iii. Suggestions

For on-site composting, it is recommended that only vegetable wastes should be used. Nevertheless, the following are normally acceptable:

- vegetable wastes from the kitchen
- flowers, including roots and soil
- coffee grounds and tea leaves including possible paper filters
- fruit waste
- bread
- eggs shells
- paper used for drying etc. in kitchen
- wastes of small domestic animals

The microbial process is accelerated by the addition of small amount of wooden chips, small branches produced from hedge trimming, etc.

Other similar materials may be used, but meat wastes as well as fish, sauces and similar wastes should be avoided. Adding meat wastes enhances the possibility of odor production, and attracts rodents. However, if meat wastes are to be added, compost containers should be placed in a steel net to keep out rodents, and mixing must be more frequent than previously suggested.

J.1.3 Construction of the Acahualinca Newly Proposed Landfill Site

a. Introduction

It is generally recognized that a sanitary landfill is the basic element in modern solid waste management, proving the fact that the disposal of most wastes is acknowledged in spite of efforts for re-utilization. By giving priority to modern solid waste management, the city of Managua should therefore strengthen final disposal activities to minimize environmental impacts.

This section presents the preliminary design and cost estimates for the newly proposed landfill site in Acahualinca which selected by the Coordinating Committee. The site comprises an area of approximately 93.0 ha, as shown in Figure J.1.3a.

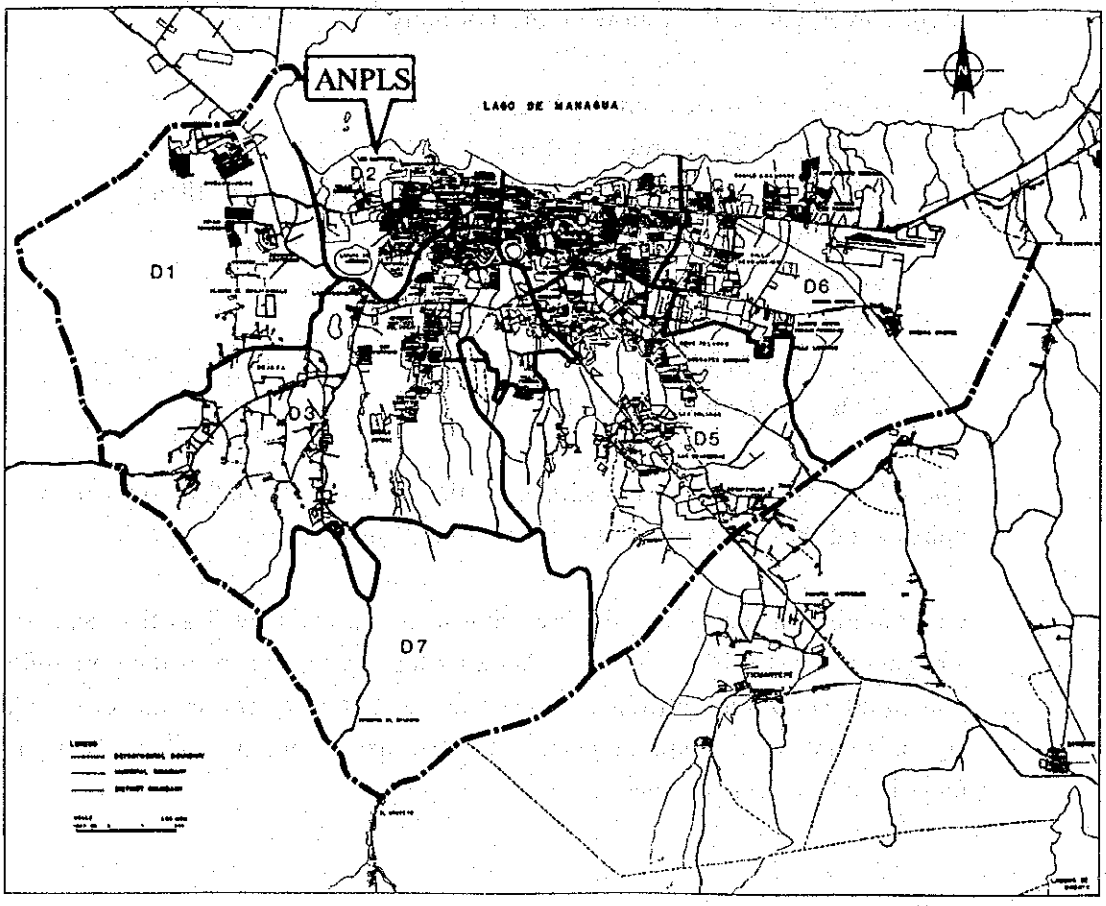


Figure J.1.3a Location of the Acahualinca Newly Proposed Landfill Site

b. Design Conditions

ba. Target Level of Landfill Operation

- Target Level : Level 3 in 2000
  Level 4 in 2010

- Requirements of Level 3 in 2000

The requirements for landfill operation in level 3 are as follows:

. weighing of waste input with a truck scale
. prevent leachate seepage
. daily waste covering with soil

- screening of working areas from outsiders
- prompt release of gas
- minimize leachate quantity discharged outside
- adequate drainage system
- proper access road
- leachate collection and circulation system

bb. Commencement of Sanitary Landfill Operation

The operation of the ANPLS is planned to commence at the beginning of 2000.

bc. Estimated Amount of Waste Disposed and Required Capacity of the ANPLS

The amount of waste disposed in the proposed landfill site is estimated in the previous chapter.

