

**THE STUDY  
ON  
SOLID WASTE MANAGEMENT  
OF  
THE URBAN AREA  
OF  
TEGUCIGALPA'S CENTRAL DISTRICT**

**FINAL REPORT  
VOLUME I**

**SUMMARY**

**MARCH 1999**

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**JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)**

**THE MUNICIPALITY OF THE CENTRAL DISTRICT  
THE REPUBLIC OF HONDURAS**

**THE STUDY  
ON  
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## PREFACE

In response to a request from the Government of the Republic of Honduras, the Government of Japan decided to conduct The Study on Solid Waste Management of the Urban Area of Tegucigalpa's Central District in the Republic of Honduras and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Honduras a study team headed by Mr. Takeshi Tomiyasu, KOKUSAI KOGYO CO. LTD., four times between December 1997 to March 1999. In addition, JICA set up an advisory committee headed by Dr. Hidetoshi Kitawaki, a professor of Toyo University, which examined the study from specialist and technical points of view.

The team held discussions with the officials concerned of the Government of Honduras, and conducted field surveys at the study area. Upon returning to Japan, the team conducted further studies and prepared this final report.

I hope that this report will contribute to the promotion of this project and to the enhancement of friendly relationship between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Honduras for their close cooperation extended to the study.

March, 1999



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Kimio Fujita  
President

Japan International Cooperation Agency



March, 1999

Mr. Kimio Fujita  
President  
Japan International Cooperation Agency

**Letter of Transmittal**

Dear Mr. Fujita,

We are pleased to submit to you the report on The Study on Solid Waste Management of the Urban Area of Tegucigalpa's Central District in the Republic of Honduras.

This report consists of three main components, a study on the present waste management situation, a solid waste management master plan until the year 2010, and a feasibility study on the priority projects for the urban area of Tegucigalpa's Central District.

Just before the termination of this Study, Honduras was hit by Hurricane Mitch, which caused severe damage to the country. Due to this damage, an additional study was carried out and revisions were made to the original premises on which the master plan was based, and subsequently the original master plan for solid waste management, and the original feasibility study on the priority projects.

The study on the present waste management situation assesses the present waste management situation of the urban area of Tegucigalpa's Central District after carrying out eleven basic surveys.

The master plan comprises a forecast of waste generation amounts; a planning framework with phased goals, targets, and strategies; the best technical system; the financial system; and the organizational and institutional system. Since improvement of the organizational and institutional system is necessary to materialize the master plan and to establish a sustainable solid waste management system, it was given the highest priority. To this end, several recommendations were made, they being, the establishment of an independent solid waste management authority and the introduction of the new waste fee collection system.

The feasibility study was conducted on the priority projects proposed to be undertaken between the years 1999 and 2002. These consist of improvements of the organizational and institutional system, the waste collection and haulage system, and the construction of new final disposal site. These projects were evaluated from financial, economic, technical, social and environmental aspects and were found to be feasible in all aspects.

During the study, four pilot projects were carried out. Two of these, the "Campaign for Raising Awareness on Solid Waste Issues" and the "Experiment on the Implementation of the Best Collection System for Marginal Areas", promoted the active participation of the counterparts and residents, provoking a strong positive response.

We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs and the Ministry of Health and Welfare. We also wish to extend our sincere gratitude to the Government of the Republic of Honduras, the Municipality of the Central District, the Embassy of Japan and the JICA office in the Republic of Honduras.

Finally, we hope that this report will help improve and enhance solid waste management and urban environment sanitation in Tegucigalpa's Central District in Honduras.

Respectfully,

  
Takeshi Tomiyasu

Team Leader

The Study on Solid Waste Management of the  
Urban Area of Tegucigalpa's Central District in  
the Republic of Honduras

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## **Outline of the Solid Waste Management Plan**

### **1. Policy for the Solid Waste Management Plan**

Most current problems related to solid waste in the Central District are attributed to the weak institutional system, especially to the inefficient financial system, and some problems in the technical system. At present, new projects can not be expected to become successful unless an appropriate institutional system is established before their implementation. Therefore, first priority was given to the improvement of the institutional system.

### **2. Improvement of the Institutional System**

The institutional system was formulated based on the following concepts.

- a) A sound financial system will be established without taking any financial assistance from donor agencies into account.
- b) First priority will be given to the establishment of a sound revenue system.
- c) Since it will be difficult for the Municipality of the Central District (AMDC) to bear the required investment for the solid waste management (SWM) works, the involvement of the private sector will be extended to reduce the required amount for investment.
- d) Prior to extending the private sector's involvement in SWM, the management system will be improved to minimize contracting out rates and to ensure the quality of the services.

#### **2.1 Organizational System**

- a) In 1999, the Solid Waste Management Executing Unit (SWEU), which will be a temporary organization to be directly under the Mayor's office, will be established.
- b) By 2001, the Municipal Cleansing Corporation (MCC) which is a Solid Waste Management Autonomous Entity will be established. The AMDC will hold at least 51% of the whole capital of the MCC.

#### **2.2 Waste Fee Collection System**

In 2001, the joint billing of waste collection fees and electricity charges will begin.

## 2.3 Waste Collection Fee System

In 2001, the new waste collection fee system, as shown below, will begin.

Type of waste			Waste Fee		
			2001 - 2002	2003 - 2007	2008 - 2010
Residential waste <sup>1</sup> : (Lps/house/month)	High income group		63	70	80
	Middle income group		22	33	36
	Low income group		11	18	20
Non- Residential waste	Business waste (Lps/ establishment /month)	Annual business income more than L.4,000,000	500		
		L.3,000,001-4,000,000	450		
		L.2,000,001-3,000,000	400		
		L.1,000,001-2,000,000	250		
		L.500,001-1,000,000	200		
		L.300,001-500,000	150		
		L.100,001-300,000	100		
		L.50,001-100,000	75		
		up to L.50,000*	50		
	Large amount discharger (Lps/ton)		480		530
	Direct haulage discharger (Lps/ton)		50		55

Note: The basic business waste fee starts at Lps50/establishment/month.

## 2.4 Management System

- The MCC's accounting, financing, planning, monitoring and supervision capabilities will be improved.
- The involvement of the private sector in SWM will be gradually extended.
- The operation of collection and haulage services will be gradually shifted from the public sector to the private sector. In that process the MCC will directly operate at least 25% of the collection and haulage works.
- The MCC will hold an open bid so that proceedings are transparent to the general public.
- The MCC limits the amount to be collected in one contract area to less than 50 ton/day.
- The contract rate of collection and haulage work will be kept at less than Lps. 300 per ton.

<sup>1</sup> The following considerations were taken into account to determine the residential waste collection fee. 1) To introduce the cross-subsidy mechanism (i.e., the affluent pay for the less well off). 2) To keep the proposed rate below the amount that people are willing to pay (WTP). 3) To keep the proposed rate below 1.0% of the resident's income. Refer to page 46.

### **3. Technical System**

#### **3.1 Discharge and Storage**

- a) The MCC will not bear any costs related to storage system except for the cost of the communal containers.
- b) The MCC will promote the use of plastic bags or plastic containers for storage of waste.
- c) The separate discharge system will begin in areas where they are feasible from 2008.

#### **3.2 Collection and Haulage**

- a) The executing body from 1999 to 2000 will be the AMDC's SWEU. After 2001 the executing agency will be the MCC.
- b) The private sector's involvement will be gradually extended, but the MCC will directly operate at least 25% of the entire collection and haulage works.
- c) Collection frequency

City center and high income residential areas: three times a week  
Other areas: twice a week

- d) Type of collection equipment

The standard type of collection equipment and collection method proposed are as follows.

Area	Collection Equipment	Collection Method
Standard residential areas	15m <sup>3</sup> Compactor truck	Curb collection
Commercial areas	15m <sup>3</sup> Compactor truck	Curb collection
Busy commercial areas	8m <sup>3</sup> Compactor truck	Curb collection
Marginal areas	5.5 m <sup>3</sup> and 10 m <sup>3</sup> container truck	Point collection
Street waste	5.5 m <sup>3</sup> and 10 m <sup>3</sup> container truck	Point collection

#### **3.3 Processing, Treatment and Recycling**

##### **1) Basic Policy**

- a) Neither major processing nor treatment plants for municipal solid waste, to be operated by the MCC, will be introduced provided that acquisition of a landfill site and its operation do not impose too much effort on the proposed waste management authority.
- b) The AMDC's SWEU will promote recycling activities by encouraging the participation of the private sector and avoid direct involvement in the execution of recycling activities.
- c) A separate discharge system will be firstly introduced in the high income residential areas, where more recyclable materials are included in the generated wastes, and gradually expanded to the middle and low income residential areas.

## **2) Implementation Plan**

- a) In 2004, the first recycling program (collection of recyclable waste at markets and public square) will be implemented.
- b) In 2008, the second recycling program (collection of recyclable waste at schools) will be implemented.
- c) In 2007, a recycling company will be jointly established by the AMDC and the private sector. This company will have a manual sorting plant near the new disposal site and start its operation by employing scavengers in 2008.
- d) In 2008, the MCC will prohibit entry to the disposal site.
- e) In 2008, the MCC will start separate collection officially.

## **3.4 Street Sweeping System**

- a) The manual sweeping method will be maintained until 2010 except in some trunk roads.
- b) The following improvement measures will be executed.
  - Economic utilization of micro-enterprises
  - Appropriate distribution of immovable litter boxes along streets
  - Appropriate allocation of collection stations for street sweeping waste
  - Introduction of a new type of cart for carrying street sweeping waste collected
  - To acquire small site offices in proper locations for street sweeping works

## **3.5 Final Disposal**

### **1) Existing Final Disposal Site**

- a) In 1999, the facilities in the existing disposal site will be improved and a weighbridge will be installed.
- b) The cooperation of scavengers will be encouraged.

### **2) New Final Disposal Site**

- a) In 2001, the committee for the selection of a new disposal site will be established.
- b) In 2002, the new site will be decided.
- c) Between 2003 and 2005, the preliminary design, EIA, acceptance from neighborhood, detailed design, tender documents will be conducted.
- d) In 2006, the new disposal site will be constructed.
- e) In 2007, the operation of the new disposal site will start.

## **3.6 Maintenance and Operation**

The private sector's involvement in SWM will be extended in order to reduce the burden and work load of the authority responsible for SWM.

### 3.7 Hygiene Education

- a) Hygiene education will be reinforced and continued through the Alcaldia Mobile Campaign.
- b) Classes on waste education will be conducted using the textbook "Basura", the video on solid waste, etc.

## 4. Project Costs

### 4.1 Costs for the Master Plan Projects

The cost for the master plan projects covers the whole SWM costs required from 1999 to 2010.

unit: million Lps

		1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Collection & Haulage	Investment	0.0	35.3	0.0	0.0	0.0	0.0	0.0	0.0	35.3	0.0	0.0	0.0
	O & M	10.2	11.6	11.2	11.2	11.2	12.6	11.2	11.2	11.2	14.5	11.2	14.5
	Contract-out	11.0	11.0	21.9	21.9	32.9	32.9	43.8	43.8	54.8	54.8	65.7	65.7
Street Sweeping	Investment	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.3	0.0	0.0
	O & M	2.8	2.8	3.3	3.5	3.5	3.5	3.7	3.9	4.1	4.2	4.4	4.6
	Contract-out	6.7	6.7	6.7	7.1	7.1	7.1	7.5	7.9	8.2	8.6	9.0	9.3
Recycling	Investment	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	2.4	0.5	0.0	0.0
	O & M	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	1.0	1.0	1.0
	Contract-out	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Final Disposal	Investment	6.3	12.2	0.0	3.0	0.6	0.0	3.0	12.8	2.1	3.0	3.0	0.6
	O & M	4.1	5.4	5.6	5.3	6.7	7.9	7.1	5.6	7.7	8.1	8.8	9.2
	Contract-out	2.6	3.0	3.6	3.6	3.8	4.4	4.0	3.8	4.2	5.0	4.6	5.3
Indirect Cost	O & M	2.6	3.0	3.6	3.6	3.8	4.4	4.0	3.8	4.2	5.0	4.6	5.3
	Total	6.3	48.1	0.0	3.0	1.8	0.0	3.0	12.8	40.4	3.8	3.0	0.6
	O & M	19.7	22.8	23.7	23.6	25.2	28.9	26.5	24.9	27.7	32.8	30.0	34.5
Total	Contract-out	17.7	17.7	28.6	29.0	40.0	40.0	51.3	51.7	63.0	63.3	74.7	75.0
	Total	43.7	88.6	52.3	55.6	67.0	68.9	80.7	89.4	131.1	100.0	107.6	110.2

### 4.2 Costs for Priority Projects

The cost for the priority projects covers the investment from 1999 to 2002 and the O & M costs from 1999 to 2010.

unit: thousand Lps

		1999	2000	2001	2002	2003	2004-2010
Collection & Haulage	Investment	0	10,503	11,216	13,547	-	35,266
	O & M	10,163	11,567	17,522	15,338	14,932	104,524
	Contract-out	10,950	10,950	21,900	21,900	21,900	153,300
Street Sweeping	Investment	0	656	0	0	-	656
	O & M	2,840	2,840	3,316	3,500	3,500	24,503
	Contract-out	6,730	6,730	6,730	7,104	7,104	49,727
Final Disposal	Investment	6,332	12,164	0	2,961	-	17,005
	O & M	3,997	5,334	5,491	5,214	6,542	46,470
	Contract-out	0	0	0	0	0	0
Indirect Cost	Investment	2,550	2,961	4,739	4,329	4,495	31,589
	O & M	19,550	22,702	31,069	28,381	29,470	207,086
	Contract-out	17,680	17,680	28,630	29,004	29,004	203,027
Total	Investment	6,332	23,323	11,216	16,509	-	52,927
	O & M	19,550	22,702	31,069	28,381	29,470	207,086
	Contract-out	17,680	17,680	28,630	29,004	29,004	203,027
Total	Total	43,562	63,705	70,915	73,894	58,474	463,041

## **5. Project Evaluation**

The implementation of the master plan is not highly likely going to incur any technical, social or environmental problems.

through its implementation, it is estimated that approximately 600,000 people will benefit from the waste collection.

