Table H.5.2.2f Collection Cost of SAN LORENZO

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	3	35	2	15
Haulage Time (min)	19	140	13	60
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	19	31	18	23
Collection Amount (ton/day)	152	152	152	152
Total Cost per Year (million Gs/year)	1061	1737	1024	1289

Table H.5.2.2g Collection Cost of CAPIATA

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	4	41	2	15
Haulage Time (min)	26	164	13	60
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	20	34	18	23
Collection Amount (ton/day)	104	104	104	104
Total Cost per Year (million Gs/year)	751	1280	701	882

Table H.5.2.2h Collection Cost of LUQUE

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	5	33	2	15
Haulage Time (min)	32	132	13	60
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	20	31	18	23
Collection Amount (ton/day)	138	138	138	138
Total Cost per Year (million Gs/year)	1036	1547	937	1179

Table H.5.2.2i Collection Cost of M.R. ALONSO

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	3	17	2	15
Haulage Time (min)	19	68	13	6
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	19	24	18	23
Collection Amount (ton/day)	65	65	65	65
Total Cost per Year (million Gs/year)	454	570	438	551

Table H.5.2.2j Collection Cost of VILLA ELISA

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	3	39	2	15
Haulage Time (min)	19	156	13	60
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	19	33	18	24
Collection Amount (ton/day)	59	59	59	59
Total Cost per Year (million Gs/year)	412	709	398	500

Table H.5.2.2k Collection Cost of NEMBY

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	4	44	1	15
Haulage Time (min)	26	176	6	60
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	18	32	16	21
Collection Amount (ton/day)	36	36	36	36
Total Cost per Year (million Gs/year)	240	425	217	282

Table H.5.2.2l Collection Cost of J.A. SALDIVAR

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	2	47	1	15
Haulage Time (min)	13	188	6	60
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	17	33	16	21
Collection Amount (ton/day)	1	1	1	1
Total Cost per Year (million Gs/year)	6	12	6	8

Table H.5.2.2m Collection Cost of ITA

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	3	58	1	15
Haulage Time (min)	19	232	6	60
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	18	38	16	21
Collection Amount (ton/day)	16	16	16	16
Total Cost per Year (million Gs/year)	103	219	96	125

Table H.5.2.2n Collection Cost of AREGUA

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	4	45	1	15
Haulage Time (min)	26	180	6	60
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	19	33	16	21
Collection Amount (ton/day)	4	4	4	4
Total Cost per Year (million Gs/year)	20	36	18	24

Table H.5.2.2o Collection Cost of LIMPIO

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	4	23	1	15
Haulage Time (min)	26	92	6	60
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	18	24	16	21
Collection Amount (ton/day)	24	24	24	24
Total Cost per Year (million Gs/year)	167	223	150	196

Table H.5.2.2p Collection Cost of VILLA HAYES

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	5	21	1	15
Haulage Time (min)	32	84	6	60
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	19	24	16	21
Collection Amount (ton/day)	11	11	11	11
Total Cost per Year (million Gs/year)	76	95	66	86

Table H.5.2.2q Collection Cost of B. ACEVAL

Item	Y-1	Y-2	Y-3	Y-4
Collection Time (min)	134	134	134	134
Haulage Distance (km)	5	31	1	15
Haulage Time (min)	32	124	6	60
Discharge Time (min)	10	10	10	10
Miscellaneous Time (min)	26	26	26	26
Unit Cost (1000 Gs/ton)	19	27	16	21
Collection Amount (ton/day)	4	4	4	4
Total Cost per Year (million Gs/year)	34	50	30	39

H.5.2.3 Haulage System

a. Considerations for planning

For the plan of a transfer station, the following items are to be considered;

aa. Transfer waste amount

- Calculation of transfer waste amount
- Seasonal fluctuation of transfer waste amount

ab. Capacity requirements

- Number of working days (days/week)
- Peak month in terms of waste generation (i.e. transfer amount)

ac. Type of transfer stations

- Direct re-loading
- Indirect re-loading
  . With storage (pit & crane or reception yards)
  . Without storage (bailing or compaction)

ad. Facility design

- Incoming conditions
  . Type and number of collection vehicles.
  . Working days and hours.
- Operation plan
- Equipment requirements
- Accessory requirements
- Sanitary requirements
- Civil works

ae. Transportation plan

- Access condition
- Working hours
- Type of vehicles
- Number of vehicles

af. Calculation of bill quantity

- Based on the design of transfer station and operation and maintenance plans.

ag. Operation and maintenance plan

- Personnel requirements
- Utilities requirements

ah. Cost estimations

- Based on the calculation of bill of quantity and construction price data collected.

b. Determination of capacity requirements

ba. Calculation of transfer waste amount

In order to start planning, the transfer waste amount of a transfer station shall be calculated. The total transfer waste amount in the year 2006 of the each municipality is calculated as shown in Table H.5.2.3a.

bb. Determination of capacity requirements

The capacity requirement of each transfer station is calculated by the following manner:

- Average daily transfer waste amount of each transfer station in the year 2006 is assumed as the following table.
- The annual working days and working hours are set up as 297 days/year and 8 hours/day.
- If the allowance for daily and monthly fluctuation of waste is set up at 1.15, the required capacity of each transfer station is calculated by the following formula:

  Daily transfer waste x 365 ÷ 297 x 1.15 = Required capacity (ton/day)

Table H.5.2.3a Transfer Waste Amount and Required Capacity of the Transfer Station

Urbanized Municipalities	Waste Amount (ton/day)	Required Capacity (ton/day)	Less Urbanized Municipalities	Waste Amount (ton/day)	Required Capacity (ton/day)
Lambare	139	196	Nemby	39	55
San Lorenzo	160	226	J.A.Saldivar	2	3
Capiata	107	151	Ita	18	25
Luque	143	202	Aregua	5	7
M.R.Alonso	67	95	Limpio	27	38
Villa Elisa	64	90	Villa Hayes	13	18
			B.Aceval	8	11

c. Selection of type of transfer stations

ca. Type of transfer stations

Depending on the method used to load transfer wastes onto transport vehicles, transfer stations may be classified into the following types:

caa. Direct re-loading type

In this type of transfer station, wastes collected by each collection vehicle are directly re-loaded into the transportation vehicles or containers.

cab. Indirect re-loading

In the indirect re-loaded type of transfer station, wastes collected are discharged from each collection vehicle at the transfer station.

i. With storage type

As for indirect re-loading with storage type, wastes discharged are once stored at the transfer station then re-loaded into the transport vehicles. There are the following types:

- Pit and crane type with compactor
- Pit and crane type with baling
- Reception yards type with loading equipment

ii. Without storage type

Instead of storage facilities, this type has hopper for receiving wastes discharged from collection vehicles. Then, wastes discharged are

processed by equipment. These types are classified into the following according to the processing equipment:

- Bailing type
- Compactor type

cb. Considerations for selection of types

In order to select the types of transfer stations, the following aspects are to be considered:

cba. Economic feasibility according to the capacity requirements

- Construction cost
- Operation and maintenance cost
- Number of personnel required for operation

cbb. Easiness and stability in operation

- Reliability of the system
- Storage capability
- Re-loading capability
- Simple operational manual

cbc. Flexibility

- Working hours
- Flexibility to the fluctuation of transfer waste amount
- Flexibility on the break down of the transfer station

cad. Safety

cbe. Operation and maintenance

- Easiness in maintenance and repair
- Durability
- Easiness in controlling

cbf. Space of the transfer stations

- Required area

cbg. Environmental acceptability

- Environmental impacts on noise, dust and odor
- Sanitation requirements

cc. Selection of type

Based on the above mentioned considerations, the indirect re-loading type with compactor and without storage facilities type is selected for the urbanized municipalities, and the direct re-loading type is selected for the less urbanized municipalities. The reasons are as follows:

< for Urbanized Municipalities >

- The required capacity of the transfer stations is shown in Table H.5.2.2g. These transfer stations are classified as middle scaled transfer stations.
- Collection vehicle proposed in the urbanized municipalities is compaction type with a capacity of 13 m^3. Therefore, the transfer station should be a compaction type.
- Construction of storage facilities requires significant amount of investment.
- This type achieves high efficiency of transfer operation. This means less requirements of space per ton of a transfer.
- It is rather easy to control environmental impacts such as littering, dust, odor and others in this type of transfer stations.

< for Less Urbanized Municipalities >

- The capacity requirement of these transfer stations is small as shown in Table H.5.2.3a. These transfer stations are classified as small scaled transfer stations.
- Collection vehicle proposed in the study is open dump truck of 10 m^3.
- Construction is the cheapest and simplest.
- As for the fluctuation of transfer waste amount, it can be overcome by having spare vehicles.
- Because this type does not require any mechanical facilities, any operational cost facility is not included.

d. Facility design

da. Indirect re-loading type transfer station

An indirect re-loading type transfer station with compactor consists of the following facilities and equipment.

- Receiving and feeding facilities
- Compaction equipment
- Accessories
- Civil works

daa. Receiving and feeding facilities

The waste receiving and feeding facilities, weigh bridge, platform, receiving hopper, feeder to compaction equipment etc., are provided.
The plan provides a truck scale upon consideration of the number of incoming collection vehicles to the plant during the peak hours in a day.
Receiving hopper provided on each compaction equipment is designed to have sufficient width enabling 2 vehicles to reach each hopper at the same time, with storage capacity equivalent to waste expected at least 20 minutes during pear hours.

dab. Compaction equipment

i. Number of compaction units

The number of compaction units for each plant must be sufficient to avoid the severe influence in capacity reduction during unexpected failure of equipment.

ii. Design capacity of each compaction unit

The maximum capacity of each compaction unit is made upon consideration of the design conditions below.

- Waste amount per day during peak month (ton/day)
- Waste amount in peak hour during peak month (ton/day)
- Type, size and loading capacity of secondly transport vehicle
- Number of vehicles going to landfill site (number/hour/compactor unit)
- Required time for compaction per cycle
- Idle time needed for connection/disconnection of vehicle to compactor unit

iii. Determination of compaction capacity

In each case, upon consideration of design factor that is related to the compression time and idle time, the real capacity of compaction equipment is decided as being capable of compacting 1.5 times of the amount to be compacted during the hour.

dac. Major accessary requirements

For the smooth operation of the plant, the following accessories are required:

- hydraulic oil pump units
- remote operating devices and automatic controllers
- car washing facilities
- waste water treatment facility
- others

Figure H.5.2.3a shows a schematic diagram of transfer station with compaction equipment.

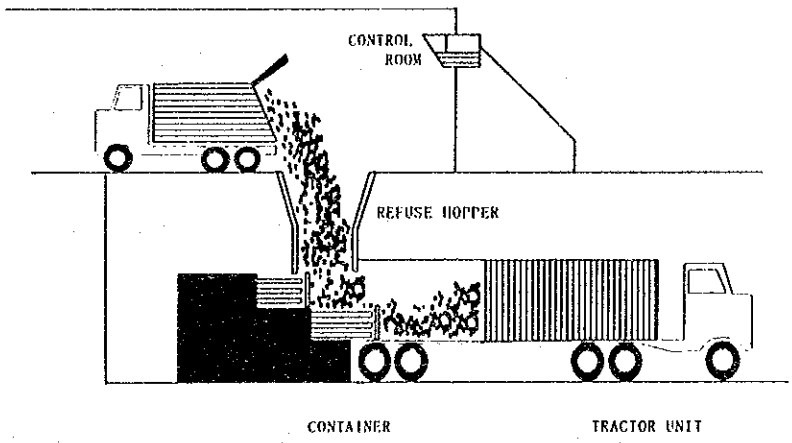


Figure H.5.2.3a Schematic Diagram of Refuse Transfer Operation

dad. Civil works

A two story main building of reinforced and steel structure is provided.
In the main building, the following equipment is installed.

- compaction equipment
- feeder
- hydraulic oil pump unit
- others

An office building with amenity facility for tractor drivers and truck scale, etc., is also constructed.
As for civil work, large parking area for transfer vehicles, ramp way for access to the platform, car washing station, car repair bay etc., are necessary.

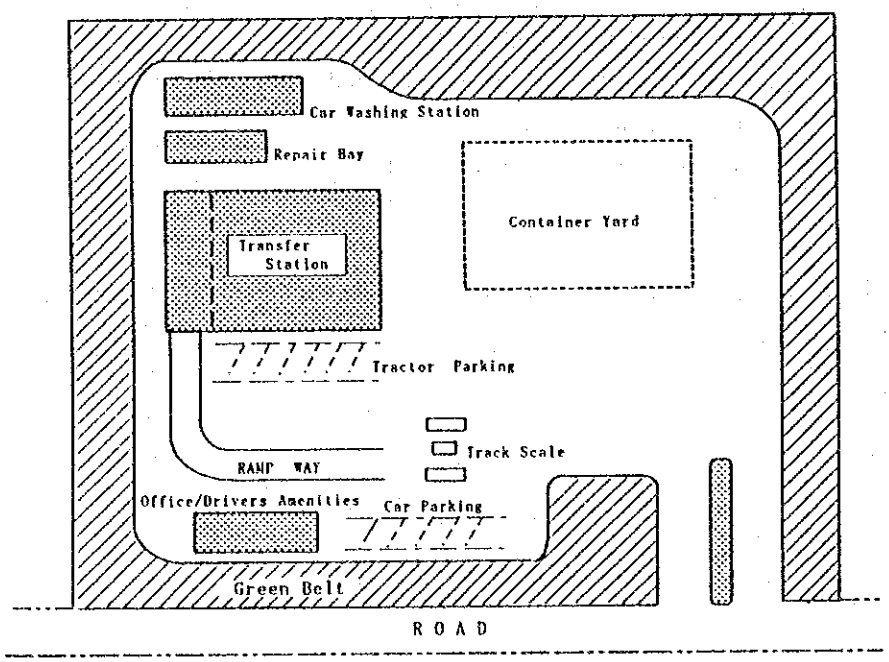


Figure H.5.2.3b Plan of Transfer Station (Indirect Re-Loading Type)

db. Direct re-loading type transfer station

A direct re-loading type transfer station consists of the following facilities and equipment.

- Receiving facilities
- Accessories
- Civil works

dba. Receiving facilities

The waste receiving facilities, platform, receiving hopper to the transportation

vehicle, are provided.
The plan provides a truck scale upon consideration of the number of incoming collection vehicles to the plant during the peak hours in a day.
Receiving hopper is designed to have sufficient width according to the transfer amount.

dbb. Major accessary requirements

For the smooth operation of the plant, the following accessories are required:

- Receiving hopper
- Car washing facilities
- Others

Figure H.5.2.3c shows a schematic diagram of the direct re-loading type transfer station.

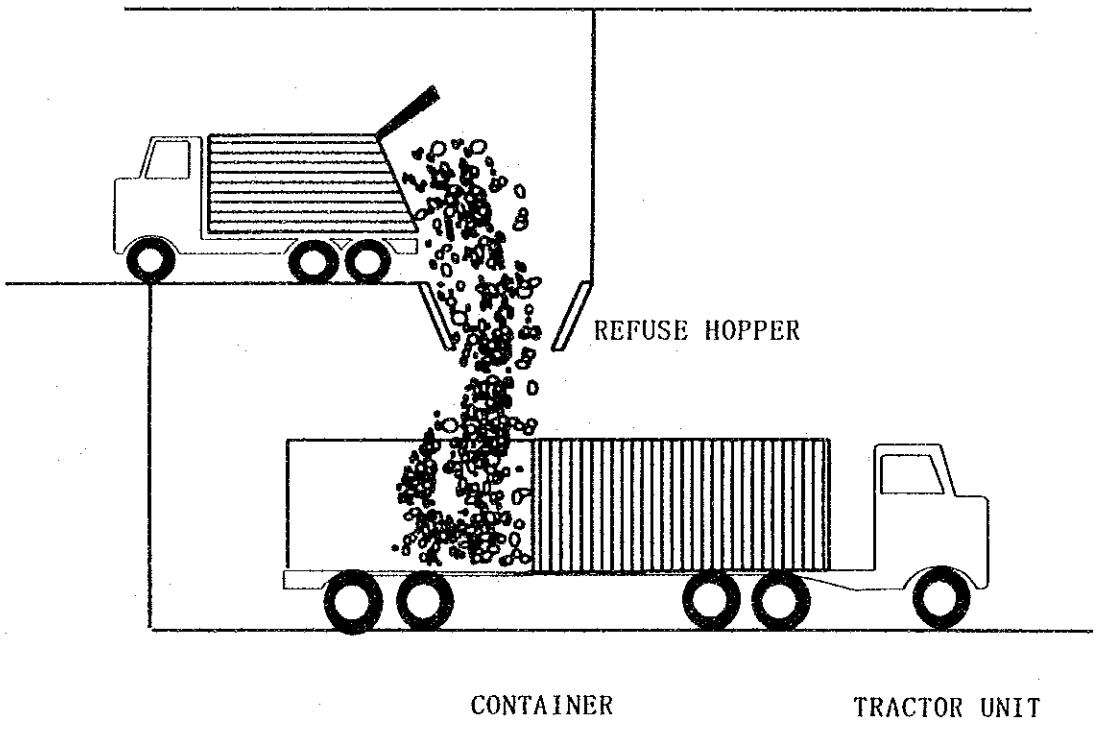


Figure H.5.2.3c Schematic Diagram of Direct Re-loading Refuse Transfer Operation

dad. Civil works

The area of direct re-loading type of transfer station is supposed to have area of 2,000 m^2. The following facilities are installed in this area.

- Approach road
- Dumping platform
- Roof above the receiving hopper
- Storage area for container

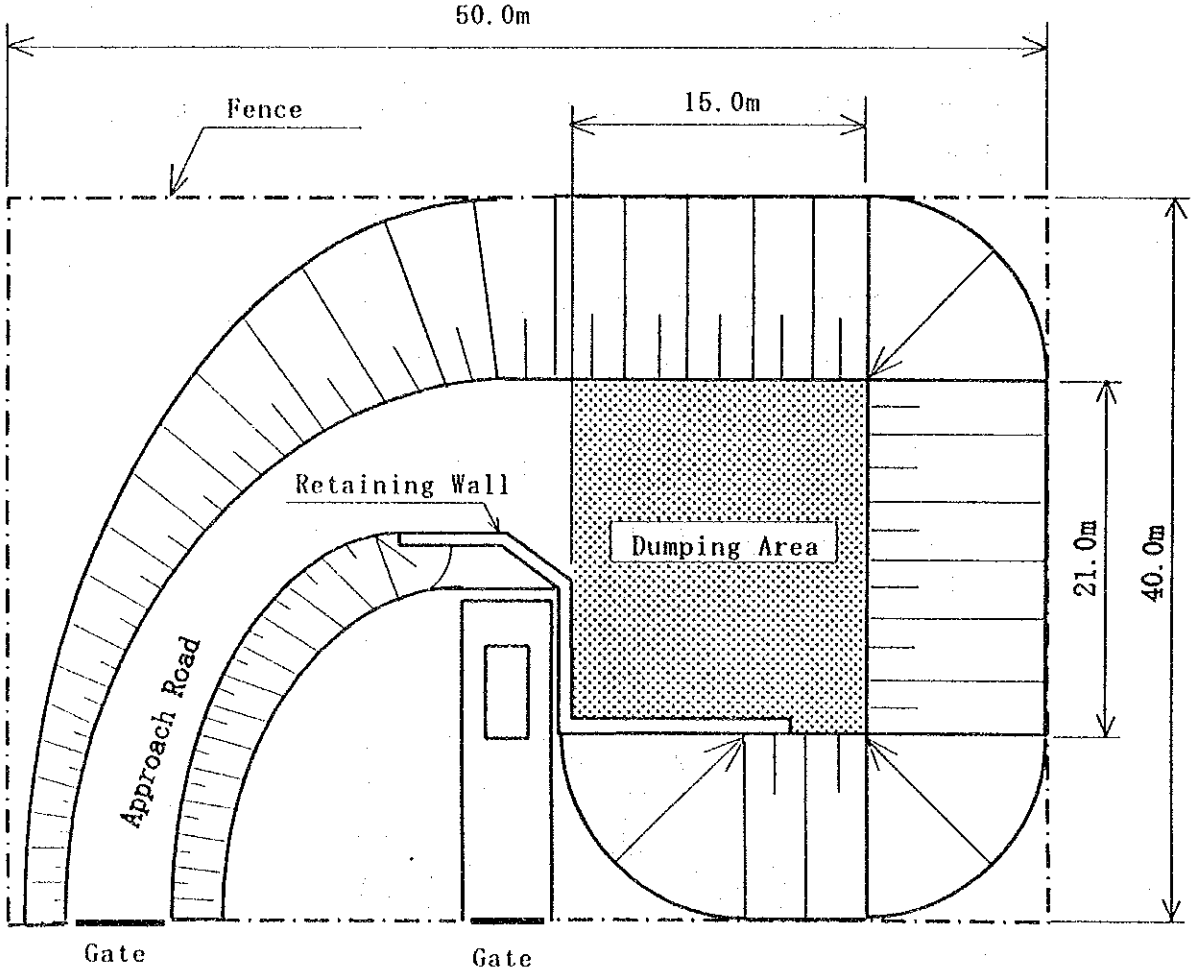


Figure H.5.2.3d Plan of Transfer Station (Direct Re-Loading Type)

e. Transportation from transfer station

ea. Haulage distance and transfer amount

To calculate (i) the required number of vehicles and (ii) the cost of transportation from the transfer station, haulage distance from transfer station to disposal site is tabulated in Table H.5.2.3b.