Leachate treatment facilities installation is proposed for 2010 in the master plan. Accordingly, the capacity of ANPLS should be designed taking into consideration the installation term of these facilities.

Landfill construction should be carried out by section, with each section having a life span of 3 to 6 years. Therefore, the construction of the ladfill which shall be utilized until 2016, according to the master plan, will be divided into 4 sections: the 1st section for 1999 – 2005, 2nd section for 2006 – 2010, 3rd for 2011 – 2013, and 4th for 2014 – 2016.

The estimated annual waste disposal amount in the ANPLS and the site's required capacity are presented in Table J.1.4b.

Table J.1.3a Estimated Daily Waste Disposal Amount and Required Capacity of ANPLS

unit: ton/day

	Year	Daily Waste Amount (ton/day)	Annual Landfill Volume (m^3/year)	Accumulated Volume & Required Capacity (M^3)
Present Acahualinca Disposal Site	1995	692.3	252,690	252,690
	1996	732.6	267,399	520,089
	1997	777.9	283,934	804,022
	1998	854.9	312,039	1,116,061
	1999	939.9	343,064	1,459,124
Phase I (Section 1)	2000	1,037.7	378,761	378,761
	2001	1,093.7	399,201	777,961
	2002	1,153.8	421,137	1,199,098
	2003	1,216.6	444,059	1,643,157
	2004	1,282.4	468,076	2,111,233
	2005	1,352.5	493,663	2,604,896
Phase II (Section 2)	2006	1,421.7	518,921	518,921
	2007	1,495.2	545,748	1,064,669
	2008	1,609.7	587,541	1,652,209
	2009	1,732.5	632,363	2,284,572
	2010	1,865.1	680,762	2,965,333
Phase III	2011-2013		680,841	2,042,523
Phase IV	2014-2016		680,841	2,042,523
Total				9,654,798

c. Facility Design

The proposed disposal site shall be equipped with the following facilities:

- **Main facilities**

  . Enclosing structure:
  enclosing dike and divider
  . Drainage system:
  open side channel, on-site drain, culvert drain, intercepter drain on reclaimed area, slope drain and diversion canal
  . Access:
  main approach road, temporary access road

- **Environmental protection facilities**

  . Buffer zone
  . Litter scattering prevention facilities
  . Gas removal facilities

. Leachate collection facilities
. Leachate circulation facilities
. Seepage control facilities
. Slope protection

- **Buildings and accessories**

. Site office
. Truck scale
. Storage building
. Safety facilities:
  gates, fences and street lights
. Fire prevention facilities:
  water tank and extinguisher,
. Others:
  parking lot and car wash

ca. Enclosing Structure

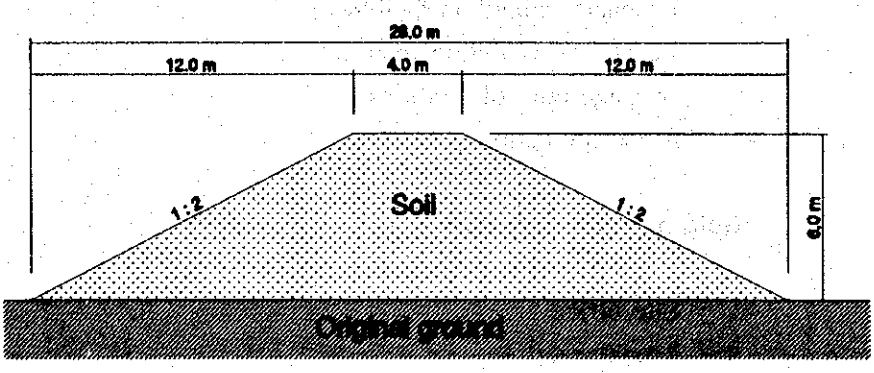
The purpose of the enclosing structure is to store wastes and to control leachate discharge from waste.

caa. Enclosing Dike

i. Description

An enclosing dike banked with earth around the filling area will be constructed to prevent seepage of rainwater and leachate and to store dumped waste. The dimensions of the enclosing structure are as follows:

.	Gradient of slope:	1 : 2
.	Crest of dike:	4.0 m
.	Height of dike:	6.0 m
.	Material of dike:	Soil



ii. Work Quantities

- Soil filling work

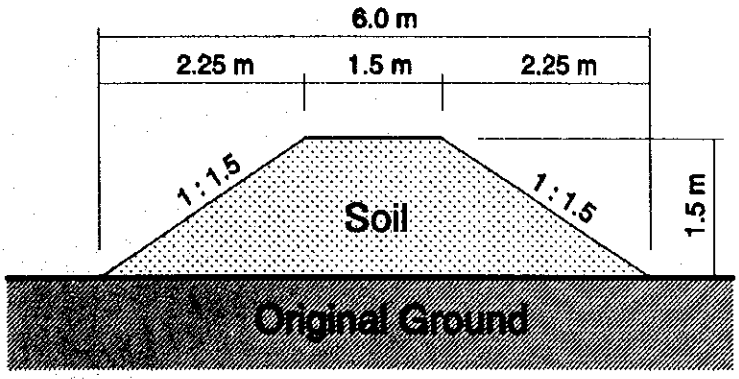
  Volume = (12.0m x 6.0m x 0.5 + 4.0m x 6.0m + 12.0m x 6.0m x 0.5) x 1.0m = 96.0 m^3/m

cab. Divider

i. Description

A divider made of soil will be constructed in the enclosing dike to separate the landfill section used from the rest and in order to reduce leachate leakage by blocking rain water.

