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JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

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MINISTRY OF PUBLIC HEALTH AND SOCIAL WELFARE
THE REPUBLIC OF PARAGUAY

THE STUDY
ON
THE SOLID WASTE MANAGEMENT
FOR
METROPOLITAN AREA OF ASUNCION

FINAL REPORT
VOLUME I
EXECUTIVE SUMMARY

KAKUSAI KOGYO Co., Ltd.

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JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

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THE REPUBLIC OF PARAGUAY

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AUGUST 1994

KOKUSAI KOGYO Co., Ltd.



In this report, project cost is estimated at February 1994 price and at an exchange rate of 1 US\$ = ¥ 106.41 = 1,880.50 Gs.

PREFACE

In response to a request from the Government of the Republic of Paraguay, the Government of Japan decided to conduct a master plan and feasibility study on the Solid Waste Management for Metropolitan Area of Asuncion in the Republic of Paraguay and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Paraguay a study team headed by Mr. Takao Yoshida, Kokusai Kogyo Co., Ltd. four times between June 1993 and June 1994.

The team held discussion with the officials concerned of the Government of Paraguay, and conducted field surveys at the study area. After the team returned to Japan, further studies were made and the present report was prepared.

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

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Paraguay for their close cooperation extended to the team.

August 1994



Kimio Fujita
President

Japan International Cooperation Agency

August 1994

Mr. Kimio Fujita
President
Japan International Cooperation Agency
Tokyo, Japan

Dear Mr. Fujita,

Letter of Transmittal

We are pleased to submit to you the study report on the Solid Waste Management for Metropolitan Area of Asuncion, Paraguay. This study contains the master plans until 2006 and the feasibility studies on the first priority projects.

The MSWM master plans were formulated for 15 municipalities in the study area based on their individual targets and the optimum technical systems which mainly comprise of inter-municipal sanitary landfill sites.

The feasibility studies were executed for the three first priority projects which consisted of collection system improvement for 15 municipalities, construction of the Chaco-i inter-municipal disposal site and the transfer station. This study concluded that the implementation of the first priority projects by the proposed executing agency, AMUAM, supported by soft loan or grant aid was appropriate.

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. And from the Paraguayan side we also wish to express our deep gratitude to the Ministry of Public Health and Social Welfare, AMUAM, 15 municipalities of the Study Area, the Embassy of Japan in the Republic of Paraguay, and the JICA office in the Republic of Paraguay.

Finally, we hope that this report will be effectively used for the implementation of the project.

Respectfully,



Takao Yoshida
Team Leader
The Study on the Solid Waste Management for Metropolitan Area of Asuncion

*The Study on the Solid Waste Management
for
Metropolitan Area of Asuncion*

BRIEF SUMMARY

1. MSWM Master Plan

1.1 Goal

The goal of MSWM Master Plan is *"Development and Realization of a Beautiful and Clean Living Environment in the Asuncion Metropolitan Area towards the 21st Century"*. This will be achieved through *Citizens' Participation and Establishment of Self-sustainable Solid Waste Management*.

1.2 Present MSWM and Priority of Improvement Projects

Based on the study on the present MSWM (Municipal Solid Waste Management) in 15 municipalities, the following conclusions were made regarding the priority of improvement on MSWM:

- In every aspect, the present MSWM of the 14 municipalities other than Asuncion, are very weak and there are some municipalities which do not have any cleansing service. Therefore, the first priority of the improvement of MSWM should be on the establishment of the basic MSWM technical system which consists of collection, street sweeping and final disposal services.
- The second priority should be on the acquisition of a future landfill for Asuncion and F.Mora municipalities in their jurisdiction, which it is very difficult to secure, except for the river channel area of the Paraguay River, an international river.
- Since the introduction of a recycling and/or resource recovery plant will require a financial burden on the local governments, reduction and resource recovery of solid wastes by it shall be done after the establishment of the above-mentioned basic MSWM technical system.

1.3 Targets

Based on the above-mentioned premisses, targets of collection, street sweeping and final disposal services for 15 municipalities are set up as follows:

Services Municipality	Collection Coverage Ratio(%)			Street Sweeping Distance(km)			Sanitary Landfill Level		
	1994	2000	2006	1994	2000	2006	1994	2000	2006
1.Highly Urbanized M.									
1-1 Asuncion	83	100	100	264	300	300	Level 1	Level 3	Level 3
1-2 F.Mora	64	85	100	2	20	40	Level 1	Level 3	Level 3
2.Urbanized M.									
2-1 Lambare	61	80	100	6	17	25	Level 1	Level 2	Level 3
2-2 San Lorenzo	16	45	70	6	21	32	Level 1	Level 2	Level 3
2-3 Capiata	15	45	70	0	6	12	Open	Level 2	Level 3
2-4 Luque	23	45	70	28	40	60	Level 1	Level 2	Level 3
2-5 M.R.Alonso	16	45	70	0	6	10	Open	Level 3	Level 3
2-6 Villa Elisa	46	65	85	0	9	20	Open	Level 2	Level 3
3.Less Urbanized M.									
3-1 Nemby	7	45	70	0	3	12	Open	Level 2	Level 3
3-2 J.A.Saldivar	0	25	50	0	1	2	None	Level 2	Level 3
3-3 Ita	18	45	70	6	10	15	Open	Level 2	Level 3
3-4 Aregua	0	25	50	2	5	10	None	Level 2	Level 3
3-5 Limpio	1	25	50	1	3	8	None	Level 3	Level 3
3-6 Villa Hayes	10	45	70	0	5	9	Open	Level 3	Level 3
3-7 Aceval	0	25	50	0	6	11	None	Level 3	Level 3

1.4 The Master Plan

The field surveys on 13 potential inter-municipal disposal sites presented by the Paraguayan side were conducted and their suitability as the inter-municipal landfill was examined regarding technical, environmental and social points of view. From the results, 11 potential sites other than 2 sites in Chaco (Northern part of the Study area) were concluded unsuitable due to the uncertainty on obtaining neighborhood consensus, etc.. As for the municipalities in the southern part of the Study area, although the potential sites were not identified, inter-municipal landfills 15 km away from their urban center were proposed as alternatives for their final disposal sites.

In total, 62 technical system alternatives for MSWM in 15 municipalities were carefully examined. The following alternatives were concluded to be the optimum technical systems.

- For Asuncion and F.Mora Municipalities:
Inter-municipal disposal at the Chaco-i sanitary landfill with a transfer station.
- For M.R. Alonso, Limpio, Villa Hayes and B. Aceval Municipalities:
Inter-municipal disposal at the Chaco-i sanitary landfill without a transfer station.
- For Lambare, San Lorenzo, Capiata, Luque, Villa Elisa, Nemby, J.A. Saldivar, Ita and Aregua Municipalities:
Inter-municipal disposal at sanitary landfills (unidentified) 15 km away from the center of the urban area of each municipality.

1.5 Selection of the First Priority Projects

With the discussion of the Paraguayan side regarding the proposed Master Plan, the following projects were concluded as the first priority projects to be implemented by 2000.

- Improvement of collection systems for 15 municipalities;
- Construction of the Chaco-i inter-municipal disposal site; and
- Construction of AML (Madame Lynch Avenue) transfer station.

2. First Priority Projects

The contents and investment costs of the First Priority Projects are presented in the table below.

Project	Executing Bodies	Description	Total Amount mill.Gs	Local Portion mill.Gs	Foreign Portion 1,000 USD
Collection Improvement	Municipality of Asuncion	Project Amount Contents - Procurement of waste collection trucks, containers and machineries for the existing workshop	8,585	303	4,565
	AMUAM	Total Project Amount	20,798	2,997	9,466
		[Collection Improvement] Project Amount Contents - Procurement of waste collection trucks, containers	11,901	5	6,325
		[Workshop] Project Amount Contents - Land acquisition: 1 ha - Construction of a workshop building Floor area: 800 m ² - Procurement of equipment for the workshop	1,781	813	515
		[Un-identified Disposal Site] Project Amount Contents - Land acquisition: 100 ha - Construction of a final disposal site Capacity: 800,000 m ³ Design life year for Phase 1: 4 years Area of landfill: approximately 25 ha Target operation level: Level 2 Facilities: Office, warehouse, truckhouse, fence, gate, parking, etc. - Procurement of equipment for landfill operation	7,116	2,179	2,626
Transfer and Transport	AMUAM	Project Amount Contents - Construction of a transfer station RC structure, two-storied building Capacity and transfer system Direct re-loading system: 15 ton/hour Indirect re-loading system: 110 ton/hour - Procurement of open and closed trailers	9,824	2,411	3,942
Chaco-i Disposal Site	AMUAM	Project Amount Contents - Land acquisition: 200 ha - Construction of a final disposal site Capacity: 1,600,000 m ³ Design life year for Phase 1: 4 years Area of site development: approximately 100 ha Target operation level: Level 3 Facilities: Office, warehouse, truckhouse, fence, gate, parking, etc. - Procurement of equipment for landfill operation	10,270	2,931	3,902
Total Project Amount			49,477	8,642	21,872

3. Financial and Economic Evaluation of the First Priority Project

3.1 Financial Evaluation

Financial evaluation was conducted by taking into consideration the whole operation, that is, revenues and expenses for solid wastes collection improvement, transfer station and final disposal (Sanitary Landfill), assuming AMUAM and Asuncion as the two implementing agencies. In addition, the financial viability of the transfer station and the final disposal were tested separately.

The resulting financial internal rates of return (FIRR) were as follows: AMUAM 10.67%, Asuncion 56.95%, the transfer station 5.10%, and the final disposal 14.23%. The above FIRR values show the viability of AMUAM and Asuncion as implementing agencies, as well as the financial viability of the transfer station and the final disposal, in accordance with the assumed viability criteria for public utilities of FIRR greater than 3%.

In Asuncion, user charges and population density are higher than those in the rest of the metropolitan area, resulting in higher values of FIRR than those for AMUAM. Another contributing factor to the high FIRR in Asuncion was the attempt to keep AMUAM expenses low, at real costs plus administrative expenses, which lowered the rental and tipping fees to be paid by the Asuncion Municipality to AMUAM. However, sensitivity analysis shows Asuncion to be highly sensitive to fluctuations in revenues and expenses, thereby justifying the seemingly high FIRR.

AMUAM, although showing lower values of FIRR, is less sensitive to fluctuations in revenues and expenses.

3.2 Economic Evaluation

Economic evaluation was quantified only for the Transfer Station, by comparing the two situations consisting of "with" and "without" the transfer station. The resulting economic rate of return (EIRR) was 18.0%.

The Solid Wastes Collection Improvement and the Final Disposal were evaluated qualitatively as environmental improvement, and the concomitant beneficial effects it brings about in public health and related aspects.

3.3 Overall Evaluation

Implementation of the Project is to directly benefit the urban population in the Asuncion Metropolitan Area, which accounted for nearly 30 % of the total population of the country in 1992 and is estimated to approach 1.5 million persons in the target year 2000. The institutional development of AMUAM can serve as a model for regional institutions, which can undertake social and economic development projects in different areas of the country.

4. Recommendations

4.1 Recommendation for Each Municipality

The 14 municipalities other than Asuncion shall establish a Department or Section, managed by a selected professional with clear duties, powers and responsibilities over the management of solid wastes in each city.

4.2 Recommendation for AMUAM

Competence and function of the AMUAM on MSWM in the Metropolitan area shall be developed. It is recommended that the AMUAM shall provide the following services for sound MSWM as the inter-municipal institution of the Metropolitan area.

- provision of the transfer and disposal operation services for the municipalities of the study area.
- provision of the maintenance services for the vehicles and equipments of the 14 municipalities other than Asuncion.
- establishment of a training program for the officials of all the municipalities in the study area, in collaboration with SENASA, so that it can benefit other Paraguayan municipalities.

Consequently, AMUAM is requested to employ qualified managers and engineers who have a thorough knowledge of MSWM.

4.3 Legislation

An appropriate legislation dealing with Solid Waste Management shall be prepared and issued, although the first step required presently is the approval of the Sanitary Code.

4.4 Executing Bodies

Upon consideration of the very weak financial and technical capabilities of the 14 municipalities other than Asuncion, AMUAM shall be the executing body of the First Priority Project and take the responsibility of fund raising, repayment, construction of facilities, procurement of equipment and operation of AML transfer station and inter-municipal landfills, excluding the collection and street sweeping improvement projects in Asuncion.

4.5 Financial Source

The financial analyses implies that AMUAM requires donations to finance initial investments during the take-off period of the MSWM, but subsequently can replace facilities and equipment with internally generated funds by rental and tipping fees, thereby ensuring continuity of the MSWM. As such, AMUAM, in cooperation with SENASA and 15 municipalities, shall make every effort to acquire such assistance in order to successfully implement the projects.