The financial evaluation shows that the implementation of the master plan will incur a 17.2% FIRR, which exceeds the cut-off rate of IDB (12%). The implementation of the priority projects is also considered to incur 23.0%, which is also over 12%.

The master plan will incur an EIRR of 16.1% and generate various unquantifiable benefits.

## **6. Recommendations**

The master plan is assessed to be feasible from the technical, social, environmental, financial, and economic viewpoints. Therefore, the AMDC should implement this master plan based on the strategies proposed in this study.

In the implementation of the master plan, the improvement of the institutional system has to be conducted first, because it is too difficult to make any new projects successful without an appropriate institutional system.

## List of Volumes

Volume I	Summary
Volume I(S)	Summary (Spanish Version)
Volume II	Main Report
Volume II(S)	Main Report (Spanish Version)
Volume III	Revised Main Report
Volume III(S)	Revised Main Report (Spanish Version)
Volume IV	Annex
Volume V	Data Book

### Note:

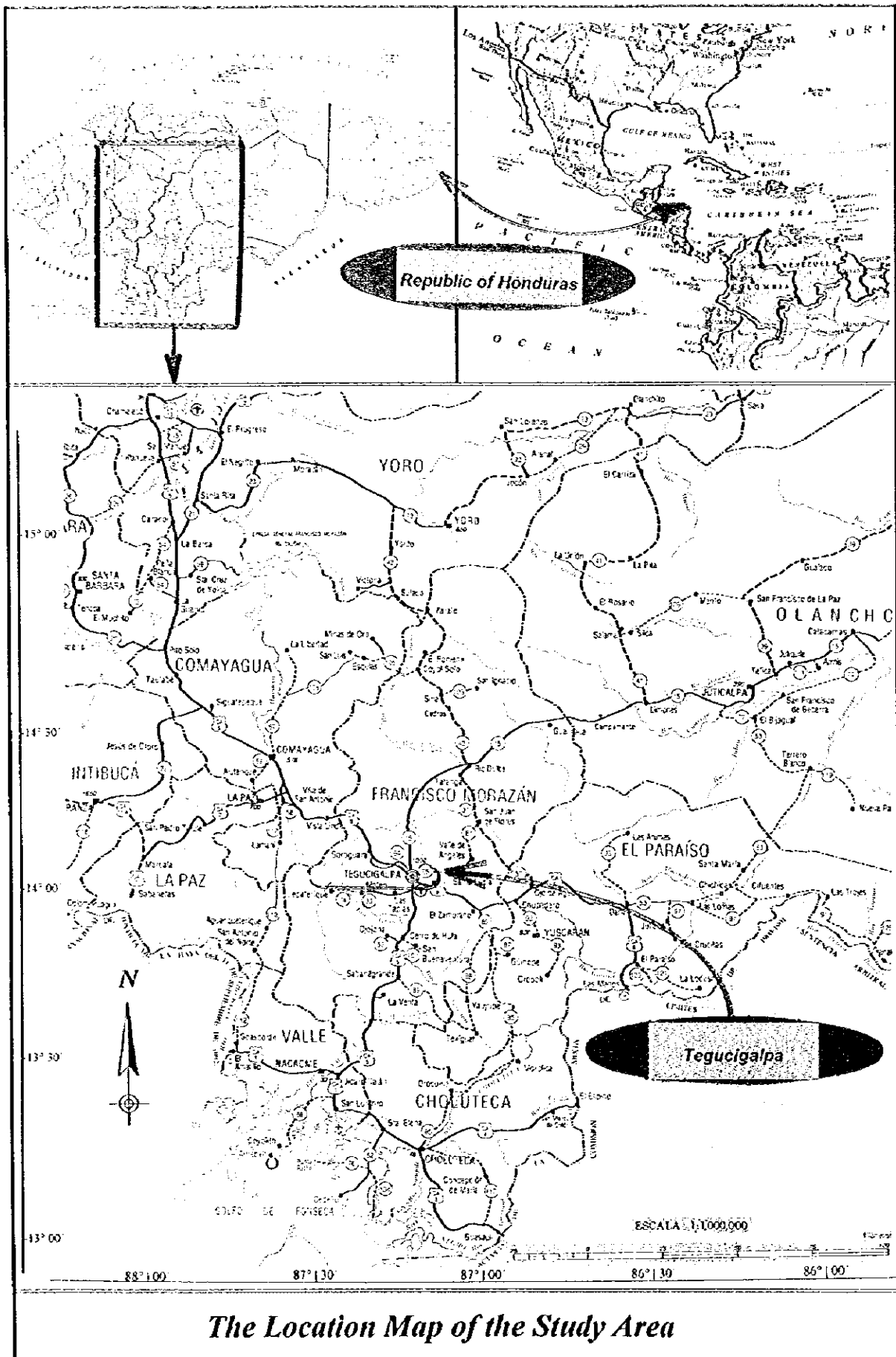
The revised main reports (English and Spanish) are being made taking into account the effect of Hurricane Mitch on solid waste management works.

Since the other reports were made before Hurricane Mitch hit Honduras, its effect on solid waste management works was not taken into account.

Although the revised main reports (English and Spanish) best illustrate the current conditions, the other reports should also be referred to for detail.

## *This is the Summary.*

In this report, the project cost is estimated using the July 1998 prices and at an exchange rate of 1US\$ = 143.85 Japanese Yen = 13.4892 Lempiras.





***Plate 1: Field Investigations (1) Waste Amount and Composition Survey***

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**Waste Amount Survey**



Collection of household waste samples



Weighing of waste samples

**Waste Composition Survey**



Waste samples were brought into the survey site



Thorough mixing of collected waste samples



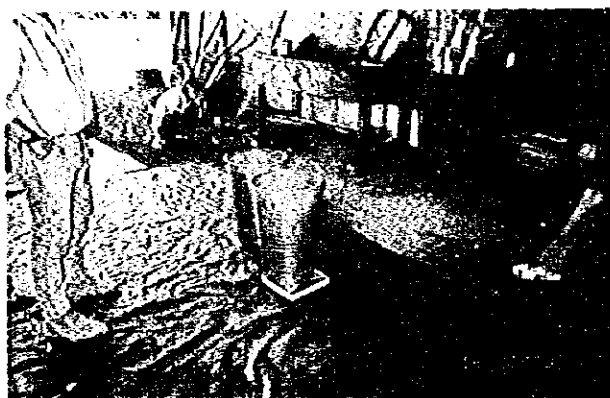
After proper mixing, the waste was divided into four segments of approximately the same size



Two segments of diagonally opposite waste were removed and the remaining waste was mixed again until the volume was reduced to the desired volume.

***Plate 2: Field Investigations (2) Waste Amount and Composition Survey***

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Waste samples were put into a calibrated plastic bucket to record volume and weight



Analysis of physical composition of waste samples

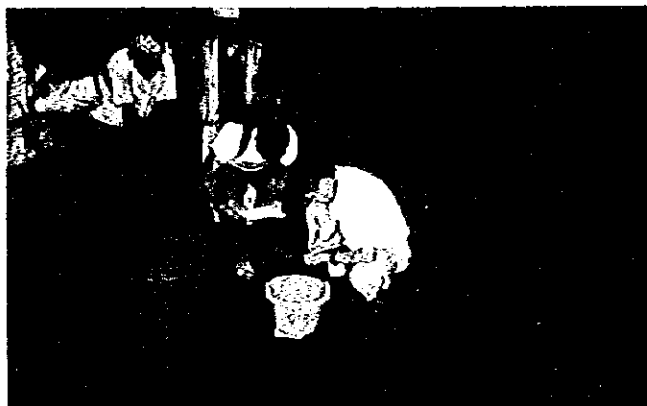


Samples were divided into 10 components



Waste samples were categorized into paper, fiber, grass & wood, plastics, rubber, leather & metal, bottles & glass, stones, food wastes, and others.

**Analysis of the three components of mixed samples**



The samples divided into 10 components were measured individually.



The samples were dried, incinerated and subjected to the three components analysis.

**Plate 3 : Field Investigations (3) Disposal Amount Survey, Public Opinion Survey, Workshop (PCM), Present Final Disposal Site Conditions**

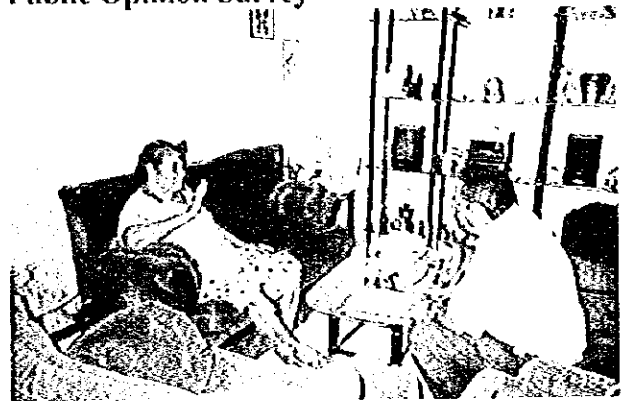
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**Disposal Amount Survey**



Determining the waste load and loading capacity of municipal and private collection vehicles

**Public Opinion Survey**



Interview of 300 households from the high, middle, and low-income areas on waste discharge and collection services

**PCM Workshop**

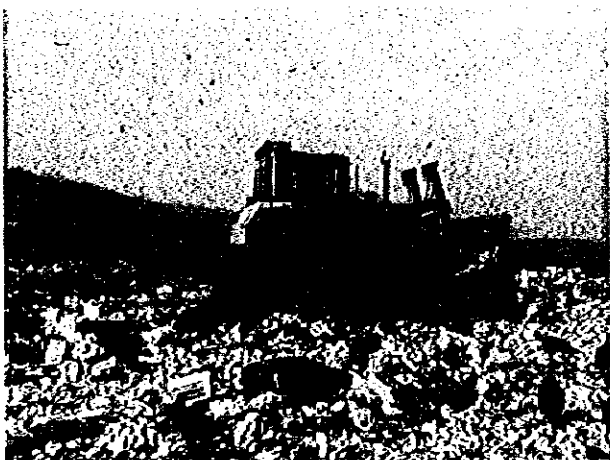


A workshop was held to discuss the different ways the final disposal site could be improved, inviting a total of 15 people representing the residents, the AMDC, scavengers and the JICA study team.

**Present Final Disposal Site Conditions**



Scavengers' burning of copper wire in their aim to recover copper occasionally sets fire to the wastes.



The final disposal site is equipped with 3 bulldozers.



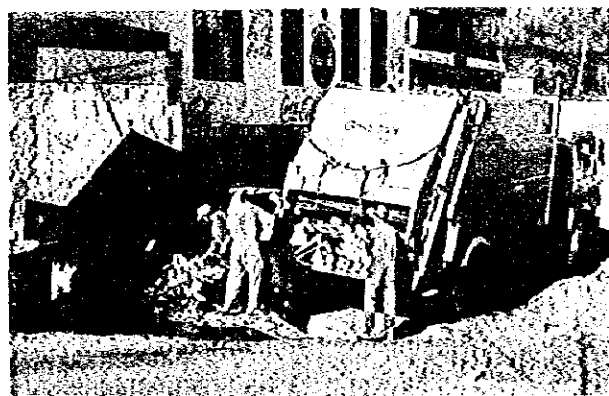
About 100 scavengers are always on the lookout for recoverable materials.

*Plate 4: Waste Collection Service*

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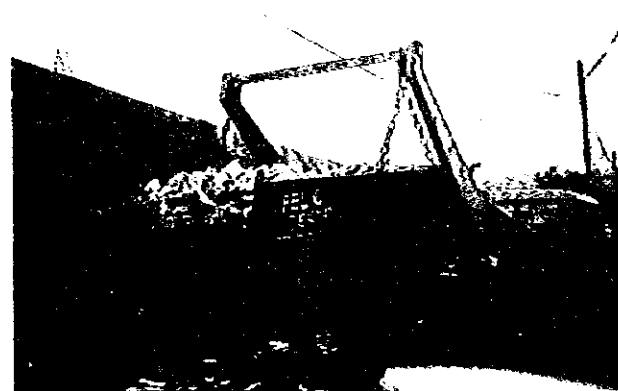
Waste collection vehicle: 15m<sup>3</sup> compactor truck



Waste collection vehicle: 15m<sup>3</sup> compactor truck



Waste collection vehicle: 12m<sup>3</sup> dump truck



Waste collection vehicle: hoist truck



A 15m<sup>3</sup> roll-on roll-off truck  
(private company vehicle)



A 15m<sup>3</sup> compactor truck loading waste from a 4.6m<sup>3</sup>  
container (private company vehicle)

**Plate 5: Pilot Project (1) Campaign for Raising Awareness on Solid Waste Issues**  
**Pilot Project (2) Experimental Implementation of the Best Collection system for Marginal Areas**

**(1) Campaign for Raising Awareness on Solid Waste Issues**



**Logotype contest :**  
 The 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup> prize winners of the logotype contest, held by a local newspaper, and the campaign mascot



**Campaign goods :**  
 Banners (30), posters (3,000), stickers (large: 5,000, small: 10,000) were made for the campaign.