.	Gradient of slope:	1 : 1.5
.	Crest of dike:	1.5 m
.	Height of dike:	1.5 m
.	Material of dike structure:	Soil
.	Distribution density:	A landfilling yard shall be closed every 4 ha.



ii. Work Quantities

- Soil filling work

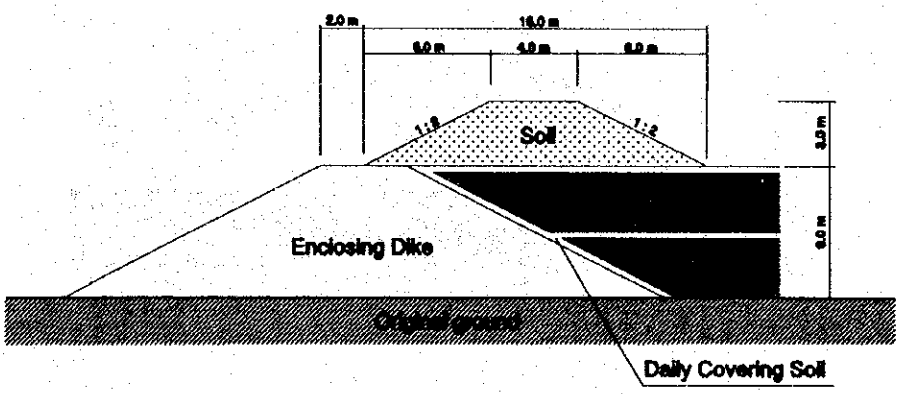
  Volume = (2.25m x 1.5m x 0.5 + 1.5m x 1.5m + 2.25m x 1.5m x 0.5) x 1.0m = 5.625 m^3/m

cac. Slope Dike

i. Description

A slope dike, also made of soil will be constructed in the enclosing dike, to prevent seepage of rainwater and leachate and to store dumped waste. The dimension of the slope dike structure is set up us follows:

.	Gradient of slope :	1 : 2
.	Crest of dike:	4 m
.	Height of dike:	3 m
.	Material of dike structure:	soil



ii. Work Quantities

- Soil filling work
  Volume = (6.0m x 3.0m x 0.5 + 4.0m x 3.0m + 6.0m x 3.0m x 0.5) x 10m
  = 30.0 m^3/m

cb. Drainage System

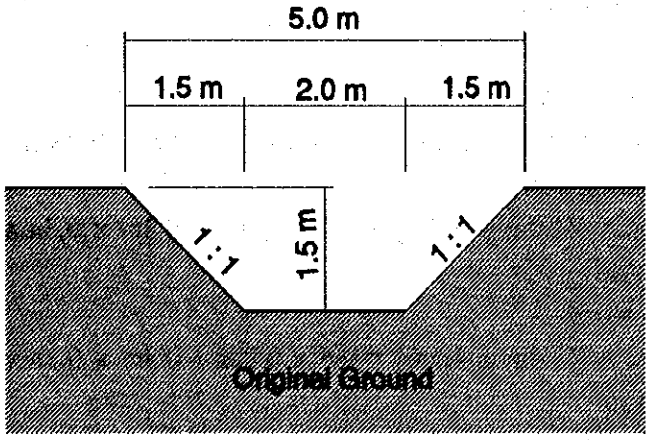
The drainage system is very important in maintaining the site and peripheral roads in good condition and also to minimize the influx of rainwater to leachate control facilities.

cba. Open Side Channel

i. Description

A side drain is generally provided around the landfill to intercept runoff water from the landfill area and to remove fluid from the site. The dimensions of the side drain are as follows:

.	Top width:	5.0 m
.	Bottom width:	2.0 m
.	Gradient of slope:	1 : 1
.	Depth:	1.5 m
.	Surface of drain:	No lining



ii. Work Quantities

– Excavation work

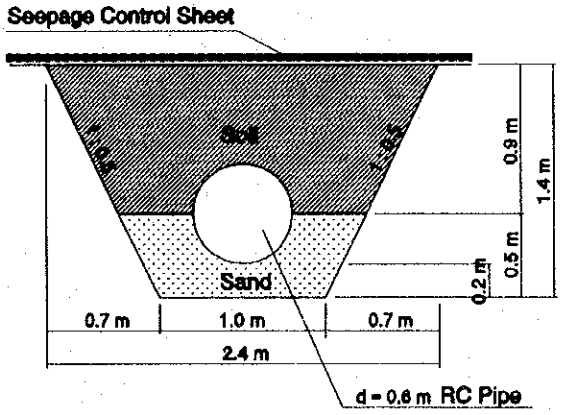
Volume = (5.0m + 2.0m) x 1.5m x 0.5 x 1.0m = 5.25 m^3/m

cbb. On-site Culvert Drain

i. Description

The on site culvert is used to drain rain water separately from the leachate.

The dimensions of the on-site drain are as follows.