The cost of MSWM in each municipality shall be recovered through the user fee in principal for establishing self-sustainable MSWM. The income shortfall was assumed to be covered by property tax (70%) from each municipality and bus ticket tax (30%) from AMUAM.

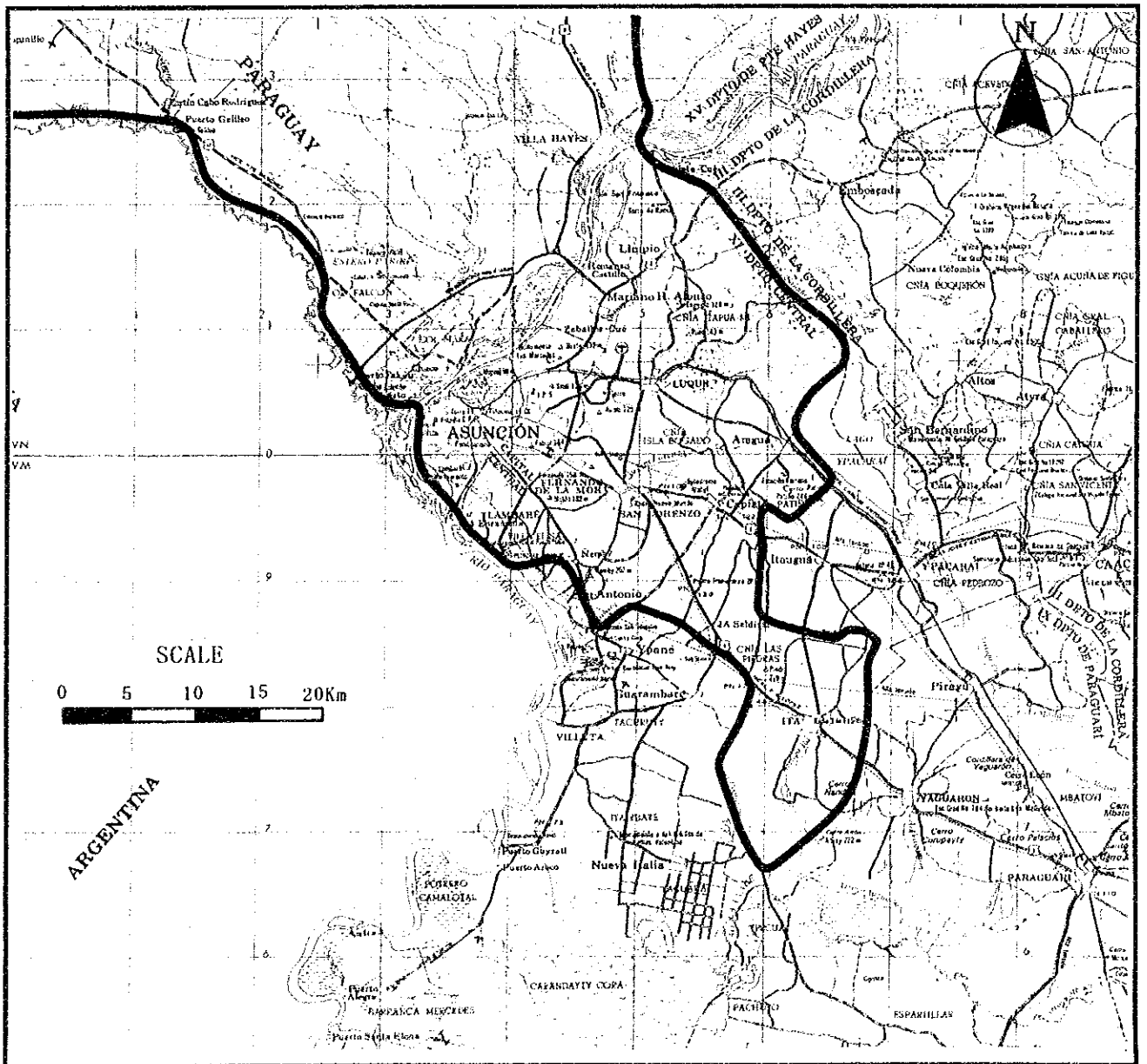
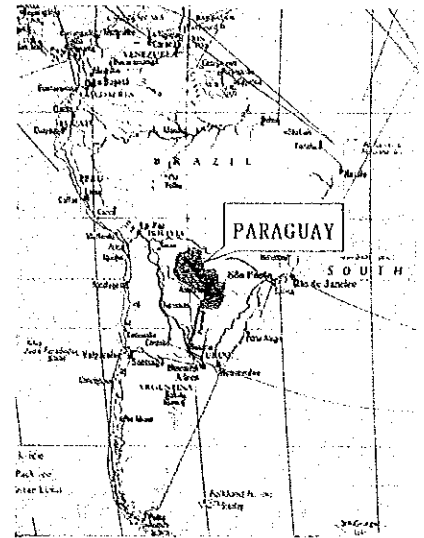
**THE STUDY
ON
THE SOLID WASTE MANAGEMENT
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METROPOLITAN AREA OF ASUNCION**

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	J Feasibility Study of the First Priority Project
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This is the EXECUTIVE SUMMARY.