**(2) Experimental Implementation of the Best Collection System for Marginal Areas**



**Educational programs on solid waste issues:**  
 The educational texts and panels produced by the counterpart and the study team were used to conduct an educational program.



**Illegal dumpsite in San Martin/Ayestas**  
 (Before the clean-up operation)



**The illegal dumpsite at San Martin/Ayestas (After the clean-up operation).** The breeding of flies and generation of foul smell were controlled.



**The suitability of the container collection system in marginal areas where collection is unsatisfactory was studied.** The clean-up operation of the illegal dumpsite was carried out to encourage the residents to dump waste into the containers and to be proud of their area.

***Plate 6: Pilot Project (3) Experimental Improvement of the Final Disposal Site***

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**(3) Experimental Improvement of the Final Disposal Site**

**1) Facility Improvement**

**a) Improvement of security facilities (gates, fences)**



Entrance to the final disposal site (Before)

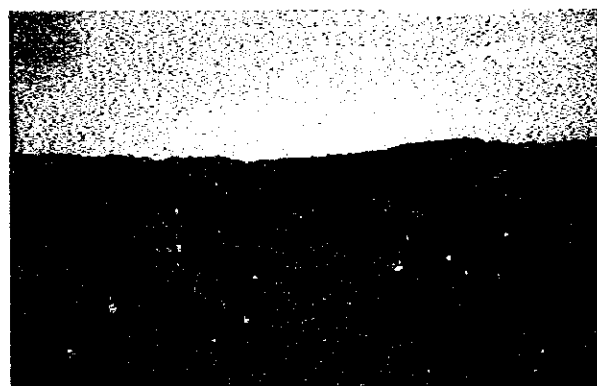


The gate constructed at the entrance to the final disposal site (After)

**b) Installation of the stationary net fence**

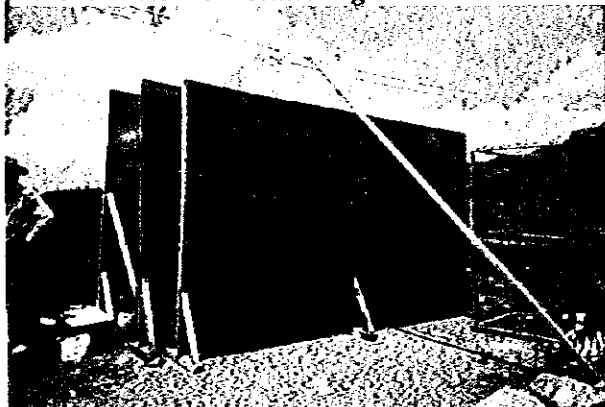


Shoulder of the final disposal site slope (Before)



Shoulder of the final disposal site slope (After)

**c) Manufacture and use of a movable net fence to prevent waste from scattering**



To minimize waste scattering at the landfill section, net fences that can be moved from one landfill section to another, depending on which section is being used, were made and installed.

**d) Installation of gas removal facilities**



To speedily remove, dissolve, and stabilize gases generated by the covered wastes, and to prevent explosions at the site, gas removal facilities were installed.

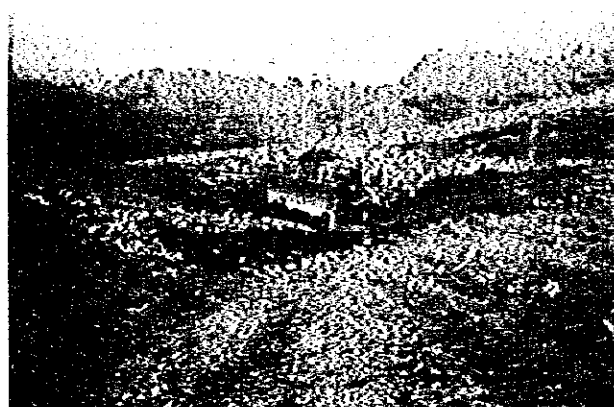
**Plate 7: Pilot Projects (3) Experimental Improvement of the Final Disposal Site**  
**Pilot Project (4) Improvement of the Managerial Capability of the Cleansing Department**

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**2) Demonstration of landfill techniques & hands-on-training on sanitary landfill techniques**  
Guidance on sanitary landfill techniques was extended using municipal owned machinery.



54 trucks of waste were hauled to the sanitary landfill experiment yard.



Waste was leveled and immediately covered.

**3) Sanitary Improvement through Scavenger Participation**



Completed first sanitary landfill layer



Formulation of final disposal site operation regulations with scavenger participation

**(4) Improvement of the Managerial Capability of the Cleansing Department**

Methods to effectively use various data were introduced and the staff were made to recognize the importance of proper management methods, to upgrade their managerial capabilities.







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## Glossary

<i>AMDC's Solid Waste Executing Unit (SWEU)</i>	A provisional waste management authority under the current AMDC administrative structure.
<i>Municipal Cleansing Corporation</i>	An autonomous waste management agency that will be established by 2001.
<i>Municipal Corporation</i>	The legislative council of the AMDC.
<i>Non-Residential Waste</i>	Municipal solid wastes that are generated from sources other than residences. For the purpose of this study, non-residential waste is divided into business waste, waste from large dischargers, and waste hauled directly (direct haulage) to the final disposal site.
<i>Residential Waste</i>	Municipal solid wastes that are generated from only residential sources. For the purpose of this study, residential waste is divided into wastes from high income residences, middle income residences, and low income residences.

### List of Abbreviations

Abbreviation	English	Español	Abbreviation
AMDC	Municipality of the Central District	Alcaldía Municipal del Distrito Central	AMDC
BCH	Central Bank of Honduras	Banco Central de Honduras	BCH
BSC	Billing Service Company	Compañía Facturadora	CF
CBO	Community Based Organization	Comunidades de Base	CB
CESCCO	Center of Studies on Control of Polluting Agents	Centro de Estudios sobre Control de Contaminantes	CESCCO
CPI	Consumer Price Index	Índice de Precios al Consumidor	IPC
DAS	Disposal Amount Survey	Estudio de Cantidad de Disposición	ECD
DC	Central District	Distrito Central	DC
DEI	Executive Bureau of Revenue	Dirección Ejecutiva de Ingresos	DEI
DF/R	Draft Final Report	Borrador de Informe Final	BI/F
EIA	Environmental Impact Assessment	Evaluación de Impacto Ambiental	EIA
EIRR	Economic Internal Rate of Return	Tasa Interna de Retorno Económica	TIRE
ENEE	National Company of Electricity	Empresa Nacional de Energía Eléctrica	ENEE
FENAFUTH	Honduras National Soccer Federation	Federación Nacional Autónoma de Fútbol de Honduras	FENAFUTH
FIRR	Financial Internal Rate of Return	Tasa Interna de Retorno Financiera	TIRF
GDP	Gross Domestic Product	Producto Interno Bruto	PIB
GRDP	Gross Regional Domestic Product	Producto Regional Interno Bruto	PRIB
IC/R	Inception Report	Informe Inicial	I/IN
IDB	Inter-American Development Bank	Banco Interamericano de Desarrollo	BID
ISW	Industrial Solid Waste	Residuo Sólido Industrial	RSI
IT/R	Interim Report	Informe Intermedio	I/IT
JICA	Japan International Cooperation Agency	Agencia de Cooperación Internacional del Japón	JICA
MCC	Municipal Cleansing Corporation	Empresa Municipal de Limpieza	EMI
METROPLAN	Urban Planning Office of AMDC	Oficina de Planificación Urbana de la AMDC	METRO-PLAN
M/M	Minutes of Meeting	Minuta de Reunión	M/R
M/P	Master Plan	Plan Maestro	P/M
MSW	Municipal Solid Waste	Residuo Sólido Municipal	RSM
OCS	Optimal Collection System	Sistema Óptimo de Recolección	SOR
O & M	Operation and Maintenance	Operación y Mantenimiento	O y M
PAHO	Pan American Health Organization	Organización Panamericana de la Salud	OPS
PCM	Project Cycle Management	Manejo de Ciclo de Proyecto	MCP
POS	Public Opinion Survey	Encuesta de Opinión Pública	EOP
P/R	Progress Report	Informe de Avance	I/A
PS	Public Sector	Sector Público No Financiero	SPNF
RAC	Residual Ash Content	Residuo de Ceniza	RC
SANAA	National Autonomous Service of Water and Sewerage	Servicio Nacional Autónomo de Acueductos y Alcantarillados	SANAA
SAS	Scavenger Attendance Survey	Muestreo sobre la Asistencia de los Recuperadores	MAR
SECPLAN	Secretariat of Planning, Coordination and Budget	Secretaría de Planificación, Coordinación y Presupuesto	SECPLAN (antes)
SEDA	Secretariat of Environment	Secretaría del Ambiente	SEDA (antes)

Abbreviation	English	Español	Abbreviation
SEP	Secretariat of Public Education	Secretaría de Educación Pública	SEP
SERNA	Secretariat of Natural Resources and Environment	Secretaría de Recursos Natural y del Ambiente	SERNA
SETCO	Technical Secretariat of International Cooperation	Secretaría Técnica de Cooperación Internacional	SETCO
SHCP	Secretariat of Finance and Public Credit	Secretaría de Hacienda y Crédito Público	SHCP
SIS	Scavenger Interview Survey	Encuesta a Recuperadores	ER
SOPTRAVI	Secretariat of Public Works, Transport and Housing	Secretaría de Obras Públicas, Transporte y Vivienda	SOPTRAVI (antes SECOPT)
SW	Solid Waste	Residuos Sólidos	RS
S/W	Scope of Work	Alcance de Trabajo	A/T
SWAS	Scavenger Waste Amount Survey	Muestro Sobre la Cantidad de Residuo Recuperado	MSCRR
SWEU	Solid Waste Management Executing Unit	Unidad Ejecutora de los Residuos Sólidos	UERS
SWM	Solid Waste Management	Manejo de Residuos Sólidos	MRS
UDAPE	Unit of Economic Policies' Analysis	Unidad de Análisis de Políticas Económicas	UDAPE
UNAH	National Autonomous University of Honduras	Universidad Nacional Autónoma de Honduras	UNAH
UNPF	United Nations Population Fund	Fondo de Población de las Naciones Unidas	FNUAP
USCS	Unified Soil Classification System	Sistema de Clasificación de Unificada de Suelos	USCS
USD	US Dollars	Dólares Americanos	USD
USW	Uncompacted Specific Weight	Peso Especifico No Compactado	PENC
WACS	Waste Amount & Composition Survey	Estudio de Cantidad y Composición de Residuos	ECCR
WAGR	Waste Amount Generation Rate	Encuesta de Cantidad y Generación de Residuos	ECGR
WCF	Waste Collection Fee	Tarifa por Recolección de la Basura	TRB
WHO	World Health Organization	Organización Mundial de la Salud	OMS
WTP	Willingness to Pay	Voluntad de Pago	VP





# **1. Outline of the Study**

## **1.1 Background**

As of 1998, the population in the urban area of the Central District in the Republic of Honduras is approximately 850 thousand; however, with the remarkable population increase, coupled with urban migration, the population is estimated to reach 1.35 million in 2010.

At present, approximately 64% of the urban population is provided with regular waste collection services. Because, the services offered by the municipality of the Central District (AMDC) cannot cope with the rapid increase in illegal settlements, the results are illegal waste dumping or open burning of waste by residents of these areas. It is also difficult to collect the waste from these districts as most are located on steep terrain.

No environmental protection measures except waste covering is carried out in the present final disposal site. Although there are soil and heavy equipment for coverage, soil coverage is not being carried out on time due to fuel shortages. Therefore, problems such as offensive odors, waste scattering, unsightly view, and the increase in scavengers are intensifying and, furthermore, the number of critics to the disposal site is on the rise.

These problems can be attributed to the following: 1) an insufficient waste fee collection system and financial system for solid waste management (SWM); 2) the administrative agency's defective organizational structure and implementation system; and 3) lack of administrators and engineers for the formulation and implementation of an appropriate SWM plan.

Currently, the Central District's critical solid waste management system is providing its services mostly with the waste collection vehicles, equipment for final disposal sites, and spare parts that were provided under the Japanese Grant Aid Program in 1993. Although four years has passed and these equipment will soon need to be renewed, there is no replacement plan because the financial situation of AMDC is extremely critical. It can be expected that the solid waste management works will collapse with the expiration of the equipment's lifespan.

Under these circumstances, the Government of Honduras officially requested the Government of Japan, to carry out a study on the solid waste management (SWM) of the urban area of Tegucigalpa's Central District in order to improve environmental and sanitary conditions. In response to the request, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, commissioned Kokusai Kogyo Co. Ltd., as a consulting company for this study.

## **1.2 Scope of the Study**

### **1.2.1 Objectives of the Study**

The Study aims to:

- Formulate a Master Plan on SWM by focusing on the main issues identified in the Preparatory Study.
- Carry out the Feasibility Study of the priority projects.
- Transfer of technology to counterpart personnel regarding the study of SWM and SWM planning methods.

### **1.2.2 Study Area**

This Study covers the urban area of the Central District, as of 1998, and the forecast urban areas in 2010, as shown in Figure 1.

### **1.2.3 Wastes Targeted**

This Study targets residential waste, market waste, commercial waste, street waste, and institutional waste. The study proposes general recommendations on how to properly handle such medical waste and industrial waste based on existing information.

### **1.2.4 Target Year**

The Master Plan covers the period between 1999 and 2010.

## **1.3 Work Processes of the Study**

The Study began in January 1998, based on the Scope of Work (S/W), signed between the Honduras Government and JICA in August 1997, and ended in November 1998.

