerns the environment and resources increased in the 1990's, and public demand for the application of impact statement tools augmented, a new major framework of General Environmental Law passed in July 1998.

Redefinition of the environmental management system

Law 41 of July 1998, the General Environmental Law of the Republic of Panama establishes the principles and norms for the protection of the environment and redefines environmental management programs. It assigns specific responsibilities to the different government entities with environmental protection and renewable natural resources management functions.

Specific designation of responsibilities

Title III of the Law delineates the State's administrative organizations for environmental management.

1. The National Authority on the Environment (ANAM), described below in detail.
2. The National Council on the Environment, which consists of three Ministers designated by the President. Its functions include recommending the national environmental policy, providing support to the National Authority on the Environment in the coordination of the Interstitutional System for the Environment.
3. The Interinstitutional System for the Environment, which includes all public institutions with environmental responsibilities
4. The National Consultative Commission on the Environment, of no more than 15 technical members from the private and public sector
5. Provincial and Municipal Consultative Commissions on the Environment, with technical representatives of local private and public representatives

Definition of environmental protection tools

Law 41 refers to the tools for the environmental management process, which include land use plans, environmental impact evaluation, environmental quality standards and environmental education.

Title IV of Law 41 assigns ANAM the duty of directing and coordinating the process for elaborating environmental quality standards with the participation of pertinent entities and the community. These standards are to be established by executive decrees, which shall include attainment schedules.

d. Current Environmental Policy and Major Issues

Title II of Law 41 defines environmental policy as 'the set of measures, strategies and actions established by the State that guide and modify and determine public and private sector behavior in the conservation, use and management of natural resources and of the environment.' That same title establishes that the Executive Branch shall approve, promote and oversee national environmental policy.

d.1. National Environmental Strategy

Fundamental public environmental policies are based on sustainable development principles as follows: valuation and conservation of the environmental patrimony, restoration of environmental resources, promotion of environmental education and development and strengthening of institutional environment management capacity.

d.2. Areas of particular concern

Panama Canal Watershed

The operation of the Panama Canal depends on the water captured and stored within its 330,000 ha watershed. The locks that lift and lower vessels to permit the transit from ocean to ocean require approximately 55 million gallons (208,175 cubic meters) of water per ship. The hydrological system of six major rivers and tributaries that drain the basin and three artificial storage reservoirs also provides water to supply the cities and communities of Panama, Colon and Arraijan.

Water requirements for both the Canal and the urban population have been increasing through the years. But the amounts that can be generated and stored by the current system are limited; thus, the ACP is in the process of evaluating projects that could be implemented to augment water supplies over the short and long term. Given that potential projects that could be developed were identified in rivers in the West of the Canal drainage basin, an area of 254,000 hectares was annexed to the existing Watershed in 1999. This additional area, known as the Western Region of the Watershed, is considered a hydrological reserve and is subject to the same management and resource protection policies as the Eastern or traditional region.

Panama Bay

Panama Bay is located on the south of Panama City, in the Gulf of Panama of the Pacific Ocean, which receives the raw wastewater from the most of the city and suffers from a serious contamination problem. It is estimated that approximately 40 million metric tons per year of untreated wastewater from households and industries are discharged into the Bay. In addition, solid wastes, often handled improperly, are dumped into creeks and rivers that flow

into the Bay and contribute to the poor conditions. Consequences of this contamination lead degradation of fishery, biodiversity and tourist resources.

Since 1975, a series of studies have been conducted to define possible solutions and actions to be taken. The most recent recommendations call for the construction of a large wastewater treatment plant at the Juan Diaz River to the East of Panama City, and two smaller ones near the Canal area.

2.5.2 Organizations Concerned

a. Institutions with major environmental responsibilities

This part presents institutions concerned with environmental issues briefly. Further descriptions of organizations related with SWM are presented in *Institutional System for SWM*.

a.1. ANAM

National Authority on the Environment (ANAM) was created by Law 41 of 1998, under Title III, which deals with the administrative organization of the State to manage the environment. Functions assigned to ANAM include:

- Direct, supervise and execute the implementation of the government's environmental policy, strategies and programs, along with the Interinstitutional Environmental System and private organizations
- Issue resolutions and technical standards for the execution of the national environmental and renewable natural resources policy
- Evaluate environmental impact statements
- Cooperate in the preparation and execution of formal and informal environmental education programs in coordination with the Ministry of Education and specialized agencies.
- Promote public participation and the implementation of Law 41 and its regulations
- Promote technical and scientific research in coordination with the National Secretariat on Science and Technology
- Prepare the annual report on the environment and present it to the Executive Branch
- Impose sanctions and fines according to regulations issued under Law 41

a.2. ACP

The Panama Canal Authority (ACP) initiated its operations on December 31, 1999, when the Panama Canal was transferred to the Republic of Panama and the United States Federal Agency that managed the Canal, the Panama Canal Commission ceased to exist. The ACP was established by a 1994 amendment to the Constitution and was organized under Law 19, of June 1997. Its main function is to operate, manage and improve the Canal. The ACP is also responsible for managing and safeguarding the water resources of the Canal watershed. Specifically, the Agency must coordinate with other private and public entities with natural resources responsibilities in the Watershed, and must approve public and private strategies, policies, programs and projects that could affect the Watershed.

a.3. ARI

The Interoceanic Region Authority was established by Law No. 5 of February 1993 to oversee and administer properties transferred to the Republic of Panama under the 1977 Treaties according to specific objectives. To achieve delineated objectives, ARI was instructed to prepare a land use plan, which establishes the zonification of the Canal Area and its watershed. Through a series of studies, ARI developed land use and regional development plans for the canal area and Watershed, which were adopted by Law 21 of July 1997.

b. Other Organizations with Environmental Issues

b.1. Panama Municipalities

The City of Panama has the legal authority to dictate measures to protect the environment throughout its 19 Corregimientos. In addition to its waste disposal responsibilities, it is charged with maintaining public parks and other green areas in the City. It also grants tree cutting permits on a case-by-case basis, following guidelines from ANAM.

b.2. Ministry of Education

Law number 10 of 24 June 1992 declares environmental education as a national strategy to preserve natural resources and the environment. Specifically the law states that the State must include environmental education in study programs at all levels of education. The law creates a National Environmental Education Commission to be coordinated by the Ministry of Education.

c. Non-Government Organizations

Non-government organizations (NGOs) with environmental concerns can be divided into two types, conservation groups and social interest societies. The major active ones are described below.

Table 2-25: Environmental Conservation Group

NAME	SINOPSIS
Asociación Nacional para la Protección de la Naturaleza	Founded in 1985. Conducts environmental education, agro-forestry projects, and park protection. It has several demonstration farms and education centers.
Sociedad Audubon de Panamá	Established in 1963 as a naturalist society in the former Canal Zone. Holds regular meetings and field trips, promoting environmental education.
Fundación Natura	Established in 1990 to administer an ecological trust fund created by the Government of Panama, the USAID and The Nature Conservancy. It finances and oversees conservation projects, both public and private.

Table 2-26: Social Interest Group

NAME	SINOPSIS
Centro de Estudios y Acción Social --CEASPA	Conducts rural environmental social studies, with emphasis on women´s participation in community projects.
Fundación para el Desarrollo de la Libertad Ciudadana	Created in 1995 to promote public participation in development projects. Main areas of interest include the Bay of Panama and the Canal Watershed.
Centro de Estudios de Acción Social	Mainly a social research organization, actively participates in the review of proposed projects and legislation.
SONDEAR	Formerly Technoserve, provides technical assistance to rural communities, primarily in the Canal Watershed.

2.5.3 Environmental Impact Evaluation Process in the Country

a. Initial applications of environmental impact tools

First regulatory guidelines were issued in 1995, under a requirement established by the Forestry Law of 1994. These guidelines contained a list of aspects that had to be contemplated in the impact study, criteria to determine if a study was necessary and a list of projects that required impact studies. The requirement that persons or firms that prepare impact studies had to be registered in the Institute of Renewable Natural Resources was also established.

b. Current Environmental Evaluation Process

b.1. Screening and Scoping

Screening is the initial analysis to determine if a project requires the preparation of an environmental impact study and scoping is the identification of the most critical impacts that could be expected of a given project. These processes are common practice in many countries and are also contemplated in the Japan International Cooperation Agency (JICA) Environmental Guidelines. However, ANAM regulations do not describe screening and scoping as regulatory requirements. The guidelines detail methodologies based on a list of projects that require environmental impact studies and five criteria to consider in the determination of categories a given project might fall into.

b.2. Criteria to determine if an environmental impact study is required, as detailed in Executive Decree 59:

1. When the project generates or presents a risk to the health of the population, flora and fauna and on the environment in general
2. When the project generates alterations to the quantity and quality of natural resources (soil, water, flora, fauna)
3. When a project presents significant alterations to the qualities of an area that had justified its protection
4. When the project causes resettlements and alterations to human groups
5. When the project affects monuments, archaeological, or historic sites

b.3. Projects that require EIS

Projects that must enter the environmental impact process are listed under Title II of the regulations and this list also identifies the government agency that must receive the EIS. Projects oriented on the disposal of wastes, including landfills and waste treatment facilities, fall under the jurisdiction of the Ministry of Health (MINSA). Projects listed include:

- Mining Sector and Hydrocarbon exploration and production
- Forestry Sector
- Agriculture Sector
- Fisheries and aquaculture Sector
- Energy and Industry Sector
    - Electrical energy generating plants larger than 1.0 MW
    - Hydroelectric generating plants larger than 1.5
    - Nuclear plants

- Iron and steel industries
- Cement plants
- Transmission lines
- Battery factories
- Cement block factories
- Industrial coffee processing

- Transport Sector

- Waste Disposal Projects

  - Construction and operation of solid waste management, treatment and final disposal systems
  - Sanitary Landfills
  - Installations for the final treatment of common wastes
  - Safe disposal of hazardous wastes
  - Sewage systems
  - Depuration plants and systems
  - Sludge treatment plants
  - Septic tanks and treatment lagoons

- Development of infrastructure

- Development Plans

b.4. Description of EIS categories

Projects in the list that do not generate significant environmental impacts and do not pose environmental risks can be considered as Category I types. Projects in the list that can generate negative impacts that can be easily mitigated to comply with standards fall under Category II. These projects imply partial effects on the environment, with no indirect, cumulative or synergistic impacts. Projects in the list that require a more thorough analysis because of the potential negative impacts fall under Category III.

According to the guidelines issued by ANAM on the Environmental Impact Evaluation Process, for the three Categories of projects, EIS must include the following discussions:

Required information and activities for Category I

- Description of project area, landscape, geographic location
- Project description through different stages
- Identification of impacts, risks
- A sworn statement that project does not pose significant environmental impacts and does not generate environmental risks according to the 5 environmental protection criteria.

Required information and activities for Category II

- Summary of results and findings with description of area and citizen participation plan

- Project description – objectives, location, justification, stages, operation, closure, costs
- Description of negative and positive impacts
- Citizen participation plan
- Environmental Management Plan – measures to mitigate impacts, surveillance and control program, risk prevention plan, contingency plan
- Citizen Participation Plan -- observations made by affected communities during information exchange
- Staff – professionals in the EIS team
- Annexes

Required information and activities for Category III

- Summary of results and findings
- Project Description – objectives, justification, location, design, stages, construction, operation, closure, costs,
- Description of Area of Influence – land use, value, property rights, potential uses, protected areas, fauna, flora, quality of the environment, scenery, climate, geology, geomorphology, hydrology, population, demography and sociology
- Identification of Impacts – positive and negative consequences of all project activities and stages, transformations of the environment, impacts (direct, indirect, cumulative, synergistic), duration of occurrence, extent
- Environmental Management Plan – measures to mitigate impacts, surveillance and control program, risk prevention plan, contingency plan
- Citizen Participation Plan -- observations made by affected communities during information exchange
- Staff – professionals in the EIS team
- Annexes – cartography and other related information

Project promoters are made responsible for the contents of EIS and must guarantee citizen participation in the environmental evaluation process. Thus, members of the civil society can request information on the EIS and can provide observations through the public consultation process.

2.6 Other Infrastructure

2.6.1 Water Supply

Water in Panama District is served by National Waterworks and Sewerage Institute (IDAAN). 97.2% of the housings in the urban areas has drinking water and 85.5% in the rural areas. The rest of the district receives water from cistern trucks.

2.6.2 Sewage and Drainage

The sanitary system for drinking water and sewerage system are in charge of IDAAN for population of more than 1,500 people and in charge of MINSA in smaller settlements. The covering indexes are high, in relation to the Central American countries. There is insufficient treatment for sewer waters, causing serious pollution problems in the receiving bodies, especially in Panama Bay.

The natural basins that drain in the metropolitan area of Panama that is the primary receiving body of those waters and wastewater, they constitute elements of high impact in the bay.

60% of drainage system of the Panama City is connected to the system.

2.6.3 Roads and Traffic System

Panama City grew physically lengthening in extension, for the narrowness caused by the old Canal Area and Panama Bay, which has generated an extensive road infrastructure toward the northeast. The traffic problems have intensified the sustained growth of vehicles that represents 57% of the country vehicular fleet. To improve the vehicular circulation a series of road works have been built, as the two corridors bounding the city, bridges in main roads and secondary roads in big urbanization's.

Panama has important ports that offer modern services to the users. The main ports are Balboa (in Panama City) in the Pacific Ocean and Cristobal (in Colon) in the Caribbean Sea. Also, in 1994 a modern port of Manzanillo was inaugurated in the coastal area of the Caribbean Sea,

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

2.6.4 Power Supply

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

2.6.5 Telephone, Internet and others

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

2.6.6 Priority Ranking of Infrastructure Investment

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

- Transfer of the DIMAUD offices from current place in Carrasquilla to Cerro Patacon sanitary landfill site. It is expected that the project (about 7 million dollars) is financed through the National Bank. It is considered to begin the transfer in October 2003.
- The installation of transfer stations in Tocumen, Pedregal and Chilibre (under study).

- The exploitation of solid waste for energy recovery. At present, this project is under study, and three private companies from Holland, United States and Canada are interested in this project.
- Construction of an oxidation lagoon for leachate in Cerro Patacon sanitary landfill.
- Construction of fencing and internal roads inside Cerro Patacon sanitary landfill (the construction is foreseen to begin this year).

The Municipality of Panama has as priority the following work:

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

Chapter 3

Field Survey

3 Field Survey

3.1 Waste Amount and Composition Survey

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

- Waste Amount Survey, and
- Waste Composition Survey.

Objectives, methodologies and results are separately described in each part and findings are discussed together in the subsequent section.

3.1.1 Waste Amount Survey

a. Objectives

The objectives of Waste Amount Survey is to know current waste generation rates of households, commercial entities, institutions, markets and street sweeping in the Study Area. Knowledge of the waste generation rate is essential for the development and design of integrated solid waste management systems.

The data of waste generation rates obtained in this survey is then applied to elaborate the waste stream that is used to comprehend the current flow of waste and to make future projections in the Study Area.

b. Methodology

b.1. Wastes Targeted

The survey covers household, commercial, institutional, market and street sweeping wastes. Waste generation sources were selected through consultation with a local contractor in order to reflect the present situation of the Study Area to the survey.

b.2. Questionnaire Survey

Questionnaire survey was also conducted to know the number of residents in houses, the number of employees in commercial and institutional entities, the number of stalls in markets, and conditions of recycle of these waste generation sources.

b.3. Survey Schedule

The survey was conducted in two seasons (from January 2002 to February in the dry season, July 2002 in the rain season). The first day of the survey was used as a trial run. Then, the sources had a chance to discharge waste accumulated before the survey started, and the sources and surveyors could get used to the survey.

b.4. Waste Generation Sources

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

Table 3-1: Number of Sources and Samples

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

Households were categorized into 3 groups according to income level, i.e., high, middle, and low income, in order to reflect living conditions in the Study Area, and the sources were distributed in 12 Corregmientos. Classification of income level was not based on actual income. It was based on observation on houses and areas where sources are located.

Table 3-2: Distribution of Sources (Households)

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

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

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

c. Results

c.1. Household Waste Generation Rate

140 samples for each income level, 420 samples in total, were obtained for the 7days in dry and rain season respectively (total number of samples are 840). Results of survey are shown in the table below.