Location Map of The Study Area



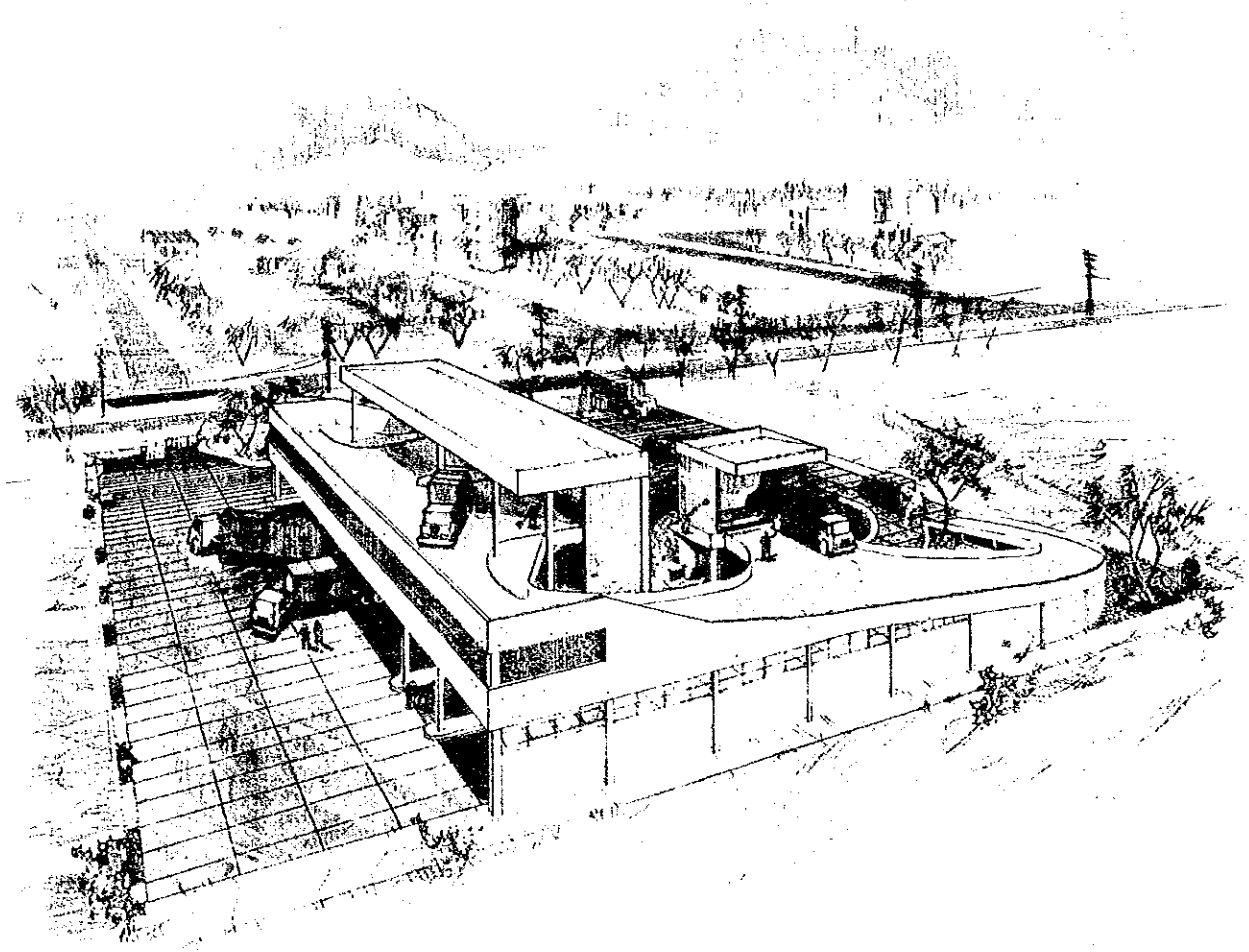


Plate 1: Image of Transfer Station

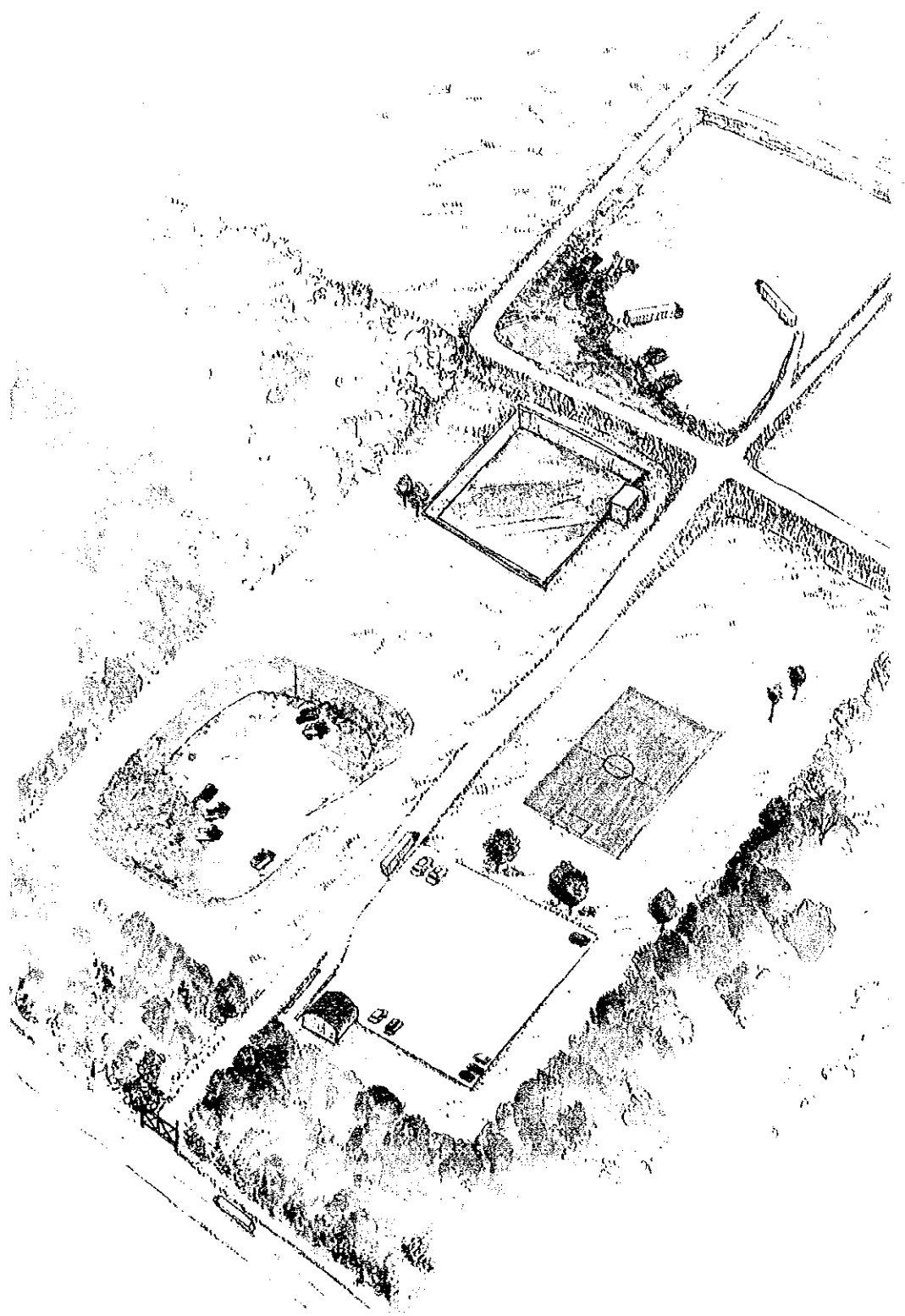


Plate 2: Image of Final Disposal Site

*Cateura Final
Disposal Site*



*Workshop of Asuncion
Municipality*



*Street Sweeping Work
in San Lorenzo*



Plate 3: Present MSWM in the Study Area



Weighing waste amount discharged by houses

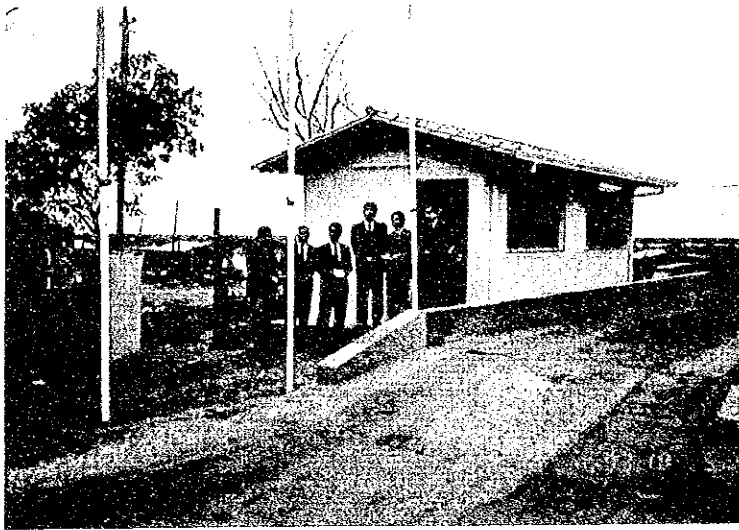


Mixing and reducing waste sample collected for waste composition analysis

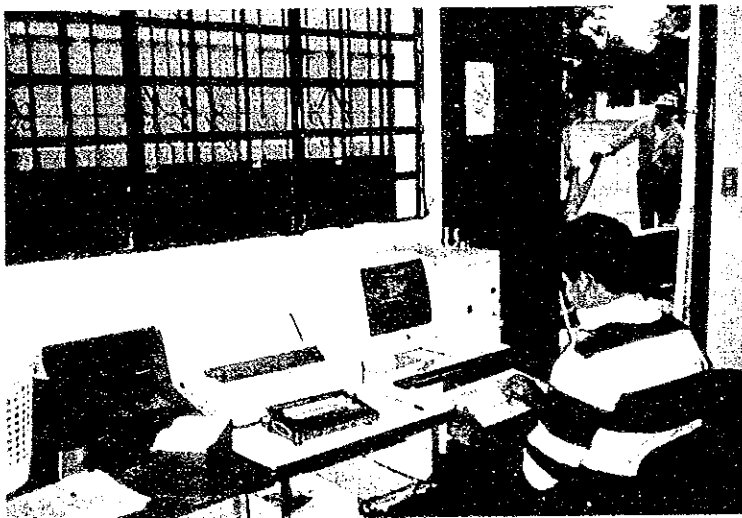


Sorting waste sample by waste categories

Plate 4: Joint Survey (1), Waste Amount and Composition



*Truck Scale Inspection
Building constructed
by Asuncion
Municipality and JICA
in Cateura Landfill
Site*

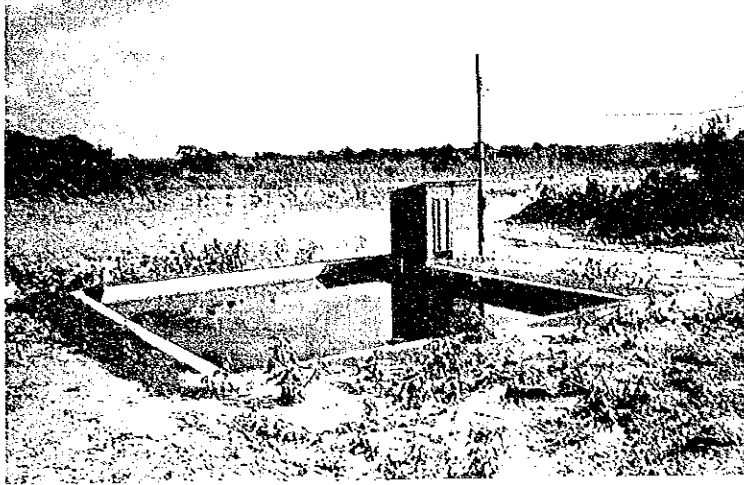


*Inside View of the
Inspection Building of
Truck Scale.
One set of Computer
is installed*

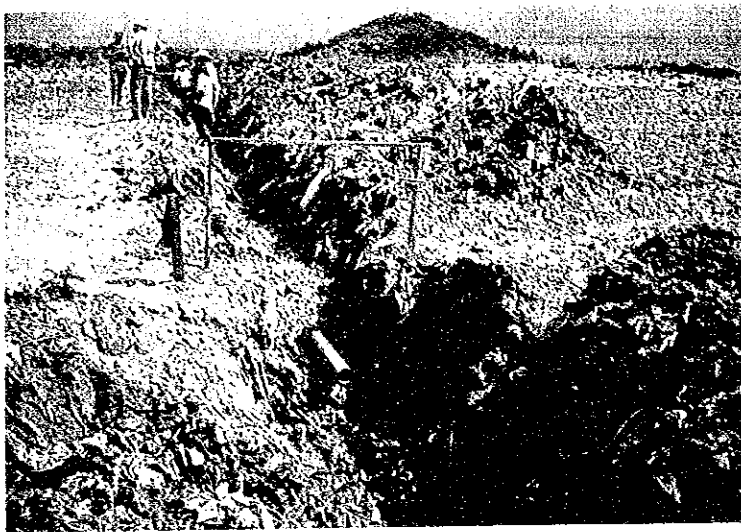


*Water Sampling for
Water Quality Analysis
at Lambare Landfill
Site*

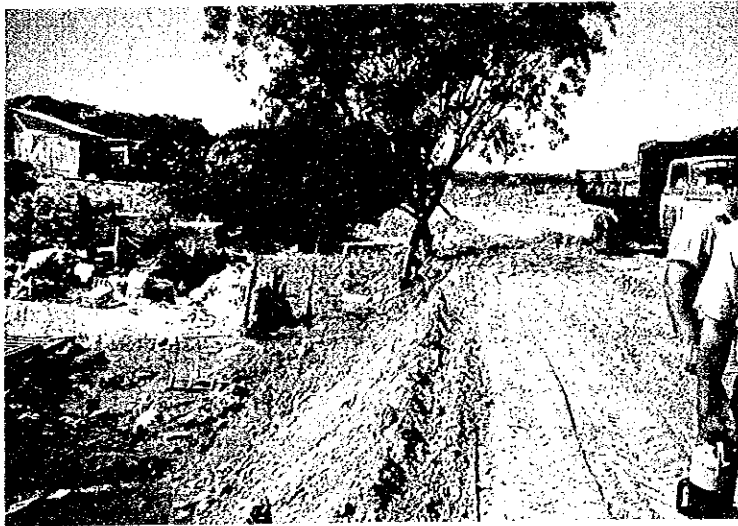
Plate 5: Joint Survey (2)



*View of the leachate
circulation pond*

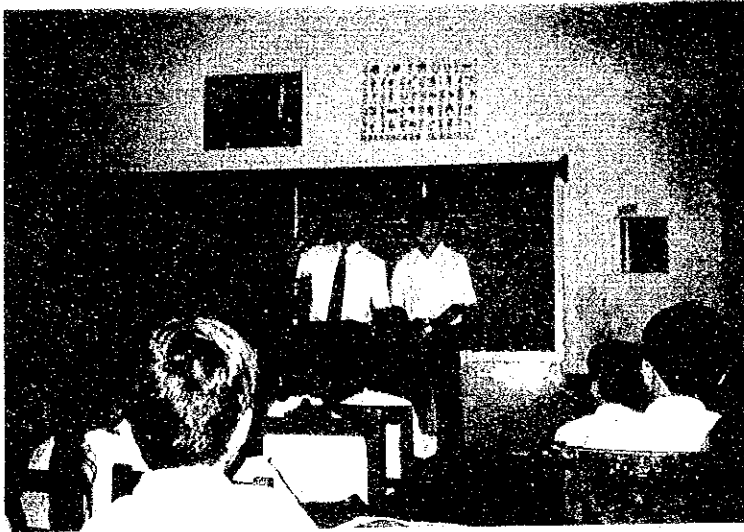


*Installing horizontal
gas removal facility*



*Constructing drain by
banking soil to
intercept sewage and
rain water to the
disposal area*

Plate 6: Experiment of Sanitary Landfill Operation



Lecture on solid waste given to the primary school students by the Study Team



Lecture on solid waste given by SENASA staff



Pupils are watching solid waste educational video made by the Study Team

Plate 7: Experiment of Solid Waste Education

*The Study on the Solid Waste Management
for
Metropolitan Area of Asuncion*

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ABBREVIATIONS

ORGANIZATIONS

AMUAM	Association of Municipalities of the Metropolitan Area
CORPOSANA	Corporation for Sanitary Work
IDB	Inter-American Development Bank
IDM	Institute of Municipal Development
JICA	Japan International Cooperation Agency
MEC	Ministry of Education
MIC	Ministry of Industry & Trade
MOPC	Ministry of Public Works and Communication
MSPBS	Ministry of Public Health and Social Welfare
OECD	Overseas Economic Cooperation Fund
SENASA	National Service of Environmental Sanitation
STP	Technical Planning Secretariat

REPORT and STUDY

AML	Madame Lynch Avenue
ASG	Apparent Specific Gravity
CRF	Capital Recovery Factor
CV	Calorific Value
DF/R	Draft Final Report
F/R	Final Report
HCV	Higher Calorific Value
HUM	Highly Urbanized Municipalities
IC/R	Inception Report
ISW	Industrial Solid Waste
ISWM	Industrial Solid Waste Management
IT/R	Interim Report
LCV	Lower Calorific Value
LUM	Less Urbanized Municipalities
MAA	Metropolitan Area of Asuncion
M/M	Minutes of Meeting
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
N.A.	Not Available
O & M	Operation and Maintenance
PR/R	Progress Report
SCF	Standard Conversion Factor
S/W	Scope of Work

SWM	Solid Waste Management
UM	Urbanized Municipalities
VC	Vinas Cue
WACS	Waste Amount and Composition Survey

SOCIO-ECONOMY

EIRR	Economic Internal Rate of Return
FIRR	Financial Rate of Return
GDP	Gross Domestic Product
GNP	Gross National Product
GRDP	Gross Regional Domestic Product
US\$	U.S.dollar
Gs	Guaranis
p.a.	per annum
mill.	million
bill.	billion

UNIT

mm	millimeter
cm	centimeter
m	meter
km	kilometer
m ²	square meter
km ²	square kilometer
ha	hectare
m ³	cubic meter
mg	milligram
lit.	litre
kg	kilogram
ton	ton
sec.	second
min.	minutes
hr	hour
d	day
%	percent
no.	number
nos.	numbers
kw	kilowatt
kj	kilojoule
kcal	kilocalorie

1. INTRODUCTION

1.1 Background

The rapid pace of socio-economic development in Paraguay has brought about an increasing complexity in the management of solid waste. Solid waste collection and disposal has become a social and public health problem of great magnitude. As in the case of many cities with large populations, the management of solid waste in the Asuncion metropolitan area has become a critical problem.

To overcome the problems and to improve the situation in a systematic manner the National Service of Environmental Sanitation (SENASA) in cooperation with the Asuncion Municipal Government and the other 14 municipalities in the Metropolitan Area wished to carry out the "Solid Waste Management Study in the Metropolitan Area of Asuncion".

In response to the request of the Government of Paraguay, the Japan International Cooperation Agency (JICA), the official agency responsible for the implementation of the technical cooperation programs of the Government of Japan, concluded the Scope of Work of the Study with the Ministry of Public Health and Social Welfare of the Government of Paraguay. Kokusai Kogyo Co., Ltd. carried out the Study.

1.2 Scope of the Study

a. Objective of the Study

The objectives of the Study are:

- to formulate a master plan for the improvement of the Solid Waste Management of the Asuncion Metropolitan Area up to the target year of 2006; and
- to conduct a feasibility study for the first priority project based on the master plan.

b. Study Area

The study area was the whole area under the jurisdiction of the Metropolitan Area of Asuncion, and was limited to the urbanized areas of the municipalities. The

Study area is shown in the Location Map.

c. Study Wastes

The wastes studied were household waste, market waste, commercial waste, street sweeping waste and institutional waste. As for the medical and industrial solid wastes, a quick diagnosis study was carried out based on the existing information and data resulting in the proposal of general recommendations for the improvement of medical and industrial solid waste management in the Metropolitan Area. Agricultural waste and animal husbandry waste were excluded from the study.