Table H.5.2.3b Haulage Distance from Transfer Station to Disposal Site

Urbanized Municipalities	Distance (km)	Transfer Amount (ton/day)	Less Urbanized Municipalities	Distance (km)	Transfer Amount (ton/day)
Lambare	36	139	Nemby	43	39
San Lorenzo	33	160	J.A.Saldivar	46	2
Capiata	39	107	Ita	57	18
Luque	31	143	Aregua	44	5
M.R.Alonso	15	67	Limpio	22	27
Villa Elisa	37	64	Villa Hayes	20	13
			B.Aceval	30	8

eb. Design conditions

The following design conditions are established in order to calculate the required number of vehicles and the transportation cost.

eba. Vehicles for transportation

Two types of vehicles are adopted.

i. for indirect re-loading type of transfer station

The following specification of compacted container trailer (CCT) is planned to be used for secondary transportation from a large scale transfer station:

- container capacity : 80 m^3
- loading capacity : 40 ton (80 x 0.2 x 2.5)
  Where 0.2 is the apparent specific gravity
  2.5 is the compaction ratio

ii. for direct re-loading type of transfer station

The following specified container truck (ROT) is planned to be used for secondary transportation from a small scale transfer station.

- container capacity : 40 m^3
- loading capacity : 7.2 ton (40 x 0.2 x 0.9)
  Where 0.2 is the apparent specific gravity
  0.9 is the safety factor

ebb. Design speed of transportation vehicle

The operating speed of a transportation vehicle is planned as 30 km/hr.

ebc. Working time

- Total working time is set up as 8 hours per day and 297 days per year.
- Loading time is planned as 0.2 hour at a transfer station.
- Discharge time is set up as 0.3 hour at the disposal site.

ebd. Fuel and lubricant cost

Based on the present haulage study, the cost of fuel and lubricant is assumed to be 209 Gs/km.

ec. Number of transportation vehicles required

Using the previous information, the following items are calculated.

eca. Total number of trips per day

Total number of trips per day = (Average transfer amount per day)/(Loading capacity of a vehicle)

ecb. Number of trips per vehicle per day

The number of trips for each vehicle in a day (8 hour/day) is determined by the formula below.

Number of trips per vehicle per day = 8 hours/one cycle time per vehicle

ecc. Number of vehicles required per day

Number of vehicles required per day = (Total number of trips per day)/(number

of trips per vehicle per day)

The number of vehicles required per day are based on the average transfer amount per day.

ecd. Stand-by vehicles

Stand-by trailers are needed during maintenance and repairing period. Spare containers should also be prepared to effectively execute secondary transportation. In order to cope with emergencies, stand-by trailers and spare containers may be mobilized and overtime work may also be considered.
Therefore one trailer truck is added to the number of trailers required by calculation, and two containers are considered for each trailer truck required by calculation.

ece. Planned number of vehicles

Planned number of vehicles is calculated by the formula below:

(Total No. of trips per day/No. of trips per vehicle per day) + (Stand-by vehicles)
Results are shown in Table H.5.2.3c.

Table H.5.2.3c Planned Number of Vehicles and Container for Transfer Station

Municipalities	Planned Number of Vehicles per day	Planned Number of Containers
1. Transfer Station with Compactor		
Lambare	3	4
San Lorenzo	3	4
Capiata	2	4
Luque	3	4
M.R.Alonso	2	2
Villa Elisa	2	2
2. Transfer Station without Compactor		
Nemby	4	6
J.A.Saldivar	2	2
Ita	3	4
Aregua	2	2
Limpio	2	4
Villa Hayes	2	2
B.Aceval	2	2

f. Cost estimate

fa. Facilities cost

The facilities cost for the transfer station which consist of the billings compaction equipment, hydraulic oil pump and other facilities required, is estimated in Table H.5.2.3d and H.5.2.3e.

Table H.5.2.3d Facilities Cost (Depreciation) for Transfer Station in Urbanized Municipalities

Municipalities	Unit Cost (Gs/ton)
Lambare	1,430
San Lorenzo	1,430
Capiata	1,430
Luque	1,430
M.R.Alonso	1,430
Villa Elisa	1,430

* Indirect re-loading type of transfer station

Table H.5.2.3e Unit Facility Cost (Depreciation) of Transfer Station in Less Urbanized Municipalities

Municipalities	Unit Cost (Gs/ton)
Nemby	129
J.A. Saldivar	129
Ita	129
Aregua	129
Limpio	129
Villa Hayes	129
B. Aceval	129

* Direct re-loading type of transfer station

fb. Transportation cost

Transportation cost are calculated based on the unit haulage cost (209 Gs/km) and the results are shown in Table H.5.2.3f and H.5.2.3g.

Table H.5.2.3f Transportation Cost from Transfer Station in Urbanized Municipalities

Municipalities	One way Distance (km)	Unit Cost (Gs/ton)
Lambare	36	6288
San Lorenzo	33	5437
Capiata	39	6724
Luque	31	6064
M.R.Alonso	15	7884
Villa Elisa	37	8487

* Indirect re-loading type of transfer station

Table H.5.2.3g Unit Transportation Cost of Less Urbanized Municipalities

Municipalities	One way Distance (km)	Unit Cost (Gs/ton)
Nemby	43	16,091
J.A.Saldivar	46	155,644
Ita	57	26,438
Aregua	44	62,122
Limpio	22	12,587
Villa Hayes	20	23,788
B.Aceval	30	39,506

* Direct re-loading type of transfer station

fc. Operation and maintenance cost

For the operation of each transfer station, manpower and utilities are required as shown in Table H.5.2.3h.

Table H.5.2.3h Manpower and Utilities for Transfer System

Items	Indirect Re-loading type	Direct Re-loading
Manpower for Plant		
Manager	2	0
Engineer	2	0
Operator	6	0
Worker	8	3
(Total)	18	3
Utilities		
Electricity(Mkw/year)	650	10
Water (m^3/year)	3,300	500

Table H.5.2.3i Operation Cost of Transfer Station for Urbanized Municipalities

Municipalities	Waste amount per day	Unit Cost (Gs/ton)
Lambare	139	2,120
San Lorenzo	160	2,120
Capiata	107	2,120
Luque	143	2,120
M.R.Alonso	67	2,120
Villa Elisa	64	2,120

* Indirect re-loading type of transfer station

Table H.5.2.3j Operation Cost of Transfer Station for Less Urbanized Municipalities

Municipalities	Waste amount per day	Unit Cost (Gs/ton)
Nemby	39	958
J.A. Saldivar	2	958
Ita	18	958
Aregua	5	958
Limpio	27	958
Villa Hayes	13	958
B. Aceval	8	958

* Direct re-loading type of transfer station

fd. Outline of transfer station

The unit operation cost of the transfer system is as shown in Table H.5.2.3k and H.5.2.3l.

Table H.5.2.3k Unit Operation Cost of Transfer System for Urbanized Municipalities

Municipalities	Waste amount per day	Type	Unit Cost (Gs/ton)
Lambare	139	IDRL	9,873
San Lorenzo	160	IDRL	8,987
Capiata	107	IDRL	10,274
Luque	143	IDRL	9,614
M.R.Alonso	67	IDRL	11,434
Villa Elisa	64	IDRL	12,037

IDRL : Indirect re-loading type of transfer station

Table H.5.2.31 Unit Operation Cost of Transfer System for Less Urbanized Municipalities

Municipalities	Waste amount per day	Type	Unit Cost (Gs/ton)
Nemby	39	DRL	17,178
J.A. Saldivar	2	DRL	156,731
Ita	18	DRL	27,525
Aregua	6	DRL	63,209
Limpio	26	DRL	13,674
Villa Hayes	13	DRL	24,875
B. Aceval	7	DRL	40,593

DRL : Direct re-loading type of transfer station

H.5.2.4 Street Sweeping System

a. Objective waste and collection amount

The objective waste is the street sweeping waste and the amount of waste collected by the street sweeping service in 2006 is as follows:

(Urbanized Municipalities)			(Less Urbanized Municipalities)		
Lambare	:	6 ton/day	Nemby	:	3 ton/day
San Lorenzo	:	8 ton/day	J.A.Saldivar	:	1 ton/day
Capiata	:	3 ton/day	Ita	:	2 ton/day
Luque	:	4 ton/day	Aregua	:	2 ton/day
M.R.Alonso	:	2 ton/day	Limpio	:	2 ton/day
Villa Elisa	:	5 ton/day	Villa Hayes	:	2 ton/day
			B.Aceval	:	3 ton/day

b. Street sweeping system

ba. Sweeping system

The present manual sweeping system is planned to be continued due to the following reasons:

- high unemployment ratio in the Study area
- poor road conditions such as relatively narrow streets, low asphalt and concrete pavement rate, poor condition of storm water drains and curb stones, lack of parking areas, etc..

bb. Storage system

The plastic bag is proposed for street sweeping in the urbanized and less urbanized municipalities.

bc. Collection system

A collection system for street swept waste in the urbanized municipalities is proposed as the 13 m^3 compaction truck and the 10 m^3 dump truck is proposed for the less urbanized municipalities.

be. Estimation of required number of collection vehicles

The required number of collection vehicles for each municipality was calculated based on the conditions and procedures described in the Section 4.2.2, collection system.
With the above-mentioned procedures, the required number of collection vehicles for each municipality is calculated and tabulated in Table H.5.2.2c and H.5.2.2d.

c. Cost estimate

ca. Method

The street sweeping service cost in 2006 of each alternative was estimated in accordance with the following methods:

- The total street sweeping service cost in 1993, which is the O & M expense excluding depreciation cost of equipment, of the city of Asuncion was calculated based on it in 1992 considering 17.8% of the inflation rate.
- The unit cost of street sweeping service work (Gs/ton) was calculated by dividing the total collection cost by the total collection amount of swept waste observed by the truck scale.
- Since the present street sweeping service cost includes little depreciation cost of equipment, the depreciation cost was calculated and added based on the price in 1993 and life span.
- The street sweeping cost obtained by the above-mentioned methods is divided into street sweeping (manual) cost and collection cost.
- The unit street sweeping cost (manual) is simply calculated by subtracting the unit collection cost from the unit street sweeping service cost.

- Upon consideration of haulage distance, work efficiencies, etc., the time share of each work item (collection, haulage, discharge and miscellaneous) for each alternative was estimated based on the present time share of collection work by the compactor 13 m^3.
- The collection time by dump truck is supposed same as that of compaction truck.
- Unit collection cost (Gs/ton) for each alternative was calculated based on collection time and collection amount of one cycle time.

cb. Unit cost

According to the above mentioned method, the unit street sweeping service cost for each alternative was calculated and tabulated in Table H.5.2.4a and H.5.2.4b.

Table H.5.2.4a Street Sweeping Service Cost for Lambare

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,847,417	3,847,417
Unit Collection Cost	Gs/ton	19,131	32,520	18,465	23,229
Collection Amount (A)	ton/day	6	6	6	6
Collection Amount (B)	ton/year	2,190	2,190	2,190	2,190
Collection Cost	Gs/year	41,896,890	71,218,800	40,438,350	50,871,510
Unit Collection Cost	Gs/km/year	1,675,876	2,848,752	1,617,534	2,034,860
Unit Street Sweeping Service	Gs/km/year	5,163,293	6,336,169	5,104,951	5,522,277
Street Sweeping Length	km	25	25	25	25
Total Cost	Gs/year	129,082,315	158,404,225	127,623,775	138,056,935

Table H.5.2.4b Street Sweeping Service Cost for San Lorenzo

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,487,417	3,487,417
Unit Collection Cost	Gs/ton	19,131	31,308	18,465	23,229
Collection Amount (A)	ton/day	8	8	8	8
Collection Amount (B)	ton/year	2,920	2,920	2,920	2,920
Collection Cost	Gs/year	55,862,520	91,419,360	53,917,800	67,828,680
Unit Collection Cost	Gs/km/year	1,745,704	2,856,855	1,684,931	2,119,646
Unit Street Sweeping Service	Gs/km/year	5,233,121	6,344,272	5,172,348	5,607,063
Street Sweeping Length	km	32	32	32	32
Total Cost	Gs/year	167,459,864	203,016,704	165,515,144	179,426,024

Table H.5.2.4c Street Sweeping Service Cost for Capiata

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,487,417	3,487,417
Unit Collection Cost	Gs/ton	19,780	33,732	18,465	23,229
Collection Amount (A)	ton/day	3	3	3	3
Collection Amount (B)	ton/year	1,095	1,095	1,095	1,095
Collection Cost	Gs/year	21,659,100	36,936,540	20,219,175	25,435,755
Unit Collection Cost	Gs/km/year	1,804,925	3,078,045	1,684,931	2,119,646
Unit Street Sweeping Service	Gs/km/year	5,292,342	6,565,462	5,172,348	5,607,063
Street Sweeping Length	km	12	12	12	12
Total Cost	Gs/year	63,508,104	78,785,544	62,068,179	67,284,759

Table H.5.2.4d Street Sweeping Service Cost for Luque

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,487,417	3,487,417
Unit Collection Cost	Gs/ton	20,428	30,500	18,465	23,229
Collection Amount (A)	ton/day	4	4	4	4
Collection Amount (B)	ton/year	1,460	1,460	1,460	1,460
Collection Cost	Gs/year	29,824,880	44,530,000	26,958,900	33,914,340
Unit Collection Cost	Gs/km/year	1,656,938	2,473,889	1,497,717	1,884,130
Unit Street Sweeping Service	Gs/km/year	5,144,355	5,961,306	4,985,134	5,371,547
Street Sweeping Length	km	18	18	18	18
Total Cost	Gs/year	92,598,386	107,303,506	89,732,406	96,687,846

Table H.5.2.4e Street Sweeping Service Cost for M.R.Alonso

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,487,417	3,487,417
Unit Collection Cost	Gs/ton	19,131	24,037	18,465	23,229
Collection Amount (A)	ton/day	2	2	2	2
Collection Amount (B)	ton/year	730	730	730	730
Collection Cost	Gs/year	13,965,630	17,547,010	13,479,450	16,957,170
Unit Collection Cost	Gs/km/year	1,396,563	1,754,701	1,347,945	1,695,717
Unit Street Sweeping Service	Gs/km/year	4,883,980	5,242,118	4,835,362	5,183,134
Street Sweeping Length	km	10	10	10	10
Total Cost	Gs/year	48,839,800	52,421,180	48,353,620	51,831,340

Table H.5.2.4f Street Sweeping Service Cost for Villa Elisa

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,847,417	3,487,417
Unit Collection Cost	Gs/ton	19,131	32,924	18,465	23,229
Collection Amount (A)	ton/day	5	5	5	5
Collection Amount (B)	ton/year	1,825	1,825	1,825	1,825
Collection Cost	Gs/year	34,914,075	60,086,300	33,698,625	42,392,925
Unit Collection Cost	Gs/km/year	1,745,704	3,004,315	1,684,931	2,119,646
Unit Street Sweeping Service	Gs/km/year	5,233,121	6,491,732	5,172,348	5,607,063
Street Sweeping Length	km	20	20	20	20
Total Cost	Gs/year	104,662,415	129,834,640	103,446,965	112,141,265

Table H.5.2.4g Street Sweeping Service Cost for Nemby

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,487,417	3,487,417
Unit Collection Cost	Gs/ton	18,294	32,316	16,477	21,482
Collection Amount (A)	ton/day	3	3	3	3
Collection Amount (B)	ton/year	1,095	1,095	1,095	1,095
Collection Cost	Gs/year	20,031,930	35,386,020	18,042,315	23,522,790
Unit Collection Cost	Gs/km/year	1,669,328	2,948,835	1,503,526	1,960,233
Unit Street Sweeping Service	Gs/km/year	5,156,745	6,436,252	4,990,943	5,447,650
Street Sweeping Length	km	12	12	12	12
Total Cost	Gs/year	61,880,934	77,235,024	59,891,319	65,371,794

Table H.5.2.4h Street Sweeping Service Cost for J.A.Saldivar

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,487,417	3,487,417
Unit Collection Cost	Gs/ton	17,094	33,437	16,477	21,482
Collection Amount (A)	ton/day	1	1	1	1
Collection Amount (B)	ton/year	365	365	365	365
Collection Cost	Gs/year	6,239,310	12,204,505	6,014,105	7,840,930
Unit Collection Cost	Gs/km/year	3,119,655	6,102,253	3,007,053	3,920,465
Unit Street Sweeping Service	Gs/km/year	6,607,072	9,589,670	6,494,470	7,407,882
Street Sweeping Length	km	2	2	2	2
Total Cost	Gs/year	13,214,144	19,179,339	12,988,939	14,815,764

Table H.5.2.4i Street Sweeping Service Cost for Ita

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,487,417	3,487,417
Unit Collection Cost	Gs/ton	17,694	37,547	16,477	21,482
Collection Amount (A)	ton/day	2	2	2	2
Collection Amount (B)	ton/year	730	730	730	730
Collection Cost	Gs/year	12,916,620	27,409,310	12,028,210	15,681,860
Unit Collection Cost	Gs/km/year	1,435,180	3,045,479	1,336,468	1,742,429
Unit Street Sweeping Service	Gs/km/year	4,922,597	6,53,896	4,823,885	5,229,846
Street Sweeping Length	km	9	9	9	9
Total Cost	Gs/year	44,303,373	58,796,063	43,414,963	47,068,613

Table H.5.2.4j Street Sweeping Service Cost for Aregua

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,487,417	3,487,417
Unit Collection Cost	Gs/ton	18,294	32,690	16,477	21,482
Collection Amount (A)	ton/day	2	2	2	2
Collection Amount (B)	ton/year	730	730	730	730
Collection Cost	Gs/year	13,354,620	23,863,700	12,028,210	15,681,860
Unit Collection Cost	Gs/km/year	1,907,803	3,409,100	1,718,316	2,240,266
Unit Street Sweeping Service	Gs/km/year	5,395,220	6,896,517	5,205,733	5,727,683
Street Sweeping Length	km	7	7	7	7
Total Cost	Gs/year	37,766,539	48,275,619	36,440,129	40,093,779

Table H.5.2.4k Street Sweeping Service Cost for Limpio

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,487,417	3,487,417
Unit Collection Cost	Gs/ton	18,294	24,471	16,477	21,482
Collection Amount (A)	ton/day	2	2	2	2
Collection Amount (B)	ton/year	730	730	730	730
Collection Cost	Gs/year	13,354,620	17,863,830	12,028,210	15,681,860
Unit Collection Cost	Gs/km/year	1,669,328	2,232,979	1,503,526	1,960,233
Unit Street Sweeping Service	Gs/km/year	5,156,745	5,720,396	4,990,943	5,477,650
Street Sweeping Length	km	8	8	8	8
Total Cost	Gs/year	41,253,956	45,763,166	39,927,546	43,581,196

Table H.5.2.4l Street Sweeping Service Cost for Villa Hayes

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,487,417	3,487,417	3,487,417	3,487,417
Unit Collection Cost	Gs/ton	18,894	23,724	16,477	21,482
Collection Amount (A)	ton/day	2	2	2	2
Collection Amount (B)	ton/year	730	730	730	730
Collection Cost	Gs/year	13,792,620	17,318,520	12,028,210	15,681,860
Unit Collection Cost	Gs/km/year	1,532,513	1,924,280	1,336,468	1,742,429
Unit Street Sweeping Service	Gs/km/year	5,019,930	5,411,697	4,823,885	5,229,846
Street Sweeping Length	km	9	9	9	9
Total Cost	Gs/year	45,179,373	48,705,273	43,414,963	47,068,613

Table H.5.2.4m Street Sweeping Service Cost for B.Aceval

Item	unit	Y-1	Y-2	Y-3	Y-4
Unit Street Sweeping Cost	Gs/km/year	3,847,417	3,487,417	3,487,417	3,487,417
Unit Collection Cost	Gs/ton	18,894	27,460	16,477	21,482
Collection Amount (A)	ton/day	3	3	3	3
Collection Amount (B)	ton/year	1,095	1,095	1,095	1,095
Collection Cost	Gs/year	20,688,930	30,068,700	18,042,315	23,522,790
Unit Collection Cost	Gs/km/year	1,880,812	2,733,518	1,640,210	2,138,435
Unit Street Sweeping Service	Gs/km/year	5,368,229	6,220,935	5,127,627	5,625,852
Street Sweeping Length	km	11	11	11	11
Total Cost	Gs/year	59,050,517	68,430,287	56,403,902	61,884,377

H.5.2.5 Sanitary Landfill

a. Introduction

It is generally recognized that a sanitary landfill is the basic element for modern solid waste management. Thus, it is acknowledged that a considerable quantity of waste has to be disposed of even if efforts are provided to reuse (recycling) or utilize (incineration, composting) the waste.