The study period consisted of the following two phases.

Phase I (Jan. - Mar. 1998): Formulation of the Solid Waste Management Master Plan

Phase II (May - Nov. 1998): Feasibility Study for the Priority Projects proposed in the Master Plan

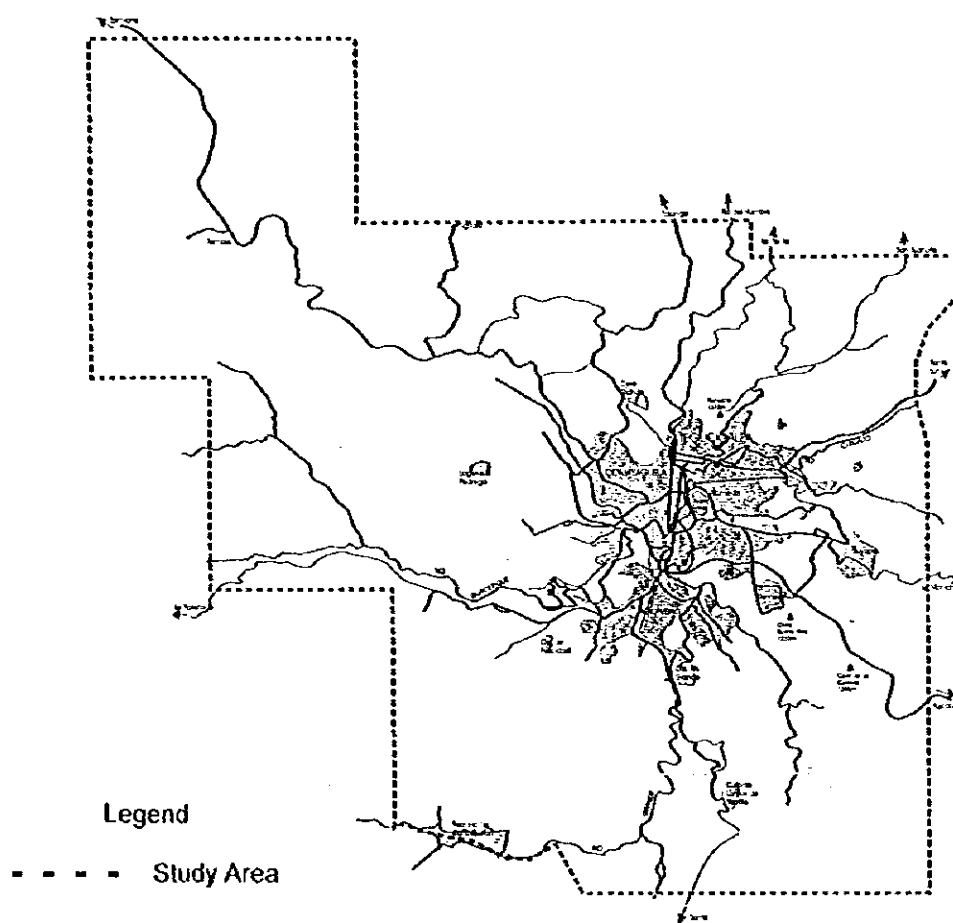


Figure 1: Study Area

## 1.4 Policies of the Study

Based on the understanding of the present situation and SWM issues in the urban area of the Central District, the following were established as basic policies of this Study.

### a. Formulation of a Practical Plan

A two phase plan (an immediate plan and a full-scale plan) was established. The basic policy for the short term plan was to enhance the plan's workability with the premise of obtaining the municipality and the Cleansing Department's cooperation. The long term plan proposed thorough solutions, including organizational and institutional reconstruction, by establishing a sufficient preparation period in order to solve further problems in the future.

### b. Formulation of a Sustainable Plan

The factor that significantly sets solid waste projects apart from other infrastructure projects, such as construction of roads and dams, is the small capital and high operation and maintenance costs it requires. In terms of investment, the operation and maintenance plan is far more important than the facility and equipment plan. Therefore, the formulation of a sustainable operation and maintenance plan was given priority.

### c. Appropriate Technology

The operation and maintenance plan is an integral part of the SWM plan. It is necessary that the either AMDC or the Cleansing Department independently carry out O&M using whatever resources they possess (technology, finance, and human resources). Thus, the basic policy for the technical plan would be the use of technology currently available in Honduras and the introduction of new technology suited to local conditions.

### d. Participation

Changes in the SWM system directly affect the residents, as waste is the result of their daily activities. Separate collection, recycling, self disposal, as well as the construction and operation of a final disposal site cannot be carried out without the consent and cooperation of the residents. Accordingly, resident participation was encouraged during the planning phase, and the opinions of the residents are fully reflected in the plan.

## 1.5 Persons Involved

### 1.5.1 Members of the Study Team

Name	Assignment
Takeshi TOMIYASU	Team Leader & Solid Waste Management Planning
Akira DOI	Collection and Transport Planning & Waste Amount and Waste Composition Surveys
Kozo BABA	Management and Financial Planning
Jose ARELLANO V.	Final Disposal Site Planning
Masaharu KINA	Environmental Consideration
Jorge Alberto RODRIGUEZ M.	Social Consideration & Public Education Programs
Andrew DORMAN	Facility Design & Cost Estimation
Victor Ojeda R.	Institution and Organization Planning
Valerio GUTIERREZ	Translator
Ayako IDO	Administrative Coordinator

### 1.5.2 Members of the Honduran Counterpart

The following staff were appointed as counterpart members in response to the request made by the Study Team.

Name	Assignment
Pastor Mendez	Chief coordinator
José Adolfo Aguilar	Administration staff of solid waste with basic computer knowledge
Marcos Matamoros	Institutional and organizational system
Angela Victoria Sánchez	Financial accounting
Marlon Aguilera	Final disposal
Pastor Mendez / Humberto Medina	Collection and haulage
Karla Lezama / Graciela Castellanos	Environmental education and social promotion
Jenny Sager	Administrative Coordinator
Myrna B. Oyuela	Secretary

## **2. Present Features of the Municipal Solid Waste Management (SWM)**

### **2.1 Profile of the Study Area**

One of the characteristic features of the Study Area is its topography. It is mountainous and lies at an elevation between 900 masl and 1,535 masl. However, most of the urban area is located between 1,000 and 1,300 masl.

According to a survey conducted by METROPLAN on 457 barrios and housing developments in the Central District, 27% of the area has a natural slope gradient between 15% and 60%; this poses a strain on waste collection activities because collection vehicles are not designed to ascend gradients exceeding 20%.

### **2.2 Findings through the Field Surveys**

#### **2.2.1 Field Surveys**

Many useful findings were obtained through various field surveys, conducted to understand the present conditions, during the study. Detailed information on these field surveys are compiled in the Annex as shown below.

Title	Annex
Waste Generation Amount Survey	2
Survey on Waste Composition and Properties of Waste	3
Disposal Amount Survey	4
Survey on Recycling System	5
Survey on Scavengers	6
Survey on Private Collectors	7
Time and Motion Survey	8
Public Opinion Surveys	9
Large Dischargers' Opinion Surveys	10
Compost Demand Survey	11
Project Cycle Management Workshop on Final Disposal	12

## 2.2.2 Waste Amount Survey

The generation amount from all sources is tabulated in Table 1. A population of 848,859 translates into a residential WAGR of 375 g/person/day and a MSW WAGR of 564 grams per Central District citizen per day.

Table 1: Generation Amount of MSW

Waste Category	Unit	WAGR	Number	Waste generation amount tons/day
<b>Residential Waste</b>				
High income	g/capita/day	541	169,772	92.9
Middle income	g/capita/day	343	254,658	87.4
Low income	g/capita/day	328	424,430	139.1
<b>Total Residential</b>				<b>318.4</b>
<b>Non-Residential Waste</b>				
Commercial	g/establishment/day	3,270	17,504	57.2
Restaurant	g/restaurant/day	24,900	1,810	45.1
Institutional	g/employee/day	100	131,003	13.1
Market	g/stall/day	3,670	5,000	18.4
Street Sweeping	kg/km/day	163.9	180	29.5
<b>Total Non-Residential</b>				<b>162.3</b>
<b>Total Waste Generated Per Day</b>				<b>480.6</b>

## 2.2.3 Waste Composition Survey

Table 2: Composition and Physical Properties (Wet base)

	Components	Residential Waste				Market Waste
		High income	Middle income	Low income	Weighted Average	
Combustibles	Food wastes	51.2%	54.4%	37.9%	47.2%	82.8%
	Paper and CB	12.9%	12.7%	10.1%	11.5%	6.7%
	Textiles	2.0%	1.9%	3.8%	2.8%	0.0%
	Plastic	6.2%	8.3%	6.7%	7.1%	2.7%
	Grass & Wood	16.5%	10.0%	10.6%	11.6%	2.9%
	Leather & Rubber	0.4%	0.0%	4.2%	2.2%	0.1%
	Sub-total	89.2%	87.2%	73.3%	82.4%	95.3%
Incombustibles	Metal	2.8%	1.1%	1.9%	1.9%	0.2%
	Glass	4.5%	2.3%	3.8%	3.5%	0.1%
	Ceramic & stone	3.5%	9.3%	21.0%	12.1%	4.4%
	Others	0.0%	0.2%	0.0%	0.1%	0.0%
	Sub-total	10.8%	12.8%	26.7%	17.6%	4.7%
Uncompacted Specific Weight		0.21 kg/l	0.20 kg/l	0.19 kg/l	0.20 kg/l	0.3 kg/l
Moisture Content		52.8%	42.8%	38.8%	46.5%	68.5%
Lower Calorific Value						
Karisato's Formula (calories/gram)		1,568	1,987	1,568	1,683	908
Dulong's Formula (calories/gram)		1,522	1,956	1,668	1,615	747

N.B.: CB = Cardboard

## 2.2.4 Waste Final Disposal Amount

The disposal amount, calculated based on the study's findings, is significantly lower than the amount estimated by the Cleansing Department. The difference is attributed to the average truck weights used by the Cleansing Department to estimate waste amount are too high. The following table shows the average weights by type of vehicle as determined by the survey in the study and those used in February 1998 by the Cleansing Department.

Table 3: Weights by Type of Vehicles

Type of Vehicle	unit: ton/vehicle		
	tons/load used by the Cleansing Section	tons/load measured by this study	Difference
Fiat compactor (13m <sup>3</sup> )	6.26	5.7	-0.56
Fiat dump truck (8m <sup>3</sup> )	6.26	2.9	-3.36
Hino compactor (15m <sup>3</sup> )	6.26	6.4	+0.14
Nissan dump truck (12m <sup>3</sup> )	6.26	3.9	-1.36
Hino dump truck (8m <sup>3</sup> )	6.26	5.3	-0.96
M. Benz dump truck (8m <sup>3</sup> )	6.26	3.2	-3.06
Hino arm-roll truck (12m <sup>3</sup> )	6.26	2.8	-3.46
Hino hoist truck (5.5m <sup>3</sup> )	6.26	1.3	-4.96
Private vehicles - small	3.5	0.3	-3.2
Private vehicles - medium	3.5	0.7	-2.8
Private vehicles - large	3.5	1.5	-2.0

## 2.2.5 Waste Stream in 1998

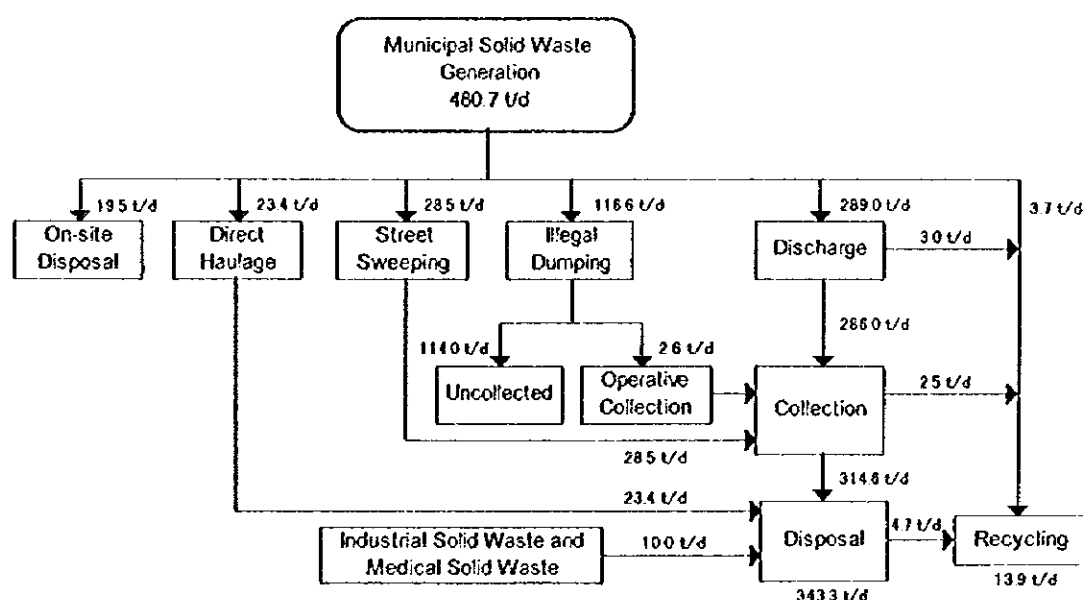


Figure 2: 1998 Central District Waste Stream

## **2.3 Assessment of the Current Municipal SWM**

### **2.3.1 Technical System**

At present, the most prevalent SWM technical system in the Study Area is rudimentary, composed only of collection and haulage of waste, mainly using compactors and dump trucks, and final disposal; it is exclusive of major processing, intermediate treatment or recycling systems. This system is basically appropriate for the Study Area as long as the acquisition of land for the disposal site is financially and/or socially unproblematic. However, considering the worldwide trend that incorporates conservation issues into solid waste management, a recycling system should be introduced gradually so long as it does not affect the financial sustainability of the cleansing work.