Table 3-3: Results of Generation Rate Survey of Household Waste

		Dry season	Rain season	Overall
High income	Number of samples	140	140	280
	Effective number of samples	140	137	277
	Maximum value (g/person/day)	5,000.0	10,995.0	10,995.0
	Average value (g/person/day)	566.1	972.2	766.9
	Minimum value (g/person/day)	20.3	20.3	20.3
	Standard deviation (g/person/day)	677.6	1,404.8	1,115.8
Middle income	Number of samples	140	140	280
	Effective number of samples	140	130	270
	Maximum value (g/person/day)	2,897.7	7,301.0	7,301.0
	Average value (g/person/day)	586.2	575.1	580.8
	Minimum value (g/person/day)	16.5	31.3	16.5
	Standard deviation (g/person/day)	499.5	746.0	629.1
Low income	Number of samples	140	140	280
	Effective number of samples	140	139	279
	Maximum value (g/person/day)	5,256.0	1,517.0	5,256.0
	Average value (g/person/day)	429.4	344.4	387.1
	Minimum value (g/person/day)	24.3	37.8	24.3
	Standard deviation (g/person/day)	569.8	287.3	452.9

Those were statistically analyzed as below. Consequently, generation rate for each income level was estimated as shown in Table 3-4.

Waste generation rate of 95% reliable value calculated by the following formula.

$$R_{95} = \overline{x} \pm 1.96 \left(\frac{\sigma}{\sqrt{n}} \right)$$

where R_{95} : 95% reliable value
$\overline{x}$: average value
σ : standard deviation
n : number of sample

Table 3-4: Estimation of Generation Rate of Household Waste

	High income	Middle income	Low income
Standard deviation (g/person/day)	1,115.8	629.1	452.9
Total number of samples (nos.)	280	280	280
Effective number of samples (nos.)	277	270	279
95 % reliable value (g/person/day)	±131.4	±75	± 53.1
Maximum value (g/person/day)	898.3	655.8	440.2
Average value (g/person/day)	766.9	580.8	387.1
Minimum value (g/person/day)	635.5	505.8	334.0

c.2. Commercial, Institutional, Market and Street Sweeping Wastes

The following table shows the waste generation rates of commercial, institutional, market and street sweeping wastes.

Table 3-5: Generation Rate of Commercial, Institutional and Market Wastes

		Number of samples (nos.)	Effective number of samples (nos.)	Standard deviation (g/employee /day)	95 % reliable value (g/employee /day)	Maximum value (g/employee /day)	Average value (g/employee /day)	Minimum value (g/employee /day)
Restaurant	Dry season	35	34	5,927.0	1992.3	10,588.8	8,596.5	6,604.2
	Rain season	35	33	2,513.3	857.5	4,938.6	4,081.1	3,223.6
	Overall	**70**	**67**	**5,079.4**	**1216.3**	**7,588.8**	**6,372.5**	**5,156.2**
Commercial	Dry season	35	35	1,915.1	634.5	2,644.6	2,010.1	1,375.6
	Rain season	35	35	2,131.4	706.1	2,532.4	1,826.3	1,120.2
	Overall	**70**	**70**	**2,013.6**	**471.7**	**2,389.9**	**1,918.2**	**1,446.5**
Institution	Dry season	35	35	163.0	54.0	239.0	185.0	131.0
	Rain season	35	35	165.6	54.9	271.1	216.2	161.3
	Overall	**70**	**70**	**163.8**	**38.4**	**239.0**	**200.6**	**162.2**
Market	Dry season	21	21	2,133.8	912.6	4,123.1	3,210.5	2,297.9
	Rain season	21	21	2,178.0	931.6	6,077.6	5,146.0	4,214.4
	Overall	**42**	**42**	**2,344.0**	**708.9**	**4,887.2**	**4,178.3**	**3,469.4**

Table 3-6: Generation Rate of Street Sweeping Waste

		Number of samples (nos.)	Effective number of samples (nos.)	Standard deviation (g/m/day)	95 % reliable value (g/m/day)	Maximum value (g/m/day)	Average value (g/m/day)	Minimum value (g/m/day)
Street sweeping	Dry season	14	14	9.6	5.0	22.7	17.7	12.7
	Rain season	14	14	9.0	4.7	18.8	14.1	9.4
	Overall	**28**	**28**	**9.3**	**3.5**	**19.4**	**15.9**	**12.4**

3.1.2 Waste Composition Survey

a. Objectives

The objective of Waste Composition Survey is to obtain data of physical and chemical properties of wastes generated in the Study Area. The study focused on determining the following:

a) bulk density
b) physical composition (wet base)
c) three contents (combustible matter, water and ash)
d) chemical analysis (carbon, hydrogen, nitrogen, sulfur, chlorine, oxygen and calorific value of combustible matter)

b. Methodology

b.1. Waste Targeted

Wastes of all 6 categories were subjects of bulk density, physical composition, three contents and chemical analyses. Table 3-7 shows the waste targeted and the number of samples.

Table 3-7: Number of Samples of Waste Composition Survey

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

b.2. Sampling

The wastes used in the Waste Amount Survey were used for the Waste Composition Survey. Wastes from each source were gathered and mixed by category and one sample was extracted from each category by using waste reduction method.

b.2.1 Bulk Density

Subsequently the bulk density of the waste sample was calculated with the following formula.

$$\text{Bulk density} = \frac{\text{Net Weight of Waste}}{\text{Volume of Waste}}$$

b.2.2 Physical Composition (wet base)

The physical composition was measured in the "wet base" (as discarded state, before the waste had a chance to dry). The above samples were divided into the following 10 components, and the weight of each was measured.

- kitchen waste
- papers
- textiles
- grass, wood, bamboo
- plastics
- rubber and leather
- metals
- bottles, glass
- stone and soil
- others

b.2.3 Water Content

After drying out for 5 to 6 days in dryer, the samples were weighed again, and the water content was calculated by the following formula.

$$\text{Water Content}(\%) = \frac{\text{Original Weight} - \text{Dry Weight}}{\text{Original Weight}} \times 100$$

b.2.4 Chemical analysis

Combustible matter (kitchen waste, paper, textile, grass and wood, plastics, rubber and leather) of the dried wastes were mixed and crushed, then samples were taken for the chemical analyses (three contents, elementary analysis and calorific value analysis).

c. Result

c.1. Bulk Density

Table 3-8 to Table 3-12shows bulk density of the wastes.

Table 3-8: Bulk Density of Household Waste

unit : kg/liter

Category	High income			Middle income			Low income		
	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season
Kitchen Waste	0.61	0.50	0.56	0.66	0.64	0.65	0.68	0.62	0.65
Paper	0.10	0.10	0.10	0.10	0.10	0.10	0.07	0.16	0.11
Textile	0.21	0.51	0.29	0.19	0.71	0.45	0.28	0.39	0.32
Grass Wood	0.09	0.08	0.08	0.12	0.07	0.09	0.10	0.15	0.12
Plastic	0.04	0.11	0.08	0.04	0.05	0.05	0.04	0.05	0.05
Rubber Leather	0.32	0.66	0.43	0.00	0.35	0.17	NA	1.67	1.67
Metal	0.36	0.10	0.26	0.18	0.11	0.15	0.15	0.22	0.18
Bottles Glass	0.84	1.08	0.96	1.09	1.67	1.38	0.86	1.49	1.18
Soil Stone	NA	0.67	0.67	0.43	NA	0.43	1.44	NA	1.44
Others	0.12	NA	0.12	0.25	NA	0.25	0.69	NA	0.69
Total	**0.14**	**0.14**	**0.14**	**0.16**	**0.19**	**0.18**	**0.16**	**0.19**	**0.17**

Table 3-9: Bulk Density of Commercial Waste

unit : kg/liter

Category	Restaurant			Commercial		
	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season
Kitchen Waste	0.46	0.54	0.50	0.49	0.40	0.44
Paper	0.16	0.15	0.15	0.05	0.06	0.05
Textile	3.12	0.17	1.65	0.19	0.18	0.19
Grass Wood	0.23	NA	0.23	0.19	0.06	0.15
Plastic	0.05	0.04	0.05	0.02	0.03	0.02
Rubber Leather	NA	NA	NA	NA	NA	NA
Metal	0.17	0.07	0.12	0.26	0.08	0.21
Bottles Glass	0.62	1.10	0.86	0.87	NA	0.87
Soil Stone	NA	NA	NA	2.94	NA	2.94
Others	NA	NA	NA	0.06	0.35	0.16
Total	**0.20**	**0.21**	**0.20**	**0.06**	**0.05**	**0.06**

Table 3-10: Bulk Density of Institutional, Market and Street Sweeping Waste

unit : kg/liter

Item	Institutional Waste			Market waste			Street sweeping waste		
	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season
Kitchen Waste	0.82	0.48	0.65	0.57	0.45	0.51	0.36	0.58	0.49
Paper	0.05	0.07	0.06	0.05	0.16	0.10	0.06	0.09	0.07
Textile	NA	0.07	0.07	NA	0.28	0.28	0.22	0.06	0.16
Grass Wood	0.10	NA	0.10	0.71	0.09	0.40	0.07	0.12	0.10
Plastic	0.02	0.02	0.02	0.04	0.05	0.05	0.04	0.08	0.06
Rubber Leather	NA	NA	NA	NA	NA	NA	0.12	0.38	0.30
Metal	0.40	0.05	0.22	1.08	0.14	0.52	0.09	0.16	0.13
Bottles Glass	0.62	0.78	0.68	0.85	4.35	3.18	0.78	2.05	1.54
Soil Stone	NA	NA	NA	NA	NA	NA	1.25	0.70	1.11
Others	NA	0.29	0.29	0.52	NA	0.52	NA	NA	NA
Total	**0.06**	**0.06**	**0.06**	**0.17**	**0.27**	**0.22**	**0.09**	**0.11**	**0.10**

Table 3-11: Bulk Density of Collection Vehicle Waste form Panama City

unit : kg/liter

Category	High income			Middle income			Low income		
	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season
Kitchen Waste	0.41	0.50	0.45	1.88	0.83	1.35	0.67	0.63	0.65
Paper	0.08	0.18	0.13	0.39	0.16	0.27	0.14	0.14	0.14
Textile	0.22	0.20	0.21	1.41	0.59	0.92	0.47	0.29	0.38
Grass Wood	0.16	0.07	0.11	0.17	0.11	0.14	0.22	0.23	0.23
Plastic	0.05	0.05	0.05	0.24	0.08	0.16	0.05	0.05	0.05
Rubber Leather	0.19	0.31	0.23	NA	0.17	0.17	0.15	NA	0.15
Metal	0.11	0.15	0.13	0.52	0.17	0.34	0.13	0.14	0.14
Bottles Glass	1.27	1.01	1.14	3.86	1.04	2.45	0.89	1.17	1.03
Soil Stone	NA	NA	NA	0.99	0.44	0.72	1.01	NA	1.01
Others	1.33	NA	1.33	0.43	2.62	1.89	0.24	NA	0.24
Total	**0.14**	**0.16**	**0.15**	**0.52**	**0.25**	**0.39**	**0.26**	**0.23**	**0.24**

Table 3-12: Bulk Density of Collection Vehicle Waste form San Miguelito and Arraijan

unit : kg/liter

Category	San Miguelito			Arraijan		
	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season
Kitchen Waste	0.38	0.77	0.57	0.32	0.74	0.53
Paper	0.05	0.29	0.17	0.05	0.18	0.11
Textile	0.12	0.39	0.25	0.23	0.35	0.28
Grass Wood	0.26	0.09	0.18	0.35	0.35	0.35
Plastic	0.11	0.07	0.09	0.04	0.07	0.06
Rubber Leather	NA	NA	NA	NA	0.00	0.00
Metal	0.16	0.31	0.24	0.23	0.41	0.32
Bottles Glass	0.12	1.24	0.79	1.13	0.63	0.93
Soil Stone	0.87	NA	0.87	NA	NA	NA
Others	0.15	NA	0.15	1.90	NA	1.90
Total	**0.11**	**0.28**	**0.19**	**0.10**	**0.25**	**0.18**

c.2. Physical Composition (wet base)

Results of physical composition survey shows below.

Table 3-13: Physical Composition of Household Waste

unit : wet base %

Category	High income			Middle income			Low income		
	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season
Kitchen Waste	35.0%	30.8%	32.9%	53.2%	53.5%	53.3%	46.9%	40.9%	43.9%
Paper	30.4%	19.6%	25.0%	17.9%	22.7%	20.3%	16.6%	19.0%	17.8%
Textile	11.7%	3.3%	7.5%	4.2%	2.3%	3.3%	6.0%	13.3%	9.7%
Grass Wood	6.6%	12.4%	9.5%	8.1%	1.8%	4.9%	4.1%	5.0%	4.5%
Plastic	9.8%	21.0%	15.4%	10.6%	8.4%	9.5%	13.1%	9.9%	11.5%
Rubber Leather	0.8%	2.1%	1.4%	0.0%	0.2%	0.1%	3.1%	3.0%	3.1%
Metal	2.3%	4.3%	3.3%	1.4%	5.2%	3.3%	3.2%	5.5%	4.3%
Bottles Glass	3.3%	5.9%	4.6%	4.1%	6.0%	5.0%	5.7%	3.5%	4.6%
Soil Stone	0.0%	0.7%	0.4%	0.1%	0.0%	0.1%	0.8%	0.0%	0.4%
Others	0.1%	0.0%	0.0%	0.5%	0.0%	0.3%	0.5%	0.0%	0.2%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 3-14: Physical Composition of Commercial Waste

unit : wet base %r

Category	Restaurant			Commercial		
	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season
Kitchen Waste	43.6%	49.2%	46.4%	23.5%	26.4%	25.0%
Paper	29.9%	35.4%	32.7%	34.9%	39.7%	37.3%
Textile	3.0%	0.1%	1.5%	1.9%	1.9%	1.9%
Grass Wood	0.3%	0.0%	0.2%	1.3%	3.6%	2.5%
Plastic	10.6%	5.5%	8.1%	14.6%	26.5%	20.5%
Rubber Leather	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Metal	1.8%	2.0%	1.9%	9.7%	1.3%	5.5%
Bottles Glass	10.8%	7.9%	9.3%	11.8%	0.0%	5.9%
Soil Stone	0.0%	0.0%	0.0%	1.8%	0.0%	0.9%
Others	0.0%	0.0%	0.0%	0.5%	0.5%	0.5%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 3-15: : Physical Composition of Institutional, Market and Street Sweeping Waste

unit : wet base %

Item	Institutional Waste			Market waste			Street sweeping waste		
	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season
Kitchen Waste	12.6%	15.3%	14.0%	54.4%	73.8%	64.1%	15.4%	14.3%	14.8%
Paper	53.6%	63.7%	58.7%	18.1%	13.8%	15.9%	18.5%	30.6%	24.6%
Textile	0.0%	1.4%	0.7%	0.0%	5.1%	2.5%	4.9%	2.0%	3.5%
Grass Wood	4.6%	0.0%	2.3%	4.4%	0.2%	2.3%	28.7%	14.6%	21.7%
Plastic	7.7%	9.1%	8.4%	10.0%	4.0%	7.0%	11.4%	22.0%	16.7%
Rubber Leather	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%	1.8%	1.3%
Metal	13.6%	4.6%	9.1%	2.7%	1.8%	2.3%	1.5%	3.4%	2.4%
Bottles Glass	7.9%	5.6%	6.8%	9.8%	1.4%	5.6%	5.4%	7.3%	6.3%
Soil Stone	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	13.3%	4.2%	8.7%
Others	0.0%	0.3%	0.2%	0.6%	0.0%	0.3%	0.0%	0.0%	0.0%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.1%	100.0%

Table 3-16: Physical Composition of Collection Vehicle from Panama City

unit : wet base %

Category	High income			Middle income			Low income		
	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season
Kitchen Waste	31.5%	40.0%	35.8%	35.1%	47.1%	41.1%	47.6%	51.9%	49.8%
Paper	14.4%	27.7%	21.1%	28.1%	25.1%	26.6%	13.5%	22.8%	18.2%
Textile	16.9%	6.5%	11.7%	4.9%	5.7%	5.3%	21.1%	10.3%	15.7%
Grass Wood	10.4%	4.7%	7.6%	10.5%	1.3%	5.9%	0.8%	0.2%	0.5%
Plastic	13.1%	11.1%	12.1%	11.6%	10.6%	11.1%	8.5%	6.6%	7.5%
Rubber Leather	0.9%	1.4%	1.1%	0.0%	0.2%	0.1%	0.7%	0.0%	0.4%
Metal	2.5%	4.4%	3.5%	1.1%	2.9%	2.0%	2.2%	2.6%	2.4%
Bottles Glass	9.4%	4.2%	6.8%	7.6%	5.9%	6.8%	2.3%	5.8%	4.0%
Soil Stone	0.0%	0.0%	0.0%	0.7%	0.1%	0.4%	2.6%	0.0%	1.3%
Others	0.9%	0.0%	0.5%	0.2%	1.2%	0.7%	0.7%	0.0%	0.4%
Total	100.0%	100.0%	100.0%	99.9%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 3-17: Physical Composition of Collection Vehicle from San Miguelito and Arraijan

unit : wet base %

Category	San Miguelito			Arraijan		
	Dry season	Rain season	Whole season	Dry season	Rain season	Whole season
Kitchen Waste	28.6%	46.5%	37.5%	28.0%	53.5%	40.7%
Paper	15.1%	24.2%	19.7%	12.5%	20.9%	16.7%
Textile	4.5%	8.6%	6.6%	19.6%	5.6%	12.6%
Grass Wood	19.3%	4.7%	12.0%	5.1%	2.2%	3.7%
Plastic	19.4%	7.6%	13.5%	18.9%	9.2%	14.1%
Rubber Leather	0.0%	0.0%	0.0%	0.0%	1.4%	0.7%
Metal	8.8%	2.4%	5.6%	4.6%	4.5%	4.5%
Bottles Glass	0.6%	6.1%	3.3%	10.5%	2.7%	6.6%
Soil Stone	2.2%	0.0%	1.1%	0.0%	0.0%	0.0%
Others	1.5%	0.0%	0.8%	0.7%	0.0%	0.4%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

c.3. Three Contents (volatile matter, water and ash)