1.3 Policy of the Study

a. Utilization of Local Consultants

Considering the eminent characteristics of an MSWM study, it was very important to pursue technology transfer to not only Paraguayan counterpart personnel but also local consultants in the course of the Study. Especially, the works which need to be done continuously even after the Study should be conducted by local consultants under the supervision of the Study Team; i.e. WACS, environmental impact studies of SWM facilities, development of an operation system of a truck scale, etc.. Therefore, Paraguayan consultants and professionals were utilized to successfully conduct the Study within a limited period, to make a master plan compatible with local conditions and to pursue technological transfer.

b. Joint Study

In order to conduct the Study successfully, the Study Team proposed the joint implementation of the Study and asked cooperation and active participation of the Paraguayan side. Especially, to smoothly conduct the Study, the Paraguayan side was requested to make political and administrative decisions regarding the following aspects:

- localization of future inter-municipal disposal site(s);
- selection of the optimum technical systems;
- selection of the first priority project; and
- determination of the executing body for the first priority project.

c. Workable Plan and Appropriate Technology

The Study Team formulated the most workable and implementable MSWM plan for the Metropolitan Area in close cooperation with the Paraguayan counterparts. Furthermore, in light of the financial limitation of the Metropolitan Area, the Study Team developed the most appropriate technology for both technical and institutional systems for MSWM in the area. The study and the plan were formulated, especially, to present and support a self-sustainable MSWM for the Metropolitan Area.

1.4 Key Assumptions

Key assumptions used in this study area are as follows:

a. Socio-economic Conditions

Items	Unit	Descriptions
1. Population		
- Projected Urban Population of the Whole Study Area	persons	1992 2000 2006 1,163,595 1,537,600 1,940,700
- Annual Growth Rate	%	3.72%/year
2. Economy		
- GDP	bill.USD	4.95 in 2000 6.06 in 2006
- Annual Increase Rate of GDP in Real Term	%	1994 - 2006 3.5%
- Future Budget Scale of the 15 Municipalities		The budget in 1994 will increase in accordance with GDP increase rate in real term.
- Income Level of the Citizens		The income will increase according to the GDP increase rate in real term/population growth rate.
- Currency Exchange Rate		1 USD = 1,880.50 Gs = 106.41 Yen
- Inflation Rate	%	20% in 1994 20% 1995 - 2000 and 15% 2001 - 2006 for the economic and financial analysis of the Study

b. Waste Amount and Composition

Items	Unit	1994	2000	2006
1. Waste Amount				
1-1 Waste Generation Ratio				
- MSW				
Household	g/person/day	961	1,020	1,083
Shop	g/shop/day	3,186	3,382	3,590
Restaurant	g/shop/day	31,958	33,924	36,011
Market	g/shop/day	5,961	6,328	6,717
Institutional	g/employee/day	78	83	88
Street Sweeping:-				
for Asuncion	g/km/day	254,700	254,700	254,700
for the other 14 municipalities	g/km/day	39,950	39,950	39,950
Hospital	g/bed/day	4,000	4,246	4,507
Bulky	g/person/day	0.6	0.6	0.7
- Other Wastes	g/person/day	30	32	34
1-2 Collection Ratio of Household Waste	%	As shown in Table 3.3a		
1-3 Annual Increase Rate of Waste Generation		The population increase plus 1 % for waste generation increase per capita.		
2. Waste Composition				
2-1 Forecast for Waste Composition		1994	2000	2006
Combustibles		72.8	75	79
Garbage		37.4	36	34
Paper		10.2	18	24
Textile		1.2	2	3
Plastic		4.2	5	7
Grass and Wood		19.2	13	10
Leather and Rubber		0.6	1	1
Non-Combustibles		27.2	25	21
Metal		1.3	2	3
Glass		3.5	5	5
Ceramic and Stone		2.5	2	2
Others (Soil, etc.)		19.9	16	11
- Total		100.0	100.0	100.0
2-2 Lower Calorific Value				
- (MSW excluding Street Sweeping and Bulky Wastes)	kcal/kg	1,192	1,452	1,697

c. Life Span of Equipment and Facilities

	Life Span (years)	Salvage value (%)
Container	5	0
Truck and Heavy Equipment	7	10
Machinery	15	0
Building and Civil Works	30	0

Note: The life span of other facilities for the disposal site depends on the period of its operation.

d. Executing Bodies for Technical Systems of MSWM

Projects	Items	Fund Raising and Repayment	Construction and Procurement	Operation
1.Collection	Asuncion Other 14 Municipalities	Asuncion AMUAM	Asuncion AMUAM	Asuncion 14 Municipalities
2.Street Sweeping	Asuncion Other 14 Municipalities	Asuncion AMUAM	Asuncion AMUAM	Asuncion 14 Municipalities
3.Maintenance of 1 and 2	Asuncion Other 14 Municipalities	Asuncion AMUAM	Asuncion AMUAM	Asuncion AMUAM
4.Transfer Station	Asuncion and F. Mora Other 13 Municipalities	AMUAM None	AMUAM None	AMUAM None
5.Final Disposal	Chaco-i Unidentified Inter-municipal	AMUAM AMUAM	AMUAM AMUAM	AMUAM AMUAM
6.Maintenance of 4 and 5		AMUAM	AMUAM	AMUAM

e. Revenue and Expenditure for Financial Analysis

Organizations	Items	Revenue	Expenditure
1. AMUAM	Collection	Rental Fee (Gs/unit)	Depreciation and Maintenance of Vehicles
	Street Sweeping	Rental Fee (Gs/unit)	Depreciation and Maintenance of Vehicles
	Transfer Station	Tipping Fee (Gs/ton)	Depreciation and O&M of Facilities, Vehicles and Equipment
	Final Disposal	Tipping Fee (Gs/ton)	Depreciation and O&M of Facilities, Vehicles and Equipment
2. Asuncion	Collection	Collection Fee (Gs/month)	Depreciation and O&M of Vehicles
	Street Sweeping	Collection Fee (Gs/month)	Depreciation and O&M of Vehicles
	Transfer Operation	Collection Fee (Gs/month)	Tipping Fee
	Final Disposal	Collection Fee (Gs/month)	Tipping Fee
3. Other 14 Municipalities	Collection	Collection Fee (Gs/month)	Rental Fee of Vehicles and O&M
	Street Sweeping	Collection Fee (Gs/month)	Rental Fee of Vehicles and O&M
	Transfer Operation	Collection Fee (Gs/month)	Tipping Fee
	Final Disposal	Collection Fee (Gs/month)	Tipping Fee

- Note: 1. Asuncion Municipality will procure vehicles and equipment necessary for collection and street sweeping services and maintenance for them.
 2. Tipping fee for disposal at the Chaco-i and unidentified landfill differs from each other.

1.5 Work Processes of the Study

The study commenced in June 1993 and ended in August 1994. The study consisted of the following two phases;

- Phase 1 : Formulation of a Master Plan (June – December, 1993)
- Phase 2 : Feasibility Study on the First Priority Project (January – August, 1994)

1.6 Study Team Member

The JICA Study Team consisted of the following members:

Team Leader/ Public Education Program	Takao YOSHIDA
Collection and Haulage Plan	Susumu SHIMURA
Intermediate Treatment Plan	Takashi TOMIYASU
Final Disposal Plan	Akira DOI
Facility Design and Cost Estimation	Junji ANAI
Equipment Operation and Maintenance Plan	Fernando Pache Saldanha
Solid Waste Composition Analysis	Koji KUSUNOKI
City Plan	Masaharu KINA
Organizational and Institutional Development Plan	Luiz Edmundo Costa Leite
Project Evaluation	Masaru OBARA
Environmental Impact Assessment	Nobuyuki KOMURO
Administrative Coordinator	Mark VILANOVA

2. PROFILE OF THE STUDY AREA

2.1 Profile of the Study Area

a. Definition of the Study Area

The study area covers the area under the jurisdiction of the members of the AMUAM (Association of Municipalities of the Metropolitan Area) except for San Antonio and Ypane municipalities, and is limited only to the urbanized areas of the 15 municipalities.

In view of MSWM, the 15 municipalities in the Study Area are classified into the following three categories as shown in Figure 2.1a.

- HUM (Highly Urbanized Municipalities):
Asuncion and Fernando de la Mora.
- UM (Urbanized Municipalities):
Lambare, San Lorenzo, Capiata, Luque, M.R. Alonso and Villa Elisa.
- LUM (Less Urbanized Municipalities):
Nemby, J.A. Saldivar, Ita, Aregua, Limpio, Villa Hayes and Benjamin Aceval.

b. Location and population

Of the 15 municipalities in the Study Area, 13 including Asuncion are located on the eastern bank near the confluence of the Paraguay River and the Pilcomayo River and its topography is generally flat. The total area is approximately 1,605 km² and its population is approximately 1.29 million. The urban population and area, which is the target of the Study, are 1.16 million in 1992 and 530 km² respectively.

c. Climate

Paraguay is located in the sub-tropical zone and its climate is characterized by its drastic changes. The average annual temperature is 22.5 °C and the average annual precipitation is 1,356.3 mm.