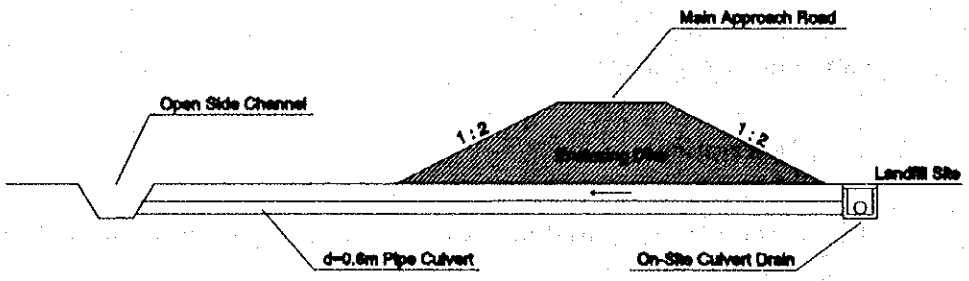
ii. Work Quantities

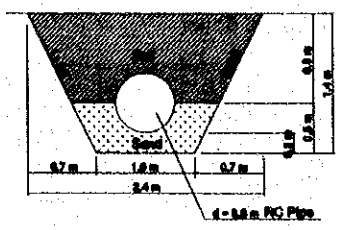
- Excavation work
  Volume = (1.0m + 2.4m) x 0.5 x 1.4m x 1.0m = 2.38 m^3/m
- Sand filling work
  Volume = [(1.0m + 1.5m) x 0.5m x 0.5 – 0.3m x 0.3mπ x 0.5] x 1.0m = 0.48 m^3/m
- Filling work
  Volume = [(2.4m + 1.5m) x 0.5 x 0.9m – 0.3m x 0.3mπ x 0.5] x 1.0m = 1.61 m^3/m

cbc. C-Pipe (I)

i. Description

The C-Pipe(I) is made up of pipes installed to drain out rain water from inside the area enclosed with dikes to the side drain outside.
The dimensions of the culvert drain are as follows:





ii. Work Quantities

- Excavation work
  Volume = (1.0m + 2.4m) x 0.5 x 1.4m x 1.0m = 2.38 m^3/m
- Sand filling work
  Volume = [(1.0m + 1.5m) x 0.5m x 0.5 – 0.3m x 0.3mπ x 0.5] x 1.0m = 0.48 m^3/m

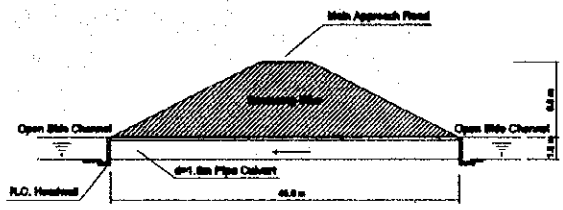
- Filling work
  Volume = [(2.4m + 1.5m) x 0.5 x 0.9m - 0.3m x 0.3mπ x 0.5] x 1.0m = 1.61 m^3/m

cbd. C-Pipe (II)

i. Description

The dimensions of the culvert drain are as follows:

. Pipe Diameter: 1.5 m
. Protection for inlet and outlet: Reinforced Concrete (R.C.) headwall



ii. Work Quantities

- Pipe Culvert Work (including excavation, laying of foundation, supply and placing, reinforced concrete pipe and refilling)

  D=1,500 mm
  Pipe Length = 40.0 m

- Reinforced concrete headwall

Reinforced concrete work	= 5.0 m^3/ 40m
Excavation work	= 3 m^3/ 40m
Sand filling work	= 73 m^3/ 40m
Filling work	= 66 m^3/ 40m

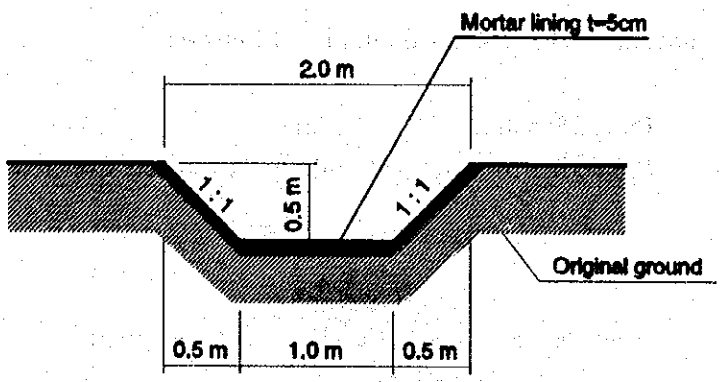
cbe. Intercepter Drain for Reclaimed Area

i. Description

An intercepter drain is provided to block surface run off water on the completed area of landfill. The interception of surface water is to prevent seepage of rain water into the waste layer and also to protect the slope of the enclosing dike.