Measuring objects of the three contents analysis are only combustible matter (kitchen waste, paper, textile, grass & wood, plastics and rubber & leather) of the waste. Table 3-18 shows results of the three contents analysis

Table 3-18: Results of Three Contents Analysis (for combustible matter)

Category			Dry season				Rain season				Average			
			Volatile matter	Water	Ash	total	Volatile matter	Water	Ash	total	Volatile matter	Water	Ash	Total
Household		High income	42.6%	53.0%	4.3%	100.0%	42.3%	47.6%	10.1%	100.0%	42.4%	50.3%	7.2%	100.0%
		Middle income	34.8%	59.1%	6.2%	100.0%	39.4%	56.0%	4.7%	100.0%	37.1%	57.5%	5.4%	100.0%
		Low income	32.2%	59.1%	8.7%	100.0%	28.9%	61.1%	10.0%	100.0%	30.6%	60.1%	9.3%	100.0%
Restaurant			36.4%	60.4%	3.2%	100.0%	27.7%	64.8%	7.5%	100.0%	32.1%	62.6%	5.3%	100.0%
Commercial			59.2%	30.3%	10.4%	100.0%	59.6%	29.7%	10.7%	100.0%	59.4%	30.0%	10.5%	100.0%
Institution			60.0%	31.3%	8.7%	100.0%	66.3%	29.6%	4.1%	100.0%	63.2%	30.4%	6.4%	100.0%
Market			35.7%	58.8%	5.5%	100.0%	29.6%	68.8%	1.6%	100.0%	32.6%	63.8%	3.6%	100.0%
Street sweeping			51.6%	42.9%	5.5%	100.0%	34.4%	41.4%	24.3%	100.0%	43.0%	42.2%	14.9%	100.0%
Collection vehicle	Panama	High income	44.3%	49.6%	6.0%	100.0%	33.6%	60.1%	6.3%	100.0%	39.0%	54.9%	6.2%	100.0%
		Middle income	42.6%	50.7%	6.6%	100.0%	31.7%	56.8%	11.5%	100.0%	37.2%	53.8%	9.1%	100.0%
		Low income	37.5%	59.2%	3.2%	100.0%	38.9%	52.9%	8.2%	100.0%	38.2%	56.1%	5.7%	100.0%
	San Miguelito		48.8%	44.6%	6.7%	100.0%	34.5%	56.8%	8.7%	100.0%	41.6%	50.7%	7.7%	100.0%
	Arraijan		51.3%	39.1%	9.6%	100.0%	13.9%	69.2%	16.9%	100.0%	32.6%	54.2%	13.3%	100.0%

c.4. Chemical Analysis

c.4.1 Elementary Analysis

Measuring objects of the elementary analysis are only combustible matter (kitchen waste, paper, textile, grass & wood, plastics and rubber & leather) of the waste. Table 3-19 shows results of the elementary analysis.

Table 3-19: Results of Elementary Analysis

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

c.4.2 Calorific Value

Calorific value measured by "Bomb Meter" method. Results of "Bomb Meter" method are "Higher Calorific Value" of combustible part of the waste. Consequently, "Lower Calorific Value" is calculated according to the following formula.

$$Ho = Hcvc \times \frac{100 - w}{100}$$

where :
Ho : higher calorific value of combustible part of waste (kcal/kg)
Hcvc : results of "Bomb Meter" test (given higher calorific value of combustible part of waste) (kcal/kg)
W :water content of total combustible waste (%)

$$Hu = Ho - 6(9h + W)$$

where :
Hu : lower calorific value of combustible part of waste (kcal/kg)
h : hydrogen content of combustible part of waste (%)
M : moisture content of combustible part of waste (%)

Table 3-20 shows results of the calorific value analysis in kilocalorie bases, also Table 3-21 shows in kilojoules bases.

Table 3-20: Results of Calorific Value Analysis (kilocalories)

		Household			Restaurant	Commercial	Institution	Market	Street sweeping	Collection vehicle				
										Panama			San Miguelito	Arraijan
		High income	Middle income	Low income						High income	Middle income	Low income		
Dry season	Water contents	53.04%	59.09%	59.10%	60.40%	30.32%	31.29%	58.83%	42.90%	49.64%	50.74%	59.22%	44.58%	39.10%
	Hydrogen contents	6.51%	6.47%	6.49%	6.29%	6.25%	6.24%	5.94%	5.73%	6.01%	6.38%	6.34%	6.30%	6.38%
	Hcvc (dry base) (kcal/kg)	3,239	3,045	4,146	4,862	3,521	3,728	4,749	3,642	4,050	4,257	1,012	3,482	4,024
	Ho (kcal/kg)	1,521	1,246	1,696	1,926	2,453	2,561	1,955	2,079	2,039	2,097	413	1,930	2,450
	Hu (kcal/kg)	**851**	**542**	**991**	**1,224**	**1,933**	**2,036**	**1,281**	**1,512**	**1,416**	**1,448**	**-284**	**1,322**	**1,871**
Rain season	Water contents	47.59%	55.97%	61.10%	64.78%	29.71%	29.58%	68.82%	41.40%	60.08%	56.83%	52.89%	56.76%	69.21%
	Hydrogen contents	8.68%	8.39%	7.89%	7.57%	7.27%	6.67%	6.30%	9.64%	7.05%	7.34%	7.63%	8.11%	8.42%
	Hcvc (dry base) (kcal/kg)	4,346	5,039	5,372	4,485	4,793	4,776	4,420	3,964	5,386	4,674	4,736	4,778	3,755
	Ho (kcal/kg)	2,278	2,219	2,090	1,580	3,369	3,363	1,378	2,323	2,150	2,018	2,231	2,066	1,156
	Hu (kcal/kg)	**1,524**	**1,430**	**1,297**	**783**	**2,798**	**2,825**	**625**	**1,554**	**1,409**	**1,280**	**1,502**	**1,288**	**286**
Average	Hcvc (dry base) (kcal/kg)	3,793	4,042	4,759	4,674	4,157	4,252	4,585	3,803	4,718	4,466	2,874	4,130	3,890
	Ho (kcal/kg)	1,900	1,733	1,893	1,753	2,911	2,962	1,667	2,201	2,095	2,058	1,322	1,998	1,803
	Hu (kcal/kg)	**1,188**	**986**	**1,144**	**1,004**	**2,366**	**2,431**	**953**	**1,533**	**1,413**	**1,364**	**609**	**1,305**	**1,079**

Table 3-21: Results of Calorific Value Analysis (kilojoules)

			Dry season			Rain season			Average		
			Hcvc kj/kg)	Ho(kj/kg)	Hu (kj/kg)	Hcvc kj/kg)	Ho(kj/kg)	Hu (kj/kg)	Hcvc kj/kg)	Ho(kj/kg)	Hu (kj/kg)
Household		High income	13,559	6,367	3,562	18,193	9,536	6,380	15,876	7,952	4,971
		Middle income	12,747	5,216	2,269	21,094	9,289	5,986	16,921	7,253	4,128
		Low income	17,355	7,100	4,148	22,487	8,749	5,429	19,921	7,925	4,789
Restaurant			20,353	8,062	5,124	18,774	6,614	3,278	19,564	7,338	4,201
Commercial			14,739	10,268	8,092	20,064	14,103	11,713	17,402	12,186	9,903
Institution			15,606	10,720	8,523	19,993	14,078	11,826	17,800	12,399	10,175
Market			19,880	8,184	5,362	18,502	5,768	2,616	19,191	6,976	3,989
Street sweeping			15,246	8,703	6,329	16,594	9,724	6,505	15,920	9,214	6,417
Collection vehicle	Panama	High income	16,954	8,535	5,927	22,546	9,000	5,898	19,750	8,768	5,913
		Middle income	17,820	8,778	6,061	19,566	8,447	5,358	18,693	8,613	5,710
		Low income	4,236	1,729	-1,189	19,825	9,339	6,287	12,031	5,534	2,549
	San Miguelito		14,576	8,079	5,534	20,001	8,648	5,392	17,289	8,364	5,463
	Arraijan		16,845	10,256	7,832	15,719	4,839	1,197	16,282	7,548	4,515

3.1.3 Findings

a. Waste Generation Rate

a.1. Household waste

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

Table 3-22: Results of Waste Generation Rate Survey

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

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

Table 3-23: Comparison of Waste Generation Rate in Latin American Countries

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

*: 95% reliable value, NA : not available
Source : [1] JICA study 2001, [2] JICA study 1999, [3] JICA study 1997, [4] JICA study 1995, [5] JICA study 1996

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

Table 3-24: Weighing Average of Waste Generation Rate

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

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

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

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

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

a.3. Collection Vehicle waste

It should be noted that a fairy large amount of medical waste was found in waste of collection vehicle from Veranillo Viejo. Therefore, it is conjectured that a considerable amount of medical waste are collected from ordinary collection routes other than the medical waste collection work.

b. Waste Composition

b.1. Physical Composition (wet base)

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

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

The table bellow presents waste composition in generation categories.

Table 3-25: Summary of Waste Composition

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

b.2. Water Content

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

c. Chemical Analysis

c.1. Three contents

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

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

Table 3-26: Weighing Average of Three Contents for Combustible Matter

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

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

c.2. Elementary components and Calorific Value

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

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

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

where *C: Carbon content (%)*

H: Hydrogen content (%)

O: Oxygen content (%)

S: Sulfur content (%)

Table 3-27 shows the lower calorific values of wastes based on the results of elementary analysis with the use of the above formulas.

Table 3-27: Comparison of Lower Calorific Value

unit kcal/kg

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

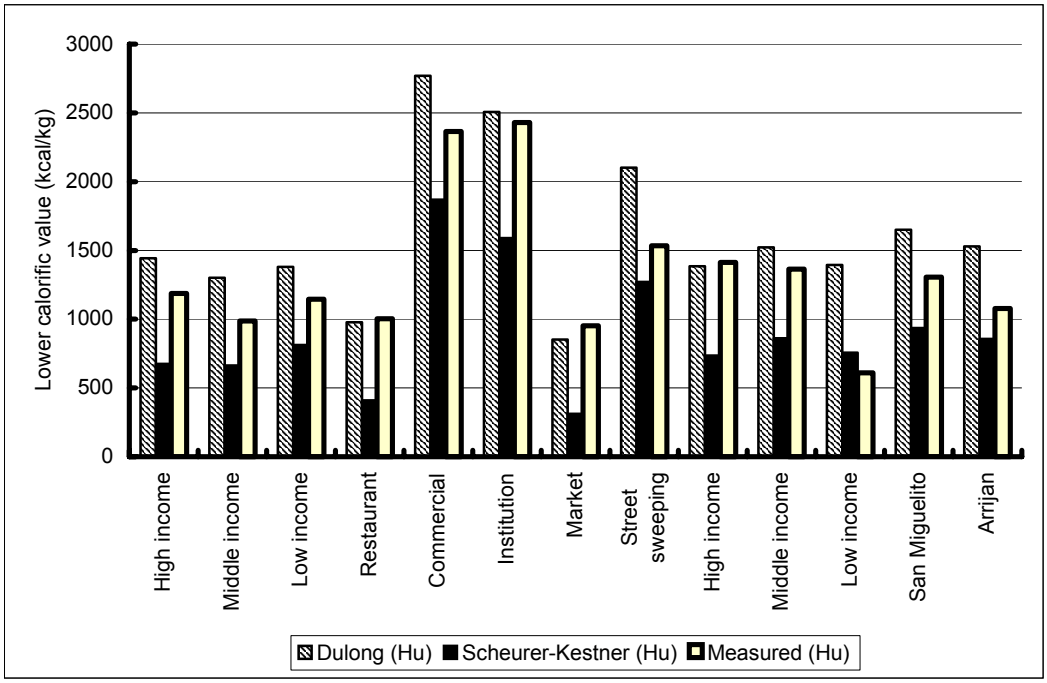


Figure 3-1: Comparison of Lower Calorific Value

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

Lower calorific values of combustible matter vary between about 990 and 2,400 kcal/kg depending on waste generation sources. Table 3-28 shows a lower calorific value of the whole waste generated in Panama Municipality with taking into account non-combustible matter and waste amount from each generation source.

Table 3-28: Lower Calorific Value of Waste

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

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

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

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

Table 3-29: Estimated Lower Calorific Value of Wastes from Institution and Business Entities

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

Table 3-30: Lower Calorific Value of Mixed Waste Collected

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

Table 3-31:Comparison of Waste Calorific Value

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

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

3.2 Time and Motion Survey

3.2.1 Objectives

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

3.2.2 The Survey Schedule

a. Target vehicles and Areas

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

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

Table 3-32: Areas Selected for Time and Motion Survey

Target Area	Corregimiento	Location and Route1
Urban Area	• Bella Vista • Calidonia • Río Abajo	• Bella Vista (AN-3-05) • Marañón (AN-01-03) • Río Abajo (BD-06-01)
Old Section of the City	• San Felipe	• San Felipe (AD-03-03)

Village	• Pacora • Alcalde Díaz	• 24 de Diciembre, (BD-04-01) • La Cabima, (BD-05-05)
Area of Detached Houses	• Juan Díaz • Juan Díaz	• Don Bosco, (BN-03-02) • Radial, (BN-04-02)
Aggregated Residential Area	• Chorrillo • San Francisco	• Chorrillo (AD-03-01) • Punta Paitilla (BN-01-05)

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

b. Schedule for Time and Motion Survey

The survey took place between January 18th, 2002 and February 5th, 2002. The schedule was established to cover all routes three times: at least one Saturday and one Monday, and any other day between Tuesday and Friday. The following table shows the schedule followed by the study.

Table 3-33: Schedule for Time and Motion Survey

Route	Capacity of vehicle	No. of vehicle	Day	Time Period
• Punta Paitilla (BN 01-05)	16 yd3	• 1926 • 1909 and 1929 • 1940	• Fri./18/Jan. • Sat./19/Jan. • Mon./21/Jan.	• 6:00 pm – 2:00 am • 6:00 pm – 2:00 am • 6:00 pm – 2:00 am
• Bella Vista (AN 03-05)	16 yd3	• 239 (2956) • 1902 • 1902	• Sat./19/Jan. • Mon./21/Jan. • Tues./22/Jan.	• 6:00 pm – 2:00 am • 6:00 pm – 2:00 am • 6:00 pm – 2:00 am
• Rio Abajo (BD-06-01)	16 yd3	• 1917 • 1917 • 1932 and 1933	• Sat./19/Jan. • Mon./21/Jan. • Wed./23/Jan.	• 12:00 noon–8:00 pm • 12:00 noon–8:00 pm • 12:00 noon–8:00 pm
• Marañon (AN 01-03)	16 yd3	• 1905 • 240 (2957) • 333 (2967)	• Thu./24/Jan. • Sat./26/Jan. • Mon./28/Jan.	• 6:00 pm – 2:00 am • 6:00 pm – 2:00 am • 6:00 pm – 2:00 am
• San Felipe (AD 03-03)	11 yd3	• 1903 • 1903 • 1903	• Fri./25/Jan. • Sat./26/Jan. • Mon./28/Jan.	• 6:00 am – 2:00 pm • 6:00 am – 2:00 pm • 6:00 am – 2:00 pm
• 24 de Diciembre (BD-04-01)	16 yd3	• 1908 • 1931 • 1933	• Sat./26/Jan. • Mon./28/Jan. • Tue./29/Jan.	• 6:00 am – 2:00 pm • 6:00 am – 2:00 pm • 6:00 am – 2:00 pm
• Don Bosco (BN-03-02)	16 yd3	• 1947 • 1938 • 1928	• Sat./26/Jan. • Mon./28/Jan. • Wed./30/Jan.	• 6:00 pm – 2:00 am • 6:00 pm – 2:00 am • 6:00 pm – 2:00 am
• Radial (BN-04-02)	16 yd3	• 1932 • 1934 and 1908 • 1937	• Thu./31/Jan. • Sat./2/Feb. • Mon./4/Feb.	• 6:00 pm – 2:00 am • 6:00 pm – 2:00 am • 6:00 pm – 2:00 am
• La Cabima (BD-05-05)	16 yd3	• 1929 • 1936 • 1936	• Fri./1/Feb. • Sat./2/Feb. • Mon./4/Feb.	• 6:00 am – 2:00 pm • 6:00 am – 2:00 pm • 6:00 am – 2:00 pm
• Chorrillo (AD 03-01)	16 yd3	• 239 (2956) and 1907 • 239 (2956) • 239 (2956)	• Sat./2/Feb. • Mon./4/Feb. • Tue./5/Feb.	• 6:00 am – 2:00 pm • 6:00 am – 2:00 pm • 6:00 am – 2:00 pm

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

3.2.3 Survey Record

The study was conducted by following up the collection vehicles selected for each area. A format sheet was prepared to register the following basic information: date, collection area and route, vehicle number and type, capacity, combustible consumption, collection method, collection shift, and crew. Additionally, on the field, time and distance for 7 type of activities were recorded. The activities were:

- t_1 = initial preparation and maintenance of the vehicle, and washing of the vehicle after collection
- t_2 = time and motion from DIMAUD´s depot (Carrasquilla or Curundú) to collection area
- t_3 = collection
- t_4 = time and motion from collection area to Final Disposal Site (Cerro Patacon) and vice versa
- t_5 = activities in Cerro Patacon (weighing and unloading)
- t_6 = time and motion from Cerro Patacon to depot
- t_7 = other activity not included above, e.g., maintenance in the collection area. In San Felipe, most of the time and distance recorded for this activity was related to activities not planned for that day´s collection, for instance, going directly in the morning from the depot to Cerro Patacón because the truck was loaded from the previous night.