The sanitary landfill is quite expensive for small municipalities, therefore two sorts of sanitary landfill measures, described below, are prepared for municipalities depending on their final disposal amount.

Level 3: M.R.Alonso, Luque, Capiata, San Lorenzo, Lambare, Villa Elisa

Level 2: Nemby, J.A.Saldivar, Ita, Aregua, Limpio, Villa Hayes, Benjamin Aceval

This section presents the cost estimates for landfills in accordance with the design standard set forth for the purpose of alternative plan examination.

b. Design Data

ba. Alternative Y-1

The following assumptions are set up for calculation of the waste amount of final disposal.

- The landfill is localized in each municipality.
- Its landfill receives only wastes collected in its municipality.
- The operation of the landfill will commence in the beginning of 1997.

The waste amount for final disposal is summarized in the table below.

Table H.5.2.5a Waste Amount of Final Disposal for Alternative Y-1

year / municipality	1,993 (ton/year)	1,997 (ton/year)	2,000 (ton/year)	2,006 (ton/year)	Total from 1997 to 2006 (ton)
Lambare	24,455	27,166	29,200	50,735	363,983
San lorenzo	7,665	18,511	26,645	58,400	364,035
Capiata	5,110	11,159	15,695	39,055	231,149
Luque	5,475	13,818	20,075	52,195	302,741
M.R.Alonso	3,285	6,622	9,125	24,455	140,734
Villa Elisa	5,840	8,134	9,855	23,360	142,950
Nemby	1,460	3,963	5,840	14,235	84,654
Saldivar	0	209	365	730	4,667
Ita	1,095	2,138	2,920	6,570	40,671
Aregua	0	626	1,095	1,825	12,723
Limpio	365	2,451	4,015	9,855	57,983
Villa Hayes	1,095	1,512	1,825	4,745	27,949
Benjamin Aceval	0	417	730	2,920	14,444

bb. Alternative Y-2 and -3

The following assumptions are set up for calculation of the waste amount of final disposal.

- The proposed landfill in A-5 site which is recommended for Asuncion and Fernando de la Mora in Chapter 4 is utilized for the final disposal site for each municipality.
- The A-5 landfill site receives wastes collected from Asuncion and Fernando de la Mora and each municipality.
- The operation of the A-5 landfill will commence in the beginning of 1997.

The waste amount of final disposal for Alternative Y-2 and Y-3 are tentatively assumed to be same as the amount set forth in Alternative X-2 and X-3, because the unit disposal cost of Alternative X-2 and -3 is nearly constant due to its large final disposal amount.

bc. Alternative Y-4

The following assumptions are set up for calculation of the waste amount of final disposal.

- The proposed landfill sites are localized in 15 km from the center of the urban area of each municipality.

- Those landfill receive wastes collected from its municipality and other neighboring municipalities.
- The operation of the landfill will commence in the beginning of 1997.

The landfill site of Alternative Y-4 is based on the assumption and it is, therefore, impossible to calculate the exact waste amount required for landfill design for cost estimation. In this section, the capacity of inter-municipal landfill site of Alternative Y-4 is assumed to be based on the total final disposal amount of Luque, San Lorenzo and Capiata.

Table H.5.2.5b Waste Amount of Final Disposal for Alternative Y-4

year / municipality	1993 (ton/year)	1997 (ton/year)	2000 (ton/year)	2006 (ton/year)	Total from 1997 to 2006 (ton)
San Lorenzo	7,665	18,511	26,645	58,400	364,035
Capiata	5,110	11,159	15,695	39,055	231,149
Luque	5,475	13,818	20,075	52,195	302,741
Total	18,250	43,488	62,415	149,650	897,925

Referring to the data given the above table, the basic data for the Alternative Y-4 are set up as follows.

- The capacity of the landfill is 1,000,000 ton.
- The final disposal amount of waste in 2006 is 150,000 ton.

c. Required Capacity of the Landfill

ca. Required Capacity of Landfill Section

The required capacity of the landfill section is calculated as follows.

- Unit weight of the waste compacted in the landfill is 0.8 ton/m^3.
- The required volume of soil for covering waste excluding final cover is 16.5 % of the total volume of waste disposed.
- Hence, the required capacity of the landfill section is calculated with the following equation.

$$Required\ Volume = Disposal\ amount\ (ton) \times (1 + 0.135)$$

cb. Required Area of the Landfill Site

The required area of the landfill site depends on the natural condition of the site, the required facilities of the landfill, etc.. In this section the required area is calculated by using the coefficient of the landfill volume which is obtained by some sample designs of landfills in accordance with landfill volume.

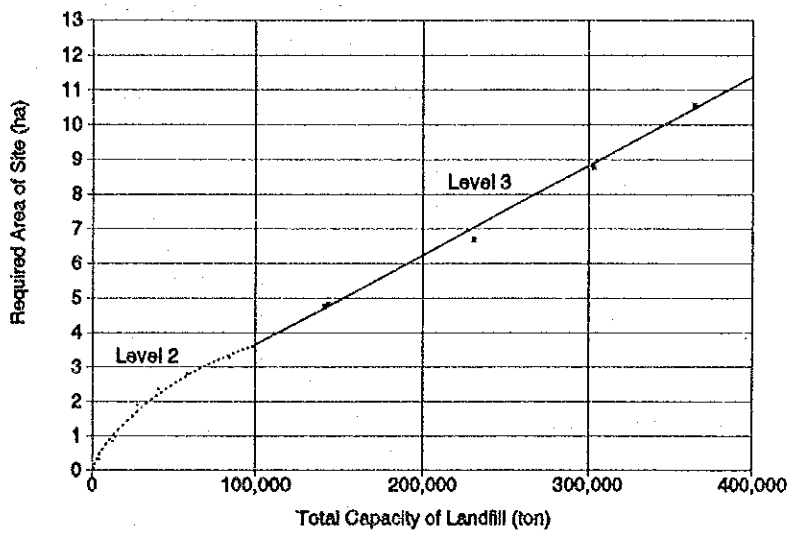


Figure H.5.2.5a Relation Chart of Required Capacity of Landfill and Required Area

Table H.5.2.5c Required Capacity of the Landfill Section and Required Area

	Waste Amount Disposed 1997--2006 (ton)	Required Area (ha)
Lambare	363,983	10.56
San lorenzo	364,035	10.56
Capiata	231,149	6.70
Luque	302,741	8.78
M.R.Alonso	140,734	4.76
Villa Elisa	142,950	4.84
Nemby	84,654	3.27
Saldivar	4,667	0.32
Ita	40,671	2.36
Aregua	12,723	0.86
Limpio	57,983	2.80
Villa Hayes	27,949	1.89
Benjamin Aceval	14,444	0.98

d. Technical Description

The technical descriptions adopted for alternative plans for the urbanized and less urbanized municipalities are basically same as the highly urbanized municipalities. However, the combination varies depending on the required level of the landfill as shown in Table below.

Table H.5.2.5d System Combination of Sanitary Landfill and Operation

Items	Level of Operation		Remarks
	2nd	3rd	
1. Site Development Works			
1.1 Main Facilities			
a. Enclosing Structure			
i. Enclosing Band	A	A	- B means that a band is made of waste disposed and earth
ii. Divider	B	A	
b. Drainage System			- The drain is for the site which is not used for landfill
i. Surrounding Drain	A	A	- If necessary
ii. On-site Drain (Surface Water)	A	A	
iii. On-site Drain (Underground Springs)	A	A	
iv. Drain for Reclaimed Area	A	A	
c. Access			
i. Approach Road	A	A	- Improvement of existing road network for accessing to the site
ii. On-site Road	A	A	
iii. Others	A	A	
1.2 Environment Protection Facilities			
i. Buffer Zone	A	A	- Movable fence,etc.
ii. Litter Control Facilities	B	A	
iii. Gas Removal Facilities	B	A	
iv. Leachate Collection Facilities		A	
v. Leachate Circulation Facilities		A	
vi. Seepage Control Facilities		B	
1.3 Buildings and Accessories			
i. Site Office	A	A	
ii. Weigh Bridge	A	A	
iii. Storage Building		A	- Gate, fence, lights, etc.
iv. Safety Facilities	A	A	- Water tank, extinguisher, etc.
v. Fire Prevention Facilities	B	A	- Monitoring well, etc.
vi. Monitoring Facilities		A	
vii. Car Wash		A	
2 Equipment			
i. Landfill Equipment	A	A	
ii. Others		A	- Water truck, Inspection Vehicles, etc.
3 Operation and Maintenance			
3.1 Operation			
a. Personnel	A	A	
b. Cover Material	A	A	
c. Utility			
i. Fuel	A	A	
ii. Water	A	A	
iii. Electricity	A	A	
d. Chemicals			
i. Insecticide	A	A	
ii. Monitoring Chemicals		A	
e. Others	A	A	- Divider, drain for reclaimed area, leachate collection pipes, etc.
3.2 Maintenance			
i. Main Facilities	A	A	
ii. Environment Protection Facilities	A	A	
iii. Building and Accessories	A	A	
iv. Equipment	A	A	

A means the facility is necessary.

B means the facility is necessary under a certain condition, or in case the budget is not enough, the facility might not be provided.

e. Cost Estimation

ea. Basic Conditions on Cost Estimation

The following assumptions are set up as the basic conditions for cost estimation.

- The land acquisition cost is excluded.
- The cost of borrow soil is 10,000 Gs/m^3.
- The access road from the existing road to the landfill site is not taken into account. Only 100 m of access road at the entrance of the landfill is included in the cost estimation of alternative plans except the alternatives Y-2 and Y-3.

eb. Method of the Cost Estimation

Alternative Y-1 and Y-4

For the several different cases of landfill capacity, the investment cost and the operation and maintenance cost are estimated in accordance with the requirement described in the technical description. The Cost-Capacity Curve is drawn by using the data obtained from their estimations. Referring to the Cost-Capacity Curve, the cost for each municipality is estimated.

Alternative Y-2 and Y-3

The disposal cost of the Alternative Y-2 and Y-3 is the same as that of Alternatives X-4 and X-5.

ec. Cost Estimation of Alternative Y-1

eca. Investment Cost (Depreciation)

Total investment cost of the several model landfills in Level 2 and 3 are estimated as shown in Table H.5.2.5e and f.

Table H.5.2.5e Cost Estimation of Landfills in Level 2 unit: mill.Gs

	Total Capacity of Landfill (ton)				
	30,000	60,000	90,000	120,000	150,000
1. Main Facilities	784	1,033	1,227	1,390	1,535
1.1 Enclosing Structure	553	747	897	1,024	1,137
1.2 Drainage System	20	23	25	28	30
1.3 Access	211	264	304	339	369
2. Environmental Protection Facilities	9	13	18	22	26
3. Building, etc.	40	52	62	71	78
4. Slope Protection	51	68	81	92	101
5. Miscellaneous (20%)	176	223	277	315	348
6. General Expense and Overhead (30%)	317	420	499	566	626
7. Design and Supervision (10%)	138	182	216	246	271
Total Cost (mill.Gs)	1,515	2,002	2,381	2,701	2,986
Unit Cost (Gs/ton)	50,498	33,372	26,457	22,508	19,909

Table H.5.2.5f Cost Estimation of Landfills in Level 3 unit: mill.Gs

	Total Capacity of Landfill (mill.ton)								
	0.1	0.5	1	1.5	2.0	2.5	3.0	3.5	4.0
1. Main Facilities	1,300	2,732	3,916	4,878	5,697	6,455	7,375	8,054	8,685
1.1 Enclosing Structure	942	2,048	2,922	3,620	4,226	4,773	5,477	5,966	6,429
1.2 Drainage System	26	47	75	109	133	157	196	220	243
1.3 Access	333	637	918	1,149	1,337	1,525	1,702	1,869	2,013
2. Environmental Protection Facilities	428	1,618	3,119	4,646	6,133	7,643	11,848	13,563	15,265
3. Building, etc.	172	435	703	950	1,183	1,410	1,922	2,162	2,395
4. Slope Protection	85	176	245	298	342	381	417	450	480
5. Miscellaneous 20%	397	992	1,597	2,150	2,671	3,178	4,312	4,846	5,365
6. G.Expense and Overhead 30%	714	1,786	2,874	3,870	4,808	5,720	7,762	8,723	9,657
7. Design and Supervision 10%	310	774	1,245	1,677	2,083	2,479	3,363	3,780	4,185
Total Cost (mill.Gs)	3,406	8,514	13,699	18,450	22,918	27,267	37,000	41,577	46,031
Unit Cost (Gs/ton)	34,065	17,028	13,699	12,300	11,459	10,907	12,333	11,879	11,508

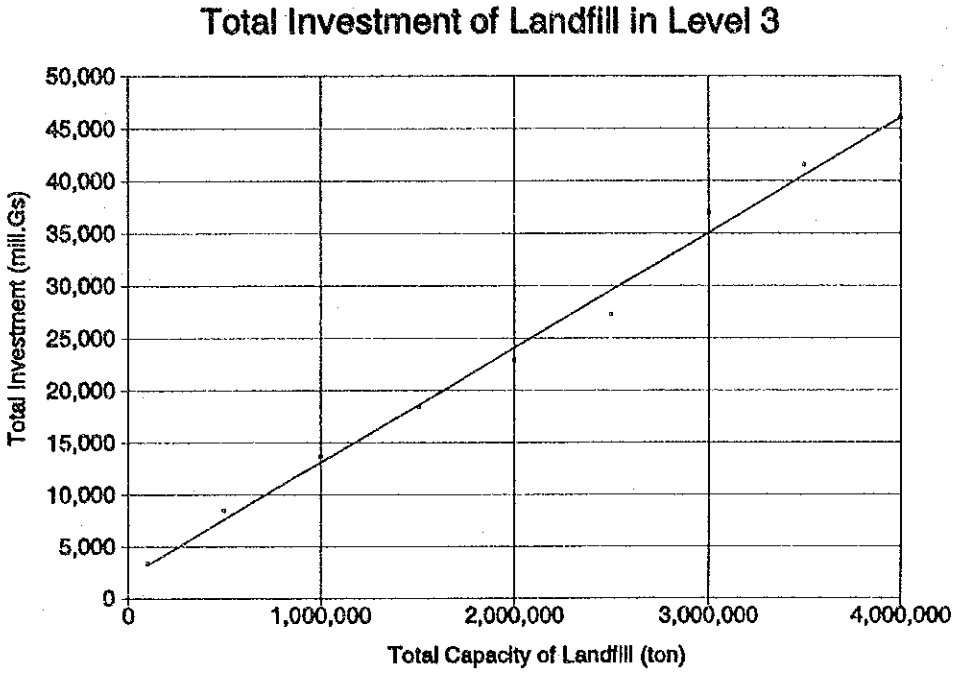


Figure H.5.2.5b Total Investment Chart of Landfill in Level 3

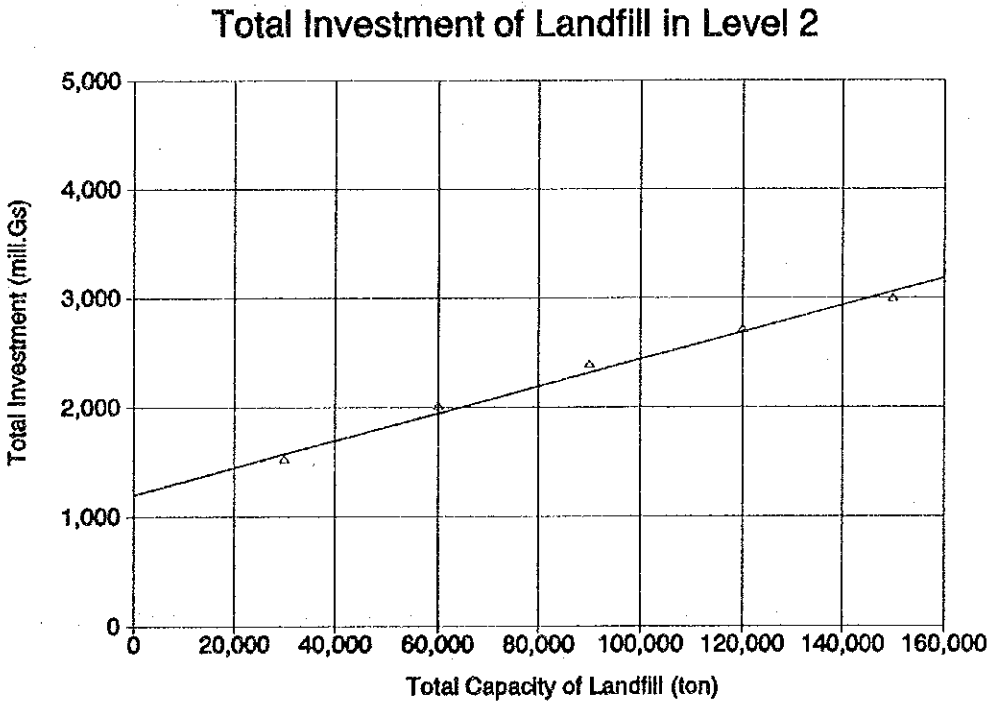


Figure H.5.2.5c Total Investment Chart of Landfill in Level 2

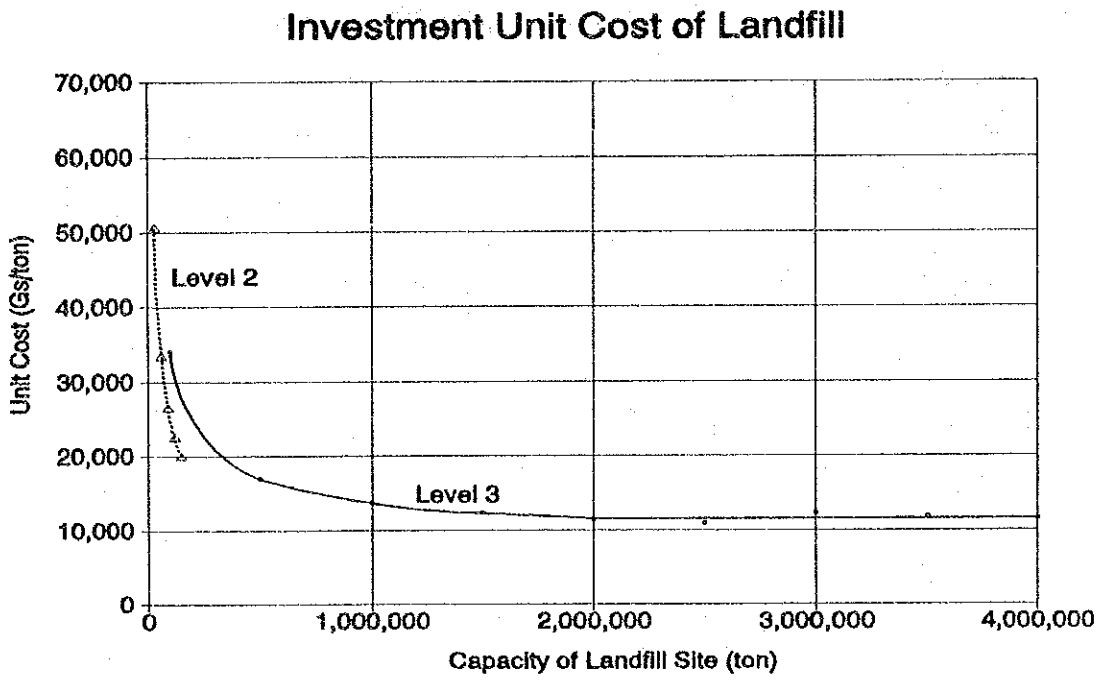


Figure H.5.2.5d Investment per Ton Chart of Landfill (Level 2 & 3)

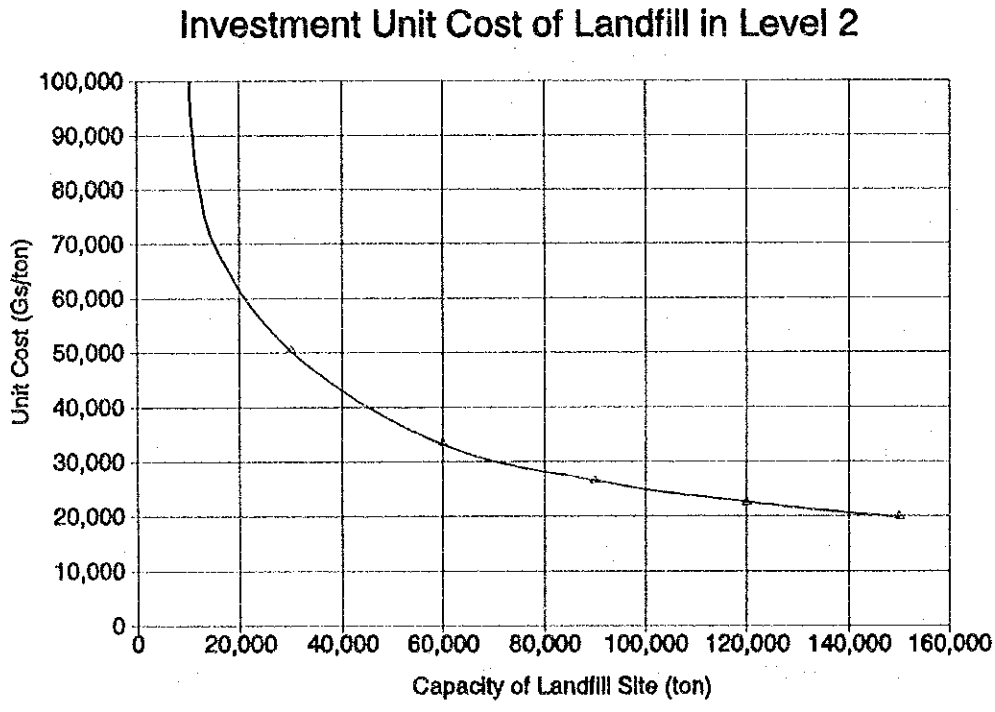


Figure H.5.2.5e Investment per Ton Chart of Landfill in Level 2

According to the charts shown in Figure H.5.2.5b, 5c, 5d and 5e, the estimated investment costs and the unit costs of landfills of each municipalities are presented in Table H.5.2.5g.