Considering that the present waste collection coverage rate in the city has reached 64% and the standard of cleanliness is generally maintained, the present waste collection service level is assessed to be fair except in areas that do not receive a regular waste collection service. Often, these are low income residential areas, where lack of a frequent service has left unhygienic conditions that have often been blamed for outbreaks of dengue fever. The expansion of a regular waste collection service, therefore, should be a continuous endeavor.

As for the collection and haulage system, the present compactor collection system functions adequately, however the present collection and haulage plan can be seen as inappropriate because the allocation of the present collection areas has no rational explanation. The efficiency of the dump truck collection system was found to be average; the reason is not only attributable to the type of vehicle used but also inferior road conditions, low accessibility, lack of people's cooperation in discharging manner, etc. In order to improve the general collection work efficiency, various measures, for example promoting a more conscientious discharge manner, phasing-out the dump truck collection system and replacing it with a more appropriate system, etc. should be examined.

The present recycling activities rely mainly on scavengers operating at the disposal site and collection workers' sorting work. Although both activities contribute to recycling, they are informal and also impose negative impacts to the present solid waste management system. It is, therefore, necessary for the governmental organizations to gradually participate in recycling and strengthen the control of informal recycling activities.

As for the final disposal system, no appropriate environmental protection measures are taken except soil coverage. Also, bulldozers operating at the landfill are not provided with sufficient amounts of diesel fuel and entry of scavengers to the site is unrestricted. Therefore, the condition of the disposal site is unacceptable. On examination of the environmental impact the disposal site poses on its environs, it is observed that the flow of leachate from the disposal site is very minimal and the generated leachate percolates into the ground before reaching the Choluteca River. It can be predicted that the impact by leachate would be marginal because the water quality of Choluteca River is far greater and worse than the leachate from the site. This is due to the discharge of raw sewage from Tegucigalpa and Comayaguela into



Choluteca River upstream from the disposal site. In addition, the existing disposal site is located far from the water basins for the Central District. Consequently, it is concluded that the existing disposal site does not pose a serious threat to the surrounding environment. However, there are some considerable negative effects caused by nuisances, offensive odors, and unsightly view etc., because it faces the main road: the number of critics to the final disposal site is on the rise.

The existing disposal site area is 31.7 hectares, of which only 12 hectares are used for landfilling. Even though the final waste disposal amount is predicted to increase in future, the site has the capacity to receive waste generated in the Study Area until 2006. The existing disposal site has a favorable natural condition in terms of environmental protection and haulage of waste. The sanitary condition will be enhanced by improving some facilities, training staff in operation techniques and raising awareness among the municipalities' staff and citizens. Therefore, the best option is considered to be the utilization of the existing disposal site, for as long as possible, providing the landfill operation level is improved. In addition, planning and construction of a new final disposal site should proceed deliberately while the existing disposal site has a reserve.

All street sweeping work is carried out manually, and it is effectively supported by many trash boxes recently installed along the streets. In consideration of the general cleanliness within the city that is maintained by an appropriate number of street sweepers, it is judged that the present system is appropriate except the collection system of street sweeping waste.

As for maintenance of equipment, the present technical system is believed to be suitable, considering the high operation rate of compactor trucks and the fact that many ten year-old FIAT compactors still function. However, repair works often take quite a long time. This is mainly due to the inherent bureaucracy that has a disposition to long processing procedures before spare parts are purchased.

### **2.3.2 Institutional and Organizational System**

#### **a. Legal Framework**

Legislation related to SWM is found in a variety of laws, regulations, and decrees. Consequently, there is no specific legal framework to help develop SWM, creating a situation that undermines the authorities' position to manage the services effectively.

#### **b. Institutional Structure**

Although the service provided by the AMDC's Cleansing Department is very important, and it is responsible for hundreds of workers, vehicles, and important funds, the hierarchic level of this section is comparatively low-ranking, affecting its ability to plan, manage, and operate services appropriately.

This situation leads to slow decision making and prolonged administrative transactions, specially for acquisition of spare parts for vehicles and machinery, as a result productivity is affected.

### **c. Organization Structure of the Cleansing Department**

An analysis of the results obtained during this study revealed that there is considerable weakness in the operation and the administrative structure of this section.

- Goals and objectives are poorly defined by this section; because of this, officials become confused, thus creating a situation where activities are uncoordinated.
- There are neither service plans nor medium and long term development plans. Authorities have not emphasized the importance of cleansing services, personnel transfer takes place with each new administration, and, as a result, there are very few plans and programs to cater for medium term and long term service needs. An obvious consequence is that the system is only able to administer day to day issues, and problems are left to workers who have been with the institution over a longer period (driver and mechanics).

### **d. Public Participation**

It is noteworthy that recently there have been changes in the public's image and perception of SWM. The AMDC has been making efforts to improve the cleanliness of the city. However, this initiative should be taken together with the institution's structural reform so that the development of this public service becomes an ongoing venture; and with time, the public will be inclined to be supportive and loyal to the institution's cause.

## **2.3.3 Financial System**

Regarding the financial situation of SWM works in 1997, the revenue from the waste collection fee, i.e. Lps. 20 million, seemed to be sufficient to cover the expenditure, which was Lps. 18 million.

However, expenditure including depreciation for vehicles and equipment donated in 1993 was Lps. 25 million, that was 1.4 times the expenditure. Considering the fact that more than 15 US\$/ton is necessary to provide sufficient collection services and more than 3 US\$/ton is necessary to dispose these waste in developing countries, at least Lps. 36 million is needed to provide sufficient SWM in the Central District.

The actual collection rates of the waste collection fees in 1997 were 49% for residential waste collection fee, which is collected jointly with the property tax, and 74% for the non-residential waste collection fee, which is collected jointly with the business income tax. Even if the collection rate of waste collection fees reach 100%, the total revenue will be Lps.32 million; it is insufficient to operate SW services and to finance the replacement of equipment.

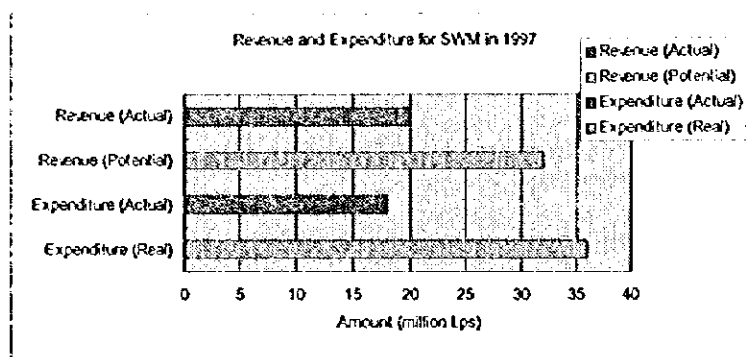


Figure 3: Revenue and Expenditure for SWM in 1997

The reason why the SWM works can be currently managed by the AMDC is mainly because of the equipment and the spare parts were granted in 1993. Although four years have passed and these equipment are due for renewal, no replacement plan is being prepared because the financial situation of the AMDC is extremely critical. The solid waste management works are likely to be in disarray with the expiration of the equipment's lifespan.

### 3. The SWM Master Plan

#### 3.1 Future Projection for the Master Plan

##### 3.1.1 Socioeconomic Indices

###### a. GDP

	1997	2000	2005	2010
Rate of increase (%)	4.9	6.0	5.0	4.0
GDP (million Lps*)	53,330	63,517	81,066	98,629

\* Lempiras using 1997 constant prices

###### b. GRDP

	1997	2000	2005	2010
Rate of increase (%)	5.9	7.0	6.0	5.0
GRDP (million Lps*)	13,609	16,516	21,893	27,942

\* Lempiras using 1997 constant prices

###### c. Population

Table 4: Projection of Population by Income Level Group

Year	Population Ratio			Population			
	High	Middle	Low	Total	High	Middle	Low
1998	20.0%	30.0%	50.0%	848,859	169,772	254,658	424,430
1999	19.5%	31.5%	49.0%	882,322	172,053	277,931	432,338
2000	19.0%	33.0%	48.0%	917,104	174,250	302,644	440,210
2001	18.5%	34.5%	47.0%	953,257	176,353	328,874	448,031
2002	18.0%	36.0%	46.0%	990,835	178,350	356,701	455,784
2003	17.5%	37.5%	45.0%	1,029,895	180,232	386,211	463,453
2004	17.0%	39.0%	44.0%	1,070,495	181,984	417,493	471,018
2005	16.5%	40.5%	43.0%	1,112,695	183,595	450,641	478,459
2006	16.0%	42.0%	42.0%	1,156,558	185,049	485,754	485,754
2007	15.5%	43.5%	41.0%	1,202,151	186,333	522,936	492,882
2008	15.0%	45.0%	40.0%	1,249,541	187,431	562,293	499,816
2009	14.5%	46.5%	39.0%	1,298,799	188,326	603,942	506,532
2010	14.0%	48.0%	38.0%	1,350,000	189,000	648,000	513,000

##### 3.1.2 Waste Amount and Composition

###### a. Waste Generation Amount

In this study, the following assumptions were set to forecast the waste generation amount.

- 1) The generation amount of all types of wastes, except street waste, will be directly proportional to the population.
- 2) The waste generation amount rates of all types of waste, except street waste, will increase by 50% of the annual GRDP growth rate.
- 3) The waste generation amount rate of street waste will remain constant until 2010.

Table 5 shows the projected waste generation amounts until 2010 based on the projected waste generation rates and the projected population. The waste generation amount per day is forecast to increase from 481 ton/day in 1998 to 1,055 ton/day in 2010.

Table 5: Projected Waste Generation Amounts until 2010

Year	Residential				Non-residential							Total
	High	Middle	Low	Sub-total	Commercial	Restaurant	Institution	Market	Street	ISW, MSW	Sub-total	
1998	92	87	139	318	57	45	13	18	28	10	172	491
1999	96	99	147	342	62	48	14	20	28	11	183	525
2000	101	111	155	367	66	52	15	21	28	12	195	562
2001	105	124	162	392	71	56	16	23	28	12	207	598
2002	110	139	170	419	76	60	17	24	30	13	221	639
2003	114	155	178	447	81	64	19	26	30	14	234	681
2004	119	173	186	478	87	69	20	28	30	15	249	726
2005	123	192	195	510	93	73	21	30	32	16	266	776
2006	127	212	203	542	99	78	23	32	33	17	282	825
2007	132	234	211	576	106	83	24	34	35	19	300	877
2008	136	258	219	613	113	89	26	36	36	20	319	932
2009	140	284	228	651	120	95	27	38	38	21	339	991
2010	144	312	236	692	128	101	29	41	40	22	361	1,053

## b. Waste Composition

The waste composition forecasts for 2004 and 2010 are as shown in Table 6.

Table 6: Waste Composition Forecast of Residential Waste

Items	1998		2004		2010	
	Rate	Amount (tons/day)	Rate	Amount (tons/day)	Rate	Amount (tons/day)
<b>Combustibles</b>						
Kitchen wastes	46%	220	42%	304	40%	422
Paper and CB	12%	58	13%	94	15%	158
Textiles	3%	14	3%	22	3%	32
Plastic	7%	34	8%	58	8%	84
Grass & Wood	12%	58	12%	87	12%	127
Leather & Rubber	2%	10	2%	14	2%	21
Sub-total	82%	394	80%	579	80%	844
<b>Non-combustibles</b>						
Metal	2%	10	3%	22	4%	42
Glass	3%	14	4%	29	5%	53
Ceramic & Dirt	13%	63	12%	87	10%	105
Others	0%	0	1%	7	1%	11
Sub-total	18%	87	20%	145	20%	211
<b>Total</b>	<b>100%</b>	<b>481</b>	<b>100%</b>	<b>724</b>	<b>100%</b>	<b>1,055</b>
Lower Calorific Value by Karisato's Formula		1,667 cal/g		1,723 cal/g		1,761 cal/g
by Dulong's Formula		1,615 cal/g		1,734 cal/g		1,778 cal/g

N.B.: CB = Cardboard

## 3.2 Examination of the Best Technical System

Considering the current situation and background of SWM in the study area, the following are policies for the selection of a technical system:

- 1) Systems and technologies to be adopted should be simple so that operation and maintenance are both easy and inexpensive.

- 2) Requirements for foreign financing to purchase, operate and maintain facilities should be minimal. The use of locally available materials and services should be maximized.
- 3) Technical system proposals have to be consistent with the institutional requirements to ensure their efficiency.

The screened potential subsystems for the Central District are listed in Table 7.