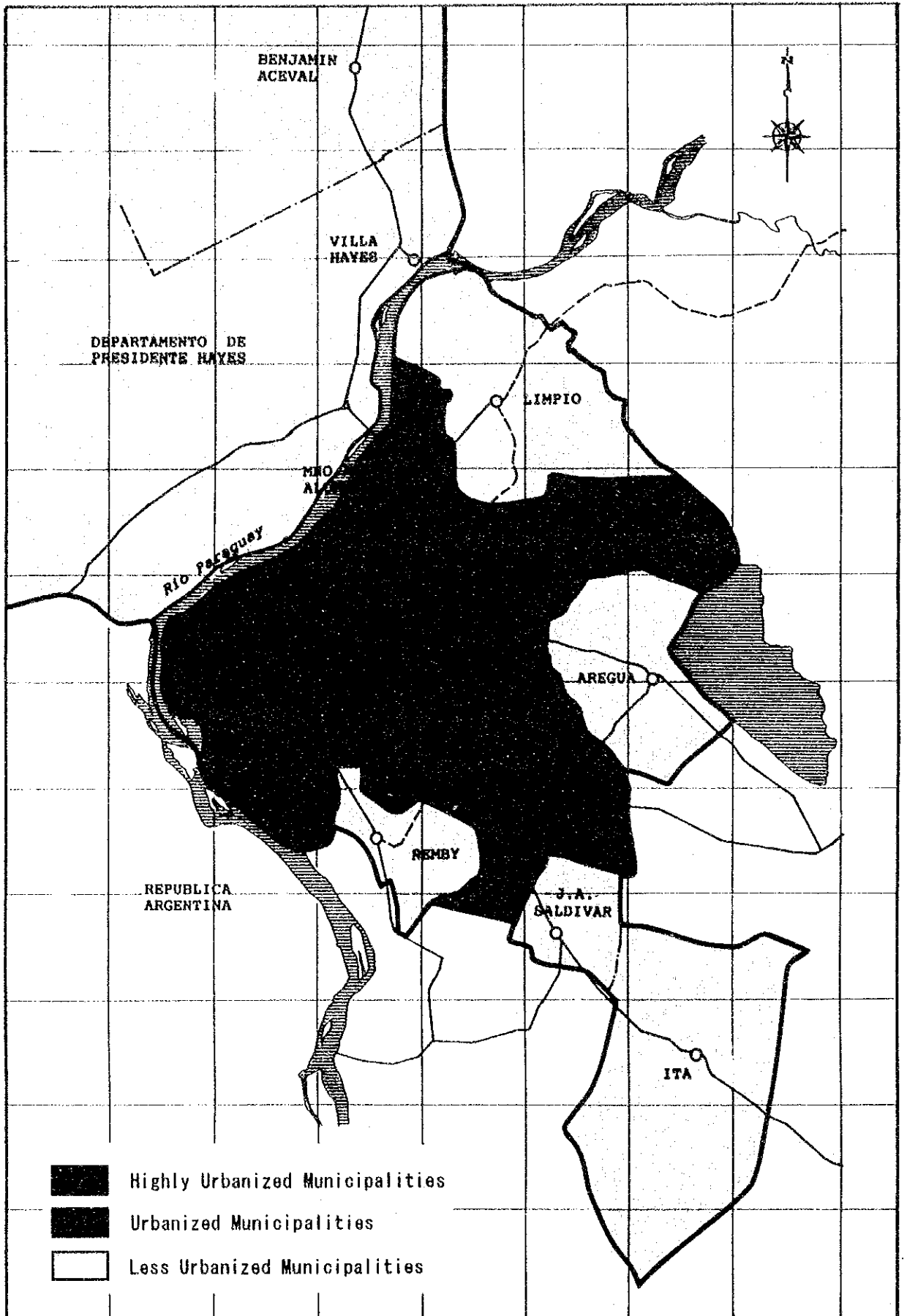


Figure 2.1a Classification of Municipalities in the Study Area

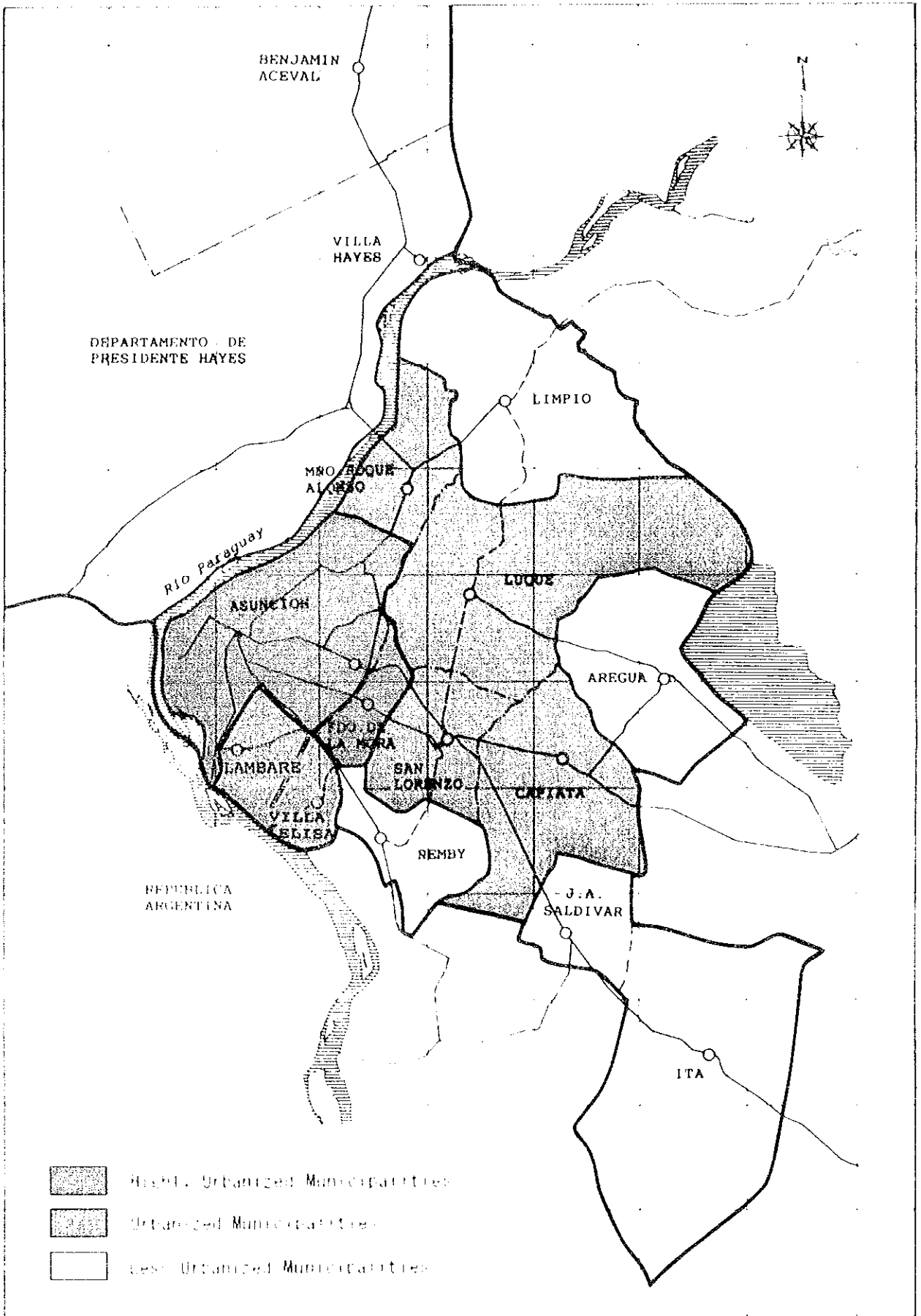


Figure 2.1a Classification of Municipalities in the Study Area

d. Administration

The country is administratively divided into 19 Departments, and more than 500 municipalities. The Departmental division did not exist until recently, and only now the Departments are being implemented by the first time elected "Governors". Governmental actions and powers are thus, basically, exercised by the National and Municipal governments.

e. Land Use

The present land use of the Study area is classified as follows:

Category	Area (km ²)	Share (%)
Urban area	340	21.2
Industrial area	3	0.2
Cultivated area	128	8.0
Pasture area	559	34.8
Forest area	255	15.9
Others (low lands and vacant areas)	320	19.9
Total	1,605	100

f. Housing

Housing, according to the 1982 census (census of 1992 was not available), were mostly (96%) independent units, multi-family units such as apartments accounting for only around 4%.

g. Water Supply and Sewage System

As for the water supply CORPOSANA took responsibility over Asuncion, Fernando de la Mora, Lambare, San Lorenzo, Luque and M.R. Alonso. The rest of the municipalities are under the responsibility of SENASA, except Ita, which is supplied by private enterprises. The public water supply system serve about 55% of houses, while wells and springs are water sources for 45%.

The sewage system is partially served only in Asuncion, Lambare, San Lorenzo and Luque by CORPOSANA. Only 15% of houses are connected to the public sewage system.

h. Master Plan for Urban Development

A tentative master plan ("Development Guidelines for Asuncion and its Metropolitan Area") was prepared by the Municipality of Asuncion in 1985. The plan, however, was never made official because of the opinion differences of the government officials.

Due to the lack of a basic development plan, the Metropolitan Area of Asuncion has expanded randomly which creates various problems in the urban area. In order to solve the problems, a Master Plan for urban development in the MAA should be formulated urgently.

i. Regional Economy

The MAA accounts for around one-third, or slightly over half a million, of the economically active population (EAP) of the country.

Unemployment rate declined from 6.6% in 1990 to 5.1% in 1991. Underemployment rate also declined from 15.4% in 1990 to 9.5% in 1991.

Main employments which are heavily concentrated in the MAA are in services, commerce, manufacturing, construction, finance and transportation concludes that economic conditions in the MAA are better than the rest of the country.

j. Municipal Finance

The financial situation of Municipalities are presented as summaries of their 1993 budgets in Table 2.1a.

Table 2.1a Municipal Revenue and Expenditure, 1993 Budget

Items Municipality	Current Revenue (%)	Capital Revenue (%)	Total Revenue (Thousand GS)	Current Expenditure (%)	Capital Expenditure (%)	Total Expenditure (Thousand GS)
1. HUM						
1-1. Asuncion	85	15	50,703,300	66	34	50,703,300
1-2. F.Mora	80	20	2,125,734	64	36	2,125,734
2.UM						
2-1. Lambare	58	42	4,103,605	53	47	4,103,650
2-2. San Lorenzo	96	4	1,250,000	63	37	1,250,000
2-3. Capiata	90	10	354,600	82	18	354,600
2-4. Luque	95	5	1,423,200	67	33	1,423,200
2-5. M.R.Alonso	93	7	919,100	79	21	919,100
2-6. Villa Elisa	71	29	283,450	87	13	283,450
3. LUM						
3-1. Nemby	68	32	304,295	38	62	306,595
3-2. J.A.Saldivar	98	2	42,000	86	14	42,000
3-3. Ita	98	2	483,450	66	34	483,450
3-4. Aregua	80	20	266,149	69	31	266,150
3-5. Limpio	95	5	408,660	70	30	408,660
3-6. Villa Hayes	98	2	401,600	74	26	401,600
3-7. B.Aceval	87	13	119,811	85	15	119,811

k. Municipal Tax System

In general, municipal revenue has traditionally depended on a few taxes, such as those levied on the practice of professions, commerce and industry, as well as on automobile registration, mass transit and construction.

Municipal revenue had a large increase in 1993, due to a Constitutional amendment whereby the collection of real estate tax changed from the jurisdiction of the Central Government to that of each Municipality.

2.2 Field Survey

a. Field Survey

Basic information such as the quantity and quality of solid waste generated in the study area, population covered by collection services, etc., is the principal and key factor for a successful and feasible municipal solid waste management plan. In order to clearly understand the present MSWM, the following field surveys were conducted:

- time and motion study for waste collection works;
- survey on scavengers;
- survey on the recycling system and the market for reusable materials;
- POS (Public Opinion Survey: in total 180 households were surveyed);
- investigation of present and future disposal sites and proposed transfer station sites; and
- study on waste amount and composition both in winter and summer.

Upon consideration of the importance of the surveys, the WACS and POS briefly described below.

b. Waste Amount and Composition Survey

ba. Method of the Survey

A WACS (Waste Amount and Composition Survey) was carried out both in winter (July 1993) and summer (February, 1994) in order to obtain the basic information on waste generation ratio, discharge and recycling amount, amount of self-disposal and collection, and finally to clarify the waste stream in the study area.

The method applied to the waste amount survey is tabulated in Table 2.2a.

Table 2.2a Method of Waste Amount Survey

Category	Generation Ratio Survey	Disposal Amount Survey	Interview Survey
MSW (Total)		X	
Household Waste	X		X
Commercial	X		
Market Waste	X		X
Institutional	X		
Street Sweeping	X		
Hospital Waste			X
Bulky Waste		X	
Others (Total)		X	
Industrial Waste		X	X
Others		X	

Note: The item given "X" was surveyed in the Study.

bb. Findings

i. Waste Generation Ratios

The waste generation ratios of each generation source were concluded as shown in Table 2.2b.

Table 2.2b Waste Generation Ratio

	Unit	1994
1. MSW		
Household	g/person/day	961
Shop	g/shop/day	3,186
Restaurant	g/shop/day	31,958
Market	g/shop/day	5,961
Institutional	g/employee/day	78
Street Sweeping :- Asuncion	g/km/day	39,950
Other 14 municipalities	g/km/day	(254,700)
Hospital	g/bed/day	4,000
Bed	g/person/day	0,6
2. Other wastes (ISW)	g/person/day	30

Note: The generation ratio for Asuncion shown in parentheses is calculated by the actual disposal amount observed by the truck scale at the Cateura Landfill while the ratios for the other 14 municipalities is the one obtained from the WACS conducted by the JICA Study Team.

The generation ratio of household waste, 961 g/person/day, is very high in comparison with those of the other countries as shown in Table 2.2c.

Table 2.2c Generation Ratio of Household Wastes

Country	City	Year	Population	GNP per capita (US\$/year)	Household waste (g/person/day)	MSW (g/person/day)
Paraguay	Asuncion	1993	506,445	1,360	961	1,312
Poland ¹	Poznan	1992	590,500	1,960	654	769
	Lublin	1992	352,500	1,960	400	508
Laos ²	Vientiane	1991	142,700	250	753	987
Malaysia ³	Pulau Pinang	1988	559,300	2,800	504	640

Source:

- *1: The Study on the Solid Waste Management for Poznan City, the Republic of Poland, May 1993.
- *2: The Study on the Solid Waste Management System Improvement Project in Vientiane, Lao People's Democratic Republic, August, 1992.
- *3: The figure is not generation ratio but disposal amount from "Solid Waste Management Study for Pulau Pinang and Seberand Perai Municipalities, August, 1989"

The reasons why the generation ratio of household waste is so high are that:

- The generation of the garden wastes, which consists of grass and wood, and others (soils, etc.), is extremely high (44.2%) in comparison with those in Poznan (1992), Pulau Pinang (1988), Rio de Janeiro (1991), Tokyo (1972), which are 10.3%, 22.2%, 16.7%, 16.6%, respectively.
- Most of the garden wastes are generated from detached houses. In the Study area, the proportion of detached houses is very high and average site area of a detached house is large enough (average 450m²) to produce an enormous amount of garden wastes according to the results of the POS.
- According to the interview survey conducted in July 1993 to the sampling household of the WACS, self disposal by means of burning, etc. and source recycling by means of feeding domestic animals are 245 g/person/day and 54 g/person/day respectively in the collection service area. Consequently the discharge (or collection) ratio comes 662 g/person/day. This is a reasonable ratio.

ii. Waste Composition

The waste composition of the Study area is summarized in Table 2.2d.