Table H.5.2.5g Summary of Estimated Depreciation of Alternative Y-1

year	In 2,006 (ton)	Total from 1997 to 2006 (ton)	Total Investment (mill.Gs)	Depreciation for Investment in 2006 (mill.Gs)	Unit Cost (Gs/ton)
Lambare	50,735	363,983	6,250	873	17,200
San lorenzo	58,400	364,035	6,250	1,004	17,200
Capiata	39,055	231,149	5,300	898	23,000
Luque	52,195	302,741	6,055	1,044	20,000
M.R.Alonso	24,455	140,734	4,067	707	28,900
Villa Elisa	23,360	142,950	4,045	661	28,300
Nemby	14,235	84,654	3,145	529	37,150
Saldivar	730	4,667	784	123	168,000
Ita	6,570	40,671	1,741	281	42,800
Aregua	1,825	12,723	12,723	183	100,000
Limpio	9,855	57,983	1,960	333	33,800
Villa Hayes	4,745	27,949	1,465	249	52,400
B. Aceval	2,920	14,444	1,300	263	90,000

ecb. Operation and Maintenance Cost of Landfill

To perform the landfill operation in compliance with the requirement of the target level, the arrangements of the equipment and manpower listed in the following table are required.

Table H.5.2.5h Required Equipment and Manpower for Operation and Maintenance of Landfill

Item	unit	Annual Amount of Waste Disposed (x 1,000 ton)					
		0–30	3–57	57–114	114–171	171–228	228–285
Machinery							
Bulldozer 90HP	unit/year	1	0	0	0	0	0
Bulldozer 210HP	unit/year	0	1	2	3	4	5
Excavator	unit/year	0	0	0	1	1	1
Water tanker	unit/year	0	1	1	1	1	1
Pick up	unit/year	0	1	1	1	2	2
Truck	unit/year	0	0	0	1	1	1
Water pump	unit/year	1	1	2	2	3	3
Labor							
Foreman	man/year	1	1	1	1	1	1
Truck scale	man/year	1	1	2	2	2	2
Operator	man/year	1	3	4	7	9	10
Mechanic	man/year	0	0	0	1	1	1
Worker	man/year	1	3	6	9	12	15
Material							
Soil for cover (min)	m^3	0	5,000	9,500	19,000	28,500	38,000
Soil for cover	m^3	5,000	9,500	19,000	28,500	38,000	47,500
(max)	L.S.	0	1	1	1	1	1
Insecticide	L.S.	0	1	1	1	1	1
Reagent for Monitoring	liter	38,016	100,201	153,252	276,091	352,717	420,433
Diesel	L.S.				1	1	1
Oil and Lubricant		1	1	1			
Utility	L.S.				1	1	1
Water	L.S.	1	1	1	1	1	1
Electricity		1	1	1			

The costs to comply with the above arrangements are presented in the next table.

Table H.5.2.5i Estimated O&M Cost of Landfill

Item	Annual Amount of Waste Disposed (X1,000 ton/year)					
	0-30	30-57	57-114	114-171	171-228	228-285
Machinery						
Bulldozer 90HP	53.6	0.0	0.0	0.0	0.0	0.0
Bulldozer 210HP	0.0	79.7	159.5	239.2	318.9	398.7
Excavator	0.0	0.0	0.0	67.4	67.4	67.4
Water tanker	0.0	41.4	41.4	41.4	41.4	41.4
Pick up	0.0	19.7	19.7	19.7	39.3	39.3
Truck	0.0	0.0	0.0	43.1	43.1	43.1
Water pump	1.8	1.8	3.7	3.7	5.5	5.5
Labor						
Foreman	12.0	12.0	12.0	12.0	12.0	12.0
Truck scale	6.8	6.8	13.5	13.5	13.5	13.5
Operator	12.0	36.0	48.0	84.0	108.0	120.0
Mechanic	12.0	0.0	0.0	12.0	12.0	12.0
Worker	6.8	20.3	40.5	60.8	81.0	101.3
Material						
Soil for cover (min)	0.0	50.0	95.0	190.0	285.0	380.0
Soil for cover (max)	50.0	95.0	190.0	285.0	380.0	475.0
Insecticide	0.0	0.8	4.8	9.5	14.3	19.0
Reagent for Monitoring	0.0	0.6	1.9	3.8	5.7	7.6
Diesel	6.2	48.1	73.4	132.4	169.2	201.7
Oil and Lubricant	0.9	2.4	3.7	6.6	8.5	10.1
Utility						
Water	2.0	3.0	2.0	4.0	4.0	4.0
Electricity	2.0	3.0	4.0	4.0	6.0	6.0
Lower Total Cost (Gs)	116.1	323.3	523.1	947.1	1,234.8	1,482.6
Upper Total Cost (Gs/ton)	ERR	10,855	9,177	8,308	7,221	6,503
Upper Total Cost (Gs)	166.1	370.6	618.1	1,042.1	1,329.8	1,577.6
Lower Total Cost (Gs/ton)	5,537	6,502	5,422	6,094	5,833	5,535

According to the data obtained Table H.5.2.5i, O&M Unit Cost Charts are drawn in Figure H.5.2.5f and H.5.2.5g for O&M cost estimation.

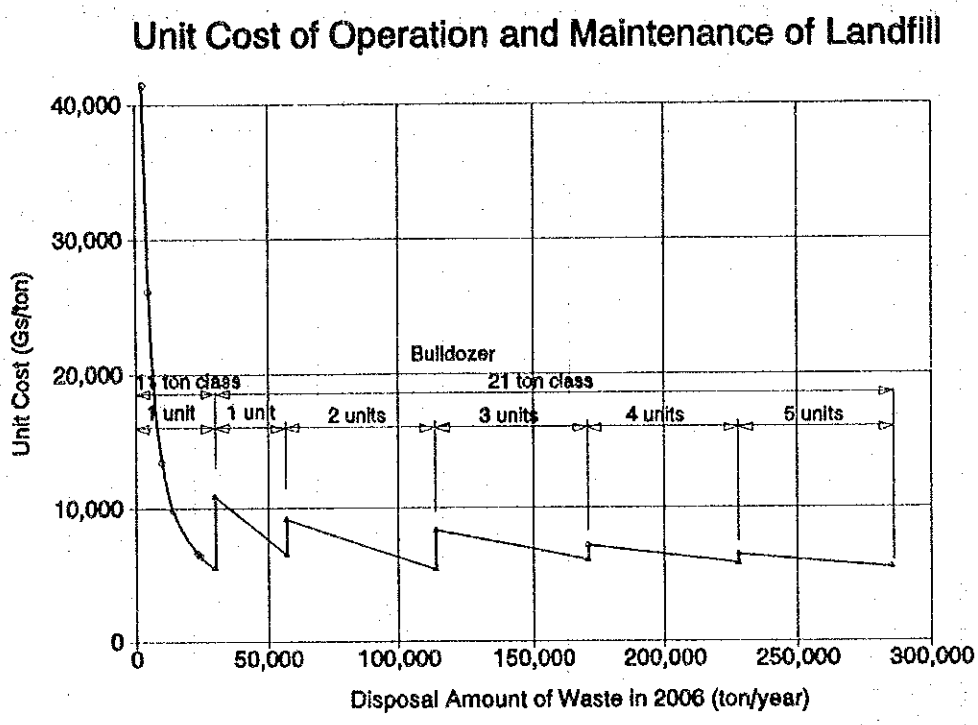


Figure H.5.2.5f O&M Unit Cost Chart of Landfill (50,000 - 300,000 ton/year)

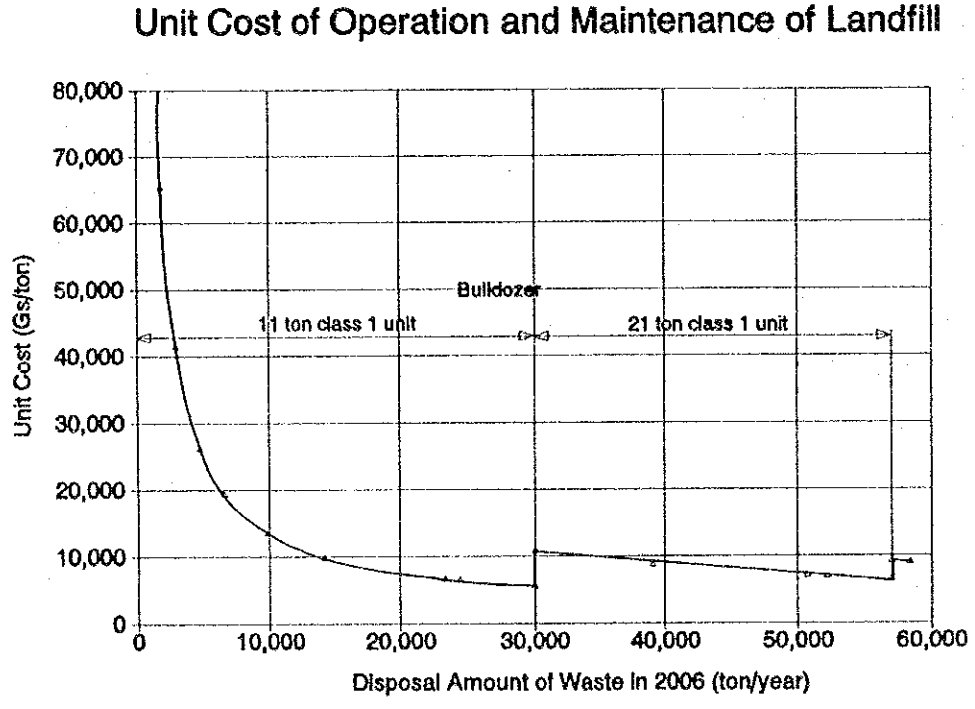


Figure H.5.2.5g O&M Unit Cost Chart of Landfill (Less than 50,000 ton/year)

According to the charts shown in Figure H.5.2.5f and 4g, the estimated O&M cost and the unit cost of landfill of each municipality is presented in Table H.5.2.5j.

Table H.5.2.5j Estimation of O&M Cost of Alternative Y-1

	Waste Disposal Amount in 2006 (ton/year)	O&M Total Cost in 2006 (Gs/year)	O&M Unit Cost (Gs/ton)
Lambare	50,735	378	7,457
San lorenzo	58,400	525	8,997
Capiata	39,055	341	8,724
Luque	52,195	363	6,948
M.R.Alonso	24,455	157	6,414
Villa Elisa	23,360	155	6,637
Nemby	14,235	140	9,822
Saldivar	730	117	160,704
Ita	6,570	127	19,338
Aregua	1,825	119	65,282
Limpio	9,855	133	13,447
Villa Hayes	4,745	124	26,134
Benjamin Aceval	2,920	121	41,426

ecc. Summary of Cost Estimation of Alternative Y-1

The cost estimation of Alternative Y-1 is summarized in Table H.5.2.5k.

Table H.5.2.5k Summary of Cost Estimation of Alternative Y-1

	Total Cost in 2006 (mill.Gs)			Unit Cost in 2006 (Gs/ton)		
	Depreci-ation	O&M	Total	Depreciation	O&M	Total
Lambare	873	360	1,233	17,200	7,457	24,657
San lorenzo	1,004	525	1,529	17,200	8,997	26,197
Capiata	898	341	1,239	23,000	8,724	31,724
Luque	1,044	363	1,407	20,000	6,948	26,948
M.R.Alonso	707	157	864	28,900	6,414	35,314
Villa Hayes	661	155	816	28,300	6,637	34,937
Nemby	529	140	669	37,150	9,822	46,972
Saldivar	123	117	240	168,000	160,704	328,704
Ita	281	127	408	42,800	19,338	62,138
Aregua	183	119	302	100,000	65,282	165,282
Limpio	333	133	466	33,800	13,447	47,247
Villa Hayes	249	124	373	52,400	26,134	78,534
Benjamin Aceval	263	121	384	90,000	41,426	131,426

ed. Alternative Y-2 and Y-3

In the alternatives Y-2 and Y-3, the landfill site in A-5 selected in Chapter 4 for Asuncion and Fernando de la Mora is planned to be utilized. Therefore, the disposal cost of Alternative Y-2 and Y-3 is the same as it of the alternative X-4 and X-5, as shown in Table H.5.2.5l.

Table H.5.2.5l Summary of Cost Estimation of Alternative Y-2 and Y-3

Item	Total Cost in 2006	Unit Cost
Investment Cost	2,643 mill. Gs	11,298 Gs/ton
O & M Cost	1,547 mill. Gs	5,893 Gs/ton
Total	4,190 mill. Gs	17,191 Gs/ton

ef. Alternative Y-4

As explained in section bc., the basic data for the Alternative Y-4 are set up as follows.

- The capacity of the landfill is 1,000,000 ton.
- The final disposal amount of waste by 2006 is 150,000 ton.

According to Figure H.5.2.5d, the investment per ton is 13,700 Gs when the capacity of the landfill is 1,000,000 ton.

According to Figure H.5.2.5f, O&M cost is 6,714 Gs/ton when annual disposal amount is 150,000 ton.

Therefore, the investment cost and O&M cost are calculated as shown in Table H.5.2.5m and 4n.

Table H.5.2.5m Estimation of Investment of Alternative Y-4

year / municipality	Waste Disposal Amount in 2,006 (ton)	Unit Cost (Gs/ton)	Depreciation in 2006 (Gs/ton)
Lambare	50,735	13,700	695
San lorenzo	58,400	13,700	800
Capiata	39,055	13,700	535
Luque	52,195	13,700	715
M.R.Alonso	24,455	13,700	335
Villa Elisa	23,360	13,700	320
Nemby	14,235	13,700	195
Saldivar	730	13,700	10
Ita	6,570	13,700	90
Aregua	1,825	13,700	25
Limpio	9,855	13,700	135
Villa Hayes	4,745	13,700	65
Benjamin Aceval	2,920	13,700	40

Table H.5.2.5n Summary of Cost Estimation of Alternative Y-4

	Total Cost in 2006 (mill.Gs)			Unit Cost in 2006 (Gs/ton)		
	Depre-ciation	O&M	Total	Depre-ciation	O&M	Total
Lambare	695	340	1,035	13,700	6,714	20,414
San lorenzo	800	392	1,192	13,700	6,714	20,414
Capiata	535	262	797	13,700	6,714	20,414
Luque	715	351	1,066	13,700	6,714	20,414
M.R.Alonso	335	164	499	13,700	6,714	20,414
Villa Hayes	320	157	477	13,700	6,714	20,414
Nemby	195	96	291	13,700	6,714	20,414
Saldivar	10	5	15	13,700	6,714	20,414
Ita	90	44	143	13,700	6,714	20,414
Aregua	25	12	37	13,700	6,714	20,414
Limpio	135	66	201	13,700	6,714	20,414
Villa Hayes	65	32	97	13,700	6,714	20,414
B. Aceval	40	20	60	13,700	6,714	20,414

H.5.3 Evaluation

H.5.3.1 Summary of Alternatives

a. Summary of Alternatives Systems

As described in Section 4.3, we concluded that Alternative X-5 should be the optimum technical system for MSWM in 2006 for Asuncion and F.Mora municipalities. Then, the use of A-5 site as the inter-municipal disposal site for the other 13 municipalities should be examined. Consequently, 4 Alternatives for each municipality are illustrated below.

aa. Alternative Y-1

Independent Disposal
A sanitary landfill inside of each municipality

ab. Alternative Y-2

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

ac. Alternative Y-3

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

ad. Alternative Y-4

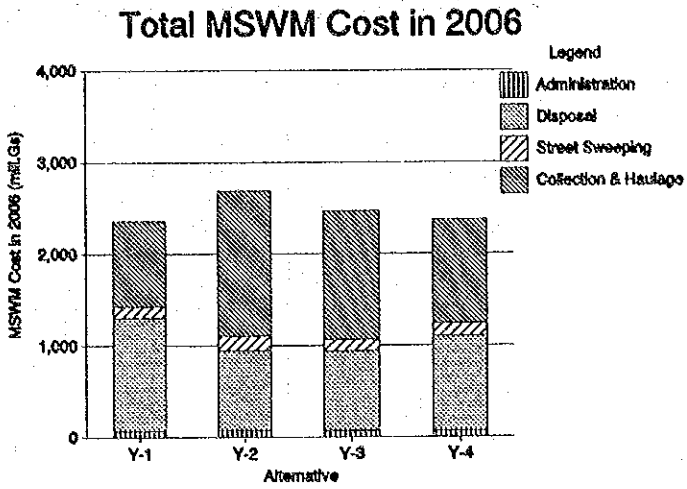
Inter-municipal Disposal
An inter-municipal sanitary landfill 15 km away from the center of the urban area of each municipality without a transfer system

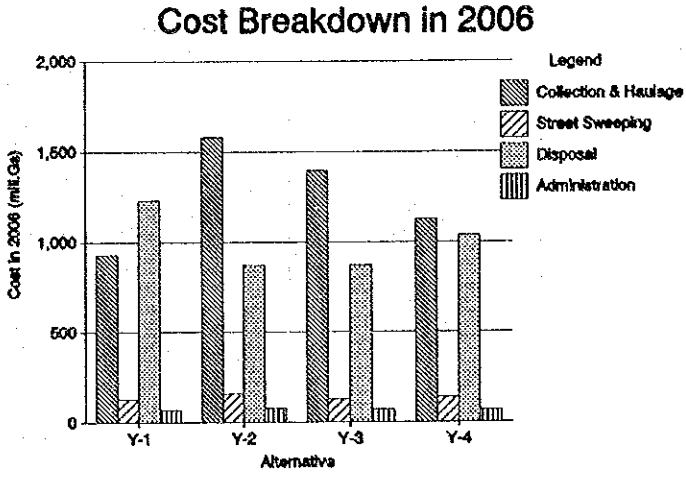
b. Annual MSWM Expenses

The annual MSWM expenses of the 4 alternatives in 2006 for 13 municipalities are tabulated in the following tables and illustrated in figures that follow:

Table H.5.3.1a Annual MSWM Expense in 2006 for Lambare

Lambare	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	929	1,579	1,395	1,128
	Unit (Gs/ton)	19,131	32,520	28,302	23,229
1.1 Collection & Haulage	Total (mill.Gs)	929	1,579	896	1,128
	Unit (Gs/ton)	19,131	32,520	18,465	23,229
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	499	0
	Unit (Gs/ton)	0	0	9,837	0
2. Street Sweeping	Total (mill.Gs)	129	158	128	138
	Unit (mill.Gs/km/year)	5.16	6.34	5.10	5.52
Sub-total	Total (mill.Gs)	1,058	1,737	1,722	1,266
	Unit (Gs/ton)	20,853	34,237	33,941	24,953
3. Final Disposal	Total (mill.Gs)	1,251	872	872	1,036
	Unit (Gs/ton)	24,657	17,191	17,191	20,414
4. Administration	L.S.	69	78	72	69
Total Cost in 2006	(mill.Gs)	2,380	2,687	2,467	2,371
Cost per Collection Amount	(Gs/ton)	46,910	52,971	48,625	46,728