Table 7: Potential Subsystems for SWM in the Central District

Technical Systems	Technical Sub-systems	Sub-system Components
Discharge and Storage	• Source Separation	• Mixed discharge • Separate discharge
	• Type of Storage Equipment	• Paper or plastic sacks • Dustbins • On-site waste storage • Containers (1 to 2 m <sup>3</sup> ) • Large communal containers (more than 5 m <sup>3</sup> )
Primary Collection	• Type of Collection System	• Handcart • Animal drawn cart • Pedal cart • Motorized cart
Secondary Collection and Haulage	• Collection Frequency	
	• Collection Method	• Mixed collection • Separate collection
	• Collection System	• Point collection • Curb side collection • Door-to-door collection • Bell collection • Public container collection
	• Collection Schedule	• Day collection • Night collection
	• Collection Vehicle	• Compactor truck • Tractor and trailer • Dump truck • Detachable truck
	• Transfer Station	
Street Sweeping	• Cleaning Method	• Manual street sweeping • Mechanical cleaning • Vacuum cleaning • Flushing
Processing and Treatment System	• Incineration	
	• Refuse Derived Fuel (RDF)	
	• Biogas Production	
	• Pyrolysis	
	• Composting	• Collective compost plant • On-site compost plant
	• Size Reduction	
	• Mechanical and Manual Sorting	
Recycling	• Government Related	
	• Private Sector Centered	
Final Disposal	• Method of Sanitary Landfill	• Four different sanitary level
Maintenance of Vehicles and Equipment	• Preventive Service Workshop	
	• Full Service Workshop	

Following the examination of various SWM technical sub-systems, the selection of the best SWM technical systems for the Central District were proposed in Table 8.

**Table 8: The Best SWM Technical System**

Category	Proposed Technical System
Discharge and Storage	<ol style="list-style-type: none"> <li>1) Source separation <ul style="list-style-type: none"> <li>• Separating recyclable and non recyclable wastes</li> </ul> </li> <li>2) Type of storage <ul style="list-style-type: none"> <li>• Plastic sacks and plastic containers for common areas</li> <li>• Communal containers for marginal areas</li> </ul> </li> <li>3) Collection frequency <ul style="list-style-type: none"> <li>• More than twice a week</li> </ul> </li> <li>4) Collection method <ul style="list-style-type: none"> <li>• To introduce the separate collection for wastes</li> </ul> </li> <li>5) Type of collection method <ul style="list-style-type: none"> <li>• Most areas: Curb collection</li> <li>• Marginal areas: Point collection with communal containers</li> </ul> </li> <li>6) Collection time <ul style="list-style-type: none"> <li>• Most areas: Day collection</li> <li>• Traffic congested areas: Night collection</li> </ul> </li> <li>7) Type of collection vehicles <ul style="list-style-type: none"> <li>• Most areas: Compactor trucks</li> <li>• Marginal areas: Detachable container trucks</li> </ul> </li> <li>8) Haulage system <ul style="list-style-type: none"> <li>• Direct transport by motor vehicles</li> </ul> </li> </ol>
Primary Collection	Primary collection is required only in marginal areas. Hand cart and pedal cart systems will be used.
Secondary Collection and Haulage	<p>Most areas</p> <ul style="list-style-type: none"> <li>• 15 m<sup>3</sup> compactor trucks</li> <li>• 8 m<sup>3</sup> compactor trucks</li> </ul> <p>Marginal areas</p> <ul style="list-style-type: none"> <li>• 5.5 m<sup>3</sup> hoist trucks</li> </ul> <p>Street sweeping waste</p> <ul style="list-style-type: none"> <li>• from 5.5 m<sup>3</sup> to 10 m<sup>3</sup> container trucks</li> </ul>
Street Sweeping	<ul style="list-style-type: none"> <li>• Manual sweeping</li> </ul>
Processing and Treatment	<ul style="list-style-type: none"> <li>• Only on-site/community based composting is encouraged.</li> </ul>
Recycling	<ul style="list-style-type: none"> <li>• Recycling activities are encouraged through educational programs.</li> </ul>
Final Disposal	<ol style="list-style-type: none"> <li>1) Existing disposal site <ul style="list-style-type: none"> <li>Level 2: Sanitary landfill with a surrounding dike and daily soil coverage</li> </ul> </li> <li>2) New disposal site <ul style="list-style-type: none"> <li>Level 3: Sanitary landfill with a liner to prevent leachate from seeping into the ground</li> </ul> </li> </ol>
Maintenance of Vehicles and Equipment	<ul style="list-style-type: none"> <li>• Preventive services are allocated to the AMDC workshop and large-scale maintenance services private garages.</li> </ul>

### 3.3 Outline of the Master Plan

#### 3.3.1 Goals and Targets

##### a. Goals

The principal goal of the SWM master plan is:

*"To establish a Sound Solid Waste Management System in order to beautify the Central District by the target year 2010".*

The master plan aims to:

- A. Establish a financially sustainable, accountable, and stable solid waste management system.
- B. To improve the unsightly view in the city caused by waste.
- C. Minimize the negative environmental impacts caused by solid waste management.
- D. Provide all citizens with an acceptable level of hygiene.

The proposed measures to be taken, in order to attain the goals, are summarized below.

No.	Proposed Measures	Effect			
		A	B	C	D
1	Improvement of the Institutional and Organizational System				
1.1	Establishment of an autonomous institution	x			
1.2	Establishment of a self-supporting accounting system	x			
1.3	Improvement of the waste fee system	x			
1.4	Reduction of the municipality's involvement in activities	x			
2	Improvement of Managerial Capability of the Executing Body				
2.1	Establishment of a data control system	x			
2.2	Improvement of the cost control system	x			
2.3	Improvement of the financial planning system	x			
2.4	Scaling down the required procurement procedures	x			
2.5	Training human resources in the solid waste management sector	x	x	x	x
2.6	Introduction of private sector participation	x	x		
3	Improvement of the Sanitary Level of the Disposal Site				
3.1	Improvement of facilities at the disposal site			x	x
3.2	Training on proper sanitary landfilling operation			x	x
4	Improvement in the Efficiency of the Collection and Haulage System and Expansion of Collection Service Areas				
4.1	Improvement of the collection and haulage plan	x	x		x
4.2	Establishment of an optimal collection system for problematic areas	x	x		x
4.3	Promotion of primary collection by CBOs	x	x		x
4.4	Promotion of adequate self disposal	x	x		x
4.5	Improvement of the efficiency of the street sweeping system	x	x		x
4.6	Promotion of recycling	x	x	x	x
5	Education				
5.1	Raising awareness on solid waste	x	x	x	x
5.2	Hygiene education	x	x	x	x
5.3	Promotion of public cooperation	x	x	x	x



## b. Targets

In order to achieve the principle goal of the master plan, the targets for the establishment of major technical system components are proposed and tabulated in Table 9.

Table 9: Targets for Establishment of Major Technical System

		1999	2000	2002	2004	2006	2008	2010
<b>A. Main Targets</b>								
Collection Rate	%	64%	64%	72%	79%	79%	85%	85%
Recycling Rate	%	3%	3%	4%	4%	4%	5%	5%
Street Sweeping Length	km	180	180	190	190	210	230	250
Final Disposal		Level 2 <sup>1</sup>			Level 3 <sup>2</sup>			
<b>B. Detailed Targets</b>								
<b>1. Waste Generation Amount</b>		<b>514</b>	<b>550</b>	<b>626</b>	<b>711</b>	<b>807</b>	<b>912</b>	<b>1,031</b>
Residential Waste	U/d	342	367	419	478	542	613	692
Non-residential Waste	U/d	144	155	177	203	232	263	299
Street Sweeping Waste	U/d	28	28	30	30	33	36	40
<b>2. Waste Collection Amount</b>	U/d	<b>330</b>	<b>352</b>	<b>451</b>	<b>558</b>	<b>636</b>	<b>776</b>	<b>878</b>
Collection of Residential Waste	U/d	229	246	314	386	440	529	600
Collection of Non-Residential Waste	U/d	72	77	106	142	162	211	239
Collection of Street Waste	U/d	28	28	30	30	33	36	40
Direct Haulage	U/d	29	31	35	41	46	53	60
On-site Disposal	U/d	21	22	25	29	33	37	42
Recycling	U/d	7	8	10	19	21	24	27
Uncollected	U/d	128	137	104	65	72	23	24
<b>3. Service Rate</b>	%	<b>64%</b>	<b>64%</b>	<b>72%</b>	<b>79%</b>	<b>79%</b>	<b>85%</b>	<b>85%</b>
High Income Residents	%	90%	90%	100%	100%	100%	100%	100%
Middle Income Residents	%	70%	70%	80%	90%	90%	93%	93%
Low Income Residents	%	50%	50%	55%	60%	60%	70%	70%
<b>4. Service Population</b>								
<b>4.1 Service Population</b>	U/d	<b>565,568</b>	<b>588,781</b>	<b>714,392</b>	<b>840,339</b>	<b>913,681</b>	<b>1,060,236</b>	<b>1,150,740</b>
High Income Residents	U/d	154,848	156,825	178,350	181,984	185,049	187,431	189,000
Middle Income Residents	U/d	194,552	211,851	285,360	375,744	437,179	522,933	602,640
Low Income Residents	U/d	216,169	220,105	250,681	282,611	291,453	349,871	359,100
<b>4.2 Unserved Population</b>	U/d	<b>316,754</b>	<b>328,323</b>	<b>276,443</b>	<b>230,156</b>	<b>242,877</b>	<b>189,305</b>	<b>199,260</b>
High Income Residents	U/d	17,205	17,425	0	0	0	0	0
Middle Income Residents	U/d	83,379	90,793	71,340	41,749	48,575	39,361	45,360
Low Income Residents	U/d	216,169	220,105	205,103	188,407	194,302	149,945	153,900
<b>5. Final Disposal Amount</b>	U/d	<b>358</b>	<b>382</b>	<b>485</b>	<b>601</b>	<b>684</b>	<b>831</b>	<b>942</b>
Municipal Waste	U/d	347	370	472	586	667	811	919
Others	U/d	11	12	13	15	17	20	22

<sup>1</sup> Level 2 means sanitary landfill without liner for leachate.

<sup>2</sup> Level 3 means sanitary landfill with liner for the prevention of leachate percolation into the ground.