The dimensions of the intercepter drain are as follows:

.	Top Width:	2.0 m
.	Bottom Width:	1.0 m
.	Gradient of Slope:	1 : 1
.	Depth:	0.5 m
.	Surface of Drain:	Mortar lining t=5cm



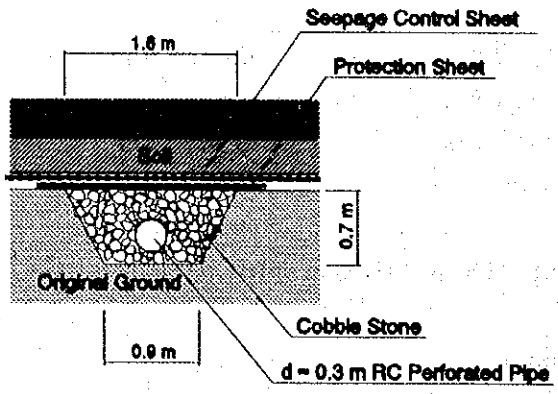
ii. Work Quantities

- Excavation work
  Volume = (2.0m + 1.0m) x 0.5m x 0.5 x 1.0m = 0.75 m^3/m

cbf. Underground Drain

i. Description

- main

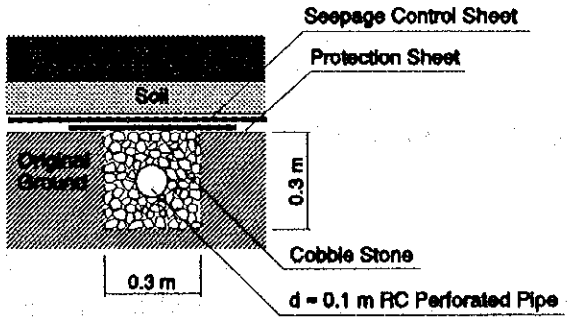


ii. Work Quantities

- Excavation work
  Volume = (1.6m + 0.9m) x 0.5 X 0.7m x 1.0m = 0.88 m^3/m
- Cobble stone filling work
  Volume = ((1.6m + 0.9m) x 0.5 x 0.7m – 0.15m x 0.15mπ) x 1.0m = 0.80m^3/m
- Concrete perforated pipe
  d = 0.3 m
- Protection sheet
  A = 2 m^2/m

i. Description

– branch



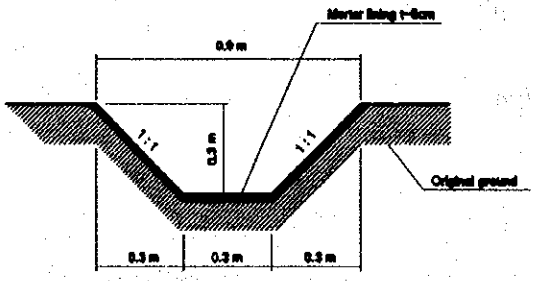
ii. Work Quantities

- Excavation work
  Volume = 0.3m x 0.3m x 1.0m = 0.09 m^3/m
- Cobble stone filling work
  Volume = 0.3m x 0.3m x 1.0m – 0.075m x 0.075mπ x 1.0m = 0.07 m^3/m
- Concrete perforated pipe
  d = 0.15 m
- Protection sheet
  A = 0.7 m^2/m

cbg. Vertical Drain

i. Description

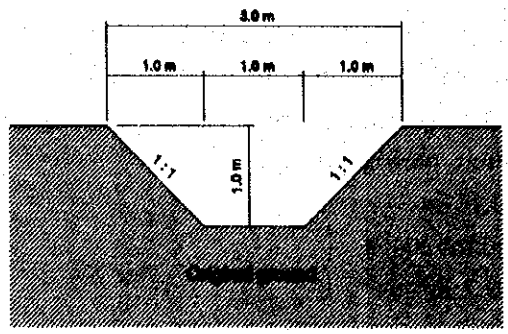
A slope drain introduces the runoff water from the intercepter drain to the open side channel provided in the original ground, to remove water without causing problems or damage to the slope. The dimensions are as follows:



cbh. Diversion Canal for Leachate

i. Description

The diversion canal for leachate is designed to only carry leachate, which can overflow from the regulation pond at freshet time, from the disposal site to the Paraguayan River directly. This diversion canal is composed of an open channel for flat land and a culvert for each intersection between a road and stream.



ii. Work Quantities

- Excavation

Volume = (3.0m + 1.0m) x 0.5 x 1.0m x 1.0m = 2.0m^3/m

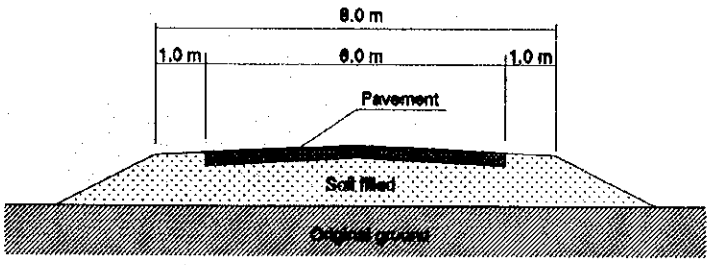
cc. Access

cca. Main Approach Road

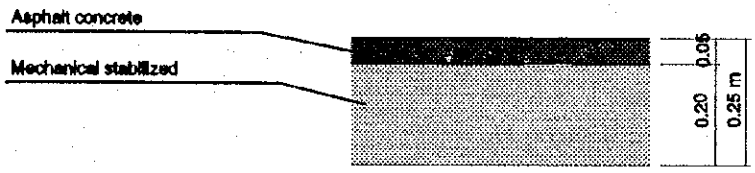
i. Description

The road at the entrance of the landfill site is paved in asphalt to facilitate the entrance and exit of waste collection trucks. In addition, the road from the entrance to the landfill section will be paved with asphalt because it shall be used for more than 10 years. The dimensions of the approach roads are shown below.