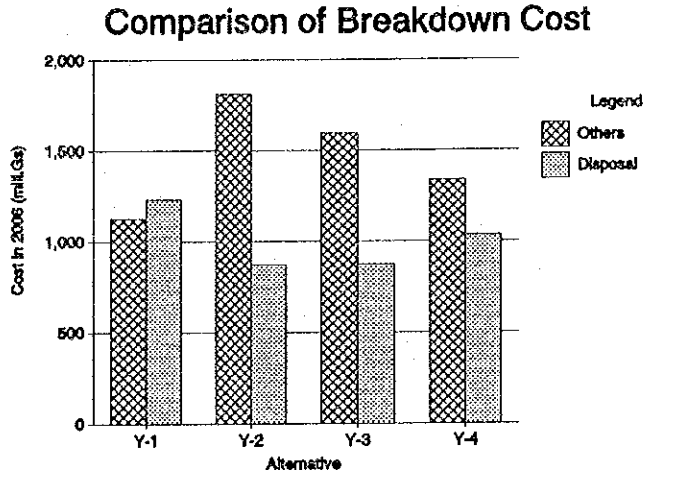


Figure H.5.3.1a Illustration of Annual MSWM Expenses in 2006 for Lambare

Table H.5.3.1b Annual MSWM Expense in 2006 for San Lorenzo

San Lorenzo	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	1,061	1,737	1,549	1,289
	Unit (Gs/ton)	19,131	31,308	27,452	23,229
1.1 Collection & Haulage	Total (mill.Gs)	1,061	1,737	1,024	1,289
	Unit (Gs/ton)	19,131	31,308	18,465	23,229
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	525	0
	Unit (Gs/ton)	0	0	8,987	0
2. Street Sweeping	Total (mill.Gs)	167	203	166	179
	Unit (mill.Gs/km/year)	5.23	6.34	5.17	5.61
Sub-total	Total (mill.Gs)	1,228	1,940	1,934	1,468
	Unit (Gs/ton)	21,027	33,219	33,116	25,137
3. Final Disposal	Total (mill.Gs)	1,720	1,004	1,004	1,192
	Unit (Gs/ton)	26,197	17,191	17,191	20,414
4. Administration	L.S.	88	88	82	80
Total Cost in 2006	(mill.Gs)	3,036	3,032	2,801	2,740
Cost per Collection Amount	(Gs/ton)	51,994	51,922	47,954	46,918

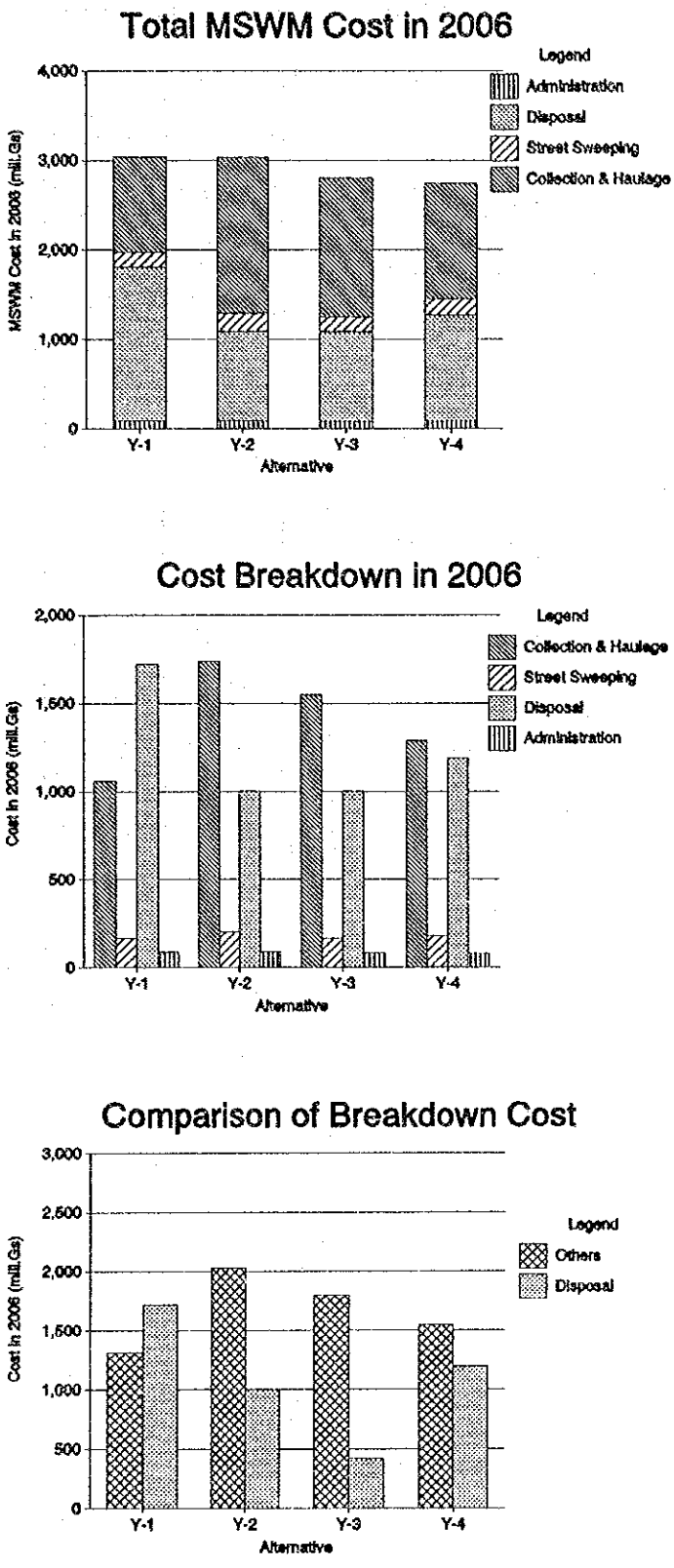
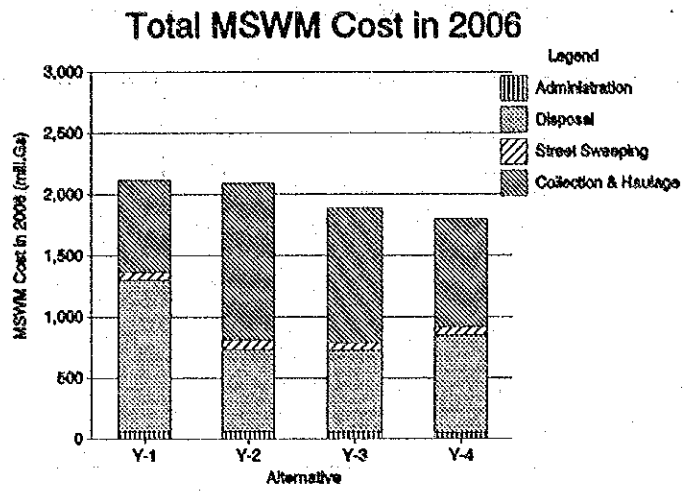
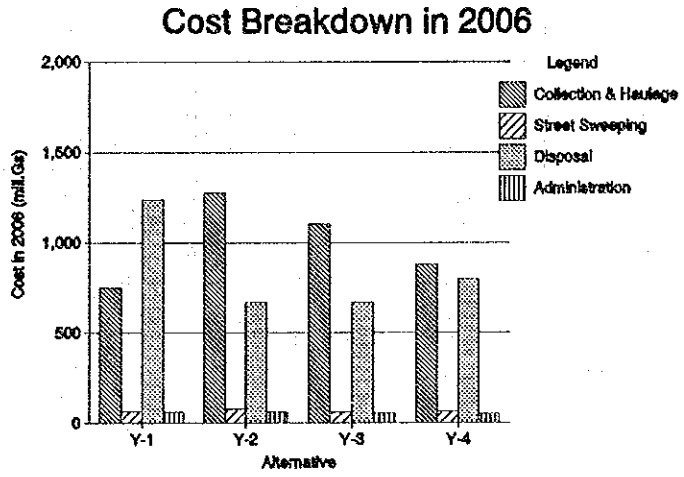


Figure H.5.3.1b Illustration of Annual MSWM Expenses in 2006 for San Lorenzo

Table H.5.3.1c Annual MSWM Expense in 2006 for Capiata

Capiata	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	751	1,280	1,102	882
	Unit (Gs/ton)	19,780	33,732	28,739	23,229
1.1 Collection & Haulage	Total (mill.Gs)	751	1,280	701	882
	Unit (Gs/ton)	19,780	33,732	18,465	23,229
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	401	
	Unit (Gs/ton)	0	0	10,274	0
2. Street Sweeping	Total (mill.Gs)	64	79	62	67
	Unit (mill.Gs/km/year)	5.29	6.57	5.17	5.61
Sub-total	Total (mill.Gs)	815	1,359	1,310	949
	Unit (Gs/ton)	20,868	34,797	33,542	24,299
3. Final Disposal	Total (mill.Gs)	1,239	671	671	797
	Unit (Gs/ton)	31,724	17,191	17,191	20,414
4. Administration	L.S.	62	61	55	52
Total Cost in 2006	(mill.Gs)	2,116	2,091	1,890	1,799
Cost per Collection Amount	(Gs/ton)	54,170	53,548	48,405	46,054





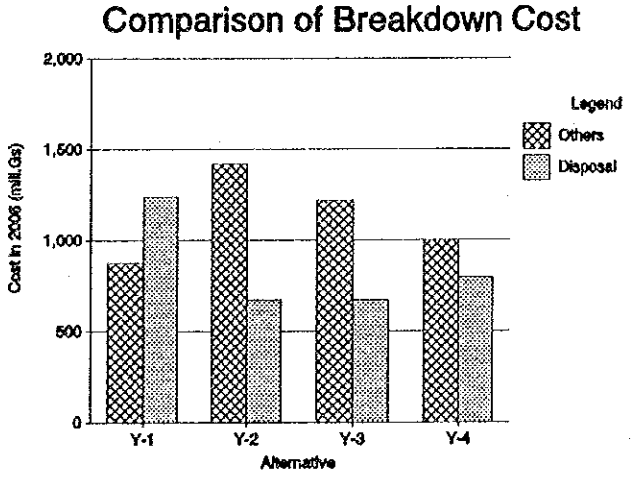
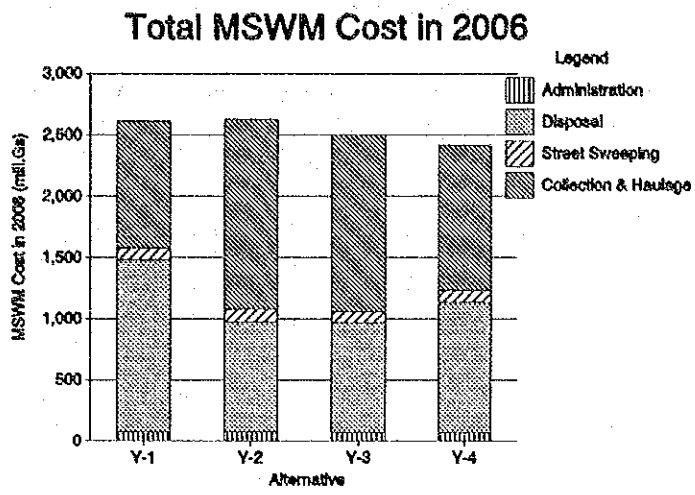
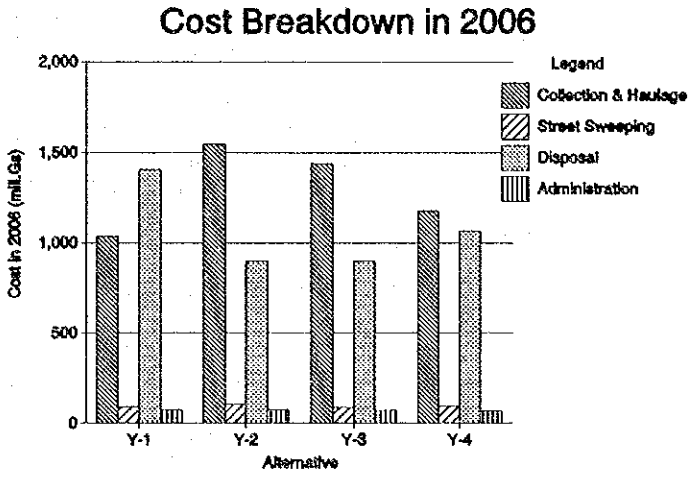


Figure H.5.3.1c Illustration of Annual MSWM Expenses in 2006 for Capiata

Table H.5.3.1d Annual MSWM Expense in 2006 for Luque

Luque	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	1,036	1,547	1,439	1,179
	Unit (Gs/ton)	20,428	30,500	28,079	23,229
1.1 Collection & Haulage	Total (mill.Gs)	1,036	1,547	937	1,179
	Unit (Gs/ton)	20,428	30,500	18,465	23,229
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	502	0
	Unit (Gs/ton)	0	0	9,614	0
2. Street Sweeping	Total (mill.Gs)	93	107	90	97
	Unit (mill.Gs/km/year)	5.14	5.96	4.99	5.37
Sub-total	Total (mill.Gs)	1,129	1,654	1,722	1,276
	Unit (Gs/ton)	21,630	31,689	32,992	24,447
3. Final Disposal	Total (mill.Gs)	1,407	897	897	1,066
	Unit (Gs/ton)	26,948	17,191	17,191	20,414
4. Administration	L.S.	76	77	73	70
Total Cost in 2006	(mill.Gs)	2,612	2,628	2,499	2,412
Cost per Collection Amount	(Gs/ton)	50,045	50,346	47,880	46,207





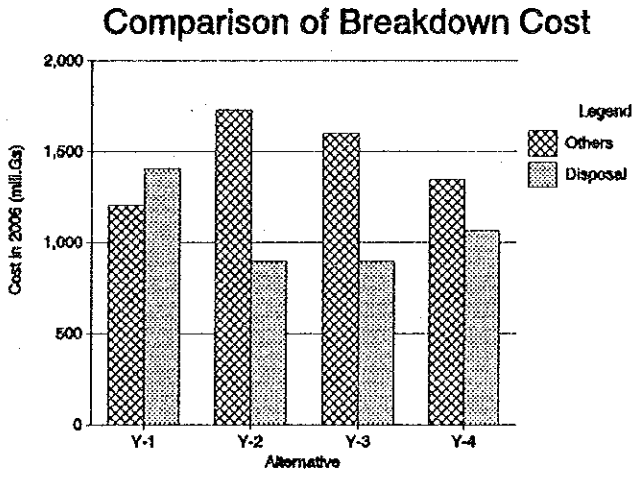
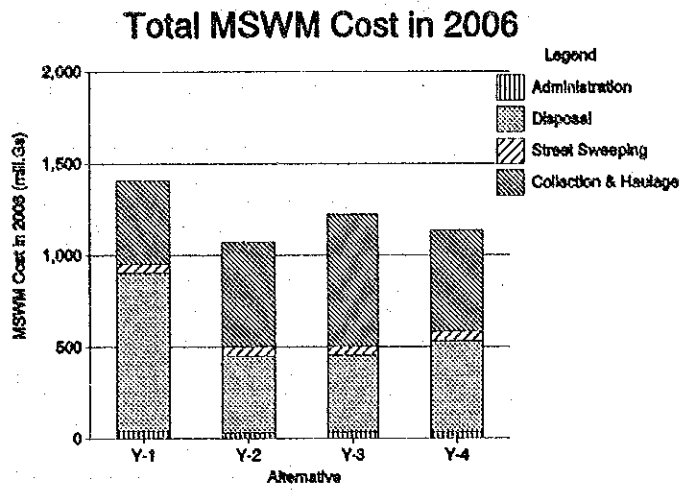
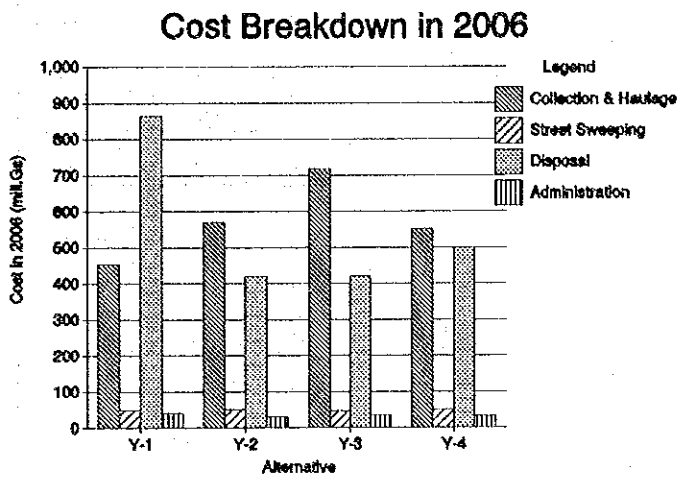


Figure H.5.3.1d Illustration of Annual MSWM Expenses in 2006 for Luque

Table H.5.3.1e Annual MSWM Expense in 2006 for M.R.Alonso

M.R.Alonso	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	454	570	718	551
	Unit (Gs/ton)	19,131	24,037	29,899	23,229
1.1 Collection & Haulage	Total (mill.Gs)	454	570	438	551
	Unit (Gs/ton)	19,131	24,037	18,465	23,229
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	280	0
	Unit (Gs/ton)	0	0	11,434	0
2. Street Sweeping	Total (mill.Gs)	49	52	48	52
	Unit (mill.Gs/km/year)	4.88	5.24	4.84	5.18
Sub-total	Total (mill.Gs)	503	622	868	603
	Unit (Gs/ton)	20,568	25,434	35,494	24,658
3. Final Disposal	Total (mill.Gs)	864	420	420	499
	Unit (Gs/ton)	35,314	17,191	17,191	20,414
4. Administration	L.S.	41	31	36	33
Total Cost in 2006	(mill.Gs)	1,408	1,074	1,222	1,135
Cost per Collection Amount	(Gs/ton)	57,559	43,904	49,969	46,424





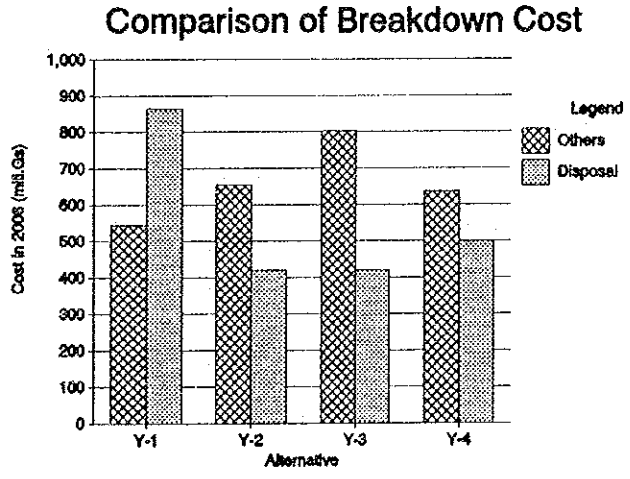


Figure H.5.3.1e Illustration of Annual MSWM Expenses in 2006 for M.R.Alonso

Table H.5.3.1f Annual MSWM Expense in 2006 for Villa Elisa

Villa Elisa	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	412	709	679	500
	Unit (Gs/ton)	19,131	32,924	30,502	23,229
1.1 Collection & Haulage	Total (mill.Gs)	412	709	398	500
	Unit (Gs/ton)	19,131	32,924	18,465	23,229
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	281	0
	Unit (Gs/ton)	0	0	12,037	0
2. Street Sweeping	Total (mill.Gs)	105	130	103	112
	Unit (mill.Gs/km/year)	5.23	6.49	5.17	5.61
Sub-total	Total (mill.Gs)	517	839	889	612
	Unit (Gs/ton)	22,132	35,916	38,057	26,199
3. Final Disposal	Total (mill.Gs)	816	402	402	477
	Unit (Gs/ton)	34,937	17,191	17,191	20,414
4. Administration	L.S.	40	37	36	33
Total Cost in 2006	(mill.Gs)	1,373	1,278	1,219	1,122
Cost per Collection Amount	(Gs/ton)	58,781	54,700	52,187	48,011