Table 2.2d Result of Waste Composition Survey

Classification	Unit	Household Waste				Commercial Waste		Market Waste	Institutional Waste
		High Income	Middle In- come	Low Income	Weighted Average	Restaurants	Others		
Physical Composition (wet base)	Apparent Specific Gravity	kg/l	0.18	0.21	0.26	0.22	0.34	0.07	0.09
	Kitchen Waste	%	31.0	42.4	18.9	36.6	75.0	18.3	13.9
	Paper	%	8.6	6.7	4.4	6.4	7.3	45.5	8.5
	Textile	%	1.6	1.0	2.1	1.3	0.1	1.0	0.3
	Plastic	%	5.0	3.7	3.9	3.9	2.8	8.0	3.0
	Grass and Wood	%	28.0	21.1	23.2	22.2	1.6	6.1	2.0
	Leather and Rubber	%	0.4	0.7	1.1	0.7	0.2	0.0	0.1
	Sub-total	%	74.6	75.6	53.6	71.1	87.0	78.9	83.3
	Metal	%	1.7	1.3	1.2	1.3	1.5	1.3	1.1
	Glass	%	6.2	3.0	1.9	3.1	5.7	4.8	7.1
Incombustibles	Ceramic and Stone	%	2.2	1.8	4.9	2.5	1.0	4.0	0.7
	Others (soils, etc.)	%	15.3	18.3	38.4	22.0	4.8	11.0	7.8
	Sub-total	%	25.4	24.4	46.4	28.9	13.0	21.1	16.7
	Total :	%	100.00	100.0	100.0	100.0	100.0	100.0	100.0
Three Contents	Combustibles (B)	%	27.87	27.48	30.26	28.08	25.88	47.12	24.94
	Moisture (W)	%	35.79	44.68	24.82	39.82	58.74	33.20	54.71
	Ash (A)	%	36.34	27.84	44.92	32.11	15.38	19.68	20.35
	Total :	%	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Chemical Analysis	Carbon (C)	%	18.23	17.03	20.76	17.90	10.94	25.29	17.37
	Hydrogen (H)	%	3.25	3.13	3.07	3.13	2.05	4.37	2.37
	Nitrogen (N)	%	0.73	0.49	0.62	0.54	0.91	0.57	0.49
	Sulfur (S)	%	0.02	0.02	0.02	0.02	0.02	0.02	0.02
	Chlorine (Cl)	%	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	Oxygen (O)	%	5.63	6.80	5.78	6.48	11.95	16.86	4.68
Total :	%	27.87	27.48	30.26	28.08	25.88	47.12	24.94	
Lower Calorific Value		kcal/kg	1,184	1,130	1,055	1,120	1,036	2,277	420
C/N Ratio		—	24.97	34.76	33.48	33.52	12.02	44.37	35.45
									49.35

iii. Waste stream

The waste streams of the 15 municipalities were prepared as a draft for the future study and presented in Tables 2.2c, 2.2f and 2.2g.

c. Public Opinion Survey

A POS (Public Opinion Survey) was carried out in order to understand the reasoning of the public regarding MSWM, which would be taken into account in the formulation of the Master Plan.

The salient features of the results of the POS are as follows:

- 96.6 % of the interviewees lived in detached houses.
- The average land area of houses is very large, approximately 450 m².
- Approximately 90 % of the interviewees are using plastic bags as waste containers, due to easy handling and most people are satisfied with it.
- More than 90 % of the interviewees of residential areas discharge garden wastes and 78.2 % of the interviewees in Asuncion discharge garden waste regularly for collection.
- Coverage rate of the waste collection in Asuncion was 78.3 %.
- Nearly 100 % of the interviewees answered will cooperate in recycling activities.
- Approximately 70 % of the interviewees are satisfied with the present municipal solid waste management.
- The present average waste collection fee and amount of willing to pay are summarized in Table 2.2h.

Table 2.2e Present Waste Stream (1)

Unit: ton/day

Items	Municipality	Asuncion	F.Mora	Lambare	San Lorenzo	Capiata
Waste Generation		670	109	111	158	97
Recycling at Generation		27	5	6	8	5
Self-disposal at Generation		217	59	41	134	81
Collection Amount		426	45	64	17	11
Recycling from Discharge to Disposal		21	4	4	6	4
Other Wastes(ISW)		15	3	3	4	3
Disposal Amount		420	44	63	15	10

Table 2.2f Present Waste Stream (2)

Unit: ton/day

Items	Municipality	Luque	M.R. Alonso	Villa Elisa	Nemby	J.A. Saldivar
Waste Generation		105	48	36	32	2
Recycling at Generation		5	2	2	2	0
Self-disposal at Generation		88	38	19	27	2
Collection Amount		12	8	15	3	0
Recycling from Discharge to Disposal		4	2	1	1	0
Other Wastes(ISW)		3	1	1	1	0
Disposal Amount		11	7	15	3	0

Table 2.2g Present Waste Stream (3)

Unit: ton/day

Items	Municipality	Ita	Aregua	Limpio	Villa Hayes	B. Aceval
Waste Generation		17	7	32	13	7
Recycling at Generation		1	0	1	1	0
Self-disposal at Generation		14	7	30	10	7
Collection Amount		2	0	0	2	0
Recycling from Discharge to Disposal		0	0	0	1	0
Other Wastes(ISW)		0	0	0	0	0
Disposal Amount		2	0	0	2	0

Table 2.2h Opinion on Waste Collection Fee

	Average amount of present collection fee per house (Gs/month)	Average amount of willingly pay (Gs/month)	Differences
Asuncion	7,825	8,227	up 5 %
San Lorenzo	2,578	4,160	up 60 %
Nemby	3,066	3,875	up 26 %

- More than 90 % of the interviewees have an opinion that the governmental sectors should bear the extra cost to maintain the beautiful sight of the city.
- Only 10 % of the interviewees have had guidance on proper method of waste discharge.
- Nearly 100 % of the interviewees understand the necessity of public cooperation and express for participation.
- In Asuncion 70.8 % of the interviewees consider the municipality should take initiatives on public cooperation.

2.3 Present Municipal Solid Waste Management

a. Technical System

The present technical system in February 1994 are summarized as follows:

- i. The curb collection system with the use of plastic bags is dominant. The collection coverage is very low or zero in less urbanized municipalities and low in urbanized municipalities except Lambare, while it is high in highly urbanized municipalities.
- ii. There are no street sweeping services except for Asuncion, F.Mora, Luque, Lambare, San Lorenzo, Ita, Aregua and Limpio where cleaning is conducted only on paved roads.
- iii. There is no processing facility for solid waste in the Study area except for the incinerator for infectious hospital waste.

- iv. Source separation is not well established. However, the distribution channel and market for the recyclable materials are well established by the private sector.
- v. Open dumping is dominant except for the Cateura landfill used by Asuncion, F.Mora and Luque which is classified as a controlled tipping landfill.
- vi. Equipment operation and maintenance in general is not submitted to planning or control. There are some controls, only in Asuncion, for operation and maintenance.
- vii. Illegal dumping is very common and it is observed in many vacant areas along the asphalt-paved roads.
- viii. Private sector activities are not monitored by the municipalities except for Asuncion.

b. Institutional System

The administrative system (hierarchy) of all the municipalities in the study area is basically the same, that is, a city council, a mayor and his appointed secretaries, the most important being the General-Secretary. The municipalities show great differences in strength and capability according to the size, population, land use patterns and budget. This situation is reflected, of course, in the administrative structure of these municipalities; some being highly developed with several Departments, Divisions, Sections, etc., while others are limited to a structure consisting of a General-Secretary, and less than five permanent employees.

Concerning municipal solid waste management there is a great diversity of institutional approaches in dealing with this matter, no city being exactly alike any other.

MSWM services are, formally, an exclusive responsibility of the municipal governments. Regardless of this, in larger cities MSWM is handled by the municipalities, either directly with their own personnel or through contracted firms or through concessionaires; in many small cities these services are not handled at all with a coverage of about 17% of the national average. Municipalities do not handle MSWM agencies as an independent body, even in large cities like Asuncion.

There is no inter-municipal cooperation concerning MSWM, except the disposal of waste from F.Mora and Luque in the Asuncion Cateura landfill.

Municipal solid waste management system differs with each municipality such as waste tax, fee collection systems, executing bodies for services, etc..

The private sector plays an important role in delivering services be it as contractors to the municipalities or as concessionaires.

Cost recovery practices for collection are well established and usually reflect the operation costs.

There are very few ordinances or codes related to Municipal SWM.

2.4 Evaluation of Present MSWM

a. Technical System

The major issues and problems identified in the present MSWM as well as the preliminary recommendations for the formulation of a master plan are described below.

- i. The priority for the improvement of the present system is given to:
 - plan and acquisition of the future landfill for the highly urbanized municipalities;
 - strengthening collection capabilities and the commencement of sanitary landfill operation for the urbanized municipalities; and
 - establishment of collection services and the commencement of sanitary landfill operation for the less urbanized municipalities.

- ii. Concerning storage and discharge of wastes, citizens do not utilize the standard types of containers, using various other kinds (cardboard boxes, wooden boxes, drums, etc.) which make collection services inefficient, difficult, dangerous and insanitary. In order to improve this situation, the municipalities should take the following measures:
 - establishment of proper storage and discharge standard;
 - instruction and enforcement of the standard established to the citizen;

- promotion of the waste stand installation; and
 - introduction of public container collection system in the core (commercial) area.
- iii. In order to solve littering by the citizens, the municipalities should install public containers in the core area in addition to the enforcement of anti-littering regulations.
 - iv. For efficient collection, the HUM (Asuncion and F.Mora) should introduce a container collection system for the institutional, non-infectious hospital, market and street sweeping wastes.
 - v. Although the present collection capability is very weak and need to be urgently strengthened, replacements of the present fleet and procurement of new collection vehicles shall be carefully examined with the consideration of their financial capabilities.
 - vi. The present manual sweeping system is suitable under the condition of high unemployment ratio, so it should be extended or implemented where this service is not provided.
 - vii. The market for compost product from municipal solid waste is very limited. It seems unnecessary to introduce a processing facility except for the treatment of hazardous wastes.
 - viii. The present recycling system mainly established by the private sector functions well. The introduction of a recycling facility shall be carefully examined in order to avoid conflict with the present private sector.
 - ix. A planning and control systems for the vehicles and equipment operation and maintenance shall be implemented, where the municipalities do not rely on the private sector.
 - x. In order to preserve the surrounding environment, the appropriate measures such as the execution of final covers, establishment of monitoring, etc. should be established when the present landfill will be closed.
 - xi. The present open dumping landfill operation should be terminated and the sanitary landfill operation introduced.

b. Institutional System

ba. Findings

- i. The institutional systems are not well established and each institutional responsibility on MSWM is not clearly defined. What exists is makeshift management systems in each of the cities.
- ii. Technical and managerial capacities of the municipalities are often very weak or non-existent, although there is a great will to improve this situation.
- iii. There is almost no operational cooperation among the municipalities, concerning MSWM, except the use of the Cateura landfill of Asuncion municipality by private operators in charge of collecting the wastes from Fernando de la Mora and Luque municipalities.
- iv. Private sector participation, on average, is more substantial than in most Latin American cities, sometimes the private MSWM provider works as a concessionaire, not only as a municipality contractor. It was found that the private market share is more the result of the public sector incompetence in coping with their duties, rather than of their greater efficiency.
- v. The situation above described has led to a very uneven system, each city dealing with their solid waste in it's particular and inconsistent way. Characteristics of these systems vary but as a whole we can find a biased service.
- vi. The informal sector operations should be mentioned, of course a non-governmental and unregulated enterprise but an important sector, mainly on the recovery and recycling operations in the Metropolitan Asuncion area.

bb. Improvement Measures

i. Establishment of a regional authority on MSWM

In order to solve common problems on MSWM and to coordinated municipalities in the Study Area, a regional authority dealing with MSWM in its area shall be established. The authority shall deal with the following matters and AMUAM could be adapted for this purpose.

- Inter-municipal disposal;
- Fleet maintenance;

- Procurement of equipment and construction of facilities;
- Procurement of equipment and construction of facility;
- Public participation campaigns;
- Development of environmental education programs; and
- Improvement of tax collection system.

This regional authority should plan its work taking into account the municipalities grouped in the same way as proposed in the Study, i.e., HUM, UM and LUM.

ii. Enactment of regional legislation

Enactment of regional legislation concerning MSWM, to be applied by the municipalities of the study area, such as:

- Ordinances concerning littering of public spaces and vacant lots;
- Ordinances concerning industrial waste and the environment;
- Standards and regulations on solid waste disposal;
- Ordinances on public participation in the collection activity;
- Ordinances regulating the tax system; and
- Standards and regulations to guide private contractors.

iii. Provision of a training program

Provision of a training program, so to form officials, managers and skilled laborers of different levels in the solid waste management institutions, in the following areas:

- Planning, design, management and control of street cleaning, waste collection, transportation and disposal operations;
- Public administration and budgeting;
- Public relations and environmental education;
- Management of the taxing system;
- Management and supervision of service contracts;
- Operation and performance control; and
- Communal participation and behavior.