- Carriageway width: 6.0 m
- Shoulder width: 1.0 m both sides
- 2 paved layer in the carriage way



Typical Cross Section



Pavement Structure

ii. Work Quantities

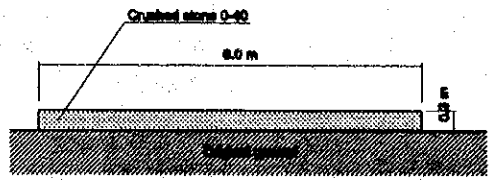
- Filling work
  Volume = (1.0m x 2.0m X 0.5 x 2 + 8.0m x 1.0m - 6.0m x 0.25m) x 1.0m
  = 8.5 m^3/m
- Asphalt concrete
  Volume = 6.0m x 0.05m x 1.0m = 0.3 m^3/m
- Mecanical stabilized
  Volume = 6.0m x 0.25m x 1.0 = 1.5 m^3

ccb. Temporary Access Road

i. Description

A temporary access road is provided in the site for landfill works. The dimensions of the temporary access road are shown below.

- Thickness of paved road: 0.3 m
- Width of paved road: 6.0 m
- Material: Crushed stone 0-40 mm



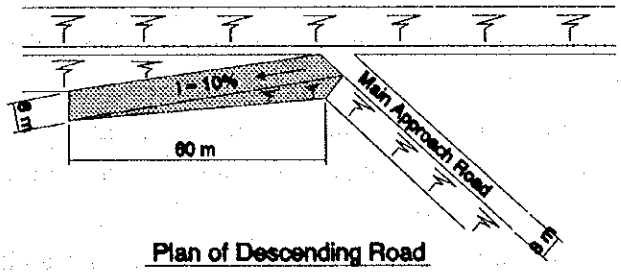
ii. Work Quantities

- Crushed stone pavement
  Volume = 6.0m x 0.3m x 1.0m = 1.8m^3/m

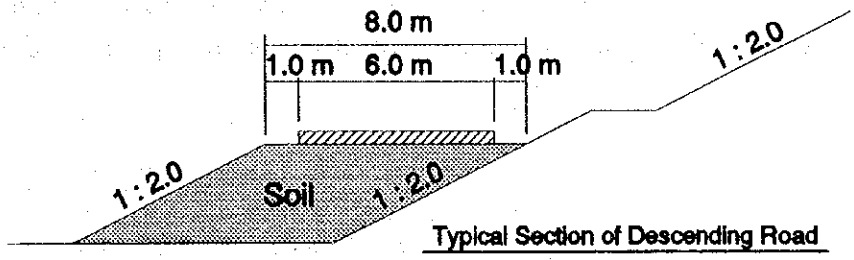
ccc. Descending Road

The descending road is a slope which connects the top of the dike to the working area or roads. Its dimensions are the same as the temporary access road.

- Width of descending road: 60 m
- Gradient of descending road: i = 10 %
- Thickness of paved road: 0.3 m
- Width of paved road: 6.0 m
- Material: Crushed stone 0-40



Plan of Descending Road

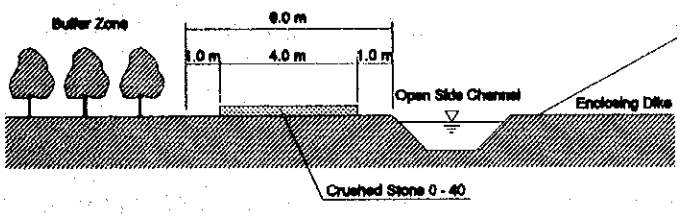


Typical Section of Descending Road

ii. Work Quantities

- Filling work
  Volume = 0.5 x 8m x 6m x 60m = 1,440 m^3
- Crushed stone pavement
  Volume = 6.0m x 0.3m x 60m = 108 m^3

ccd. Maintenance Road



- Crushed stone pavement
  Volume = 4.0m x 0.3m x 1m = 1.2 m^3/m

cd. Environmental Protection Facilities

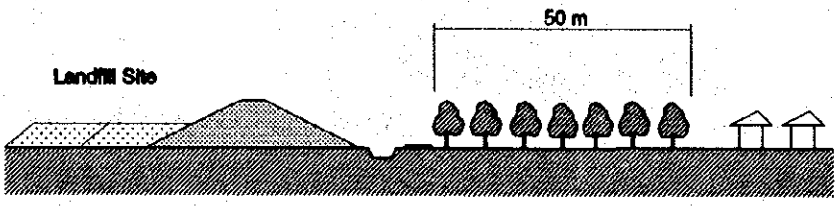
Environmental protection facilities are provided to prevent primary and secondary pollution outbreaks during and after completion of landfill operations.

cda. Buffer Zone

A buffer zone is provided between the disposal site and residential areas for the purpose of:

- screening the landfill site from residents
- reducing the noise and vibrations emitted during landfilling operation,
- reducing odors
- balancing the site with the natural surroundings in a harmonious fashion

The buffer zone is formed with a green belt and will have a width of 50m. The greenbelt will be planted with approximately 400 trees per hectare.