The odometers of the trucks did not work; consequently, the total distance could not be compared between the collection vehicle and the follow up vehicle.

Following tables show the most important results from the surveys:

Table 3-34: Time Elapsed for Each Activity and Type of Area

Type of Area	Activity in hours and their Percentages							Total
	T1	T2	T3	T4	T5	T6	T7	
Aggregated Residential (hrs.)	3.2	1.0	23.1	9.5	3.7	2.2	2.4	45.0
Percentage (%)	7%	2%	51%	21%	8%	5%	5%	100%
Detached houses (hrs.)	0.6	2.9	23.1	5.9	1.9	1.4	2.1	37.9
Percentage (%)	2%	8%	61%	16%	5%	4%	5%	100%
Urban (hrs.)	2.6	1.4	39.0	6.5	2.8	2.5	4.6	59.2
Percentage (%)	4%	2%	66%	11%	5%	4%	8%	100%
Old Section of the City (hrs.)	2.8	0.9	4.3	1.2	0.8	1.0	3.5	14.4
Percentage (%)	19%	6%	30%	9%	5%	7%	24%	100%
Village (hrs.)	2.6	3.0	19.2	6.2	1.9	2.0	1.2	36.1
Percentage (%)	7%	8%	53%	17%	5%	6%	3%	100%
Grand Total (hrs.)	11.8	9.1	108.8	29.3	11.1	9.0	13.6	192.7
Percentage (%)	6%	5%	56%	15%	6%	5%	7%	100%

Table 3-35: Distance Traveled During Each Activity, Type of Area, and Number of Trips

Type of Area	Number of Trips	Activity in Kilometers							Total
		T1	T2	T3	T4	T5	T6	T7	
Aggregated Residential	14	0.0	34.7	57.7	304.8	40.5	75.0	39.1	551.8
Detached houses	10	0.0	71.4	85.3	270.6	24.3	63.0	17.6	532.2
Urban	15	0.0	32.4	140.0	248.7	35.1	104.3	36.3	596.8
Old Section of the city	3	0.0	24.9	24.4	44.3	10.8	43.4	15.0	162.8
Village	7	0.0	110.2	91.8	222.7	16.2	53.8	9.9	504.6
Total	49	0.0	273.6	399.2	1,091.1	126.9	339.5	117.9	2,348.2

Table 3-36: Disposal Amount for Every Area Selected for Time and Motion

Disposal Amount (Tons)				
Type of Area	Route	Day	Trips	Total (Tons)
Aggregated Residential	Chorrillo	02-Feb-02	1	4.23
		04-Feb-02	2	12.73
		05-Feb-02	2	8.72
	Punta Paitilla	18-Jan-02	3	14.28
		19-Jan-02	3	12.65
		21-Jan-02	3	14.95
Detached houses	Don Bosco	26-Jan-02	2	7.22
		28-Jan-02	2	10.92
		30-Jan-02	1	6.03
	Radial	01-Feb-02	2	6.45
		02-Feb-02	1	2.97
		04-Feb-02	2	8.01
Urban area	Bella Vista	19-Jan-02	2	10.45
		21-Jan-02	2	11.84
		22-Jan-02	2	12.51
	Marañón	24-Jan-02	2	12.56
		26-Jan-02	2	11.07
		28-Jan-02	2	13.73
	Rio Abajo	19-Jan-02	1	7.37
		21-Jan-02	1	8.08
		23-Jan-02	1	4.69
Old Section of the City	San Felipe	25-Jan-02	1	1.89
		26-Jan-02	1	3.43
		28-Jan-02	1	2.28
Village	24 de Diciembre	26-Jan-02	1	5.45
		28-Jan-02	0	0.00
		29-Jan-02	2	8.51
	La Cabima	01-Feb-02	1	5.14
		02-Feb-02	1	4.60
		04-Feb-02	2	11.11
Grand Total			49	243.87

3.2.4 Findings

The results obtained in this study are compared with indicators suggested by CEPIS and previous studies in order to evaluate the collection service. CEPIS management tools are used by this study because they are derived from experiences in Latin America. They can

be used as a starting point for comparison until indicators that suit better the conditions of Panama are developed.

a. Kg/Collection Time Indicator

This indicator reflects implicitly the type of infrastructure, population density, collection method, number of collection workers, vehicle characteristics, collection schedule, etc.[1] The results are shown in the following table.

Table 3-37: Comparative Table of Kg/Collection Time Indicator

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

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

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

Taking into account that the collection method is currently similar in all the areas (mixed collection), it is understandable that this indicator is mostly affected by population density. The lowest values are found in the least populated areas (Village and Detached Houses) and the highest in the most populated areas (Aggregated Residential and Urban). The Old Section of the City is a special case because it is less clear the reason for a low indicator value. The area is similar to the aggregated residential area which is made of Punta Paitilla and Chorrillo routes; however, its indicator is similar to Detached Houses and Village areas. Consequently, a more detailed breakdown of the areas is required. The following table shows the results of the breakdown.

Table 3-38: Breakdown for Aggregated Residential Area and Old Section of the City

	Trips	Tons	Kg/Trip	t_3	hrs/trip	Kg/hour
San Felipe	3	7.6	2,533	4.3	1.4	1,767
Chorrillo	5	25.7	5,140	12.2	2.4	2,107
Punta Paitilla	9	41.9	4,656	10.9	1.2	3,844

The previous table shows that Chorrillo and San Felipe indicators are similar; the two sectors have in common that they belong to the daytime shift. On the other hand, Punta Paitilla is part of the Nighttime shift. Consequently, it is possible that the first two routes might be affected by daytime traffic.

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

b. Kg/Trip Indicator

This indicator reflects if the routes have been designed properly and also helps to prevent overload on the vehicles.[2]

Table 3-39: Comparative Table of Kg/Trip Indicator

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

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

Generally, the indicator values fall below the recommended values; only the Urban area shows a value within the recommended CEPIS adjusted values. The Old Section of the City (the only sector serviced by a 8 m^3 truck, all others are serviced by a 12 m^3 trucks) presents a low value which confirms the low performance found in that area. On the other hand, the Aggregated Residential area shows an uncharacteristic low performance which suggests that further improvement is possible in the area by modifying the collection type (use of container) because a door to door collection in such aggregated area might not be the most efficient type of collection.

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

Low performance for this indicator could also be due to bulk density difference. It was observed that Panama produces a considerable amount of paper and plastic compared to other Latin American countries as the following table shows.

Table 3-40: Bulk Density Comparison

Unit: gm./lt.

Category \ City		Asunción, Paraguay[1]	Managua, Nicaragua[2]	Tegucigalpa, Honduras[3]	Adana-Mersin, Turkey[4]	San Salvador, El Salvador[5]	On-Nuch, Thailand[6]	Panama Dry Season[7]
Residential	High Income	220	200	200	300	198	140	140
	Middle Income				250-270	202	140	160
	Low Income				330-360	207	150	160
Commercial	Restaurant	340	320	NA	410-470	353	NA	200
	Others	70	40	NA	60-90	60	NA	60
Institutional		90	250	NA	40-80	85	NA	60
Market		360	280	250	340-370	335	NA	170
Road sweeping		NA	160	NA	130-210	172	NA	90

[1]JICA, 1994, "The Study on the Solid Waste Management for the Metropolitan Area of Asuncion in the Republic of Paraguay"
[2]JICA, 1994, "The Study on the Solid Waste Management System of the City of Managua in the Republic of Nicaragua".
[3]JICA, 1997, "The Study on the Solid Waste Management of the Urban Area of Tegucigalpa´s Central District in the Republic of Honduras".
[4]JICA, 2000, "The Study on Regional Solid Waste Management for Adana-Mersin in the Republic of Turkey"
[5] JICA, 2000 "The Study on Regional Solid Waste Management for San Salvador Metropolitan Area in the Republic of El Salvador".
[6] JBIC, 2001, "JBIC Special Assistance For Project Formation (SAPROF Phase 1) For Solid Waste Management at On-Nuch"
[7]JICA, 2002, "The Study on Solid Waste Management Plan for Municipality of Panama in the Republic of Panama".

The low bulk density is clearly the result of a larger amount of lighter material (paper and plastic) in the waste composition for the case of Panama and On-Nuch, Thailand. The following table reflects the waste composition for the different previous cases.

Table 3-41: Waste Composition Comparison

Composition	Asunción	Managua	Tegucigalpa	Adana-Mersin, Turkey	San Salvador	On-Nuch	Panama Dry Season
Combustible	71.1	75.1	82.4	89.71-93.15	93.4-95.5	55.9-58.3	12.6-55.0
Kitchen Waste	36.6	34.8	47.2	63.01-64.41	57.6-66.0	9.5-10.7	9.0-53.6
Papers	6.4	5.4	11.5	14.80-18.42	13.0-18.5	1.0-1.7	0.0-7.3
Textiles	1.3	1.9	2.8	1.62-2.60	1.1-2.5	1.8-6.9	0.3-28.7
Grass, Wood, Bamboo	22.2	27.1	7.1	2.18-2.66	2.7-16.8	15.0-18.7	7.7-14.5
Plastics	3.9	3.9	11.6	5.92-6.69	5.8-12.1	0.1-0.5	0.0-3.6
Rubber, leather	0.7	2.0	2.2	0.25-0.30	0.0-1.5		
Incombustible	28.9	24.9	17.6	6.85-10.29	4.5-6.6		
Metals	1.3	1.7	1.9	1.25-1.40	1.1-1.3	1.4-1.7	1.3-13.6
Bottles, glass	3.1	2.9	3.5	3.08	1.3-3.7	5.5-6.6	2.8-11.8
Ceramics and soil	2.5	8.1	12.1	1.38-2.17	0.2-0.7	0.0-0.3	0.0-13.3
Others	22.0	12.2	0.1	1.14-3.64	1.1-1.7	0.0-0.1	0.0-0.7

The low indicator value (Kg/trip) might be due to different bulk density. However, bulk density between low and high income in Panama is negligible, but the difference of indicator is substantial between the urban area and rests of areas (more than 1,000 Kg/trip). Additionally, difference in bulk density is very different between San Salvador and Panama; however, the San Salvador, Aggregated Residential, Detached Houses, and Village areas show values below the indicator value, whereas the Urban area values` fall within the indicator range.

Moreover, the technical specification by Heil for their Model F-400 recommends compaction performance specification of "up to 800 Lbs. per yd^3". For the 8 m^3 truck, the recommended performance would be 4,000 Kg maximum capacity; on the other hand, for the 12 m^3 truck, the recommended performance would be 5,818 Kg maximum capacity. Both values fall within CEPIS adjusted recommended range of values which should confirm the validity of CEPIS adjusted values. In any event, the suggested range by CEPIS Adjusted values is an attainable indicator which does not seem to be decisively affected by bulk density.

c. Kg/Km of Collection Indicator

In this indicator, it is considered implicitly population density, collection method, storage, routing, frequency and number of workers.[3]

Table 3-42: Comparative Table of Kg./km. Indicator

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

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

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

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

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

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

This indicator considers implicitly collection method, storage, age and physical fitness of collection workers, type of vehicles, and number of trips.[4]

Table 3-43: Comparative Table of Kg/Worker/Trip or Kg/Worker/hr Indicator

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

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

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

It is difficult to establish a comparison by using the CEPIS parameter because it considers compactors of 14 m^3 and this study only considered trucks of 8 and 12 m^3. However, if the comparison is made with San Salvador, their performance is generally better because the high value 1,278 Kg/worker/hr could only be found in the eastern part of the study area, the other 3 sectors of the study area (Central, West, and North) have values smaller than 600 Kg/worker/trip. Consequently, the number of members in the crew and their physical fitness can be considered satisfactory.

e. Kg/Total kilometers Indicator

This indicator considers implicitly population density, collection method, storage, frequency, routing, and crew number. Compared to the Kg/km of Collection indicator, the main difference might be defined by the distance to discharge (transfer station or sanitary landfill).[5]

Table 3-44: Comparative Table of Kgs/total kilometers Indicator

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

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

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

The lowest values are found again in the Detached Houses and Village areas. The sanitary landfill is located on the western part of the district; the two areas mentioned previously are located in the eastern/northern part of the district. Consequently, the low values in the two areas might be the result of longer haulage distance. Again, the Old Section of the City is a special case; the low value might be due mostly to the small amount of waste collected in the area.

f. Comments

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

Aggregated residential area

The indicator values fall within the recommended values and usually are the highest among all the areas, except for the indicator Kgs/trip. Consequently, the performance is good overall, but there is room for improvement by reviewing the routes design and making sure the collection vehicles are used optimally. Additionally, it is important to note that the high performance in this area is due mainly to Punta Paitilla route; the Chorrillo's values are lower. As it was mentioned previously, Chorrillo´s value is closer to San Felipe than to Punta Paitilla because the first two belong to daytime shift and the second one to the nighttime shift. Consequently, the performance of Chorrillo and San Felipe might be affected by daytime traffic.

Detached Houses area

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

Urban area

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

Old Section of the City

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

the indicator values for the Old Section are closer to the former ones (Detached Houses and Village areas).

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

Village area

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

3.3 Public Opinion Survey

Public Opinion Survey (POS) on municipal SWM in the Study Area was conducted in January and February 2002.

3.3.1 Objectives

The survey aimed to clarify:

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

3.3.2 Number of Samples

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

a. Households

a.1. Sample Size

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

a.2. Selection of Samples

Samples were selected over the Study Area with taking into account distribution of income level (See Table 3-45) and population in each corregimiento (See Table 3-46).

Table 3-45: Distribution of Households according to Income Level

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

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

Table 3-46: Distribution of Samples (Household)

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

b. Institutions

60 business establishments were selected as samples for the survey (See Table 3-47).

Table 3-47: Samples of Business Establishments

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

3.3.3 Formulation of Questionnaire

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

a. Residents

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

b. Business Establishments

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

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

b.2. Factories

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

b.3. Hospitals

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

3.3.4 Results of the Survey

The results are presented in Annex.

3.3.5 Findings

a. Residents

General Issues

Female occupies a large part of interviewees, 72%, in the survey. Many interviewees get news through radio, TV and newspapers every day. This shows that the residents are considerably concerned with state with society. Average size of household in the study area is 4.4 persons/household. More than half of interviewees have their own houses. What is noteworthy in the study area is that 55% do not have garden and 35% have small gardens that are less than 100m^2. The other issue to be mentioned is that considerably large part of households have immigrated into the study area (15% replied that they have been living in the study area for less than 5 years).

Present Situation of Public Services

Infrastructures such as water supply, electricity and roads are well developed and considerably large part of residents benefit from them. 96% are connected with water supply, 98% has electricity and 66% has access roads of asphalt pavement. Further more, 49% are connected to sewer pipes and 37% has septic tanks.

In order to receive those public services, residents pay 33 US$/month/household for electricity, 40US$ for transport, 39US$ for telephone, 16US$ for water supply and 4US$ for

waste collection service. As average household income is 920US$/month/household, fee for electricity occupies 3.6% of the income, traffic 4.3%, telephone 4.2%, water supply 1.7% and waste collection service 0.4%.

Discharge of Waste

Almost of residents receive waste collection service in manner of curbside or container collection. Small number of residents exercise burning (8%) and burying (1%) waste. Most of residents use plastic bag as recipient of waste (365/384). It should be noted that about half of the interviewees suffer from animal scavenging (sometimes 18%, often 29%).