These areas should concentrate on training courses especially on the job training, supported by good quality audio-visual programs and brochures.

3. THE MASTER PLAN

3.1 Localization of Inter-municipal Final Disposal Site

In order to formulate the MSWM master plan for the Study area, based on the selection guidelines of an inter-municipal final disposal site prepared by the Study Team, the Paraguayan Technical Committee presented the Study Team 13 potential sites as shown in Figure 3.1a.

Based on the evaluation report of the 13 potential sites presented by the Team, the Paraguayan Supervisory Committee decided to select the A-2 and A-5 sites as the candidate inter-municipal disposal sites for the study of alternatives of the Master Plan.

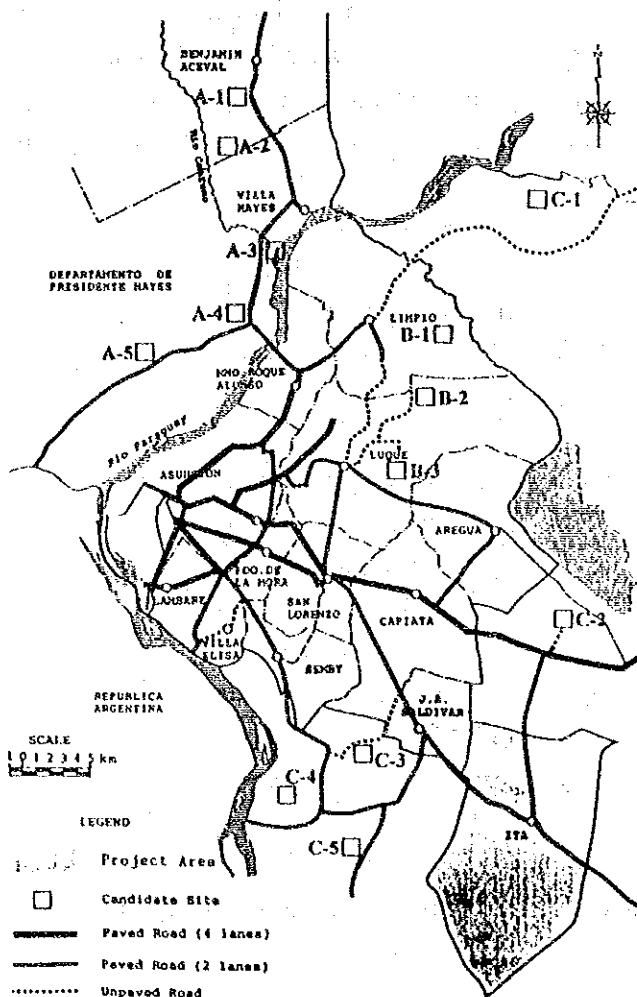


Figure 3.1a Location Map of Potential Sites

From the results of the examination of the 62 technical system alternatives, the Paraguayan Supervisory Committee agree to the optimum technical systems for MSWM master plan recommended by the Study Team. Consequently, A-5 site (Chaco-i) was selected as an inter-municipal disposal site for the Study area.

3.2 Examination of Technical System Alternatives for Master Plan

a. Work Flow of the Examination

The work flow for the examination of technical system alternatives for the MSWM Master Plan applied to the study is shown in Figure. 3.2a.

The examination and selection works of the optimum technical system alternative were divided into three stages, i.e., stage A for the examination of technical system components, stage B for the selection of the optimum technical system alternatives for Asuncion and Fernando de la Mora and stage C for the selection for the other 13 municipalities.

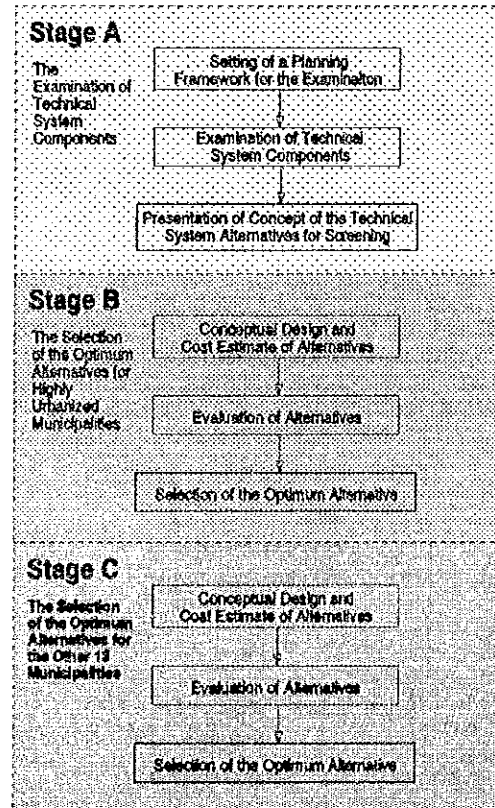


Figure 3.2a Work Flow of the Examination of Technical System Alternatives

b. Planning Framework for the Examination

The planning framework, i.e. target year, future population, forecast on waste amount and composition, future economic and financial conditions, etc., was set up for the examination work. Based on additional data obtained during the progress of the Study, the planning framework was partly modified for the preparation of the Master Plan.

c. Examination of Technical System Components

The MSWM technical system consists of several sub-systems, i.e. collection, transfer, intermediate treatment, etc.. Each sub-system has various technical system components, e.g. incineration, composting, RDF (Refuse Derived Fuel), etc., for intermediate treatment. Various system components of sub-systems were examined and primarily screened for the comparison of the technical system alternatives.

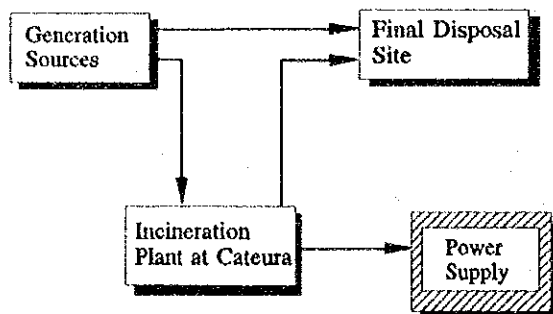
d. Presentation of technical system alternatives for HUM

After the examination of each technical system component, technical system alternatives for each municipality were presented combining the selected technical system components as shown below.

da. Alternative X-1

Independent Disposal

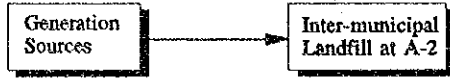
**An incineration plant at Cateura; and
A sanitary landfill at Cateura**



db. Alternative X-2

Inter-municipal Disposal

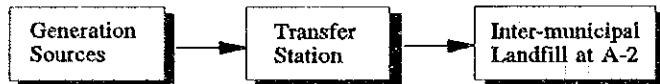
An inter-municipal sanitary landfill at the A-2 site without a transfer system



dc. Alternative X-3

Inter-municipal Disposal

An inter-municipal sanitary landfill at the A-2 site with a transfer system



dd. Alternative X-4

Inter-municipal Disposal

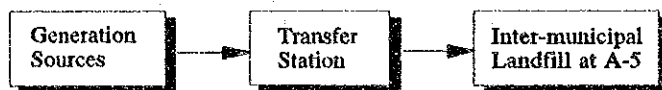
An inter-municipal sanitary landfill at the A-5 site without a transfer system



de. Alternative X-5

Inter-municipal Disposal

An inter-municipal sanitary landfill at the A-5 site with a transfer system



e. Conceptual Design and Cost Estimation

Regarding the 5 alternatives presented, the conceptual design and cost estimation of the following systems and facilities for each alternative were carried out:

- Storage and collection system
- Transfer station and haulage system
- System for street sweeping
- Incineration Plant
- Sanitary landfill

For the comparison of the 5 alternatives, annual expenses in the year 2006 of the alternatives were calculated as shown in Table 3.2a.

Table 3.2a Summary of Alternatives for HUM

Municipality	Waste Disposal from 1997 to 2006 (ton)	Waste Disposal in 2006 (ton)	Cost of Each Alternative in 2006				
			X-1	X-2	X-3	X-4	X-5
Asuncion	2,023,901 (1,167,717)	221,190 (85,575)	14,542	11,930	10,836	11,284	10,797
			70,019	57,441	52,174	54,332	51,986
Fernando de la Mora	315,464 (246,016)	41,245 (15,914)	3,039	2,308	2,089	2,180	2,023
			73,681	55,955	50,660	52,843	49,047

Note: Shadow shows the least cost alternative.
 Double line shows the second least cost alternative.
 () shows the amount only for X-1.

f. Evaluation of alternatives for HUM

fa. Method

Upon consideration of very weak financial capability of each municipality, the evaluation of alternatives in this report was carried out by stressing financial points of view and other aspects (technical, environmental and social points of view) were examined on some important points. As a result, the alternative which requires the minimum annual expense for MSWM in 2006 was selected as the optimum alternative for each municipality. The reasons why we took the method in this report are described below.

- In response to the request from the Paraguayan side, the technical system alternatives for the formulation of MSWM master plan should be prepared for each municipality individually. Each municipality had 4 or 5 alternatives and total number of alternatives came to 62.
- If each alternative is set up to guarantee a certain level of environmental improvement, the financial aspect dominates the other aspects. Because, except for the introduction of an incineration plant (Alternative X-1), there appeared to be no technical difficulty observed in the alternatives presented.
- The evaluation of social aspects, such as the possibility of inter-municipal cooperation regarding operation of transfer stations, landfill and collection equipment, was subject to the decision made at the time of the IT/R meeting by the Paraguayan side.

fb. Evaluation for Asuncion and F.Mora

As for the optimum technical system for Asuncion and F.Mora Municipalities, the Study Team proposed the Municipalities to select the Alternative X-5; that is

Inter-municipal disposal

An inter-municipal sanitary landfill at A-5 with a transfer system.

The summary of evaluation is as follows:

- Least cost among the 5 alternatives.
- There is no technical difficulty observed in comparison with the other alternatives.
- Socially, there will be some difficulties such as setting-up the inter-municipal disposal site in Chaco; i.e. outside of the jurisdiction of Asuncion and F.Mora Municipalities. However, the resolution of these

matters was discussed with the Paraguayan side at the IT/R meeting. As a result of the discussion, the matters in question, i.e. the acquisition of land and cooperation of Villa Hayes municipality where the site is located, could be solved by the efforts of the Paraguayan side.

- Compared with the present technical system, the proposed system is more environmentally acceptable.

fc. Financial Evaluation

Financial evaluation consists of the least cost method to be selected among different alternatives for each city, furthermore, a comparative analysis was conducted between the least cost alternative and the estimated revenues. For revenue estimation, the number of households in 1992 was extended to project the figure in 2006 using the assumed population growth rates. The number of shops was also projected using the assumed GDP growth rate. The fees to be paid by beneficiaries were mainly those obtained from the Willingness to Pay survey. The collection rate of fees was assumed to be 80%

Results of Highly Urbanized Municipalities are as follows:

Municipality	unit	Least Cost Alternative	Estimated Revenue
Asuncion	Million Gs.	10,797	18,915
F.Mora	Million Gs.	2,023	3,188

It can be seen that estimated revenues are sufficient to cover total costs of the least cost alternative.

g. Presentation of technical system alternatives for UM and LUM

Based on the results of the examination works for HUM, technical system alternatives for each municipality were presented combining the selected technical system components as follows:

ga. Alternative Y-1

Independent Disposal

A sanitary landfill inside of each municipality



gb. Alternative Y-2

Inter-municipal Disposal

An inter-municipal sanitary landfill at the A-5 site without a transfer system



gc. Alternative Y-3

Inter-municipal Disposal

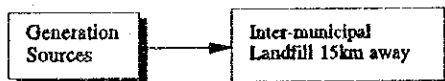
An inter-municipal sanitary landfill at the A-5 site with a transfer system



gd. Alternative Y-4

Inter-municipal Disposal

An inter-municipal sanitary landfill 15 km away from the center of the urban area of each municipality without a transfer system



h. Conceptual design and cost estimate of alternatives

Based on the results of the examination work for HUM, suitable systems of storage, collection, haulage, street sweeping, and final disposal for each alternative were conceptually designed, and the annual expenses in the year 2006 of each alternative was estimated as shown in Table 3.2b.