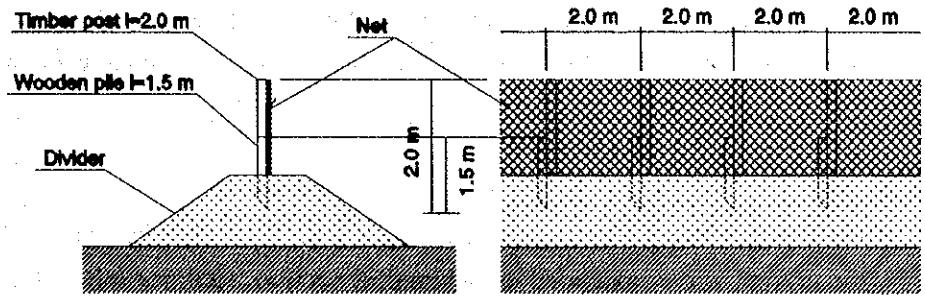
ii. Work Quantities

number of trees planted = 400 trees/ha

cdb. Litter Scattering Prevention Facilities

Litter scattering during landfill operation, before the waste is covered with soil, is inevitable. Therefore, as a means of prevention, a temporary fence made of materials available locally like wood, and with nets to catch flying litter is constructed.

- Height: 3.0 m
- Material of post: Wooden pile and timber post
- Distribution density: The landfill yard shall be closed with nets every 2 m.



ii. Work Quantities

- Wooden pile (diameter 0.1m x 1.5 m)
  N = 5 piles/10m
- Timber post (diameter 0.05m x 2.0m)
  N = 5 posts/10m
- Net
  A = 2.0m x 10m = 20 m^2/10m

cdc. Gas Removal Facilities

Microbial decomposition occurs when organic matters are present during landfilling operations, producing water, gas and inorganic chlorides. Microbial decomposition is accelerated when landfill structures house aerobic organisms, thereby producing carbon dioxide, water and ammonia without difficulty.

Decomposition is slow when landfill structures house anaerobic organisms, thereby producing obnoxious odor, combustible gases, e.g. methane, carbon dioxide, that adversely affect the environment.

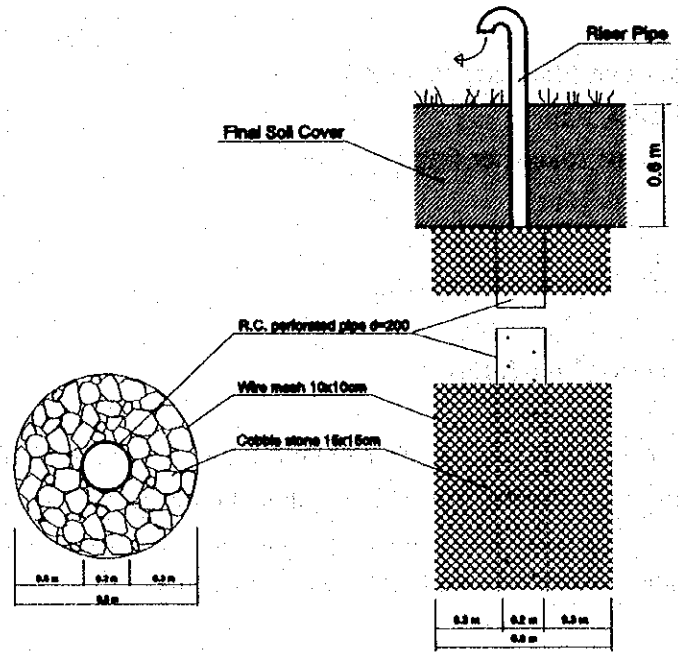
Gas leakage usually occur at the weak points on the boundary surface between the landfill site and surrounding structures. Disaster prevention measures, such as gas removal facilities, are necessary at points where gas pockets burst unexpectedly thus producing fires, odors, etc..

As for gas removal facilities, there are three types under consideration: by evacuation, pumping, and ventilation, the most economical of which is by evacuation. Therefore evacuation was selected.

The completed landfill site gas removal facilities have been designed at 3–4 positions per hectare. As disaster prevention measures, the gas removal facilities are considered effective. However, since it is necessary not to leave waste exposed over a long period of time, covering materials are considered very important.

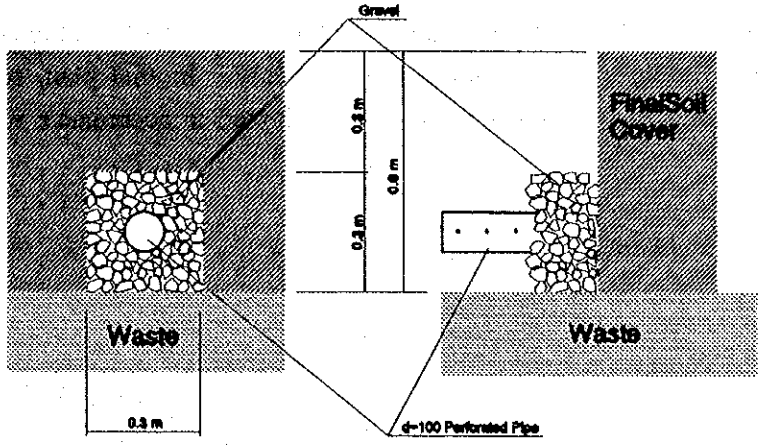
i. Vertical Gas Removal

Prior to landfilling activities, a vertical gas removal facility is installed 2–3m below the ground and is extended as the landfill section becomes full. After completion of landfilling activities the vertical gas removal pipe on the ground exhausts the gas. The structure is shown below.