Waste Collection Services

92% of residents receive waste collection service. The rest, 8%, who do not have collection service are found in Pueblo Nuevo (3), Parque Lefevre (3), Tocumen (1), Pacora (4), Las Cumbres (17) and Chilibre (3). Municipality (DIMAUD) practices important role in the waste collection service. 338 out of 384 interviewees (88%) answered that the municipal collectors pick up their waste. Curbside collection is the principal manner (69%) followed by container collection (20%).

Table 3-48: Do you have waste collection service?

Corregimiento	Yes	No
01 San Felipe	5	
02 El Chorrillo	14	
03 Santa Ana	12	
04 Calidonia	12	
05 Curundu	10	
06 Betania	27	
07 Bella Vista	17	
08 Pueblo Nuevo	9	3
09 San Francisco	22	
10 Parque Lefevre	19	3
11 Rio Abajo	17	
12 Juan Diaz	45	
13 Pedregal	23	
14 Tocumen	41	1
15 Pacora	25	4
17 Las Cumbres	29	17
18 Chilibre	19	3
19 Ancon	7	
Total	353	31

Although DIMAUD is trying to provide the citizens with daily waste collection service, the results of survey show that this is not necessarily carried out for the whole citizens. As Figure 3-2 shows, there are regional disparities in the frequencies. The service is provided more frequently to Reverted, Southwestern, Central, Eastern and Northern areas in the order named. Reverted area was incorporated in collection areas after Panama Canal had returned to Panama from USA in 1999. The area still has small population, then, it is too early to

evaluate the waste collection service in the area. In the rest of areas than Reverted, the more frequent collection service is provided to where the higher population density is found. This is rational in its own way, because highly populated areas generate more waste.

However, as Figure 3-3 shows, it is conjectured that collection frequencies of twice or three times week would not be planed and it would happen accidentally. Especially, the collection service is likely to be unpunctual in Eastern and Northern. This might be caused by troubles in other areas such as vehicles failure and traffic congestion.

70% of residents (very satisfied 31%, satisfied 39%) of the study area are satisfied with the present waste collection service. This shows that DIMAUD waste collection service considerably meets with demand of the residents. As Figure 3-4 shows, it is conjectured that higher quality of collection service is provided to the Central.

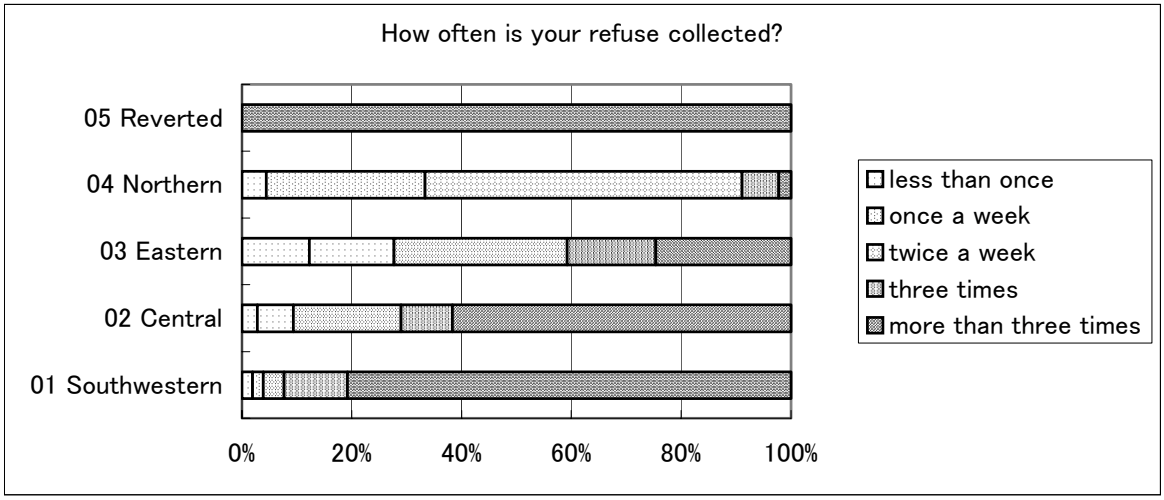


Figure 3-2: Collection Frequency

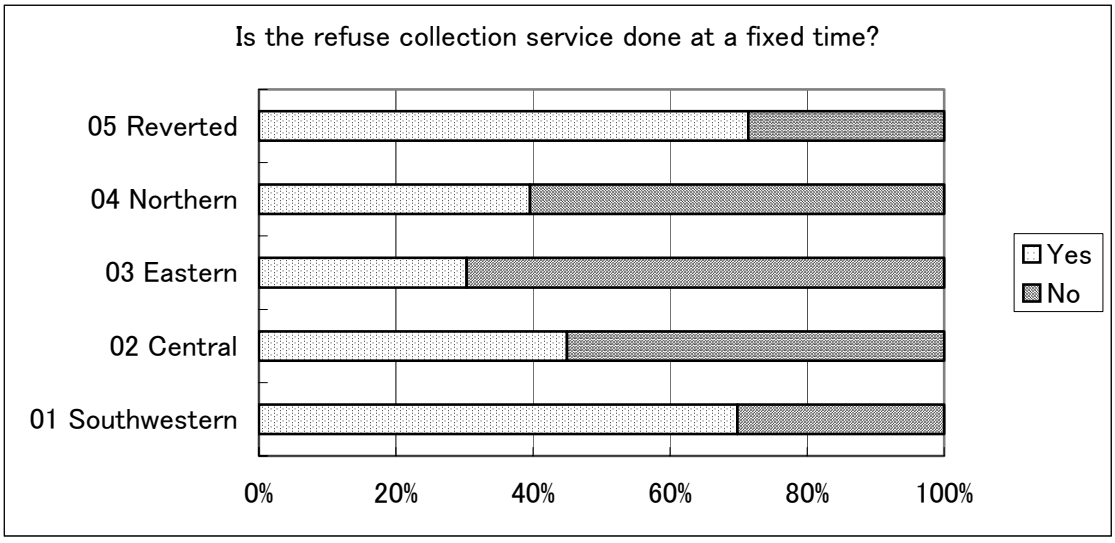


Figure 3-3: Punctuality of Collection Service

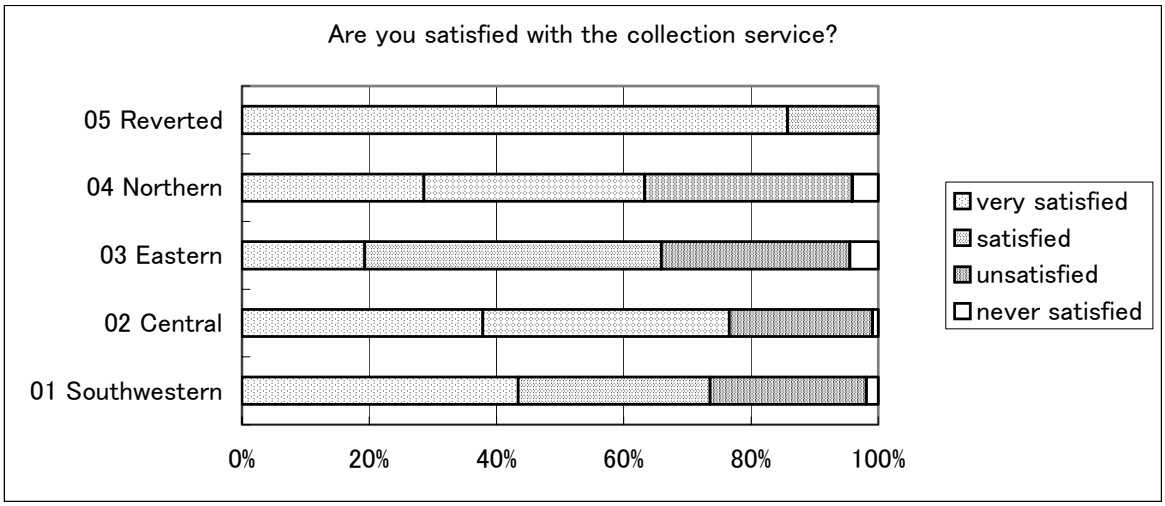


Figure 3-4: Degree of Satisfaction with Collection Service

Recycling and waste reduction

84% replied that they are willing to cooperate with separate collection that is necessary for recycling. 86% also replied that recycling is necessary in the study area. These may imply that the residents are satisfied with the present waste collection service and sense necessities of recycling and resource conservation.

The results revealed that recycling activities are not common practice in the study area. Only 13% (48 household) replied that someone comes to their houses to collect or buy recyclable/reusable materials. Most frequently collected or sold materials are bottles (32/48) and aluminum cans (29/48).

Regarding composting, 13% answered that they make compost from their kitchen waste. In the study area, 55% do not have garden and 35% have small garden (less than 100m^2). This may imply that there would be small demands for compost.

Financial Matters and Tariff system

60% replied that they are satisfied with the present tariff system (because it is cheap 21%, appropriate 38% and cheap and appropriate 1%). 40% are dissatisfied with the tariff as they feel it is expensive.

The results revealed that the average willingness to pay for waste collection service was US$ 6.07/month/household. Meanwhile, the present tariff system requires the residents to pay about 5 to 12 US$ for the service (about 2 to 6 US$ for low income, about 7 to 8 US$ for middle income and 10 to 12 for high income). Comparing these figures, it can be said that willingness to pay is lower than the actual payment. The results also revealed that average income of the residents is US$ 920.48/month/household. The willingness to pay of US$ 6.07

is about 0.7% of the income and actual tariff is about 0.8% (supposing that tariff of middle-income, US$ 7.5, is representative). In general, it is said that waste collection and disposal fee is between 0.75% and 1.7% of income in middle-income countries[6]. The willingness to pay in the study area is at the bottom of the range and the actual tariff is in the range. Consequently, it could be said that the actual tariff for the residents would be appropriate and not be far from the willingness to pay.

The residents prefer being imposed waste collection fee at waste amount (43%, 165/384) to other manners such as at land property, electricity, income and water consumed. As for manner of billing, 48% replied that they accept independent direct billing, 43% accept joint billing with water supply, and few people accept joint billing with income tax, property tax, electricity and telephone. According to the results, it seems for the residents to set fee at waste amount discharged and to bill independently are reasonable, however, the residents would also accept the present billing system, joint billing with water supply.

Public Cooperation and Education

Only 31% have been given education or guidance about proper handling and discharge of waste. 60% of the residents of the 31% have gotten such knowledge from their family member and only 23% of them have received such education at schools. Considerable number of residents, 98%, thinks that environmental and sanitary education is necessary at schools.

As for a campaign to raise the citizens' awareness on environment, 97% think that it is necessity and 48% (186/384) think that municipality should take such action, and 93% showed their willingness to cooperate to such activities.

Conclusion

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

- Major part of the residents do not have gardens (55%) or have small gardens that less than $100m^2$(35%). And only 13% make compost from their kitchen waste. Accordingly, a market of compost may be small at present and in the near future.
- Great number of the residents (92%) is covered with waste collection service. DIMAUD plays critical role in provision of the service (88% receive municipal waste collection service).

[6] Sandora Cointreau-Levine, December 1991, Conceptual Issues and Experiences in Developing Countries

- DIMAUD tries to provide the residents with daily waste collection service. However, the results revealed that the whole residents do not necessarily receive such service. From this fact, it is conjectured that required capacity to conduct the daily waste collection service is beyond the present waste collection capacity of DIMAUD.
- Central, Southwestern and Reverted seem to receive higher quality of waste collection service than Eastern and Northern. Therefore, there would be a room to improve the service in the areas.
- The present tariff and billing system seem to be acceptable for the residents.
- The residents seem to be satisfied with the collection service and begin to be acquainted with necessity of recycling and resource conservation.
- The residents feel necessity of environmental education at schools and campaign to raise citizens' awareness on environment. Municipality is expected to act main role in the activities, and the residents have willingness to cooperate with such activities.

b. Business Establishments

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

General Issues

47 business establishments that are subjects of the survey are various, i.e., from less than 10 employees to more than 100, from less than 50 m^2 of floor area to more than 1,000m^2 and from less than US$100,000 of annual sales to more than US$3,000,000. Principal wastes discharged from them are paper (32 establishments), plastic (31), cardboard (36), aluminum (11), woods (24) and food waste (24).

Waste Storage, Discharge, Collection and Disposal

Considerable number of them (39) receives municipal waste collection service, however 17 out of them also benefit from private waste collection service due to exiguous collection frequency.

40 business establishments replied that they are satisfied with the collection service, although there are differences in degree of satisfaction.

Almost all business establishments (43) recognize that their waste is disposed in the municipal landfill.

Recycling and Waste Reduction

Majority (27) separates waste for recycling. They sell off such recyclable materials to other business establishments (7) and junkman's (5). This makes out that there is a recyclable material market. Prevailing recyclable materials are paper (15 business establishments), cardboard (15) and plastic (8).

42 business establishments replied that recycling is necessary. However, 39 are opposed to increase of waste collection fee due to introduction of recycling.

Financial Matters

Amount of waste collection fee that the business establishments pay at present are various between 167 and 4,700US$/month depending of their sizes. 12 feel that the fee is expensive and 17 think that it is appropriate.

As for manner of setting fee, 11 show approval with setting fee corresponding to sales and 19 to waste amount discharged. Meanwhile, almost all of them are opposed to setting fee corresponding to floor area, electricity consumed and number of employees.

Public Cooperation and Education

Almost all business establishments (46) replied that they would cooperate with maintaining sanitation environment of the city. And all of them replied that a campaign to raise citizens' awareness on environment is necessary. In the interview survey to residents, about half of them said that municipality should hold such campaign. Meanwhile, the business establishments think that various organizations should take action in such campaign, i.e., central government (35), municipality (37), Junta Comunal (21) and Junta Local (25).

Conclusion

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

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

b.2. Factories

General Questions

10 factories were subjects to the survey. Types of their businesses are various such as manufacturing of doors, food processing and paper manufacturing. Number of their employees also varies from less than 20 to more than 100 and floor areas are from less than 100m^2 to more than 1,000m^2.

Waste Storage, Discharge, Collection and Disposal

Wastes generated from those factories are various, e.g., ash, dust, food, metal, paper, cardboard, plastics, rubber and wastewater. Those wastes are temporarily stored in plastic bags and tanks. Most of factories receive waste collection service every day and their wastes are disposed in the municipal landfill, Cerro Patacon.

Recycling and Waste Reduction

Only three (3) factories separate their waste for recycling, e.g., selling to manufactures and junk mans. However, all of 10 factories said that recycling is necessary right now.

Four (4) factories register amount of chemicals received from outside. Meanwhile, only one (1) factory registers amount of chemicals outgoing.

Financial Matters

Two (2) factories pay US$200 to 300 per month for municipal waste collection service. Seven (7) factories pay for private collection service. Fees range between US$13 and US$700. Three (3) regards the fees expensive, meanwhile five (5) do appropriate.

Willingness to pay for the collection service, in case that it is operated satisfactory, is not so different from the actual payment. It may be because the waste collection service satisfies their demands at a certain extent at present.

All of the factories (10) answered that they prefer being charged collection fee based on amount of waste generated. Six (6) accept independent billing.

Five (5) companies do not want to accept increase of waste collection fee due to introduction of recycling. Three accept 10% increase of the fee. It may say that factories may accept slight increase of the fee, although they generally dislike it.

Public cooperation and education

All of them (10) have willingness to cooperate for keeping the city clean and preserving environment from deterioration. Also, they feel necessity of a campaign to encourage those.

Many factories think that the municipality should take such action followed by the central government, schools and private companies. The factories regard unimportance of communities in such actions.

Conclusion

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

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

b.3. Hospitals

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

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

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

3.4 Recycle Market Survey

3.4.1 Objectives

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

The size of the markets and the prices of reusable articles are the main survey items since they could influence the selection of alternatives.

Information on items such as bottles, metals, papers and plastic was investigated by interviewing waste picker, and recycling companies and by using existing data.

3.4.2 Methodology

In order to make the survey following two types of main sources were used.

Primary sources
- Statistic of the National Accounts, the Republic's General Controller Office.
- Results of the interviews survey

Secondary sources
- Mollie Brown: "Reciclaje de Panamá", made in the first semester of 1998, for Autoridad de la Región Interoceánica (ARI)
- Práxedes Castro, Perspective of the recycling in Panama within the context of the environmental cleaning. (Editorial USMA, Panama, 1994)
- Yolanda Castillo and Mylene Ortega, Diagnosis of the Process of the Sweepings in the Metropolitan Area: Period of 1903 – 1997. 1998. (Graduation Work, Panama University).

a. Targets of Survey

The survey targets are waste picker, middleman and recycling industries.

b. Samples

The survey carried out for 20 samples. Table 3-49 shows outline of surveyed samples.