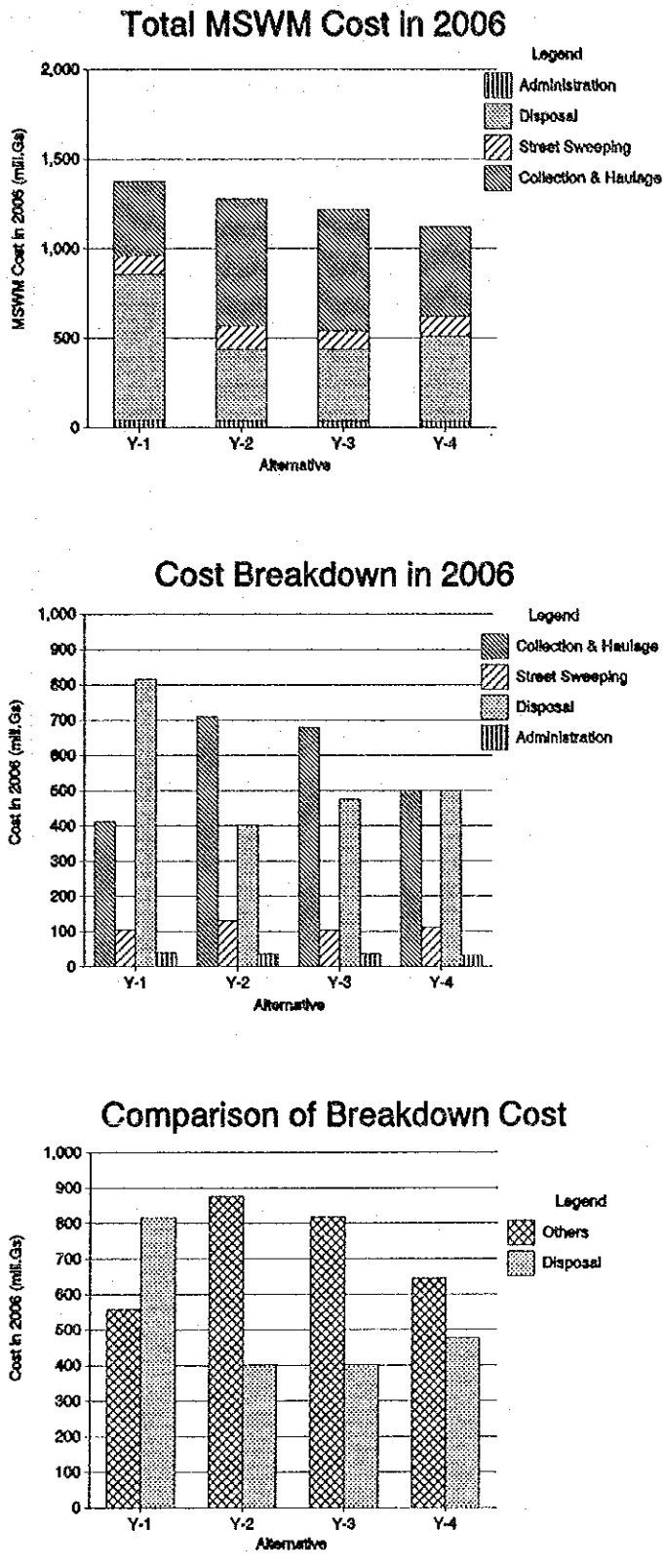
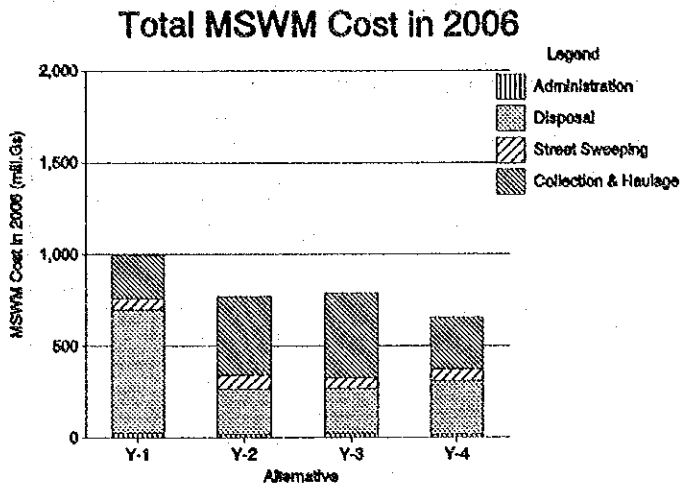
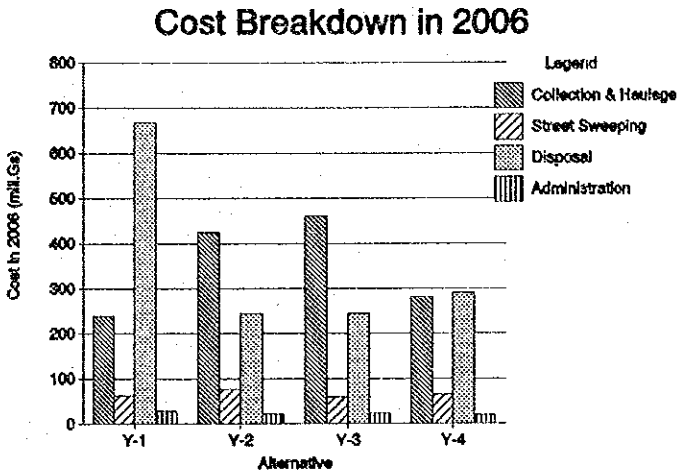


Figure H.5.3.1f Illustration of Annual MSWM Expenses in 2006 for Villa Elisa

Table H.5.3.1g Annual MSWM Expense in 2006 for Nemby

Nemby	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	240	425	462	282
	Unit (Gs/ton)	18,294	32,316	33,655	21,482
1.1 Collection & Haulage	Total (mill.Gs)	240	425	217	282
	Unit (Gs/ton)	18,294	32,316	16,477	21,482
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	245	0
	Unit (Gs/ton)	0	0	17,178	0
2. Street Sweeping	Total (mill.Gs)	62	77	60	65
	Unit (mill.Gs/km/year)	5.16	6.44	4.99	5.45
Sub-total	Total (mill.Gs)	302	502	652	347
	Unit (Gs/ton)	21,215	35,265	45,803	24,377
3. Final Disposal	Total (mill.Gs)	669	245	245	291
	Unit (Gs/ton)	46,972	17,191	17,191	20,414
4. Administration	L.S.	29	22	23	19
Total Cost in 2006	(mill.Gs)	1,000	769	790	657
Cost per Collection Amount	(Gs/ton)	70,233	54,030	55,477	46,134





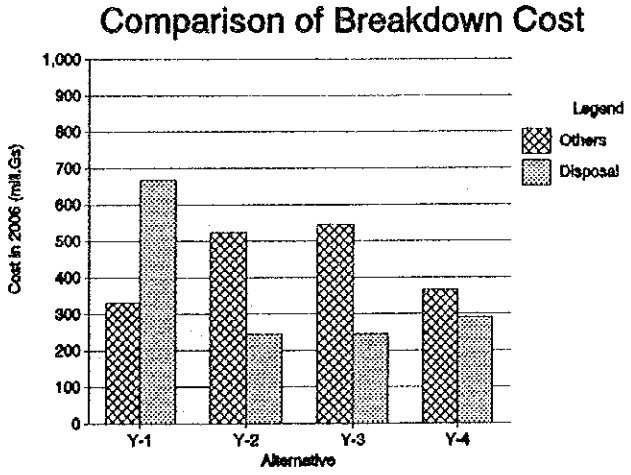
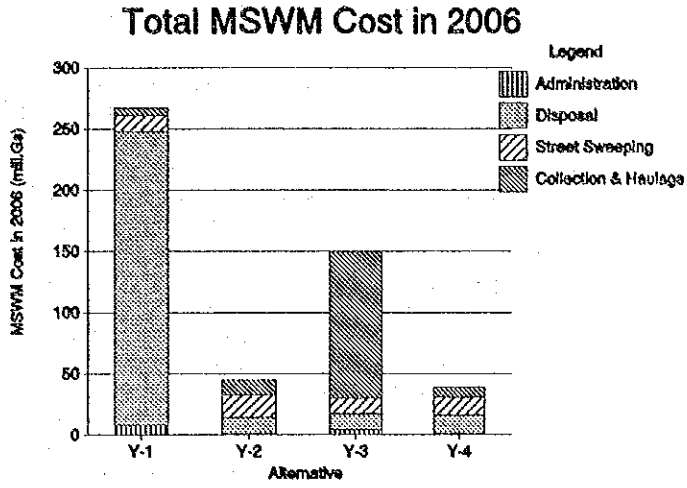
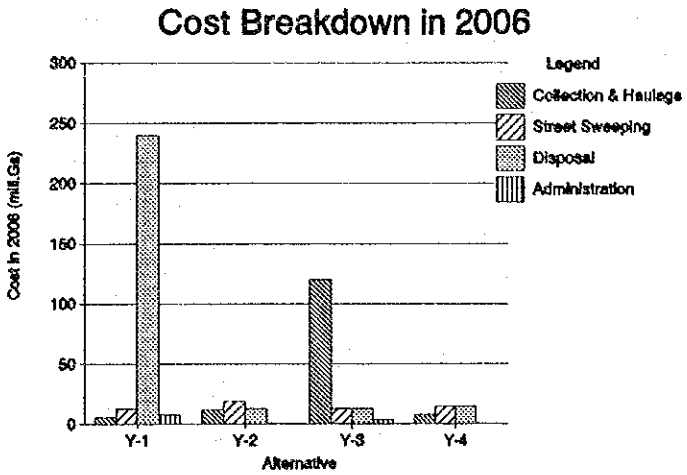


Figure H.5.3.1g Illustration of Annual MSWM Expenses in 2006 for Nemby

Table H.5.3.1h Annual MSWM Expense in 2006 for Saldivar

Saldivar	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	6	12	120	8
	Unit (Gs/ton)	17,094	33,437	173,208	21,482
1.1 Collection & Haulage	Total (mill.Gs)	6	12	6	8
	Unit (Gs/ton)	17,094	33,437	16,477	21,482
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	114	0
	Unit (Gs/ton)	0	0	156,731	0
2. Street Sweeping	Total (mill.Gs)	13	19	13	15
	Unit (mill.Gs/km/year)	6.61	9.59	6.49	7.41
Sub-total	Total (mill.Gs)	19	31	140	23
	Unit (Gs/ton)	26,027	42,466	191,781	31,507
3. Final Disposal	Total (mill.Gs)	240	13	13	15
	Unit (Gs/ton)	328,704	17,191	17,191	20,414
4. Administration	L.S.	8	1	4	1
Total Cost in 2006	(mill.Gs)	267	45	150	39
Cost per Collection Amount	(Gs/ton)	365,438	61,446	205,364	53,478





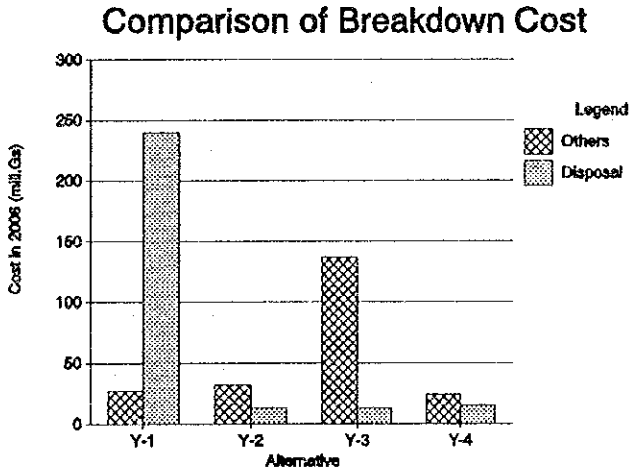
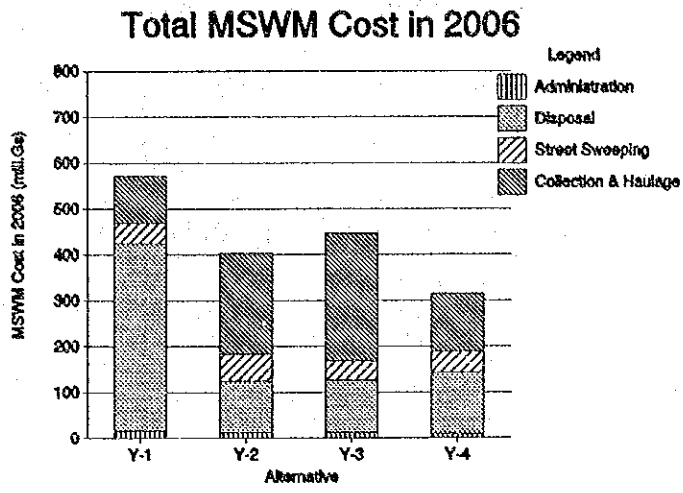
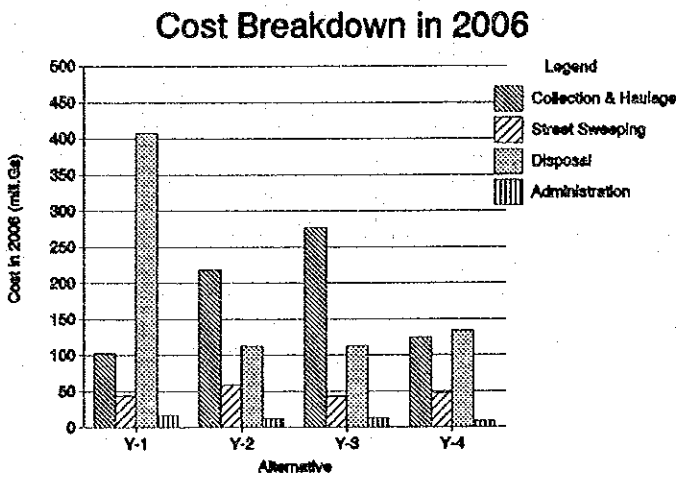


Figure H.5.3.1h Illustration of Annual MSWM Expenses in 2006 for Saldivar

Table H.5.3.1i Annual MSWM Expense in 2006 for Ita

Ita	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	103	219	277	125
	Unit (Gs/ton)	17,694	37,547	47,491	21,482
1.1 Collection & Haulage	Total (mill.Gs)	103	219	96	125
	Unit (Gs/ton)	17,694	37,547	16,477	21,482
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	181	0
	Unit (Gs/ton)	0	0	27,525	0
2. Street Sweeping	Total (mill.Gs)	44	59	43	47
	Unit (mill.Gs/km/year)	4.92	6.53	4.82	5.23
Sub-total	Total (mill.Gs)	147	278	380	172
	Unit (Gs/ton)	22,374	42,314	57,839	26,180
3. Final Disposal	Total (mill.Gs)	408	113	113	134
	Unit (Gs/ton)	62,138	17,191	17,191	20,414
4. Administration	L.S.	17	12	13	9
Total Cost in 2006	(mill.Gs)	572	403	446	315
Cost per Collection Amount	(Gs/ton)	87,048	61,290	67,874	47,991





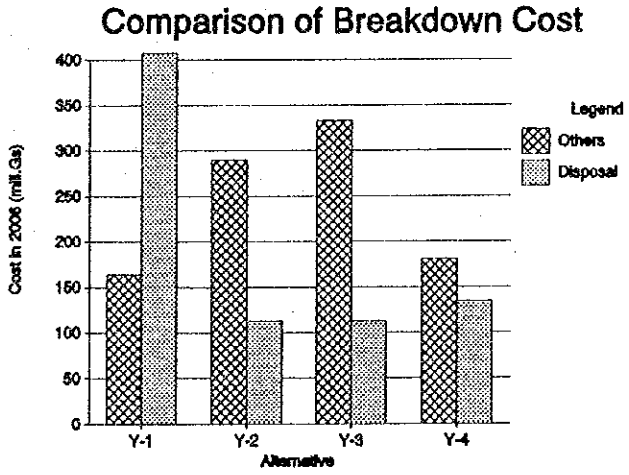


Figure H.5.3.1i Illustration of Annual MSWM Expenses in 2006 for Ita

Table H.5.3.1j Annual MSWM Expense in 2006 for Aregua

Aregua	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	20	36	133	24
	Unit (Gs/ton)	18,294	32,690	79,686	21,482
1.1 Collection & Haulage	Total (mill.Gs)	20	36	18	24
	Unit (Gs/ton)	18,294	32,690	16,477	21,482
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	115	0
	Unit (Gs/ton)	0	0	63,209	0
2. Street Sweeping	Total (mill.Gs)	38	48	36	40
	Unit (mill.Gs/km/year)	5.40	6.90	5.21	5.73
Sub-total	Total (mill.Gs)	58	84	186	64
	Unit (Gs/ton)	31,781	46,027	101,918	35,068
3. Final Disposal	Total (mill.Gs)	302	31	31	37
	Unit (Gs/ton)	165,282	17,191	17,191	20,414
4. Administration	L.S.	11	3	6	3
Total Cost in 2006	(mill.Gs)	371	119	206	104
Cost per Collection Amount	(Gs/ton)	203,178	65,115	113,088	57,147

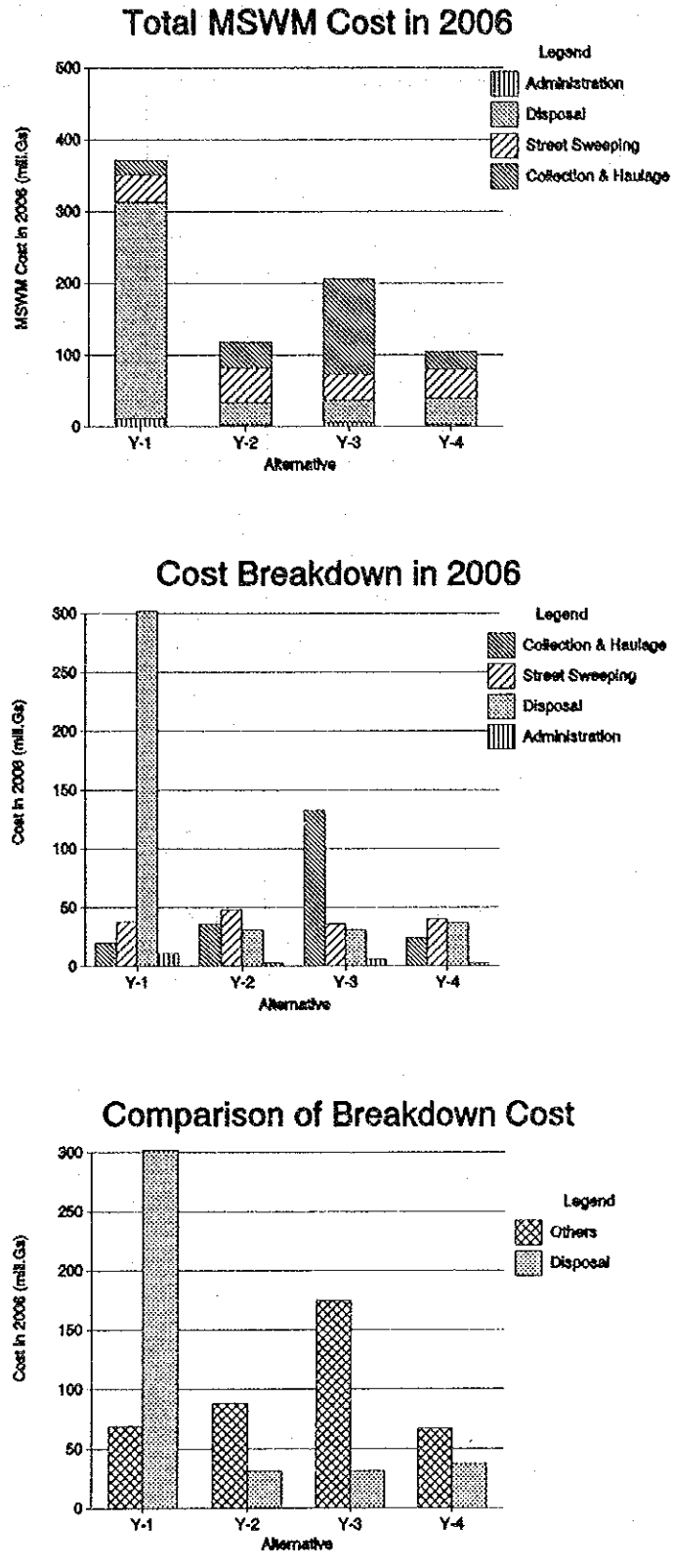
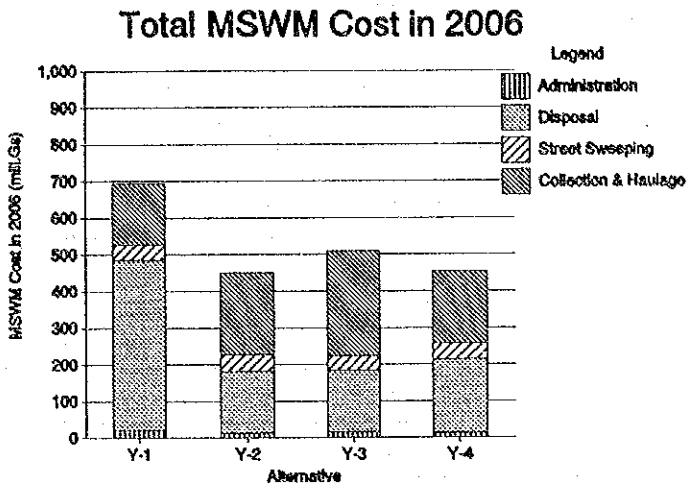
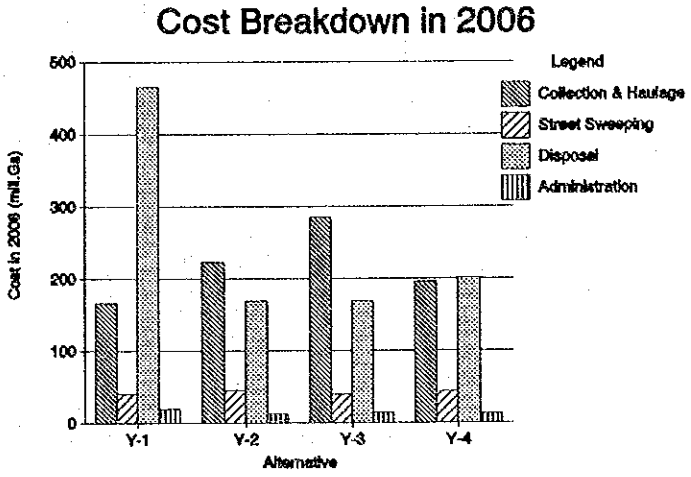