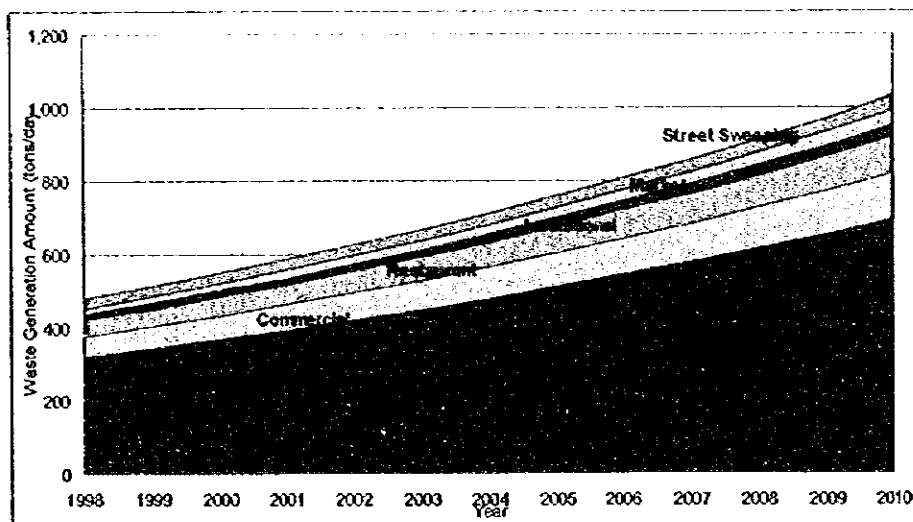


Figure 4: Waste Generation Amount Forecast until 2010

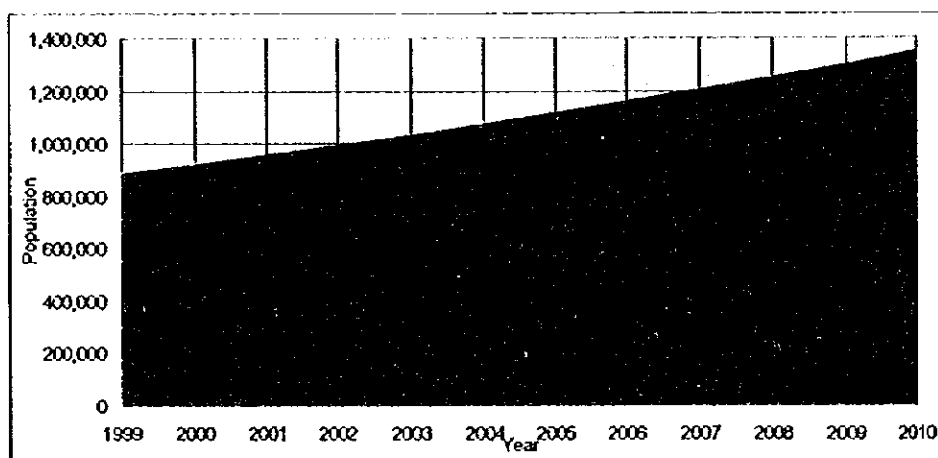


Figure 5: Master Plan of Service Population

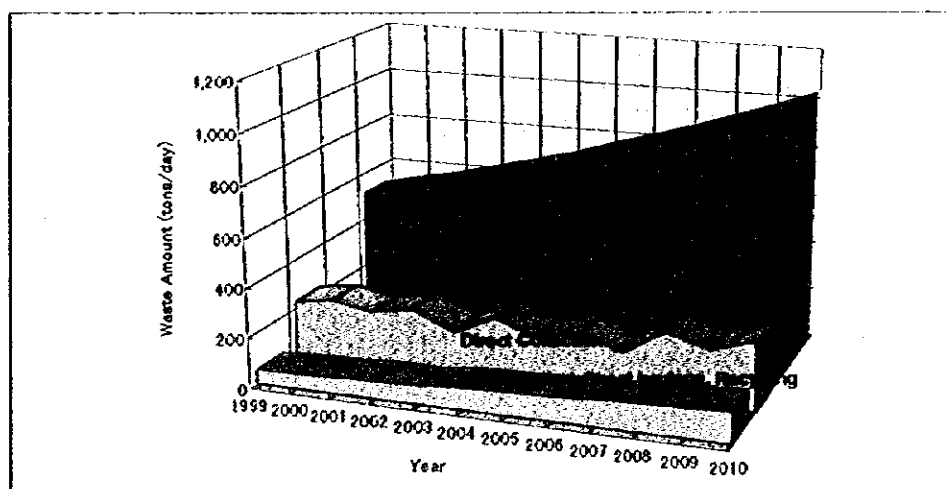


Figure 6: Master Plan of Waste Collection and Haulage

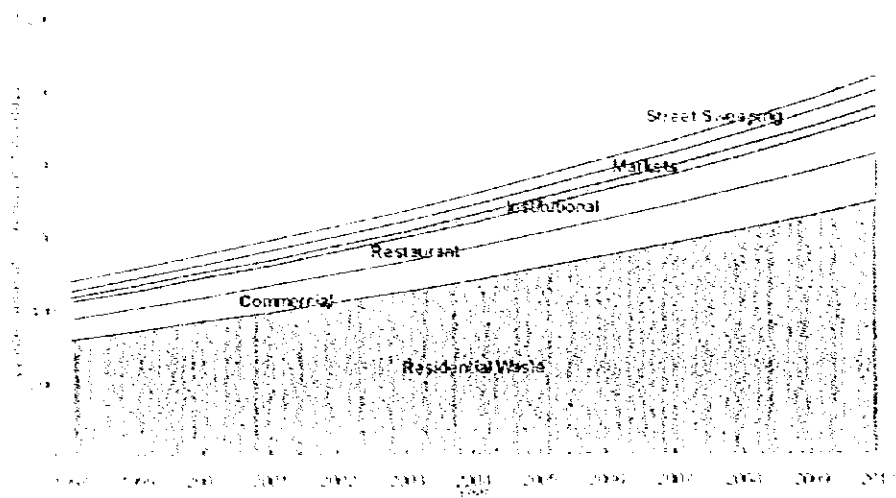


Figure 4 Waste Generation Amount Forecast until 2010

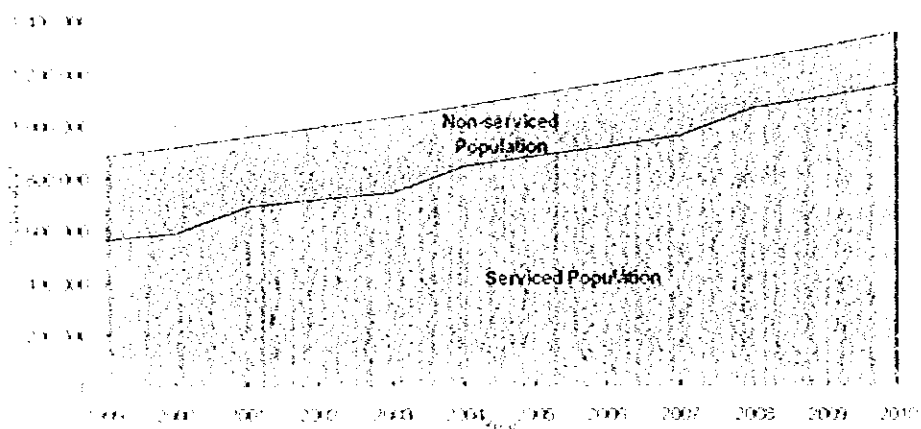


Figure 5. Master Plan of Service Population

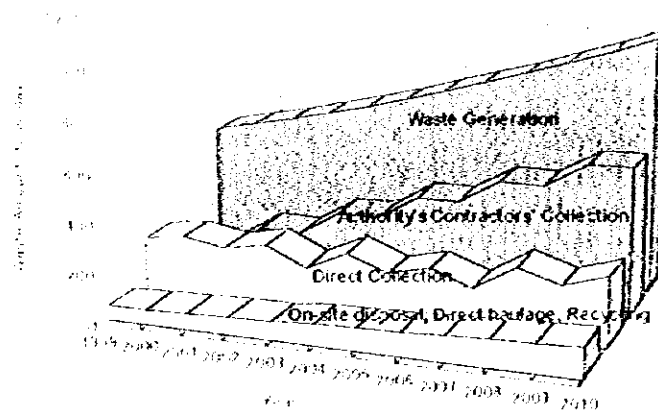
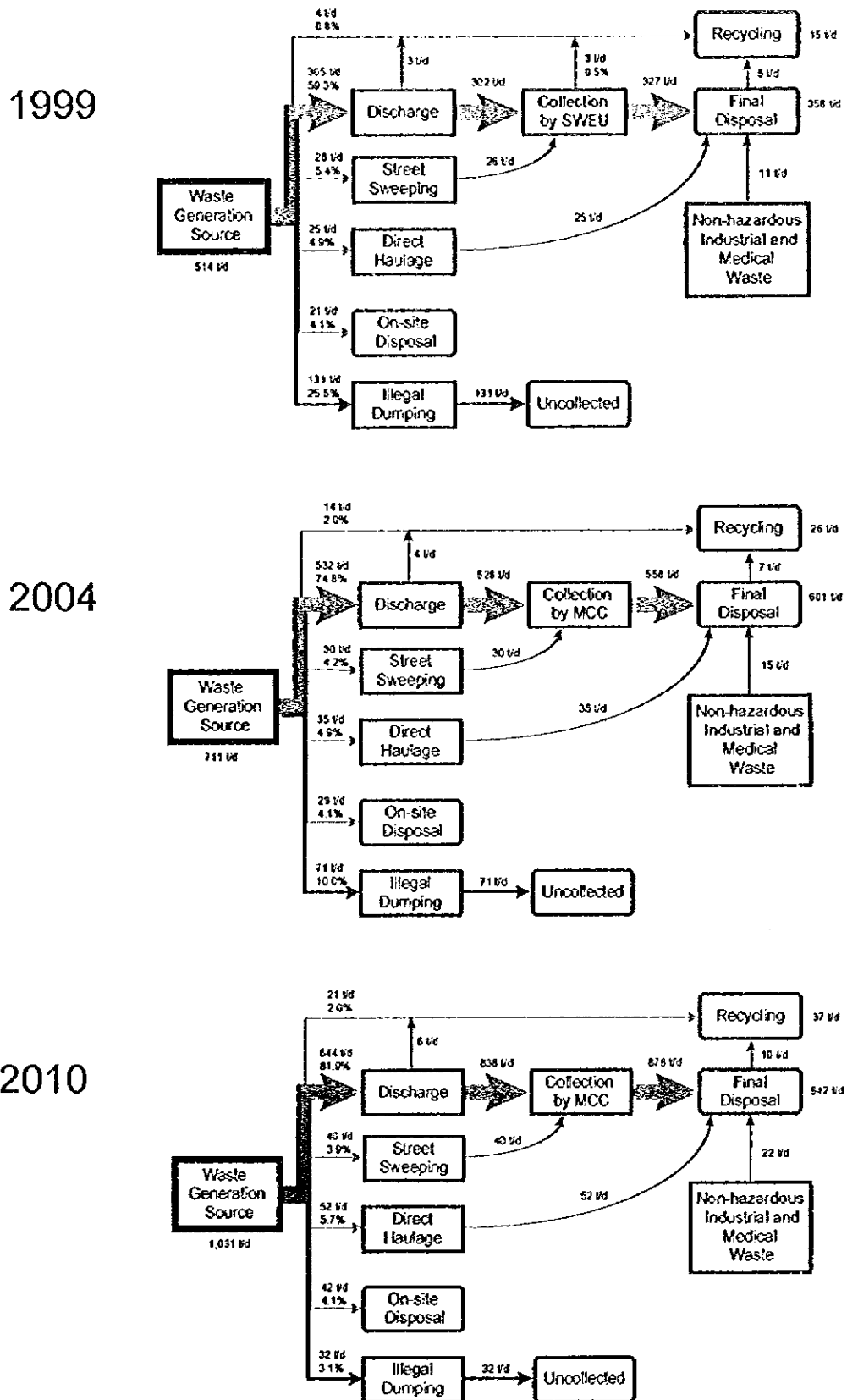


Figure 6 Master Plan of Waste Collection and Haulage

Figure 7: Waste Stream Forecast for the Central District



### **3.3.2 Master Plan Concepts**

#### **a. Institutional, Organizational, and Financial System Reform**

##### **a.1 Institutional System**

- 1) The private sector's participation will be expanded.
- 2) The current cleansing status will be upgraded.

##### **a.2 Organizational System**

- 1) The executing agency of solid waste management will become autonomous, creating a Municipal Cleansing Corporation (MCC), to bring about more flexibility and stability.
- 2) A self-supporting accounting system will be established so that revenue from the waste collection fee is apportioned to only solid waste management works.

##### **a.3 Financial System**

- 1) The new waste fee system will be based on the most appropriate combination of the following concepts.
  - Polluter-pays-principle (waste dischargers pay the SWM cost).
  - Cross-subsidy mechanism (the affluent pay for the less well off).
  - Minimization of the waste fee collection costs.
  - Strong enforceability of the collection system.
  - Different service levels in accordance with the amount of collection fee paid.
- 2) A disposal fee will be imposed on direct waste hauliers.

##### **a.4 Management System**

- 1) The AMDC's new Solid Waste Management Executing Unit (SWEU), created during the first phase of the institutional reform program, will be required to have a sound managerial capability to control the participation of the private sector. The management capability of the SWEU, especially regarding cost control, financial planning, technical planning, contracting, monitoring and supervision works, will be improved compared to the current Cleansing Department.
- 2) Accountability and transparency of solid waste management practices will be established in the SWEU.

##### **a.5 Education and Raising Awareness**

When raising public awareness through education and encouragement of social participation, the following should be considered.

- 1) Inform the citizens on:
  - Environmental problems and health problems related to SWM.
  - Changes in the organization structure, the responsibilities, and legal powers of the organization.

- Existing legislation; explaining penalties and punitive measures to transgressors and the enforcement procedures.
  - Duties and responsibilities of the citizens, including the waste collection fee and the methods of payment.
  - Procedures to submit complaints to the authorities.
- 2) Institutionalize the municipal education program on sanitation: "Mobile Municipality" as a means to promote social participation in the improvement of public health through clean-up campaigns, cultural activities, and provision of primary medical services to residents (e.g., ante- and postnatal care, immunization programs, dental check-ups, etc.).
- 3) Education programs for school students and local groups through effective use of existing resources.

Public education cannot proceed if the human resources responsible for SWM do not have a sufficient information base with which they can teach the general public. The master plan proposes a human resource training program, consisting of three training courses.

- Public Affairs
- Operations
- Support Services

#### **b. Technical System**

##### **b.1 Storage and Discharge**

- 1) The type of containers used will be regulated.
- 2) A separate discharge system for recyclable and non-recyclable wastes will be introduced.

##### **b.2 Collection and Haulage**

- 1) Areas given a priority for waste collection services are as follows.
1. City center.
  2. High and middle income residential areas.
  3. Low income residential areas in the city limits.
  4. Low income residential areas in the outskirts of the city.
- 2) The compactor truck collection system will be extended.
- 3) In problematic areas, the dump truck system, the arm-roll container system, the hoist truck container systems, etc., will be appropriately adapted depending on the conditions in each area.
- 4) In problematic areas, primary collection will be provided by micro-enterprises or community based organizations (CBOs) and secondary collection by the AMDC. The AMDC will promote primary collection activities, however, all costs incurred for this service will be shouldered directly by the users.

### **b.3 Processing, Treatment and Recycling**

- 1) No major processing or treatment plants for solid waste will be introduced.
- 2) Recycling activities will be promoted by the AMDC's SWEU and carried out mainly by the private sector. The SWEU will not participate in recycling activities directly.

### **b.4 Street Sweeping**

- 1) All street sweeping work will be carried out manually.
- 2) An appropriate collection and transportation system for street waste will be introduced.

### **b.5 Final Disposal**

- 1) The sanitary level of the existing disposal site will be improved to minimize the negative impacts on the environment.
- 2) The whole area of the existing final disposal site will be fully utilized, in order to continue its operation for as long as possible.
- 3) The control of scavengers will be reinforced; they will be prohibited from continuing their activities at the disposal site by 2010, without ensuing considerable social impacts.

### **b.6 Maintenance System**

- 1) Only preventive and daily maintenance as well as repair services, that cannot be done at private workshops, will be conducted by the AMDC's workshop. The rest will be undertaken by the private sector.