Table 3-49: Outline of Samples

No.	Name of company	Main products
1	Bolsas y Cartuchos de Papel, S.A.	Recycledpaper
2	Fibras Panamá, S.A.	
3	Industrias Panameñas de Papel, S.A.	
4	Productos Universales de Papel, S.A.	
5	Reciclado de Panamá, S.A.	
6	Aluminio de Panamá, S.A.	Recycled metal
7	Compra y Venta de Metales	
8	Compra y Venta Tabasará, S.A.	
9	Forjas Técnicas, S.A. (FORJATEC)	
10	Fundidora Istmeña, S.A.	
11	Fundición Yisalex, S.A.	
12	Industrias de Reciclaje, S.A. (INDRESA)	
13	Metal Group Panamá, S.A.	
14	Procesos Ambientales, S.A.	

No.	Name of company	Main products
15	Reciclajes de Metales, S.A. (REIMSA)	
16	Recimetal Panamá, S.A.	
17	Vidrios Panameños, S.A.	Recycled glass
18	Constructora Vidriera, S.A. (COVISA)	
19	Eco Toner, S.A.	Others
20	Granja San Fernando	

c. Survey Item

The survey items are as follows.

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

3.4.3 Results of the Survey

a. Recycling system

a.1. Recovery Materials

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

These recovery materials is mainly from:

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

a.2. Street Waste Picker

The street waste picker s, commonly called "piedreros", make their work bursting the bags of waste deposited on the sidewalks that are gathered by the DIMAUD; also, they extract materials from temporary storage (bin and containers) or collect aluminum tins and glass bottles that are discarded in streets and sidewalks. Official data do not exist about the amount of street waste picker s dedicated to this activity nor their contribution to the recovery of materials, but it must be assume that the contribution is significant. The street waste picker s sell the materials to the nearest purchasing point, within the city.

Vicente González, a street waste picker with many years of experience, recovers clear, bottles, aluminum cans, newspaper and cardboard. In average he recovers 5 bottles daily, 12 pounds of aluminum and 20 pounds of paper. On the other hand, Inocente, in addition to the mentioned materials, also recovers textiles; the daily averages of recovery are similar to those of Vicente: 6 bottles of different kind, 7 pounds of aluminum, 20 pounds of paper and 20 pounds of textiles. These two street waste picker s share the same limitations: little capacity to transport high volume of waste, thus has suggested aid in order to increase the purchasing points, and manual vehicles.

According to the data obtained, a street waste picker could generate a monthly income (26 days of work) between U$ 120.00 and U$ 170.00.

Table 3-50: Daily Recovery Amount of Street waste picker

Material	Units or pounds	Amount ($U)
Glass	5- 10 units	0.25 – 0.50
Aluminum tins	12 - 15 pd.	2.40 – 3.00
Paper	20 – 25 pd.	1 – 1.50
Other (textile, etc.)	20-30 pd.	1 – 1.50
Totals		**4.65 – 6.50**

Source: based on interviews to Street waste picker s, January of 2002

a.3. Waste Picker at Cerro Patacon Final Disposal Site

The waste collected by DIMAUD and other waste collection companies of Panama City and San Miguelito, are disposed of in Cerro Patacón's sanitary landfill, where waste picker (pepenadores) do the recovery work. The recovered materials are sold to representatives of the recycling companies; but mainly to the owners of small factories ("bunker"), located in an area near Cerro Patacón named "Mocambito". The number of "pepenadores" in Cerro Patacón varies, between 300 and 1,000 persons, including children.

a.4. Others Recycle Activities

Different companies from the banking, commercial and industrial sector make the recovery and sale their waste or authorize their employees to do this work. The waste are stored in a determined area awaiting the pass of the vehicles of the recycling companies to come and undertake the corresponding transaction. Generally, the income generated in this activity is shared or given in it's totality to the workers who do the recovery work; also it is destined to financing social activities for the employees. Some educative centers and communitarian organizations, periodically, make activities to recover and sell recyclable material, mainly paper.

Additionally, an undetermined number of people recover materials at their homes and in urbanized areas, who sell occasionally to purchasing points or directly to the recycling industries.

b. Intermediate Structure

After recovered, the material go through an intermediate structure until arriving at the final consumer.

b.1. Direct Purchase

The recycling companies make the direct purchase of recyclable material to private companies and institutions, sending for such effect, their own vehicles. However, as the separation in the source is made in small scale, the direct purchase does not contribute significant volumes of materials. In addition, when the recycling company makes the direct purchase, the price of purchase will be the lowest of the market, which is not a stimulus to those who recover directly in the source.

b.2. Purchasing Points

There are two kinds of purchasing points: those that are established by the recycling industries, and those that are property of small retailers; they are located in Panama District but the main ones are in Cerro Patacón. The points of purchase in the capital city are not permanent, they are opened and closed periodically; some specialize in the purchase of certain

material, but the majority accepts all type of recyclable material. The required investments are minimum: a physical space not very big, the weight and, mainly, availability of cash, since it has to do with retail trade.

The most important purchasing point is located in Cerro Patacón. The main commercialized materials are white paper, newspaper, aluminum cans and wood. The white paper, one of the main materials of buy / sale, is separated and packed in plastic bags by workers who earn a wage of $5 per day, to have it directly available for the owners of the recycling factories or to the companies of recycling that arrive with their trucks to Cerro Patacón.

b.3. Recycling Factories

The purchase points (except those which are property of the recycling industry) sell the materials gathered together to the factories of recycling in where the workings of cleaning, classification, crushing and packing are made. The workers of these factories are in charge of which the material gathering the requirements demanded by the recycling industry, specially in terms of its purity. Once classified, the material is crushed or compacted, ready for the sale.

b.4. The recycling industry Material

The materials classified and without impurities, compacted and baled is sold to the factories of recycling to be put to under different material industrialist processes depending on the type of material. Between the factories of recycling and the industrialists to complicated relation exists: in some cases, it happens with the recycling of the to paper, the industrialists assign to factories one quota monthly minim of 200 tons of waste, because below this volume the factories would operate with losses. But the most conflicting subject is the related one to the prices of the material, which is very determined by the tendencies of the international market. Although the recycling factories successively to transfer the losses in the leaves prices to the purchase points

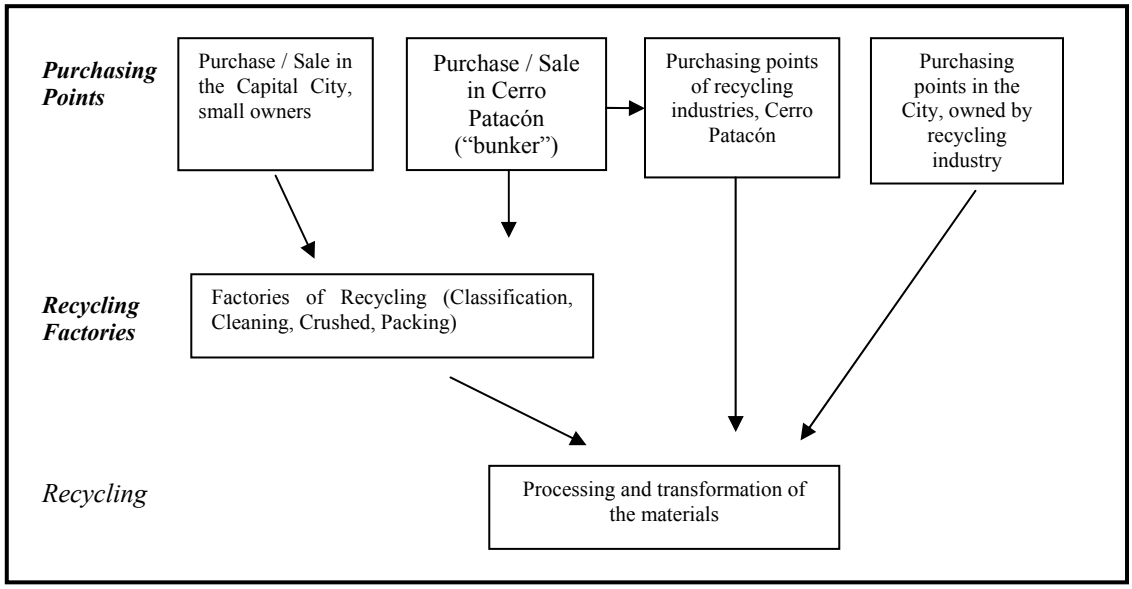


Figure 3-5: Recycling Structure in the Study Area

c. Final Consumption of Recycled Products

The recycling industry produces raw material for national and international industries, and final products will go to final consumers. Metal is sold in ingots to small industries that make tablets, boards and other articles; whereas an important part of the fused material is exported in ingots. The glass industry founds the material provided by the recycling factories and it uses as raw material to produce glass packages that soon are sold in the national and international market. The paper industry turns the waste into an ample variety of products for the national and international market: also it supplies to national industries that produce paper bags.

An example is Bolsas y Cartuchos de Papel, S.A., which was created in 1950 and at the moment it has 60 employees. This company buys recycled paper in average 4 tons annual from IPEL, S.A. As well, one of its main buyers is the chain of McDonald´s restaurants, which uses the bags of recycled paper for the packing of the fast food.

c.1. Metal

Between 1996 and September of 2001, the F.O.B. value of the exports of waste metal ascended to $U 48.6 million. The greater percentage corresponded to aluminum (79%) and in minor proportion iron and steel, copper, gold and lead as it is observed.

Table 3-51: Waste Metal Export Amount (1996 to 2001)

Material	F.O.B. Value ($U)
Aluminum	38,429,015
Iron and steel	5,817,782
Copper	3,061,028
Gold	1,233,656
Lead	80,113
Total	**48,621,594**

Source: General Controller, Direction of Statistics and Census. Exports According to Tariff Description and Country of Destiny, 1996, 1997, 1998, 1999, 2000, Sept. 2001.

The exports go mainly to the United States and Central and South America, although in the last years the countries of Asia are acquiring a greater importance in the purchase of metal remainders.

c.2. Paper

In Panama a strong demand of recovered paper and cardboard for the recycling exists, because it is cheaper than the virgin paper. The products that are recycle include cuts of paper (leftover of the process of production in plant and printers), paper of used office, newspapers, portfolios of Manila, cardboard, mixture of paper of remainders like lottery tickets, etc.

c.2.1 International Market

The exports of recovered paper went to mainly 4 countries: Colombia, Costa Rica, Venezuela and the United States. Between 1996 and September of 2001, 10,575,252 kg. were exported, distributed as follows: Colombia, 4,373,210 kg; Costa Rica, 4,122,015 kg; Venezuela, 1,257,936 kg, and the United States, 115.190 kgr. A marginal export is registered to Ecuador (19.190 kg) and Peru (22.000 kg).1996 2000.

On the other hand, in the same period, 15.317.536 kg molded pulp packages to carry eggs were exported to seven countries: Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua and Dominican Republic.

c.2.2 National Market

Some recycling factories specialize in the recovery, classification and packing of white paper, newspaper and magazines to be sold to the paper industry. According to the owner of Reciclados de Panamá, S.A., the specialization in this material obeys to the fact that cardboard requires of greater physical space and the sale is made in a slower way.

Reciclados de Panamá, S.A., can be consider a typical paper recycling factory. It initiated operations in 1997, it has 10 permanent workers and their annual sales ascend to $U 360,000.

Annually it commercializes (it buys and it sells) 2,400 tons of materials. In the opinion of the owner, it requires to commercialize a minimum of 200 tons monthly in order to maintain a profit yield of his company.

This small company is in a highly competitive sector, controlled in its industrial stage by MOLPASA and Papelera Istmeña. On the one hand, it must guarantee it's "cuota" of purchase of 200 ton/monthly as a minimum, with stable prices; and by another, it must procure the uninterrupted supplying on the part of the recuperators. In order to increase the volumes of storing, Reciclados de Panamá, tried to establish purchasing points in the city, but without success, due to the difficulties to control the handling of daily cash and the weighing one of the material.

Table 3-52:Purchase and Sales Price of Waste Paper

Product	Price paid to recovery workers	Sale price to recycling industries
Newspaper	$ 0.03 /pound	$ 0.05 /pound
White paper not printed	$ 0.10 /pound	$ 0.12 /pound
White paper printed	$ 0.08 /pound	$ 0.10 /pound
Colored paper	$ 0.02 /pound	$ 0.03 /pound

Source:
Data taken from information given by Reciclados de Panamá, S.A.

The increasing activity of recovery of paper remainders in the banking and commercial sector of the capital is perceived like a factor of competition for several reasons: first, the material can be offered to a lower price, than of the market, and second, stimulates the development – in the industry – of the operations of cleaning and classification, own by the recycling factories, which could reinforce the monopolistic structure of this sector.

c.3. Plastic

Between 1996 and September of 2001, Panama exported 7,799,633 kg (gross weight) of plastic remainders with a F.O.B. value of $U 1,728,367. Although the exported volume has increased substantially, the international prices have experienced a pronounced fall as of year 2000.

Table 3-53: Plastic Waste Export Amount in 1996 to 2001

Export country	Amount (kg)	F.O.B. ($U) VALUE
ARGENTINA	65,000	16,250
CHINA (Continental)	46,000	5,060
CUBA	14,968	5,940
CHILE	1,239,031	333,687
COLOMBIA	8,23,400	235,196
COSTA RICA	3,989,052	749,323
ECUADOR	739,945	161,800
UNITED STATES	142,981	32,708
HONDURAS	150,009	33,897
NICARAGUA	170,245	32,456
PERU	98,967	24,232
EL SALVADOR	97,750	13,212
ISRAEL	184,200	54,000
VENEZUELA	24,000	6,000
MEXICO	440	100
ITALY	13,645	3,000

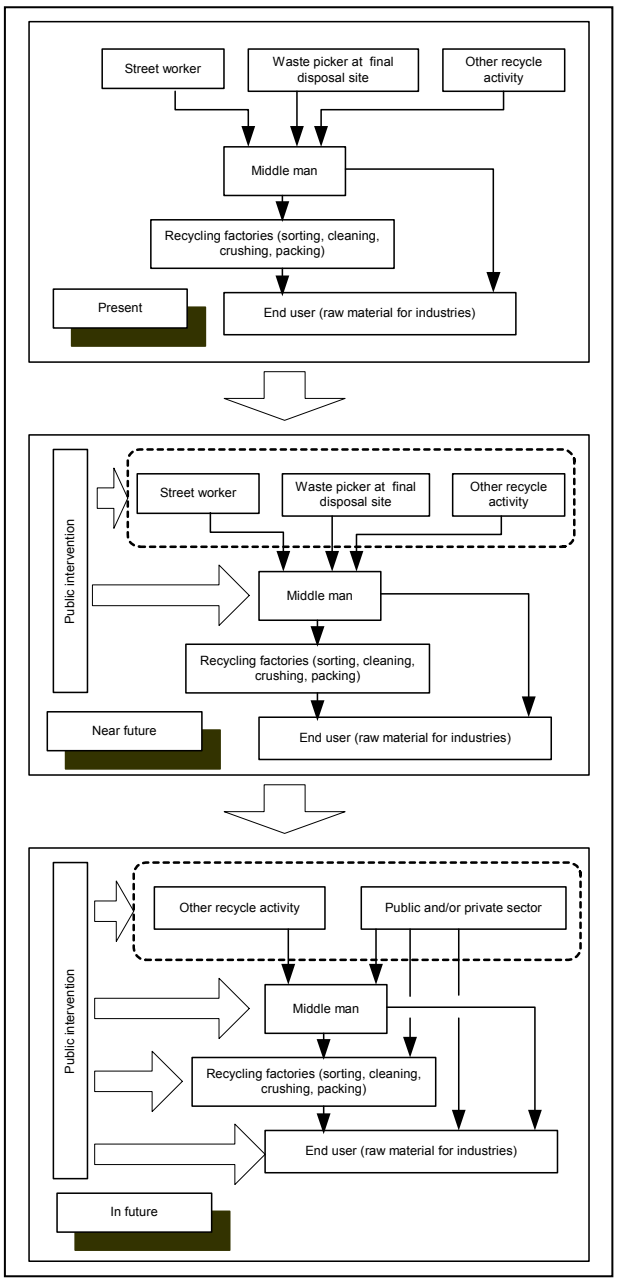
Source: General Comptroller, Direction of Statistic and Census, "Exports According to Tariff Description and Country of Destiny, 1996, 1997, 1998, 1999, 2000.

c.4. Glass

In Panama the glass bottles of all forms and sizes are the only class of this material that is recycle, due mainly to the fact that this material is 100% apt for recycling, which means that losses of quality does not exist during the reprocessing stage. Other glasses, like centers pieces for lights, glass for windows and mirrors, cannot be recycle and are considered polluting agents in the process of recycling glass. The energy savings and a smaller depreciation of the machinery is the economic factors that stimulate glass recycling, because the remainders of this material are melted at a much lower temperature. In addition, the glass recovered locally has a lower price than the imported glass.