Figure H.5.3.1j Illustration of Annual MSWM Expenses in 2006 for Aregua

Table H.5.3.1k Annual MSWM Expense in 2006 for Limpio

Limpio	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	167	223	285	196
	Unit (Gs/ton)	18,294	24,471	30,151	21,482
1.1 Collection & Haulage	Total (mill.Gs)	167	223	150	196
	Unit (Gs/ton)	18,294	24,471	16,477	21,482
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	135	0
	Unit (Gs/ton)	0	0	13,674	0
2. Street Sweeping	Total (mill.Gs)	41	46	40	44
	Unit (mill.Gs/km/year)	5.16	5.72	4.99	5.45
Sub-total	Total (mill.Gs)	208	269	415	240
	Unit (Gs/ton)	21,106	27,296	42,111	24,353
3. Final Disposal	Total (mill.Gs)	466	169	169	201
	Unit (Gs/ton)	47,247	17,191	17,191	20,414
4. Administration	L.S.	20	13	15	13
Total Cost in 2006	(mill.Gs)	694	452	509	454
Cost per Collection Amount	(Gs/ton)	70,404	45,821	51,674	46,110





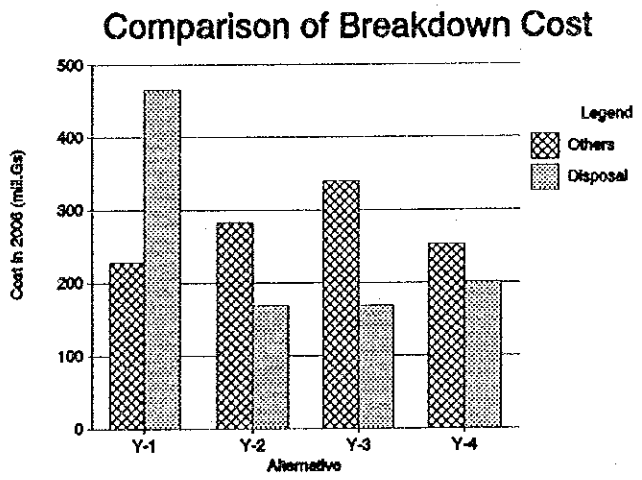
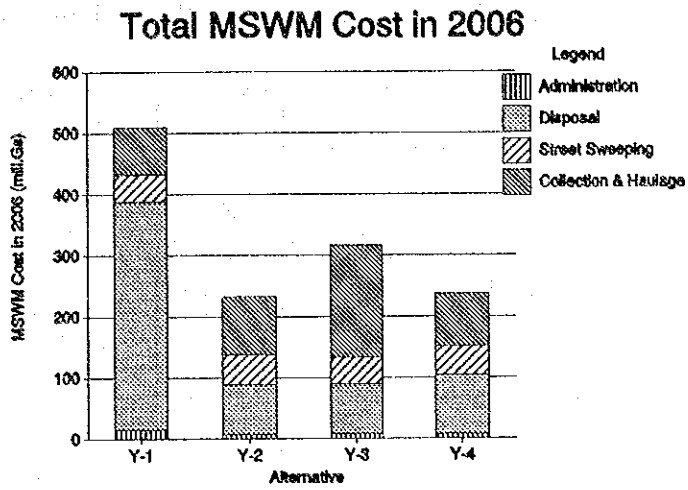
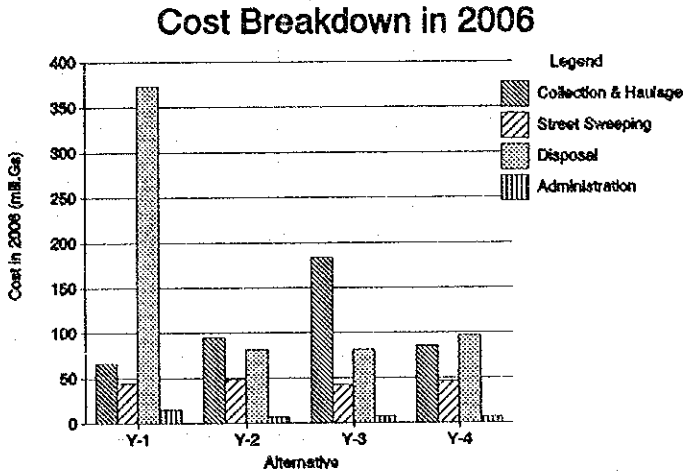


Figure H.5.3.1k Illustration of Annual MSWM Expenses in 2006 for Limpio

Table H.5.3.11 Annual MSWM Expense in 2006 for Villa Hayes

Villa Hayes	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	76	95	184	86
	Unit (Gs/ton)	18,894	23,724	41,352	21,482
1.1 Collection & Haulage	Total (mill.Gs)	76	95	66	86
	Unit (Gs/ton)	18,894	23,724	16,477	21,482
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	118	0
	Unit (Gs/ton)	0	0	24,875	0
2. Street Sweeping	Total (mill.Gs)	45	49	43	47
	Unit (mill.Gs/km/year)	5.02	5.41	4.82	5.23
Sub-total	Total (mill.Gs)	121	144	270	133
	Unit (Gs/ton)	25,501	30,348	56,902	28,030
3. Final Disposal	Total (mill.Gs)	373	82	82	97
	Unit (Gs/ton)	78,534	17,191	17,191	20,414
4. Administration	L.S.	15	7	8	7
Total Cost in 2006	(mill.Gs)	508	232	262	237
Cost per Collection Amount	(Gs/ton)	107,156	48,965	55,297	49,897





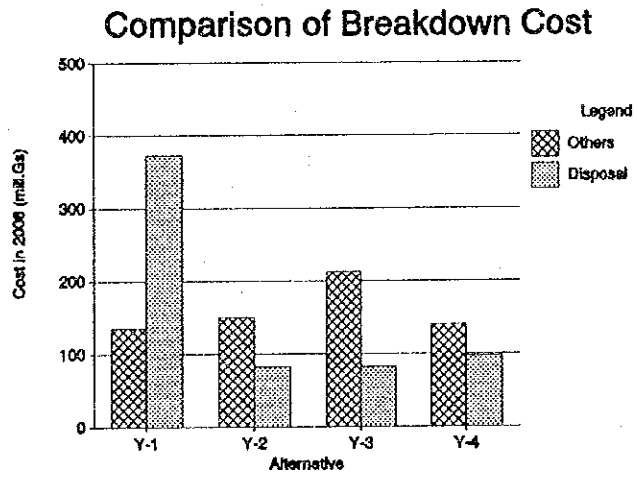
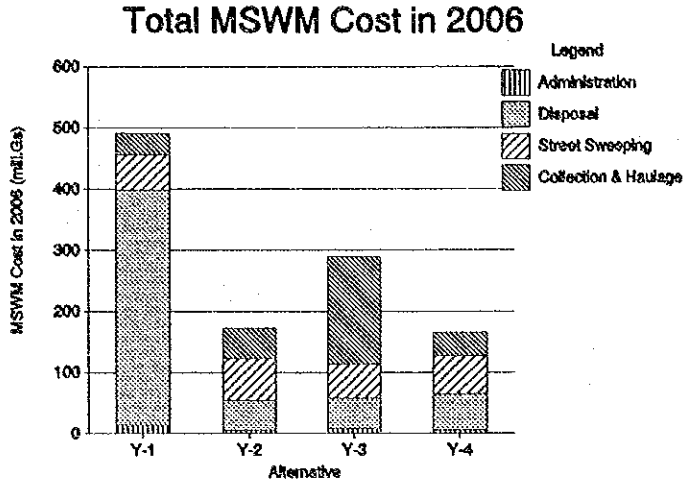
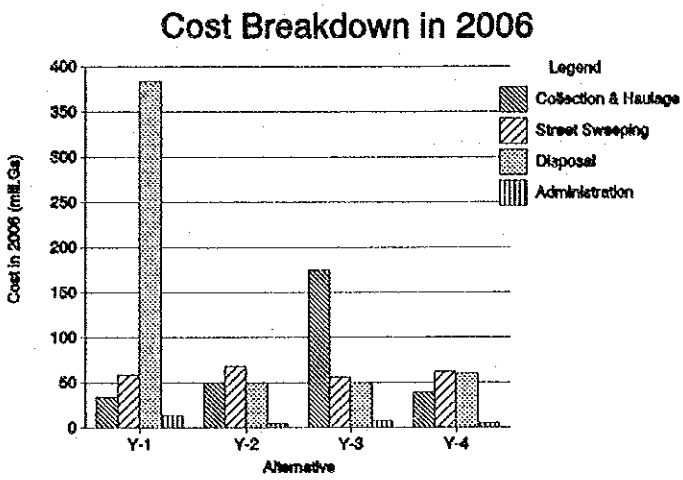


Figure H.5.3.11 Illustration of Annual MSWM Expenses in 2006 for Villa Hayes

Table H.5.3.1m Annual MSWM Expense in 2006 for Benjamin Aceval

Benjamin Aceval	Unit	Y-1	Y-2	Y-3	Y-4
1. Total Collection & Haulage	Total (mill.Gs)	34	50	175	39
	Unit (Gs/ton)	18,894	27,460	66,206	21,482
1.1 Collection & Haulage	Total (mill.Gs)	34	50	30	39
	Unit (Gs/ton)	18,894	27,460	16,477	21,482
1.2 Transfer Operation & Haulage	Total (mill.Gs)	0	0	119	0
	Unit (Gs/ton)	0	0	40,593	0
2. Street Sweeping	Total (mill.Gs)	59	68	56	62
	Unit (mill.Gs/km/year)	5.37	6.22	5.13	5.63
Sub-total	Total (mill.Gs)	93	118	231	101
	Unit (Gs/ton)	31,849	40,411	79,110	34,589
3. Final Disposal	Total (mill.Gs)	384	50	50	60
	Unit (Gs/ton)	131,426	17,191	17,191	20,414
4. Administration	L.S.	14	5	8	5
Total Cost in 2006	(mill.Gs)	491	173	290	165
Cost per Collection Amount	(Gs/ton)	168,174	59,330	99,190	56,653





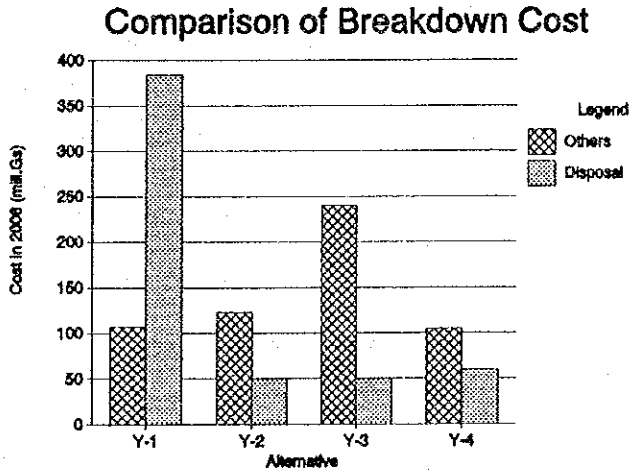


Figure H.5.3.1m Illustration of Annual MSWM Expenses in 2006 for Benjamin Aceval

H.5.3.2 Evaluation

a. Method

Generally, the optimum technical system would be selected by evaluating the following aspects:

- technical points of view;
- economical and financial points of view;
- environmental points of view; and
- social points of view.

The evaluation in this report, however, is carried out by stressing financial points of view and the other aspects are only briefly described on some important points. Consequently, the least cost method on the financial aspects; i.e. basically, the alternative which requires the minimum annual expense for MSWM in 2006 is to be selected as the optimum alternative for each municipality. The reasons why we take the method in this report are described below:

- In response to the request from Paraguayan side, the technical system alternatives for the formulation of MSWM Master Plan should be prepared for each municipality individually. Each municipality has 4 or 5 alternatives and total number of alternatives comes to 62. This makes it very difficult to explain the above-mentioned four items regarding each alternative.
- 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) it seems to be no technical difficulty observed in the alternatives presented.
- The social aspects, such as the possibility of inter-municipal cooperation regarding operation of transfer stations, landfill and collection equipment, is subject to the decision to be made at the time of the IT/R meeting.

b. Evaluation for Lambare Municipality

ba. Conclusion by the Study Team

As for the optimum technical system for Lambare Municipality, we propose the Municipality 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 the municipality.

bb. Evaluation

bba. Summary

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 the municipality; i.e. outside of the jurisdiction of Lambare Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.
- Compared with the present technical system, the proposed system was more environmentally acceptable.

The details of the evaluation are described below.

bbb. Technical Evaluation

i. Working conditions

Workers involved in solid waste management are engaged in different types of work determined by such processes as collection, transportation, operation of transfer station and final disposal. The following two types of works in particular require improved working conditions to ensure both safety and hygiene.

- loading of solid waste into collection trucks; and
- landfill work at disposal site.

Since the same technical systems will be applied to the discharge/storage, collection and final disposal, there is little difference on working conditions among the 4 alternatives.

ii. Operation and maintenance

Operation and maintenance difficulties in the disposal site are estimated to be

almost the same at every alternative plan.

iii. Construction

The technology used in Paraguay presently will be good enough for the construction of the landfill except for heavy equipment.

bbc. Social Evaluation

i. Possibility of land acquisition

The acquisition of the land for the inter-municipal landfill site 15 km away from the center of the urban area of the municipalities seems to be rather difficult. Therefore, the municipalities should make every effort to find an inter-municipal landfill in cooperation with the other municipalities.

ii. Compatibility with regional development plans

Although the Urban Development Master Plan is not established in the Study area, the future landfill site shall be identified in compatibility with the regional development plans to be prepared.

iii. Possibility of acquiring neighborhood consensus

The future landfill site shall be identified with careful consideration of possibility of acquiring neighborhood consensus.

iv. Transactional facilitation

Obtaining the approval of the neighborhood and the municipality, where the inter-municipal landfill will be located, would require certain efforts due to the possibilities of adverse environmental impact by the operation of the landfill. Therefore, it is necessary for the municipality to make every effort to obtain the approval of the neighborhood and the municipality where the landfill will be located.

bbd. Environmental Evaluation

i. Surface water pollution, groundwater pollution and soil contamination

There is still a small possibility of leachate seepage even if a liner is applied at the proposed landfill to prevent groundwater pollution.

ii. Odor

Among the facilities, the landfill, followed by the transfer stations, produces a lot of pungent odor.

iii. Dust and scattered wastes

The production of dusts and scattered wastes is difficult to prevent in landfill sites regardless of the perfect and immediate execution of the earth coverage operation.

iv. Traffic noise and safety

This impact is related to the traffic volume to the MSWM facilities. Only a small difference will be observed among the 4 alternatives.

v. Operation noise

The biggest sources of noise at the landfill site are from heavy construction machines and incoming vehicles.

vi. Impact on landscape

In terms of the required scale for the final disposal site, the impacts of Alternative Y-1 is bigger than the other alternatives because the site will be located in the vicinity of the urban area of the municipality.

c. Evaluation for San Lorenzo Municipality

ca. Conclusion by the Study Team

As for the optimum technical system for San Lorenzo Municipality, we propose the Municipality 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 the municipality.

cb. Evaluation

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 of the urban area of the municipality; i.e. outside of the jurisdiction of San Lorenzo Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.
- Compared with the present technical system, the proposed system is more environmentally acceptable.

The details of the evaluation are the same as those for Lambare as described in the previous section.

d. Evaluation for Capiata Municipality

da. Conclusion by the Study Team

As for the optimum technical system for Capiata Municipality, we propose the Municipality 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 the municipality.

db. Evaluation

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 of the urban area of the municipality; i.e. outside of the jurisdiction of Capiata Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.
- Compared with the present technical system, the proposed system is more environmentally acceptable.

The details of the evaluation are the same as those for Lambare as described in the

previous section.

e. Evaluation for Luque Municipality

ea. Conclusion by the Study Team

As for the optimum technical system for Luque Municipality, we propose the Municipality 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 the municipality.

eb. Evaluation

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 of the urban area of the municipality; i.e. outside of the jurisdiction of Luque Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.
- Compared with the present technical system, the proposed system is more environmentally acceptable.

The details of the evaluation are the same as those for Lambare as described in the previous section.

f. Evaluation for M.R.Alonso Municipality

fa. Conclusion by the Study Team

As for the optimum technical system for M.R.Alonso Municipality, we propose the Municipality to select the Alternative Y-2; that is

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

fb. Evaluation

fba. Summary

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 in Chaco; i.e. outside of the jurisdiction of M.R.Alonso Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.
- Compared with the present technical system, the proposed system is more environmentally acceptable.

The details of the evaluation are described below.

fbb. Technical Evaluation

i. Working conditions

Workers involved in solid waste management are engaged in different types of work determined by such processes as collection, transportation, operation of transfer station and final disposal. The following two types of works in particular require improved working conditions to ensure both safety and hygiene.

- loading of solid waste into collection trucks; and
- landfill work at disposal site.

Since the same technical systems will be applied to the discharge/storage, collection and final disposal, there is little difference on working conditions among the 4 alternatives.

ii. Operation and maintenance

Operation and maintenance difficulties in the disposal site are estimated to be almost the same at every alternative plan.

iii. Construction

The technology used in Paraguay presently will be good enough for the con-

struction of the landfill except for heavy equipment.

fbc. Social Evaluation

i. Possibility of land acquisition

The acquisition of the land for the inter-municipal landfill site seems to be rather easy.

ii. Compatibility with regional development plans

Although the Urban Development Master Plan is not established in the Study area, the A-5 site will not meet with problem of this matter.

iii. Possibility of acquiring neighborhood consensus

Since the nearest residence is located 1,000 m away from the border of the A-5 site, there seems to be no problems on this matter. However, it may require to give some benefits to the Villa Hayes Municipality for the approval of landfill operation.

iv. Transactional facilitation

Obtaining the approval of the neighborhood and Villa Hayes Municipality would require certain efforts due to the possibilities of adverse environmental impact by the operation of the landfill. Therefore, it is necessary to involve Villa Hayes Municipality for the inter-municipal landfill operation at the A-5 site.

fbd. Environmental Evaluation

i. Surface water pollution, groundwater pollution and soil contamination

There is still a minimum possibility of leachate seepage even if a liner is applied at the proposed landfill to prevent groundwater pollution.

ii. Odor

Among the facilities, the landfill, followed by the transfer stations, produces a lot of pungent odor.

iii. Dust and scattered wastes

The production of dusts and scattered wastes is difficult to prevent in landfill sites regardless of the perfect and immediate execution of the earth coverage operation.

iv. Traffic noise and safety

This impact is related to the traffic volume to the MSWM facilities. Only a small difference will be observed among the 4 alternatives.

v. Operation noise

The big sources of noise at the landfill site are heavy construction machines and incoming vehicles.

vi. Impact on landscape

In terms of the required scale for the final disposal site, the impacts of Alternative Y-1 is bigger than the other alternatives because the site will locate in the vicinity of the urban area of the municipality.

g. Evaluation for Villa Elisa Municipality

ga. Conclusion by the Study Team

As for the optimum technical system for Villa Elisa Municipality, we propose the Municipality 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 the municipality.

gb. Evaluation

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.
- In the social points of view, there will be some difficulties such as setting-up the inter-municipal disposal site 15 km away from the of

the urban area of the municipality; i.e. outside of the jurisdiction of Villa Elisa Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.

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

The details of the evaluation are the same as those for Lambare as described in the previous section.

h. Evaluation for Nemby Municipality

ha. Conclusion by the Study Team

As for the optimum technical system for Nemby Municipality, we propose the Municipality 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 the municipality.

hb. Evaluation

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.
- In the social points of view, there will be some difficulties such as setting-up the inter-municipal disposal site 15 km away from the of the urban area of the municipality; i.e. outside of the jurisdiction of Nemby Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.
- Compared with the present technical system, the proposed system is more environmentally acceptable.

The details of the evaluation are the same as those for Lambare as described in the previous section.

i. Evaluation for J.A.Saldivar Municipality

ia. Conclusion by the Study Team

As for the optimum technical system for J.A.Saldivar Municipality, we propose the Municipality 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 the municipality.

ib. Evaluation

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.
- In the social points of view, there will be some difficulties such as setting-up the inter-municipal disposal site 15 km away from the of the urban area of the municipality; i.e. outside of the jurisdiction of Saldivar Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.
- Compared with the present technical system, the proposed system is more environmentally acceptable.

The details of the evaluation are the same as those for Lambare as described in the previous section.

j. Evaluation for Ita Municipality

ja. Conclusion by the Study Team

As for the optimum technical system for Ita Municipality, we propose the Municipality 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 the municipality.

jb. Evaluation

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.
- In the social points of view, there will be some difficulties such as setting-up the inter-municipal disposal site 15 km away from the of the urban area of the municipality; i.e. outside of the jurisdiction of Ita Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.
- Compared with the present technical system, the proposed system is more environmentally acceptable.

The details of the evaluation are the same as those for Lambare as described in the previous section.

k. Evaluation for Aregua Municipality

ka. Conclusion by the Study Team

As for the optimum technical system for Aregua Municipality, we propose the Municipality 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 the municipality.

kb. Evaluation

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.
- In the social points of view, there will be some difficulties such as setting-up the inter-municipal disposal site 15 km away from the of the urban area of the municipality; i.e. outside of the jurisdiction of Aregua Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.