Table 3.2b Summary of Alternatives for UM and LUM

Municipality	Waste Disposal 1997-2006 (ton)	Waste Disposal in 2006 (ton)	Total Cost of Each Alternative in 2006			
			Upper(annual expenses):mill.Gs Lower(unit cost):Gs			
			Y-1	Y-2	Y-3	Y-4
Lambare	363,983	50,735	2,380 46,910	2,687 52,971	2,467 48,625	2,371 46,728
San Lorenzo	364,035	58,400	3,036 51,994	3,032 51,922	2,801 47,954	2,740 46,918
Capiata	231,149	39,055	2,116 54,170	2,091 53,548	1,890 48,405	1,799 46,054
Luque	302,741	52,195	2,612 50,045	2,628 50,346	2,499 47,880	2,412 46,207
M.R.Alonso	140,734	24,455	1,408 57,559	1,074 43,904	1,222 49,969	1,135 46,424
Villa Elisa	142,950	23,360	1,373 58,781	1,278 54,700	1,219 52,187	1,122 48,011
Nemby	84,654	14,235	1,000 70,233	769 54,030	790 55,477	657 46,134
J.A.Saldivar	4,667	730	267 365,438	45 61,446	150 205,364	39 53,478
Ita	40,671	6,570	572 87,048	403 61,290	446 67,874	315 47,991
Aregua	12,723	1,825	371 203,178	119 65,115	206 113,088	104 57,147
Limpio	57,983	9,855	694 70,404	452 45,821	509 51,674	454 46,110
Villa Hayes	27,949	4,745	508 107,156	232 48,965	262 89,666	237 49,897
Benjamin Aceval	14,444	2,920	491 168,174	173 59,330	290 99,190	165 56,653

Note: Shadow shows the least cost alternative.

Double line shows the second least cost alternative.

* Although Y-2 is the second least cost alternative, Y-2 shall be the optimum alternative due to the unrealistic nature of the Alternative Y-4.

i. Evaluation of Alternatives for UM and LUM

ia. Evaluation for Lambare, San Lorenzo, Capiata, Luque, Villa Elisa, Nemby, J.A.Saldivar, Ita and Aregua Municipalities

As for the optimum technical system for the above-mentioned 9 municipalities, the Team proposed them to select the Alternative Y-4; that is

Inter-municipal disposal

An inter-municipal sanitary landfill 15 km away from the center of the urban area of each municipality.

The summary of evaluation is as follows:

- Least cost among the 4 alternatives.
- There is no technical difficulty observed in comparison with the other alternatives.
- Socially, there will be some difficulties such as setting-up the inter-municipal disposal site 15 km away from the center of the urban area of each municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting. As a result of the discussion, it was confirmed that the Paraguayan side should make every effort on the localization and acquisition of site(s) and attainment of neighborhood consensus, etc..
- Compared with the present technical system, the proposed system is more environmentally acceptable.

ib. Evaluation for M.R.Alonso, Limpio, Villa Hayes and B. Aceval Municipalities

As for the optimum technical system for the above-mentioned 4 Municipalities, the Team proposed them to select the Alternative Y-2; that is

Inter-municipal disposal

An inter-municipal sanitary landfill at A-5 without a transfer system.

The summary of evaluation is as follows:

- Least cost among the 4 alternatives for Limpio, Villa Hayes and M.R. Alonso Municipalities.
- As for B.Aceval although Y-2 is the second least cost alternative, the Alternative Y-4 is not possible because the Municipality of Villa

Hayes shall take Alternative Y-2.

- There is no technical difficulty observed in comparison with the other alternatives.
- Socially, there will be some difficulties such as setting-up the inter-municipal disposal site in Chaco; i.e. outside of the jurisdiction of M.R.Alonso, Limpio and B.Aceval and within the jurisdiction of Villa Hayes Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting. As a result of the discussions, the matters in question, i.e. the acquisition of land and cooperation of Villa Hayes municipality where the site is located, could be solved by the efforts of the Paraguayan side.
- Compared with the present technical system, the proposed system is more environmentally acceptable.

ic. Financial Evaluation

Financial evaluation was conducted between the least cost alternative and the estimated revenues. Results for Urbanized and Less Urbanized Municipalities are as follows.

Table 3.2c Result of Evaluation Revenue

Municipality	Least Cost Alternative (Millon Gs)	Estimated Revenue (Millon Gs)
Urbanized		
Lambare	2,371	1,783
San Lorenzo	2,740	2,053
Capiata	1,799	1,356
Luque	2,412	1,757
M.R.Alonso	1,074	793
Villa Elisa	1,122	725
Less Urbanized		
Nemby	657	486
J.A.Saldivar	39	24
Ita	572	204
Aregua	104	64
Limpio	452	341
Villa Hayes	232	234
B.Aceval	165	88

It can be seen that among Urbanized and Less Urbanized Municipalities, only in Villa Hayes revenues exceed the least cost alternative. For the rest of the municipalities, revenues do not cover the least cost alternative even under the unlikely scenario of 100% collection rate of fees from the beneficiaries. The resolution methods of this problems is described in Section 4.3, Financial Plan.

j. Examination of institutional requirements

The institutional requirements for the optimum technical alternatives were presented as general requirements to be applied at regional and municipal levels.

The selection of the most appropriate Master Plan alternative should not be determined from the institutional aspects. Since institutional demands generally result from prevailing technological conditions, attention should be given instead, to the selection of the optimum technical system.

k. Selection of the Optimum Technical System

At the discussion of the IT/R which was submitted to the Paraguayan side in December, 1993, the Study Team proposed optimum MSWM technical systems for the 15 municipalities as shown in Table 3.2d. The Paraguayan Supervisory Committee approved the technical systems recommended by the Team, as the optimum technical system of MSWM Master Plan for 15 municipalities in the Study area.

Table 3.2d Recommendations on Optimum Technical System

Municipalities	Optimum Alternative	Remarks
1. HUM		
1-1. Asuncion	Inter-municipal landfill at A-5 site with a transfer system	If the acquisition of transfer station site(s) is difficult, a direct transportation system shall be examined.
1-2. F.Mora	Inter-municipal landfill at A-5 site with a transfer system	If the acquisition of transfer station site(s) is difficult, a direct transportation system shall be examined.
2. UM		
2-1. Lambare	Inter-municipal landfill 15 km away from the center	If the acquisition of a landfill site for both inter-municipal and independent disposal will be difficult, participation in landfill operation at A-5 may be examined.
2-2. San Lorenzo	Inter-municipal landfill 15 km away from the center	In order to realize the least cost technical system, the municipality should make every effort to obtain an inter-municipal landfill site.
2-3. Capiata	Inter-municipal landfill 15 km away from the center	In order to realize the least cost technical system, the municipality should make every effort to obtain an inter-municipal landfill site.
2-4. Luque	Inter-municipal landfill 15 km away from the center	In order to realize the least cost technical system, the municipality should make every effort to obtain an inter-municipal landfill site.
2-5. M.R.Alonso	Inter-municipal landfill at A-5 site without a transfer system	The municipality shall make an effort to join the inter-municipal landfill operation at A-5 site
2-6. Villa Elisa	Inter-municipal landfill 15 km away from the center	In order to realize the least cost technical system, the municipality should make every effort to obtain an inter-municipal landfill site.
3. LUM		
3-1. Nemby	Inter-municipal landfill 15 km away from the center	In order to realize the least cost technical system, the municipality should make every effort to obtain an inter-municipal landfill site.
3-2. J.A.Saldivar	Inter-municipal landfill 15 km away from the center	In order to realize the least cost technical system, the municipality should make every effort to obtain an inter-municipal landfill site.
3-3. Ita	Inter-municipal landfill 15 km away from the center	In order to realize the least cost technical system, the municipality should make every effort to obtain an inter-municipal landfill site.
3-4. Aregua	Inter-municipal landfill 15 km away from the center	In order to realize the least cost technical system, the municipality should make every effort to obtain an inter-municipal landfill site.
3-5. Limpio	Inter-municipal landfill at A-5 site without a transfer system	The municipality shall make an effort to join the inter-municipal landfill operation at A-5 site
3-6. Villa Hayes	Inter-municipal landfill at A-5 site without a transfer system	The municipality shall make an effort to join the inter-municipal landfill operation at A-5 site
3-7. Benjamin Aceval	Inter-municipal landfill at A-5 site without a transfer system	The municipality shall make an effort to join the inter-municipal landfill operation at A-5 site

I. Optimum MSWM Institutional Systems

As for the optimum institutional system of MSWM Master Plans for 15 municipalities corresponding to the above-mentioned technical systems, the following decisions were made by the Paraguayan side.

Ia. Metropolitan system

Regarding the metropolitan system on MSWM, the Supervisory Committee decided that the AMUAM will act as the overall coordinating body on MSWM in the Metropolitan Area in collaboration with SENASA.

Ib. Municipal system

As for the municipal systems on MSWM, the Study Team requested the Paraguayan side that each municipality should select its municipal system from the following models.

i. Full Municipal Operation

Municipal department operating their own equipment and employing their own personnel.

ii. Municipal Operation with Private Companies

Municipal department contracting the services (or part of them) with private companies.

iii. Full Municipal Company's Operation

Municipal company operating their own equipment and their own personnel.

iv. Municipal Company with Private Companies

Municipal company contracting the services (or part of them) with private companies.

v. Concession

Concession of the collection and disposal services, retaining the street sweeping services with the municipality.

In response to the request made by the team, all 15 municipalities expressed their intentions to conduct their MSWM by themselves, provided the capital for procurement of equipment and final disposal sites were ensured. These intentions were confirmed at the Supervisory Committee meeting for the discussion of the PR/R (2) held in March 1994.

3.3 The Master Plan

a. Planning Framework

aa. Goal, Targets and Strategy

i. Goal

DEVELOPMENT AND REALIZATION OF A BEAUTIFUL AND CLEAN LIVING ENVIRONMENT IN THE ASUNCION METROPOLITAN AREA TOWARDS THE 21st CENTURY.

The goal of the Solid Waste Management Master Plan is achieved through:

- **Citizens' Participation and**
- **Establishment of Self-sustainable Solid Waste Management**

ii. Targets

Table 3.3a Targets of Collection, Street Sweeping and Final Disposal Services

Services Municipality	Collection Coverage Ratio(%)			Street Sweeping Distance(km)			Sanitary Landfill Level		
	1994	2000	2006	1994	2000	2006	1994	2000	2006
1.Highly Urbanized M.									
1-1 Asuncion	83(73)	100	100	264	300	300	Level 1	Level 3	Level 3
1-2 F.Mora	64	85	100	2	20	40	Level 1	Level 3	Level 3
2.Urbanized M.									
2-1 Lambare	61	80	100	6	17	25	Level 1	Level 3	Level 3
2-2 San Lorenzo	16	45	70	6	21	32	Level 1	Level 2	Level 3
2-3 Capiata	15	45	70	0	6	12	Open	Level 2	Level 3
2-4 Luque	23	45	70	28	40	60	Level 1	Level 2	Level 3
2-5 M.R.Alonso	16	45	70	0	6	10	Open	Level 3	Level 3
2-6 Villa Elisa	46	65	85	0	9	20	Open	Level 2	Level 3
3.Less Urbanized M.									
3-1 Nemby	7	45	70	0	3	12	Open	Level 2	Level 3
3-2 J.A.Saldivar	0	25	50	0	1	2	None	Level 2	Level 3
3-3 Ita	18	45	70	6	10	15	Open	Level 2	Level 3
3-4 Aregua	0	25	50	2	5	10	None	Level 2	Level 3
3-5 Limpio	1	25	50	1	3	8	None	Level 2	Level 3
3-6 Villa Hayes	10	45	70	0	5	9	Open	Level 2	Level 3
3-7 Aceval	0	25	50	0	6	11	None	Level 2	Level 3

Note: Collection coverage was estimated based on the number of users in February 1994. However, the ratio for Asuncion is based on "Servicio Derecoleccion Diferenciata, Direccion de Medio Ambiente" while the figure based on number of users is 73 %.

iii. Strategies for the Attainment of the Goal

The proposed strategies for the attainment of the Goal is detailed in the six paragraphs as follows:

- Provision of facilities and equipment to apply to the basic objective for the execution of Municipal SWM.
- Provision of solid waste services and facilities to minimize solid waste production and the need for landfill, and to develop sanitary landfills.
- Provision of appropriate and scheduled services to the citizens for proper storage, collection and reception of solid waste. Illegal dumping must be eliminated.
- Self-financed solid waste management through the increase of citizens' burden.

- Increase in public involvement in environmental protection and attention on environmental matters.
- Full control over activities related to Municipal SWM and the cleanliness of the Asunción Metropolitan Area.

ab. Target Year and Population

i. Target Year

The master plan covers a period from 1994 to 2006. The period of the plan is divided into the following three stages.

Table 3.3b Target Year

Category of Plan	Target Year
Master Plan	1994 – 2006
Medium Term Improvement Plan	2001 – 2006
Short Term Improvement Plan for F/S	1997 – 2000
Immediate Improvement Plan	Present – 1996

ii. Population Forecast for the Urban Area

Since there is neither an urban area development master plan nor an official population forecast for the Study area, the population forecast was carried out by the Study Team.

Based on the past population growth rates, the future population is projected and tabulated in Table 3.3c.