3.4.4 Findings

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



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

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

3.5 Water Quality Survey

3.5.1 Objectives

The objectives of the survey are the following.

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

3.5.2 Survey Schedule

a. Number of Samples and Sampling Points

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

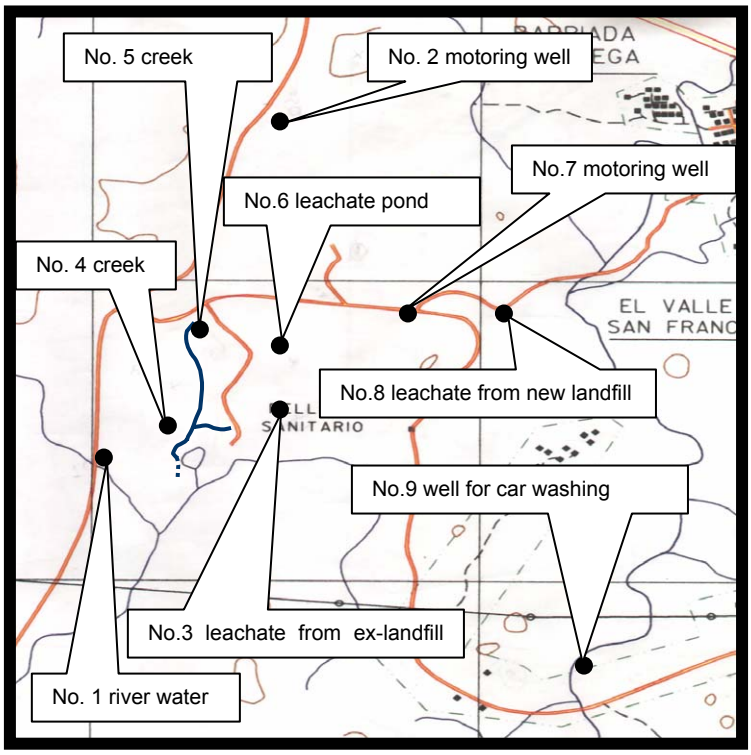


Figure 3-6: Location of Sampling Point

Table 3-54: Outline of the Sampling Point

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

b. Construction of Monitoring Well

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

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

c. Sampling

Sampling was carried out between January 28 and 30 at the designated points by the Study Team.

3.5.3 Survey Record

Results of the water quality analysis shows below table.

Table 3-55: Results of Waste Quality Analysis(1)

Item	Unit	Leachate			River water			Groundwater		
		Ex-landfill	Present landfill	Pond	Discharge point		Natural	Car wash	Upper	Down
					Upper	Down				
		No.3	No.8	No.6	No.5	No.4	No.1	No.9	No.2	No.7
Flow Volume	L/seg	0.00003	0.32	-	0.4	0.4	0.8	-	<0.1	0.95
Groundwater level	m	-	-	-	-	-	-	-	0.52	3.0
pH		6.9	6.9	9.6	6.8	6.7	7.0	7.7	7.1	6.9
Temperature	ºC	27.5	34.4	28.9	25.3	28.3	25.0	28.3	28.9	29.9
Conductivity	µS/cm	4130	9120	1255	1172	2140	287	696	1070	4590
Suspended Solids	mg/L	227.2	42	84.4	3.6	38.8	0.8	5.2	30.8	31.6
Turbidity	NTU	321	89.2	164	4.06	46.9	1.1	6.0	20.4	13.5
Color	PtCo	1638	1858	108	35	76	6	0	1	98

Item	Unit	Leachate			River water			Groundwater		
		Ex-landfill	Present landfill	Pond	Discharge point		Natural	Car wash	Upper	Down
					Upper	Down				
		No.3	No.8	No.6	No.5	No.4	No.1	No.9	No.2	No.7
Alkalinity	mg/L	453	3192	199	434	440	140	313	302	735
Oil Content	mg/L	1181.0	28.0	434.0	36.0	13.0	14.0	17.0	2.0	35.0
Fecal Coliforms	cfu/100ml	12500	4750	6	20500	2400	520	0	95	30500
Total Coliforms	cfu/100ml	19500	51000	22	54000	5650	755	0	285	250000
BOD_5	mg/L	32.0	762.1	15.7	6.1	36.3	20.5	0	6.8	22.9
COD	mg/L	35.4	1009	20.9	4	54	25	0	0	37.5
Ammonia Nitrogen	mg/L	33.0	491.4	<5.0	8.1	7.8	<5.0	<5.0	<5.0	7.1
Total Nitrogen	mg/L	35.4	495.0	<5.0	9.0	8.2	<5.0	<5.0	<5.0	8.5
Na^+	mg/L	445.0	490	191.2	82.5	99.0	16.4	111.9	68.0	109.4
Ca^{2+}	mg/L	78.9	245.0	10.8	49.4	69.5	13.7	20.7	69	362.5
HCO_3^-	mg/L	553.8	3895.3	181.8	529.7	536.6	170.8	330.9	346.5	896.9
SiO_2	mg/L	31.8	40.9	17.7	29.5	55.7	50.5	50.6	31.3	83.6
Cl^-	mg/L	691.3	1181.7	254.1	141.8	336.8	53.2	59.1	100.4	756.3
P	mg/L	620.0	5616.0	365.0	35.0	194.0	79.0	25.0	37.0	92.0
Cd^{2+}	mg/L	0.018	0.035	0.008	0.010	0.017	0.005	0.012	0.008	0.035
CN^-	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Pb	mg/L	0.35	0.30	0.26	0.24	0.35	0.21	0.22	0.33	0.23
Cr	mg/L	0.0021	0.0054	0.0030	0.0036	0.0018	0.0027	0.0024	0.0021	0.0017
Cr^{6+}	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
As	mg/L	0.0046	0.0021	0.0022	0.0033	0.0026	0.0024	0.0030	0.0048	0.0177
Hg	mg/L	0.0010	0.0011	0.0005	<0.0002	<0.0002	<0.0002	0.0010	<0.0002	0.0010
Cu	mg/L	0.262	0.038	0.013	0.015	0.025	0.022	0.025	0.020	0.047
Zn	mg/L	0.117	0.587	0.030	0.042	0.040	0.032	0.443	0.033	0.065
Fe	mg/L	15.720	8.195	0.113	0.420	7.890	0.115	0.063	0.552	0.595
Mn	mg/L	6.272	4.830	0.220	2.987	1.643	0.062	1.272	0.405	3.930
PCB's Aroclor 1016	µg/L	19.9	21.6	ND	ND	ND	ND	ND	ND	ND
PCB's Aroclor 1260	µg/L	41.5	24.8	ND	ND	ND	ND	ND	ND	ND

3.5.4 Findings

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

a. Leachate

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

No.8 showed an appropriate water quality as leachate from the final disposal site. It is remarkable that some organic chlorine compound which seems to be PCB was detected at No.3 and 8. The origin is indistinct but is thought to attribute to buried materials. In this survey, PCB was detected only from leachate so that groundwater and surface water might be judged free from PCB. However, we cannot jump into a conclusion with this only one survey. Therefore, continuous observation will be needed in future.

b. River Water

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

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

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

c. Groundwater

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

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

3.6 Traffic Volume Survey

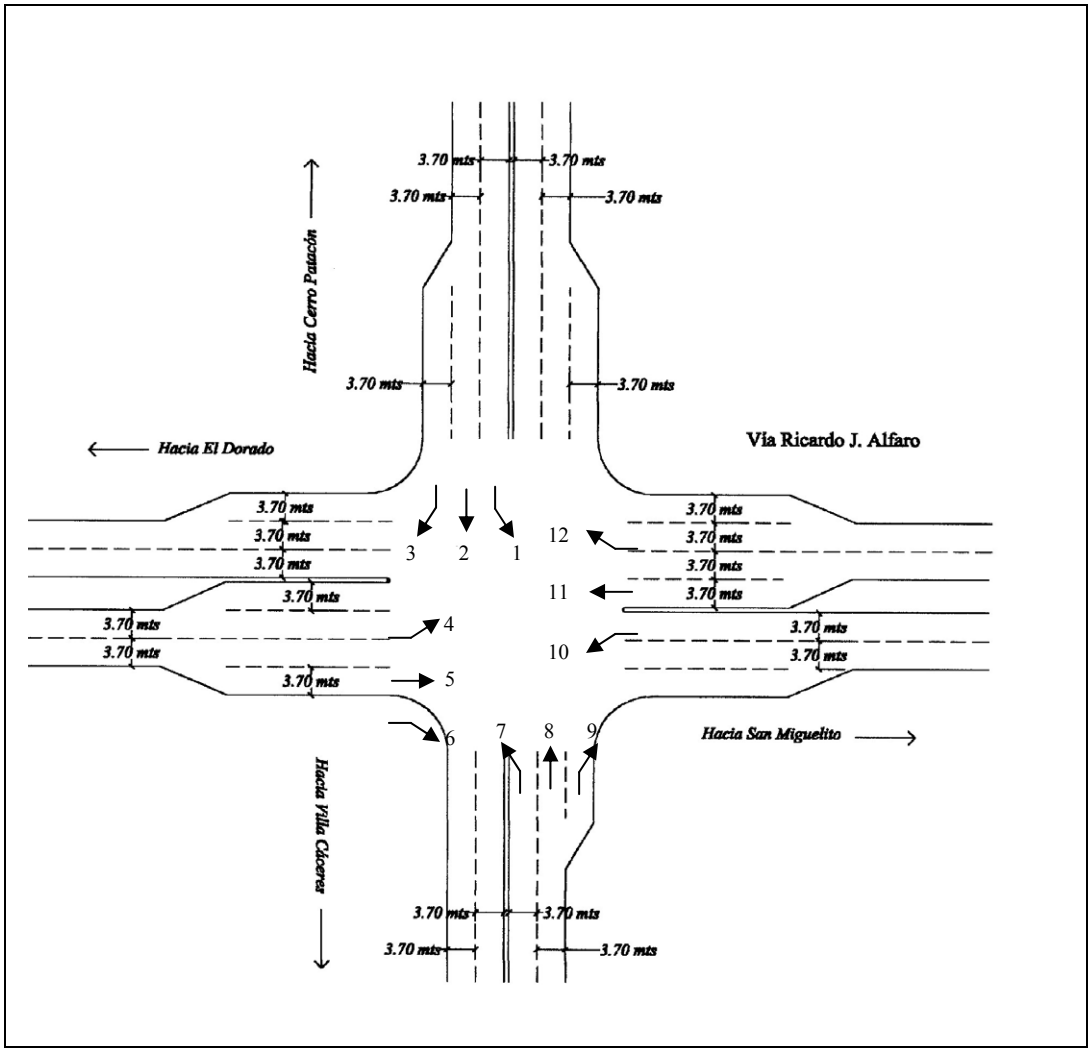
3.6.1 Objectives

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

3.6.2 Survey Schedule

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

- Intersection of Via Ricardo J. Alfaro and Ave. La Paz:
  25 Friday, 26 Saturday and 27 Sunday, January 2002 for 24 hours respectively
- Via Transistmica in Victoriano Lorenzo:
  1 Friday, 2 Saturday and 3 Sunday, February 2002 for 24 hours respectively
- Via Jose A. Arango in Santa Marta:



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

Figure 3-7: Intersection of Via Ricardo J. Alfaro and Ave. La Paz

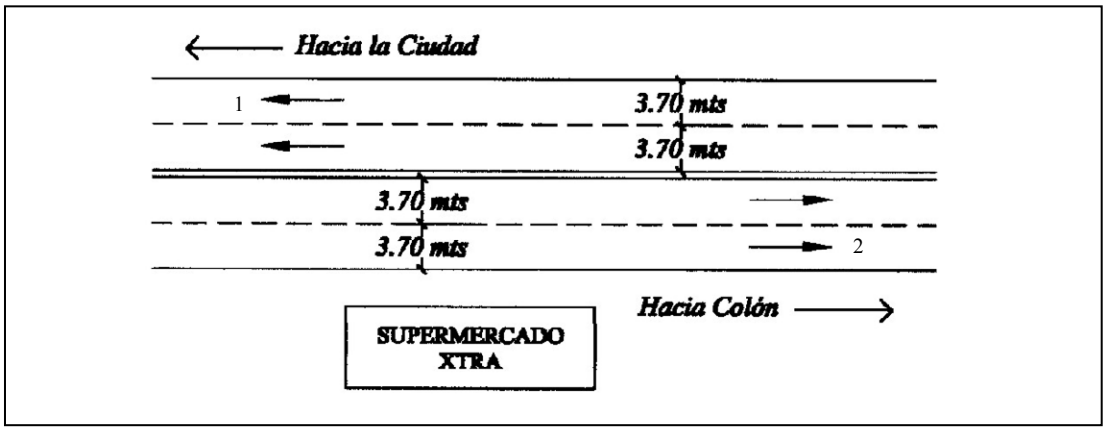


Figure 3-8: Via Transistmica

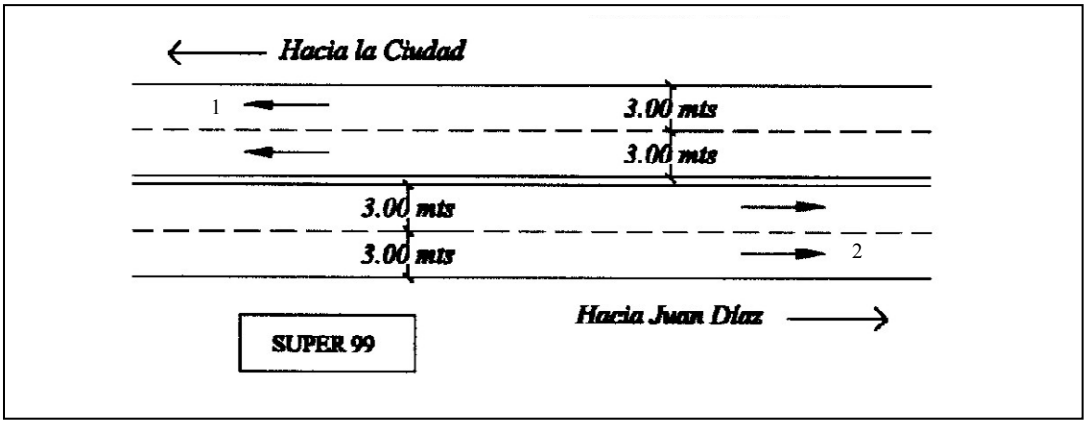


Figure 3-9: Via Jose A. Arango

3.6.3 Survey Record

The survey record is presented in data book.

3.6.4 Findings

a. Traffic Volume

a.1. Intersection of Via Ricardo J. Alfaro and La Ave. La Paz

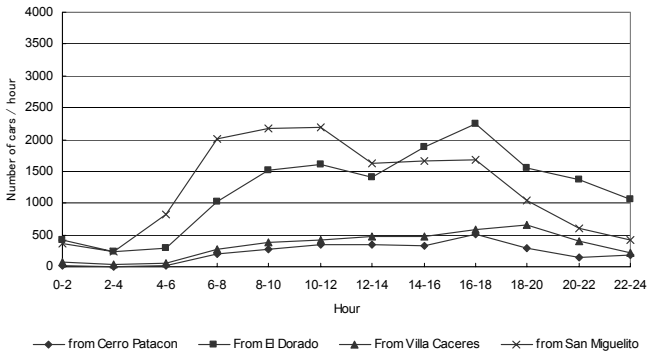


Figure 3-10: Traffic Volume at the Intersection of Via Ricardo J. Alfaro and Ave. La Paz (Weekday)

Figure 3-10 shows traffic volume passing through the intersection on weekday. Vehicles going through Via Ricardo J. Alfaro occupied the majority of the traffic volume. Number of vehicles running from direction of San Miguelito to El Dorado exceeded the opposite direction in the morning and vice versa in the afternoon.

Meanwhile, major variation was not found in number of vehicles passing through Ave. La Paz the whole day, although the traffic volume had a peak early in the evening.

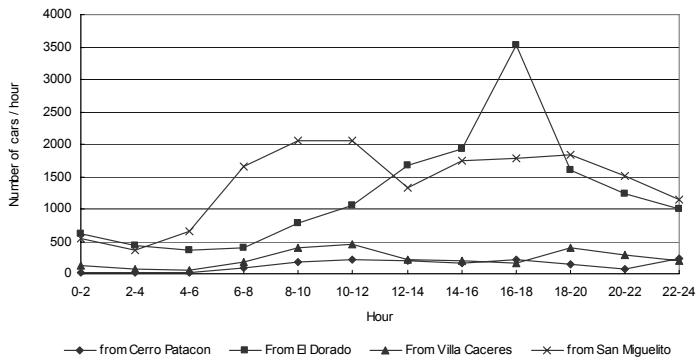


Figure 3-11: Traffic Volume at the Intersection of Via Ricardo J. Alfaro and Ave. La Paz (Saturday)

Figure 3-11 shows traffic volume in the intersection on Saturday. The traffic tendency was as almost same as one on the weekday.