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

The details of the evaluation are the same as those for Lambare as described in the previous section.

l. Evaluation for Limpio Municipality

la. Conclusion by the Study Team

As for the optimum technical system for Limpio Municipality, we propose the Municipality to select the Alternative Y-2; that is

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

lb. Evaluation

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.
- In the social points of view, there will be some difficulties such as setting-up the inter-municipal disposal site in Chaco; i.e. outside of the jurisdiction of Limpio Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.
- Compared with the present technical system, the proposed system is more environmentally acceptable.

The details of the evaluation are the same as those for M.R.Alonso as described in the previous section.

m. Evaluation for Villa Hayes Municipality

ma. Conclusion by the Study Team

As for the optimum technical system for Villa Hayes Municipality, we propose the Municipality to select the Alternative Y-2; that is

Inter-municipal disposal
An inter-municipal sanitary landfill at the A-5 without a transfer station.

mb. Evaluation

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.
- In the social points of view, there will be some difficulties such as setting-up the inter-municipal disposal site within the jurisdiction of Villa Hayes Municipality especially to obtain consensus of the citizen in the municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.
- Compared with the present technical system, the proposed system is more environmentally acceptable.

The details of the evaluation are the same as those for M.R.Alonso as described in the previous section.

n. Evaluation for Benjamin Aceval Municipality

na. Conclusion by the Study Team

As for the optimum technical system for Benjamin Aceval Municipality, we propose the Municipality to select the Alternative Y-2; that is

Inter-municipal disposal
An inter-municipal sanitary landfill at the A-5 without a transfer station.

nb. Evaluation

The summary of evaluation is as follows:

- Although Y-2 is the second least cost alternative, the Alternative Y-4 is not possible because the Municipality of Villa Hayes shall take the Alternative Y-2.
- There is no technical difficulty observed in comparison with the other alternatives.
- In the social points of view, there will be some difficulties such as

setting-up the inter-municipal disposal site at the A-5 in Villa Hayes; i.e. outside of the jurisdiction of Benjamin Aceval Municipality. However, the resolution of these matters was discussed with the Paraguayan side at the IT/R meeting.

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

The details of the evaluation are the same as those for M.R.Alonso as described in the previous section.

o. Summary of Evaluation

The summary of the alternative evaluation is presented in Table H.5.3.2a.

Table H.5.3.2a Summary of alternative Evaluation

Municipality	Waste Disposal 1997--2006 (ton)	Waste Disposal in 2006 (ton)	Total Cost of Each Alternative in 2006 Upper(total cost):mill.Gs Lower(cost per year):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 alterative.

* 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.

H.5.3.3 Financial Evaluation

Financial evaluation consists of the least cost method to be selected among different alternatives for each city estimated in Section H.5.3.1. Further, a comparative analysis was conducted between the least cost alternative and the estimated revenues.

For revenue estimation, the number of households in 1992 was used to project using the assumed population growth rates in 2006. 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%. Table H.5.3.3a shows the resulting estimated revenues broken down by type of beneficiaries.

For Urbanized and Less Urbanized Municipalities, the least cost alternatives in relation to estimated revenues are shown below.

Table H.5.3.3a 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.

Table H.5.3.3b Estimated Total Revenues in 2006 (Assuming 80% Collection Rate)

Unit: 1,000 Guarani

Municipality Type	Household	Food Shops	Other Shops	Market Shops	Estimated Revenues
Highly Urbanized	**12,063,441**	**110,700**	**9,520,015**	**408,726**	**22,102,882**
1. Asuncion	9,887,090	79,380	8,540,086	408,726	18,915,282
2. F.Mora	2,176,351	31,320	979,930	0	3,187,601
Urbanized	**6,957,153**	**34,310**	**1,454,766**	**21,661**	**8,467,891**
3. Lambare	1,453,790	9,721	319,726	0	1,783,238
4. San Lorenzo	1,602,644	9,175	419,619	21,661	2,053,099
5. Capiata	1,132,689	4,068	219,747	0	1,356,503
6. Luque	1,444,305	6,002	306,332	0	1,756,640
7. M.R. Alonso	678,724	2,791	111,904	0	793,419
8. Villa Elisa	645,000	2,553	77,438	0	724,991
Less Urbanized	**1,040,250**	**5,285**	**389,191**	**5,561**	**1,440,287**
9. Nemby	347,009	1,780	137,320	0	486,109
10. J.A. Saldivar	18,507	76	5,404	0	23,988
11. Ita	138,481	926	60,450	4,327	204,184
12. Aregua	33,350	280	29,897	0	63,527
13. Limpio	213,454	1,195	124,705	1,234	340,588
14. Villa Hayes	217,486	748	15,776	0	234,010
15. B. Aceval	71,963	280	15,638	0	87,882
TOTAL	20,060,843	150,296	11,363,973	435,948	32,011,061

H.6 Institutional Requirements

H.6.1 Private Versus Public Participation in MSWM

Municipal Solid Waste Management is a public service and as such, it always should be managed by a level of Government usually represented by the municipalities or any other local level authority, while provision of the services may not stay as a governmental task.

This is an almost universal occurrence, varying only in the degree of the involvement of the public sector which ranges from operating by its own means all the system or only exercising its regulatory and control power.

In the study area many different situations appear, including, in some of the less urbanized cities, a case where there is no government involvement at all.

Concerning most usual cases of system operation, i.e.,the collection (and sometimes the street cleaning) activities, basically three situations usually can occur:

a. Operation is fully made by the municipality, with it's own personnel and equipments,services being provided by an independent authority (such as a municipal company) or by the regular municipal administrative structure usually a municipal department or sector under the control of the Public Works, Public Health or Public Services Department.

   In this case, funding comes from the Municipal Treasury which, in turn, charges households through the local taxation system.

   The alternative of the municipality working as an independent authority such as a Public Corporation, is commonly made so to avoid the red tape and managerial constraints (specially the salaries structure), unavoidable to ignore in a governmental department.

b. Operation is contracted by the municipality with a private firm, working under municipal control and receiving payment from the municipal treasury, according to the amount of services rendered, all this embodied in a fixed term (usually from five to ten years) contract service.

   This contract is awarded by the municipality through a public bid and payments are made monthly according to the amount of refuse collected. In this case fees are also charged by the municipality to the household owners.

c. Operation is made by a private firm working as a concessionaire under a franchise system, the municipality exercising light control over the services and the private firm collecting fees directly from the serviced households and other solid waste producers.

Variation of these basic schemes may occur, such as the following examples:

a–1. Full responsibility and rendering of the services belong to the municipal government, but the government relies also to " third party contracts" with private companies, such as the leasing of the fleet of collection vehicles and landfill equipment (with or without the drivers and operators), or the contracting the mechanical maintenance out to private shops

b–1. A variation of this model has been practiced mostly in some European cities, when the contractor operates government property represented by the collection trucks and also garages, workshops and offices.

c–1. In this system a government agency or the municipality sets the rates and the performance criteria for the services but this is not always true. Sometimes the role of government is only to define the area to be serviced and the prices of service and form of payment are discussed between the parties.

c–2. We should also mention the situation where a private firm or individual, formally or informally, contract the services with the refuse producers without any governmental interference.

In the study area almost all these situations occur, with variations from city to city, in the operational and in the cost recovery practices.

Reasons for the selection of each of these alternatives may vary, usually this selection being made according to tradition, the will of public authorities to reduce the operating costs, or the inability to face the operating or capital costs of the system.

Regardless of all the above considerations, the confrontation of public versus private operation in Latin America shows, on average, a better and more efficient service being provided by the private enterprises, usually at a lower cost and better quality than that provided by the public sector.

The reason for this situation is that generally, government agencies do not have incentives to increase productivity and efficiency, but rather, their management is very much influenced by political and other non–managerial issues.

In the study area, the private sector is very weak due to the lack of a larger market and to very low competition among the few private companies. As a matter of fact,

in most cases there have never had a competitive biding process to award concessions or collection contracts and payments are not tied to performance indicators, like tons of refuse collected.

Regardless of all the above, it is important to consider that, a private enterprise would have as its main objective, the attempt to maximize it's profit and thus neglect the social or environmental costs of it's operations, be it on collection, street sweeping or disposal services.

This is the reason why the government shall always be present through regulatory control and monitoring so to safeguard the public's interests and to enforce the regulations concerning solid waste production, storage and disposal.

H.6.2 Basic Principles

The basic principle that shall govern the institutional system of a municipal solid waste management project is the one that states that, being a solid waste problem closely related to public health, it's ultimate responsibility shall remain, always, with the public sector, i.e., the government.
Based on this principle, we can also state that, the municipalities shall be strong in their institutional and technical capabilities in all cases, including when the operational responsibility is transferred to a private enterprise.

Other principles that shall be followed for the development of an efficient and sustainable municipal solid waste system are:

- The services provided by the system shall be fully paid by the customers
- The system designed has to be affordable to the customers, using appropriate technologies and systems.
- To those not able to pay fully for the services, a crossed subsidy, using an overprice charged to the most affluent producers shall be practiced
- Being an activity heavily dependent upon non-skilled labor, technical solutions for countries with a high degree of unemployment, like Paraguay, shall emphasize the use of manpower instead of machinery.

H.6.3 Legislation and enforcement

As already stated previously, legislation concerning MSWM in the municipalities of the study area is almost nonexistent. As a matter of fact, there is not a single code related to solid waste management, but sparse ordinances in some of the cities of the study area, usually concerned with vacant lots' cleaning and disposal operations.

On the same line, enforcement of the existent legislation is very rare, municipalities relying only in their capacity and strategic position to charge fines together with all the other municipal taxes, including the annual automobile license.

H.6.4 Administration, Organization and Management

The extent and depth of the administration, organization and management requirements of the SWMS will depend upon the institutional model adopted in each or all the cities of the study area.

This statement means that, if adopted a model that permits the municipality to control all the operational activities, the administrative structure and corresponding management; organizational systems will be more staffed than if the role of the municipality will only be of controlling and monitoring private operations.

In any case, however, the municipality is to have full knowledge of the services being rendered and a planned control system to evaluate efficiency and effectiveness.

H.6.5 Revenue Source

Fees to be paid by beneficiaries of solid wastes disposal services are the sole revenue source under consideration. To be realistic, government subsidies may also need to be considered for communities which for one reason or another are unable to cover the costs of their own solid wastes disposal services. Also, government subsidies may be required when a project is deemed to bring large benefits to the society at large, without directly contributing to the revenues disposal services. An example would be a reduction in the incidence of a disease transmitted by vectors proliferating in waste dumps operated improperly.

Solid wastes disposal services are usually operated under the "Beneficiary Pays Principle (BPP)". This means that the beneficiaries of solid wastes disposal services (households, commercial and industrial firms, hospitals and institutions) are expected to pay their corresponding shares in the cost of providing such services.

These fees should be low enough to be within the "Ability to Pay" of beneficiaries, but high enough to cover the operation costs and also the investment and replacement costs (depreciation costs). The "Ability to Pay" was assumed to be taken into account by beneficiaries in their answers to the "Willingness to Pay" survey conducted in this Study.

An interview survey was conducted in order to find out the Willingness to Pay for solid wastes disposal services by the beneficiaries, that is, households and commercial firms. For this purpose, households were classified according to income groups, while commercial firms were classified into food shops and others. The questionnaire designed in such a way as to make each respondent think repetitively on the value he/she would be wiling to pay, starting from a hypothetical value, UNDER THE ASSUMPTION that the solid wastes disposal services were SATISFACTORY. The respondent reached the final answer after three or four iterations.

The average Willingness to Pay by category of Municipalities showed that households are willing to pay significantly more than the fees actually being paid, provided that the service is satisfactory. Results from the interview survey are as follows.

HUM:	8,227 G/mo.
UM:	4,160 G/mo.
LUM:	3,875 G/mo.

H.6.6 Public Cooperation

Cooperation from the producers of solid waste is fundamental to the success of any MSWM system.

As a matter of fact, without this class of cooperation, no system is successful, since it is almost impossible to perform all the collection and cleansing activities without the help and cooperation of the citizens.

Public cooperation in the study area is a matter of high concern since the nonexistence of an institutional system has led to a great unawareness of the people in general about their role on MSWM and about health and environmental problems imposed by the improper collection and disposal of wastes.

As an example of this situation, the public opinion survey conducted by the study team in the study area showed that only 10% of the interviewees have had guidance on method of proper discharge of wastes, while nearly 100 % of the interviewees understand the necessity of public cooperation and express for cooperation.

This means that efforts shall be made, primarily by the municipalities, to produce a public awareness campaign on MSWM issues, so to gain the cooperation of the people in general, including difficult issues like on selection of disposal sites and on the imposing of municipal waste taxes or fees.

Other issues that the public awareness campaign should care of are public attitude concerning storage and discharge manner, file of complaints and paying fines.

H.6.7 Summary of General Institutional Requirements

As previously stated, the institutional system is composed of four sub–systems. A summary of the requirements applicable to the problems of the Study Area for each sub–system is given below:

i. Organization and Management

It will be dependent upon the decision on the extent of privatization of the services.

ii. Legislation and Enforcement

Creation and establishment of legislation on solid waste management and systems to enforce it.

iii. Finance (Revenue Sources)

Also dependent upon the extent of privatization, the local legislation and the citizens' capability to pay.

iv. Public Cooperation

Creation and establishment of mass education campaigns, mainly at the primary school level.

H.6.8 Institutional Requirements for Master Plan Alternatives

a. Method of institutional study

The design of a Master Plan for Asuncion will select technical as well as institutional alternatives that best fits the conditions of the study area.

The institutional system shall be regarded in two levels: one for the entire Metropolitan Area (the Metropolitan System) and another for each one of the Municipalities considered autonomously (the Municipal Systems).

The decision on which institutional system for each level, (and accordingly which sub-systems) should be selected, will be dependent upon decision criteria based on the following aspects:

aa. Technical aspects

Technical alternatives will be heavily dependent on decisions that are going to be made in relation to the technical system (and sub-systems) that best fits the study.

ab. Economical and financial aspects

The main requirement for the design of the economical and financial sub-system is such that it will provide a self sustainable system, affordable to the consumers and covering the majority of the solid waste producers. It is important also to remember that shared solutions, (specially concerning disposal units) shall generate economies of scale.

ac. Customs and other cultural aspects

Being an activity heavily dependent on the behavior of the public, it is very important that the selected institutional system take into account the way in which people deal with the production, storage and discharge of solid waste.

Along with the above criteria, the institutional system shall be designed taking into account the three categories into which the municipalities of the Study area were

divided and grouped for the Master Plan Study. These categories are:

- Highly Urbanizes Municipalities
- Urbanized Municipalities
- Less Urbanized Municipalities

In each of these groups, a selection based on the decision criteria above presented will be made, taking also the interconnection between the three different groups into account.

b. Alternatives to be selected

For each level of the institutional system (metropolitan or municipal), there are basically the following decisions to be made:

- Metropolitan System:
  Existence or not of a Metropolitan Agency to deal with solid wastes management and, in the affirmative circumstance, the type and extent of this entity.

- Municipal System:
  Nature and type of the public entity in charge of Solid Waste Management, this decision being strongly influenced by the importance and extent of the private sector participation in the system operation and support.

These decisions will be made according to the following requirements:

ba. Concerning organization and management

Each one of the municipalities shall have its own SWM unit, the size and organizational scheme of each being dependent upon the extent of the private sector participation and the size of the municipality. If the municipality is to operate with its own personnel, the structure of the SWM unit has to be more complex than if the services are hired with a private contractor. In this case, the municipality's structure will be designed so to be concentrated on the supervision, control and monitoring of the private operating company.

In any case, the SWM unit needs to have full managerial capacity and technical knowledge so to handle proficiently it's tasks, be it as operator or as supervisor and controller.

It is also important to emphasize that, also in both cases, the SWM unit needs to have administrative independence from other government bodies and possibly a financial autonomy. This means that in the HUM and UM, the SWM unit may be organized as a company or a decentralized body, and in the LUM it should be embodied in a exclusive department or section within the municipality's administrative structure.

In other words, SWM shall not be mixed or subordinated to other municipal services, specially those dealing with public or personnel transportation and equipment management.

We should remember, though, that if the technical system study finds a shared disposal site for each group of cities more viable from the technical, environmental and economical point of view, the SWM units of the involved cities will have to make arrangements so to have a common administration concerning the disposal operations.

bb. Concerning legislation and enforcement

According to the Paraguayan constitution, each municipality is autonomous for establishing it's SWM ordinances. Regardless of this fact, the cities of the Study area should manage to enact common ordinances in respect to SWM, specially in the case of refuse disposal.

Enforcement of the legislation, in it's turn, shall be made by each city through their own enforcement agents. This procedure however shall be preceded by a public information campaign and a training stage for the agents.

bc. Concerning finance (revenue source)

The financing of the MSWM is the most important step to insure sustainability to the system, and for the same time, the most critical decision to be made.

In the cities composing the study area, there are basically two types of system financing today: the first is to charge the household and other property owners through the municipal taxing system; the second is to charge the consumers through an single monthly bill, be it charged by the municipality, by the service provider or by the concessionaire.

An appraisal of these two systems shows that both are adequate from the collection mechanism stand point but a more rational tariff structure should be provided after a study taking into account the different types of wastes produced, their quantity

and the affordability to pay of each economic segment of the population.

Finally, it is important to devise a mechanism to penalize the citizens, be it a fine or another kind of penalty.

bd. Concerning public cooperation

This issue also shall be conducted as a joint effort of all the municipalities of the Study area. For this task, audiovisual materials shall be produced and shared by all the municipalities as well as booklets and other printed materials, the teaching and distribution teams however shall belong to each municipality.

The tasks of these teams shall be subject to a planning stage and to a specific and secure budget so that the educational efforts have continuity, a basic condition to be well succeeded.

c. Preliminary Proposals

The alternatives selection process will take into account their interconnection and the dependency upon the technical systems to be selected, final decision relying on the Paraguayan authorities.

Some proposals however, mainly devised to foster discussions, are given ahead.

ca. Concerning the metropolitan system

The Establishment of a Metropolitan Entity conceived to deal with solid waste in the Asuncion Metropolitan Area shall have a positive impact in the outcomes of the several municipal systems, based on the following factors:

- The Study area is almost all continuously urbanized, being usually difficult to perceive the boundaries of each municipality, showing that the division of the area in several municipalities usually relies only upon political considerations rather than economical or geographical ones. This means that there is a complete and permanent flow of people and goods between all the municipalities, just as if it were a single large city.

- Economies of scale arise, specially when dealing with disposal facilities and when purchasing equipment and parts.

- The smaller municipalities would not be able to afford their own equipment, such as bulldozers, graders and front end loaders, not withstanding the fact that they would not need it on a permanent full time basis.

- Legislation and educational programs will have a greater impact if applied on a metropolitan wide basis.

- A metropolitan entity will have a much stronger political strength and effectiveness than each of the municipalities alone, when demanding support from the national government or when requesting financing for their capital requirements.

The Metropolitan entity shall be conceived based on the model of the present AMUAM – Asociacion de las Municipalidad del Area Metropolitana, but with a higher operational capacity and a more permanent staff and supporting background.

This entity may be conceived as a decentralized organization subordinated to a national government body or as a private company, with shares belonging to each municipality in proportion to it's population or budget.

cb. Concerning the municipal systems

It is very difficult to suggest, at this stage of the study, a model, or models, for the institutional system to be implemented in each municipality, because they will be very dependent upon the technical systems, not yet selected and by political considerations, not covered in this study. Nevertheless, the models more prone to be selected will be the following:

- Municipal Department operating their own equipment and employing their own personnel.

- Municipal Department contracting the services (or part of them) with private companies

- Municipal Company operating their own equipment and their own personnel

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

- Concession of the collection and disposal services, the street sweeping

services remaining with the municipality.

H.7 Selection of the Optimum Alternatives

H.7.1 Overall Evaluation

As clearly described in the previous sections, the evaluation of technical system alternatives for selection was done by the least cost method. Based on the data obtained from the "Willingness to Pay" survey, the revenue was estimated in the financial evaluation assuming 80% of fees will be collected. The Table H.7.1a and H.7.1b presents the summary of these evaluations.

Table H.7.1a Summary of Evaluation for HUM

Municipality	Waste Disposal from 1997 to 2006 (ton)	Waste Disposal in 2006 (ton)	Cost of Each Alternative in 2006 Upper(total cost):mill.Gs Lower(cost in 2006):Gs					Average Willingness to Pay (Gs/household/month)	Estimated Revenues (mill.Gs/year)	Required Fee by Household (Gs/household/month)
			X-1	X-2	X-3	X-4	X-5			
Asuncion	2,023,901 (1,167,717)	221,190 (85,575)	14,542 70,019	11,930 57,441	10,836 52,174	11,284 54,332	10,797 51,986	8,227	18,915	Same as Willingness to Pay
F.Mora	315,464 (246,016)	41,245 (15,914)	3,039 73,681	2,308 55,955	2,089 50,660	2,180 52,843	2,023 49,047	8,227	3,188	Same as Willingness to Pay

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