### 3.4 The SWM Master Plan

System	Description																																								
1. Institutional System																																									
1.1 Administration & Organization	1) In 1999, the Solid Waste Management Executing Unit (SWEU), which will be a temporary organization directly linked to the Mayor's office, will be established.  2) In 2000, the Municipal Cleansing Corporation (MCC) which is a Solid Waste Management Autonomous Entity will be established. The AMDC shall hold at least 51% of whole capital of the MCC.																																								
1.2 Financial System																																									
1.2.1 Waste Fee Collection System	In 2001, the joint billing of waste collection fees and electricity charges will begin.																																								
1.2.2 Waste Collection Fee	1) Residential waste collection fee: (unit: Lps/month/house) <table><tr><td></td><td>2001</td><td>2003</td><td>2008</td></tr><tr><td>high-income group:</td><td>Lps. 63</td><td>Lps. 70</td><td>Lps. 80</td></tr><tr><td>middle-income group:</td><td>Lps. 22</td><td>Lps. 33</td><td>Lps. 36</td></tr><tr><td>low-income group:</td><td>Lps. 11</td><td>Lps. 18</td><td>Lps. 20</td></tr></table> 2) Non-residential waste collection will be charged according to their annual turnover according to the proposed fee table. <table><tr><th>Annual business income</th><th>Fee Rate</th></tr><tr><td>more than Lps.4,000,000</td><td>Lps. 500 /establishment/month</td></tr><tr><td>Lps.3,000,001-4,000,000</td><td>Lps. 450 /establishment/month</td></tr><tr><td>Lps.2,000,001-3,000,000</td><td>Lps. 400 /establishment/month</td></tr><tr><td>Lps.1,000,001-2,000,000</td><td>Lps. 250 /establishment/month</td></tr><tr><td>Lps.500,001-1,000,000</td><td>Lps. 200 /establishment/month</td></tr><tr><td>Lps.300,001-500,000</td><td>Lps. 150 /establishment/month</td></tr><tr><td>Lps.100,001-300,000</td><td>Lps. 100 /establishment/month</td></tr><tr><td>Lps.50,001-100,000</td><td>Lps. 75 /establishment/month</td></tr><tr><td>up to Lps.50,000*</td><td>Lps. 50 /establishment/month</td></tr></table> 3) Collection service rate for large discharger: <table><tr><td>Lps. 480/ton in 2001</td></tr><tr><td>Lps. 530/ton in 2008</td></tr></table> 4) Direct haulage rate: <table><tr><td>Lps. 50/ton in 2001</td></tr><tr><td>Lps. 55/ton in 2008</td></tr></table>		2001	2003	2008	high-income group:	Lps. 63	Lps. 70	Lps. 80	middle-income group:	Lps. 22	Lps. 33	Lps. 36	low-income group:	Lps. 11	Lps. 18	Lps. 20	Annual business income	Fee Rate	more than Lps.4,000,000	Lps. 500 /establishment/month	Lps.3,000,001-4,000,000	Lps. 450 /establishment/month	Lps.2,000,001-3,000,000	Lps. 400 /establishment/month	Lps.1,000,001-2,000,000	Lps. 250 /establishment/month	Lps.500,001-1,000,000	Lps. 200 /establishment/month	Lps.300,001-500,000	Lps. 150 /establishment/month	Lps.100,001-300,000	Lps. 100 /establishment/month	Lps.50,001-100,000	Lps. 75 /establishment/month	up to Lps.50,000*	Lps. 50 /establishment/month	Lps. 480/ton in 2001	Lps. 530/ton in 2008	Lps. 50/ton in 2001	Lps. 55/ton in 2008
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1.3 Management System	1) The MCC's accounting, financing, planning, monitoring and supervision capabilities will be improved.  2) The involvement of private sector will be gradually extended in the SWM services.  3) The operation of collection and haulage service will be gradually shifted to from the public sector to the private sector. In that process the MCC will directly operate at least 25% of the collection and haulage works.  4) The MCC will hold an open bid so that proceedings are transparent to the general public.  5) The MCC limits the amount to be collected in one contract area to less than 50 tons/day.  6) The contract rate of collection and haulage work will be kept at less than Lps. 300 per ton.																																								



2. Technical System																				
2.1 Discharge and Storage	<p>1) The MCC will not bear any costs related to discharge and storage system except for the cost of communal containers.</p> <p>2) The MCC will promote people to use plastic bags or plastic containers for storage of waste.</p> <p>3) The separate discharge system will begin in adequate areas from 2008.</p>																			
2.2 Collection and Haulage	<p>1) Executing body will be the AMDC's SWEU from 1999 to 2000, and after 2001 the executing agency will be the MCC.</p> <p>2) The private sector's involvement will be gradually extended, but the MCC will directly operate at least 25% of the entire collection and haulage works.</p> <p>3) Collection Frequency City center and high income residential areas: three times a week Other areas: twice a week</p> <p>4) Type of Equipment</p> <table> <tr> <th>Area</th><th>Collection Equipment</th><th>Method</th></tr> <tr> <td>Standard residential areas</td><td>15m<sup>3</sup> Compactor truck</td><td>Curb collection</td></tr> <tr> <td>Commercial areas</td><td>15m<sup>3</sup> Compactor truck</td><td>Curb collection</td></tr> <tr> <td>Busy commercial areas</td><td>8m<sup>3</sup> Compactor truck</td><td>Curb collection</td></tr> <tr> <td>Marginal areas</td><td>5.5 - to 10 m<sup>3</sup> container</td><td>Point collection</td></tr> <tr> <td>Street waste</td><td>5.5 - to 10 m<sup>3</sup> container</td><td>Point collection</td></tr> </table>		Area	Collection Equipment	Method	Standard residential areas	15m <sup>3</sup> Compactor truck	Curb collection	Commercial areas	15m <sup>3</sup> Compactor truck	Curb collection	Busy commercial areas	8m <sup>3</sup> Compactor truck	Curb collection	Marginal areas	5.5 - to 10 m <sup>3</sup> container	Point collection	Street waste	5.5 - to 10 m <sup>3</sup> container	Point collection
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2.3 Processing, treatment, recycling	<p>1) Basic Policy</p> <p>a) Neither major processing nor treatment plants for municipal solid waste, to be operated by the MCC, will be introduced provided that acquisition of a landfill site and its operation do not impose too much effort on the proposed waste management authority.</p> <p>b) The AMDC's SWEU will promote recycling activities by encouraging the participation of the private sector and avoid direct involvement in the execution of recycling activities.</p> <p>c) A separate discharge system will be firstly introduced in the high income residential areas, where more recyclable materials are included in the generated wastes, and gradually expanded to the middle and low income residential areas.</p> <p>2) Implementation Plan</p> <p>a) In 2004, the first recycling program that recyclable waste is collected at markets and public square will be implemented.</p> <p>b) In 2008, the second recycling program that recyclable waste is collected at schools will be implemented.</p> <p>c) In 2007, the recycling company will be jointly established by the AMDC and the private sector. This company will have a manual sorting plant near the new disposal site and start its operation by employing scavengers in 2008.</p> <p>d) In 2008, the MCC will prohibit private people to enter the disposal site.</p> <p>e) In 2008, the MCC will start the separate collection officially.</p>																			
2.4 Street sweeping system	<p>1) The present street sweeping work is mainly conducted manually and is deemed to be an appropriate method until 2010 due to cheap labor costs and inferior road conditions that would hamper mechanical street sweeping equipment. Therefore, this system basically would be maintained until 2010.</p> <p>2) Following improvement measures will be executed.</p> <p>a) Economic utilization of micro-enterprises</p> <p>b) To install more litter boxes along streets</p> <p>c) To increase the number of collection points</p> <p>d) To use a new type of cart to carry litter collected</p> <p>e) To set up site offices with space</p>																			

2.5 Final disposal	<p>1) Existing Final Disposal Site</p> <ul style="list-style-type: none"> <li>a) In 1999, the existing disposal site sanitary will be improved in order to improve the sanitary level and to provide the sufficient function to enable good landfill management.</li> <li>b) The cooperation of scavengers will be promoted.</li> </ul> <p>2) New Final Disposal Site</p> <ul style="list-style-type: none"> <li>a) In 2001, the committee for selection of a new disposal site will be established.</li> <li>b) In 2002, the new site will be decided.</li> <li>c) Between 2003 and 2005, a preliminary design, EIA, acceptance from neighborhood, detailed design, tender documents will be conducted.</li> <li>d) In 2006, the new disposal site will be constructed.</li> <li>e) In 2007, the new disposal site will start the operation.</li> </ul>
2.6 Operation and maintenance	<p>Employing a large number of people is risky and is also difficult to maintain the level of management required, so it is recommended that the private sector participates in SWM works in order to reduce the burden and work load on the authority responsible for SWM.</p>
2.7 Hygiene education	<ul style="list-style-type: none"> <li>1) Hygiene education in Alcardia Mobile Campaign will be reinforced.</li> <li>2) School education will be conducted by using the textbook "Basura", the video on solid waste, etc.</li> </ul>

### 3.5 SWM Project Cost

#### a. Total Cost from 1999 to 2010

Table 10: Summary of the Costs Involved in SWM Works

		unit: 10 <sup>6</sup> Lps.											
	Activities	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1	<b>Administration</b>												
1.1	Institutional, Organizational and Financial Reform												
	To improve the financial system												
	Organizational reform												
	Improvement of managerial capability												
1.2	Hygiene Education												
	To operate the mobile municipality campaign												
	To conduct hygiene education at school												
	To start education on recycling												
1.3	General administrative work												
Cost	Investment	00	00	00	00	00	00	00	00	00	00	00	00
	Operation and Maintenance Cost	26	30	36	36	38	44	40	38	42	50	46	53
	<b>Total Cost</b>	<b>26</b>	<b>30</b>	<b>36</b>	<b>36</b>	<b>38</b>	<b>44</b>	<b>40</b>	<b>38</b>	<b>42</b>	<b>50</b>	<b>46</b>	<b>53</b>
2	<b>Collection and Haulage System</b>												
	Detailed design on collection vehicles (1st phase)												
	Arrangement of financial source (1st phase)												
	Procurement of collection vehicles (1st phase)												
	Operation of vehicles procured at the 1st phase												
	Detailed design on collection vehicles (2nd phase)												
	Arrangement of financial source (2nd phase)												
	Procurement of collection vehicles (2nd phase)												
	Operation of vehicles procured at the 2nd phase												
Cost	Investment	00	353	00	00	00	00	00	00	353	00	00	00
	Operation and Maintenance Cost	102	116	112	112	112	126	112	112	145	112	145	145
	Contracting Out	110	110	219	219	329	329	438	438	548	548	657	657
	<b>Total Cost</b>	<b>102</b>	<b>468</b>	<b>112</b>	<b>112</b>	<b>112</b>	<b>126</b>	<b>112</b>	<b>112</b>	<b>465</b>	<b>145</b>	<b>112</b>	<b>145</b>
3	<b>Recycling System</b>												
	Preparation for recycling point collection (1st phase)												
	Recycling point collection (1st phase) start												
	Preparation for recycling point collection (2nd phase)												
	Recycling point collection (2nd phase) start												
	Establishment of a recycling company by MCO and private sector												
	Construction of a sorting plant												
	Separate collection by MCO start												
	Recycling company start operation												
Cost	Investment	00	00	00	00	13	00	00	00	24	05	00	00
	Operation and Maintenance Cost	00	00	00	00	00	05	05	05	05	10	10	10
	<b>Total Cost</b>	<b>00</b>	<b>00</b>	<b>00</b>	<b>00</b>	<b>13</b>	<b>05</b>	<b>05</b>	<b>05</b>	<b>29</b>	<b>15</b>	<b>10</b>	<b>10</b>
4	<b>Street Sweeping System</b>												
	To increase litter boxes along the streets												
	To increase the number of collection points												
	To introduce a new type of carts for carrying litters collected												
	To set up site offices												
	To operate it in the new method												
Cost	Investment	00	07	00	00	00	00	00	00	07	03	00	00
	Operation and Maintenance Cost	28	28	33	35	35	35	37	39	41	42	44	46
	Contracting Out	67	67	67	71	71	71	75	79	82	86	90	93
	<b>Total Cost</b>	<b>96</b>	<b>102</b>	<b>100</b>	<b>106</b>	<b>106</b>	<b>106</b>	<b>112</b>	<b>117</b>	<b>129</b>	<b>132</b>	<b>134</b>	<b>140</b>
5	<b>Final Disposal System</b>												
	Improvement of the existing disposal site												
	Establishment of the new disposal site committee												
	Siting a new disposal site												
	To conduct EIA and obtain an approval from Ministry of Environment												
	Preliminary design of a new disposal site												
	To get acceptance from neighborhood												
	Arrangement of financial source												
	Detailed design												
	Construction												
	Operation												
Cost	Investment	63	122	00	30	06	00	30	128	21	30	30	06
	Operation and Maintenance Cost	41	54	56	53	67	79	71	56	77	81	88	92
	Contracting Out	104	176	56	83	72	79	100	184	98	111	118	98
	<b>Total Cost</b>	<b>208</b>	<b>352</b>	<b>112</b>	<b>169</b>	<b>145</b>	<b>158</b>	<b>209</b>	<b>368</b>	<b>196</b>	<b>222</b>	<b>236</b>	<b>194</b>
Cost	Investment	63	481	00	30	18	00	30	128	404	38	30	06
	Operation and Maintenance Cost	197	228	237	236	252	289	265	249	277	328	300	345
	Contracting Out	117	177	286	290	400	400	513	517	630	633	747	750
	<b>Total Cost</b>	<b>437</b>	<b>886</b>	<b>523</b>	<b>556</b>	<b>670</b>	<b>689</b>	<b>807</b>	<b>894</b>	<b>1311</b>	<b>1000</b>	<b>1076</b>	<b>1102</b>

## b. Cost Analysis

Table 11: Estimated Unit SWM Costs

unit: Lps/ton

Item	1997*	1999 to 2000 average	2001 to 2007 average	2008 to 2010 average
Collection & Haulage	83.6	175.4	263.1	266.7
Street Sweeping	N.A.	920.2	974.2	975.0
Final Disposal	5.5	37.9	45.2	37.5
Recycling	0	0	261.7	290.2
Others	N.A.	N.A.	N.A.	N.A.
Total SWM Works	130.2	290.8	361.5	349.7

Note:

\*: This excludes depreciation.

The unit cost of the collection and haulage works is broken down as follows.

Direct operation costs: Lps. 202.8 per ton

Contracting out price: Lps. 300.0 per ton

The costs for the proposed waste management authorities to directly operate collection and haulage works (Lps. 202.8 per ton) exclude the administration cost and the financial cost, while their contracting out price exclude only the administration cost and include a profit.