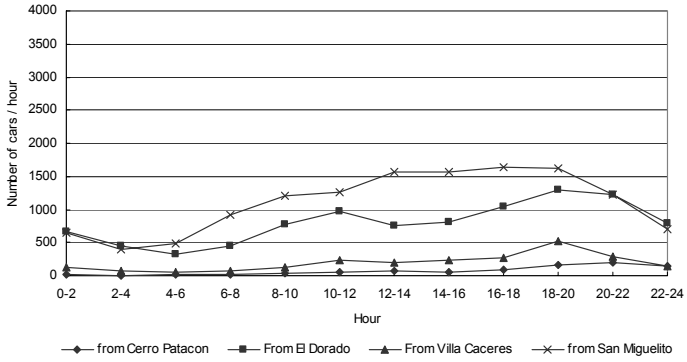


Figure 3-12: Traffic Volume at the Intersection of Via Ricardo J. Alfaro and Ave. La Paz (Sunday)

However, as Figure 3-12 shows, the traffic volume on Sunday was obviously fewer than that on weekday and Saturday. And there were no peaks of traffic in the morning and evening.

a.2. Via Transistmica

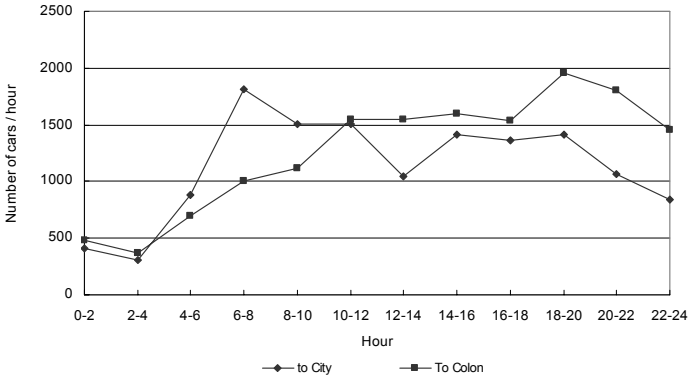


Figure 3-13: Traffic Volume of Via Transistmica (Weekday)

As Figure 3-13, Figure 3-14 and Figure 3-15 show, vehicles going to the city center through Via Transistmica exceeded ones to Colon in the morning in number and vice versa in the afternoon/evening through the week. This tendency was prominent on weekday and Saturday. In addition, the traffics were heavy by the midnights.

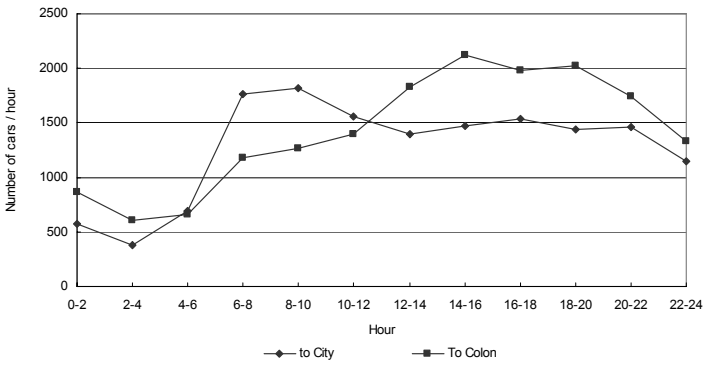


Figure 3-14: Traffic Volume of Via Transistmica (Saturday)

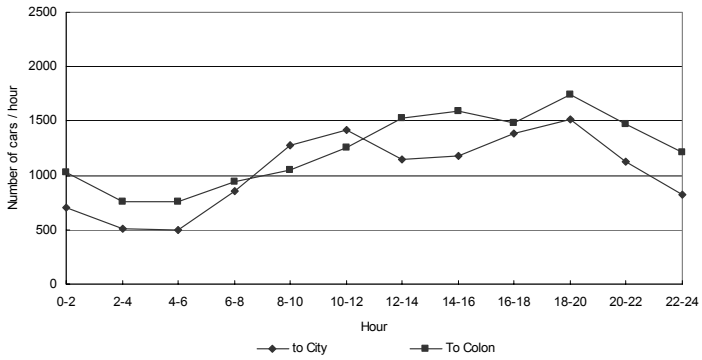


Figure 3-15: Traffic Volume of Via Transistmica (Sunday)

a.3. Via Jose A. Arango

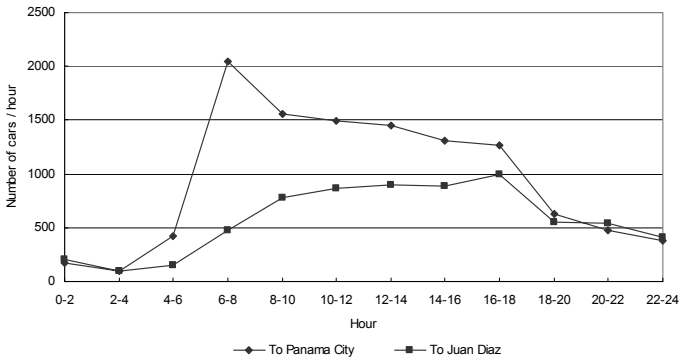


Figure 3-16: Traffic Volume of Via Jose A. Arango (Weekday)

As Figure 3-16 and Figure 3-17 show, traffic to the city center on the weekday and Saturday were prominently heavy. Especially, it concentrated during 6 am and 8 am on weekday.

Meanwhile, traffic was not heavy in the morning and was heavy between 4 pm and 8 pm in the evening during Sunday, as Figure 3-18 shows.

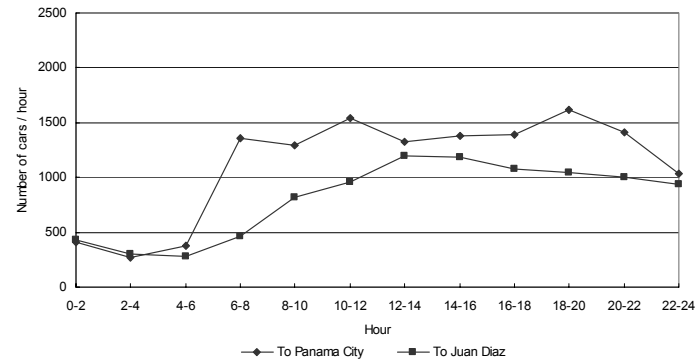


Figure 3-17: Traffic Volume of Via Jose A. Arango (Saturday)

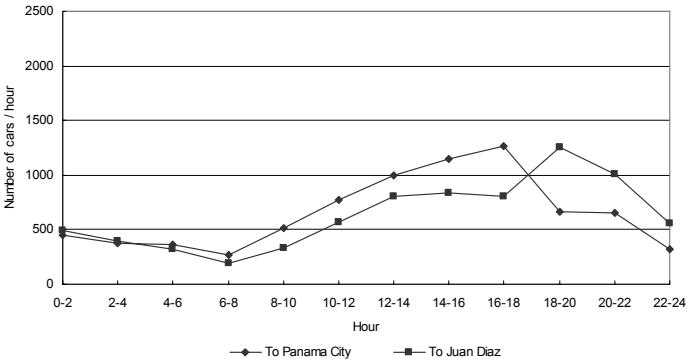


Figure 3-18: Traffic Volume of Via Jose A. Arango (Sunday)

b. Calculated Traffic Volume and Actual Traffic Volume

Possible traffic volume in each road was calculated and compared with the actual traffic volume. It was obtained by a manner that is popular in Japan, USA and others. Detailed manner is presented below.

b.1. Intersection of Via Ricardo J. Alfaro and Ave. La Paz

i) Calculated Traffic Volume

Possible traffic volume of one side of Via Ricardo J. Alfaro was obtained as 2,455 pcu/h, as shown below.

- Basic traffic volume of one lane: 2,200 pcu/h (passenger car unit / hour)
- Possible traffic volume (C_C): This is obtained by multiplying the basic traffic volume by various corrections.
- Width of lane (γ_L): 1.0 is applied, as the width of lane (3.7m) is more than 3.5 m
- Conditions along the road (γ_I): 0,9 is applied, as it is urbanized area.
- Mix of heavy vehicle (γ_T) : $\dfrac{100}{(100-T)+E_T \times T} = \dfrac{100}{(100-7.1)+2.0\times 7.1} = 0.93$

  Here, γ T: correction by mix of heavy vehicle

  ET: conversion coefficient of heavy vehicle to passenger car. 2.0 is applied as it is urbanized area.

T: Mixed ratio of heavy vehicle, 7.1%

Mixed ratio of heavy vehicle (T) was obtained based on number of vehicles in each type for a week as follows.

Type of car	Weekday*	Saturday	Sunday	Total	%
Passenger car	272,360	58,469	43,687	374,516	92.9
Bus/Trucks	21,495	3,980	1,796	27,271	6.8
Waste collection truck	920	162	170	1,252	0.3
Total	294,775	62,611	45,653	403,039	100.0

* The value was obtained by multiplying one of a weekday by 5 days.

- Green indication ratio of traffic light (L): 2/3 (by actual time counting. Although there were certain differences in days and time zones, the green indication ratio was about 2/3)
- Number of lanes: 2

Consequently, the possible traffic volume of one side of Via Ricardo J. Alfaro was obtained as follows.

$$C_C = C_B \times \gamma_L \times \gamma_I \times \gamma_T \times L \times N$$
$$= 2{,}200 \times 1.0 \times 0.9 \times 0.93 \times \frac{2}{3} \times 2$$
$$= 2{,}455.2$$

ii) Comparison with actual traffic volume

Actual traffic volume at peaks in the morning and evening obtained by this survey was between 2, 000 and 2,500 pcu/h. Those are close to 2,455 pcu/h of the possible traffic volume. This would mean that the actual traffic volume reaches to the possible one at peaks. Actually, traffic congestions are often found at the intersection. In Figure 3-11, the peak of the actual traffic volume is far beyond the possible one. This is likely to show heavy traffic congestion.

b.2. Via Transistmica

i) Calculated Traffic Volume

Possible traffic volume of one side of Via Transistmica was obtained as between 1,683 and 2,244 pcu/h, as shown below.

- Basic traffic volume of one lane: 2,200 pcu/h (passenger car unit / hour)

- Possible traffic volume (C_C): This is obtained by multiplying the basic traffic volume by various corrections.
- Width of lane (γ_L): 1.0 is applied, as the width of lane (3.7m) is more than 3.5 m
- Conditions along the road (γ_I): 0,9 is applied, as it is urbanized area.
- Mix of heavy vehicle (γ_T) : $\frac{100}{(100-T)+E_T \times T} = \frac{100}{(100-18.2)+2.0\times 18.2} = 0.85$

  Here, γ T: correction by mix of heavy vehicle

  ET: conversion coefficient of heavy vehicle to passenger car. 2.0 is applied as it is urbanized area.

  T: Mixed ratio of heavy vehicle, 18.2%

Mixed ratio of heavy vehicle (T) was obtained based on number of vehicles in each type for a week as follows.

Type of car	Weekday*	Saturday	Sunday	Total	%
Passenger car	235,780	54,732	47,285	337,797	81.8
Bus/Trucks	59,660	9,670	5,362	74,692	18.1
Waste collection truck	355	78	36	469	0.1
Total	295,795	64,480	52,683	412,958	100.0

* The value was obtained by multiplying one of a weekday by 5 days.

- Green indication ratio of traffic light (L): 1/2 to 2/3 (There is a crossing with traffic lights. However, it cannot be applied the green indication ration at the point, as the crossing is with over pass. Consequently, 1/2 to 2/3 for the ratio was assumed according to the actual conditions.)
- Number of lanes: 2

Consequently, the possible traffic volume of one side of Via Transistmica was obtained as follows.

In case of L = 1/2

$$C_C = C_B \times \gamma_L \times \gamma_I \times \gamma_T \times L \times N$$
$$= 2{,}200 \times 1.0 \times 0.9 \times 0.85 \times 1/2 \times 2$$
$$= 1{,}683$$

In case of L = 2/3

$$C_C = C_B \times \gamma_L \times \gamma_I \times \gamma_T \times L \times N$$
$$= 2{,}200 \times 1.0 \times 0.9 \times 0.85 \times 1/2 \times 2$$
$$= 1{,}683$$

ii) Comparison with actual traffic volume

The actual traffic volume at peaks were about 2,000 pcu/h. This is between 1,683 and 2,244 pcu/h of the possible traffic volume. Therefore, it is conjectured that actual traffic volume often exceeds the capacity of the road. Actually, traffic congestions are frequently found on the road.

b.3. Via Jose A. Arango

i) Calculated Traffic Volume

Possible traffic volume of one side of Via Jose A. Arango was obtained as between 1,675 and 2,233 pcu/h, as shown below.

- Basic traffic volume of one lane: 2,200 pcu/h (passenger car unit / hour)
- Possible traffic volume (C_C): This is obtained by multiplying the basic traffic volume by various corrections.
- Width of lane (γ_L): $0.24 \times W_L + 0.22 = 0.24 \times 3.0 + 0.22 = 0.94$

  Here, width of lane is 3.0m
- Conditions along the road (γ_I): 0,9 is applied, as it is urbanized area.
- Mix of heavy vehicle (γ_T) : $\frac{100}{(100-T)+E_T \times T} = \frac{100}{(100-11.2)+2.0 \times 11.2} = 0.90$

  Here, γ T: correction by mix of heavy vehicle

  ET: conversion coefficient of heavy vehicle to passenger car. 2.0 is applied as it is urbanized area.

  T: Mixed ratio of heavy vehicle, 11.2%

Mixed ratio of heavy vehicle (T) was obtained based on number of vehicles in each type for a week as follows.

Type of car	Weekday*	Saturday	Sunday	Total	%
Passenger car	158,820	41,852	28,705	229,377	88.8
Bus/Trucks	22,455	4,369	2,011	28,835	11.1
Waste collection truck	165	29	39	233	0.1
Total	181,440	46,250	30,755	258,445	100.0

* The value was obtained by multiplying one of a weekday by 5 days.

- Green indication ratio of traffic light (L): 1/2 to 2/3 (There are several traffic rights nearby. 1/2 to 2/3 for the ratio was assumed according to the actual conditions.)
- Number of lanes: 2

Consequently, the possible traffic volume of one side of Via Jose A. Arango was obtained as follows.

In case of L = 1/2

$$C_C = C_B \times \gamma_L \times \gamma_I \times \gamma_T \times L \times N$$
$$= 2{,}200 \times 0.94 \times 0.90 \times 0.90 \times 1/2 \times 2$$
$$= 1{,}675$$

In case of L = 2/3

$$C_C = C_B \times \gamma_L \times \gamma_I \times \gamma_T \times L \times N$$
$$= 2{,}200 \times 1.0 \times 0.9 \times 0.85 \times 1/2 \times 2$$
$$= 1{,}683$$

ii) Comparison with actual traffic volume

Actual traffic volume is about or below 1,500 pcu/h, which less than 1,675 pcu/h of the minimum possible traffic volume calculated, during the almost whole day. However, the actual traffic volume exceeded in the morning of weekday. This may indicate that traffic congestions happen during that time zone.

c. Present Status of Collection Vehicle

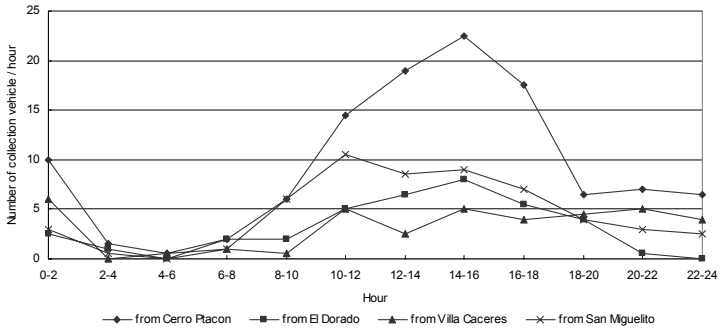


Figure 3-19: Traffic Volume of Collection Vehicle at the Intersection of Via Ricardo J. Alfaro and Ave. La Paz (Weekday)

Figure 3-19 shows the present status of collection vehicles going into the intersection of Via Ricardo J. Alfaro and Ave. La Paz. The intersection is the entrance of Cerro Patacon Final Disposal Site. Therefore, the figure shows number of collection vehicles coming into and going out of the site. The

majority of vehicles pass through the intersection between 10 am and 8 pm where traffic is heavy. It indicates that waste transport efficiency is decreased by the heavy traffic.

d. Recommendation for Increasing Collection and Transport Efficiency

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

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

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

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