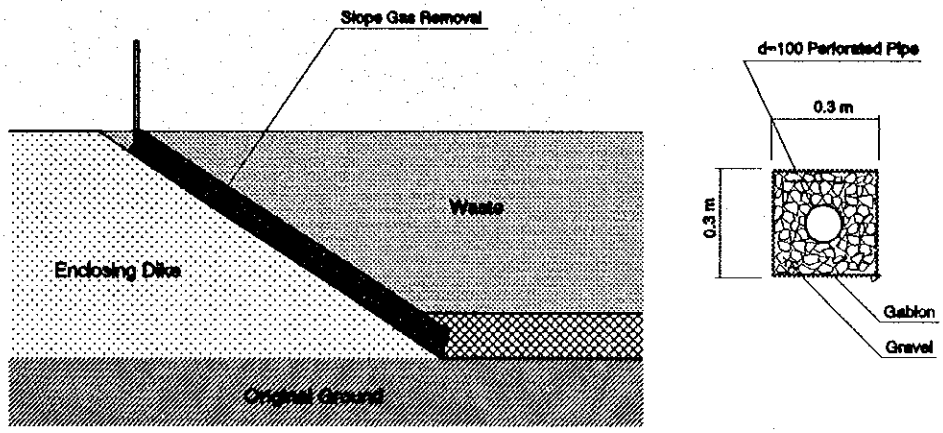


Note: R.C. Reinforced Concrete

ii. Horizontal Gas Removal



iii. Slope Gas Removal



cdd. Leachate Collection Facilities

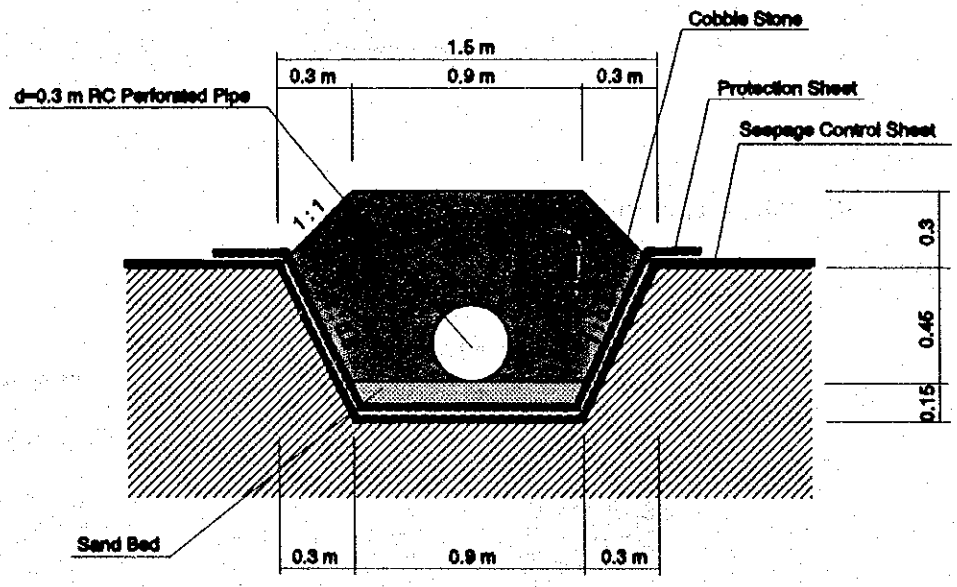
Leachate collection facilities only collect water contaminated with waste and decomposed polluted water, carrying them to the leachate control facilities without allowing them to infiltrate the ground.

There are different types of leachate collection facilities available and depending on the conditions and requirements, a different form is installed.

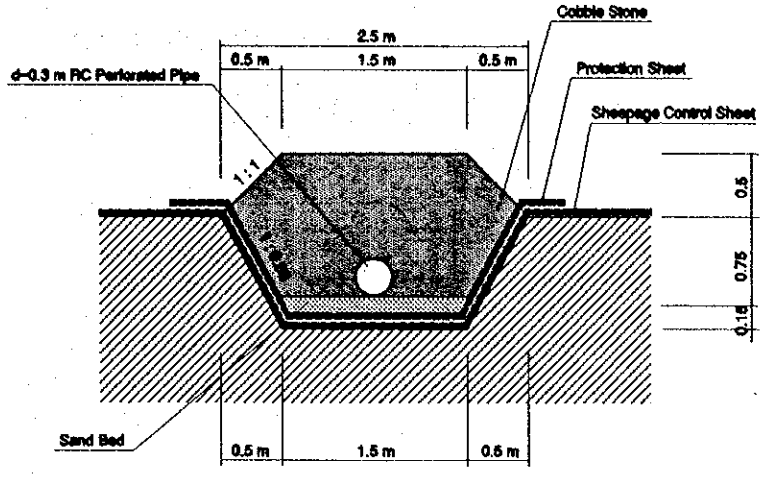
i. Horizontal leachate collection

The horizontal leachate collection facility installed at the bottom of the disposal site is to collect leachate and to drain it out quickly. In this plan, two types of horizontal leachate collection facilities were adopted in accordance with the flow capacity.

- **for branch**



- **main**



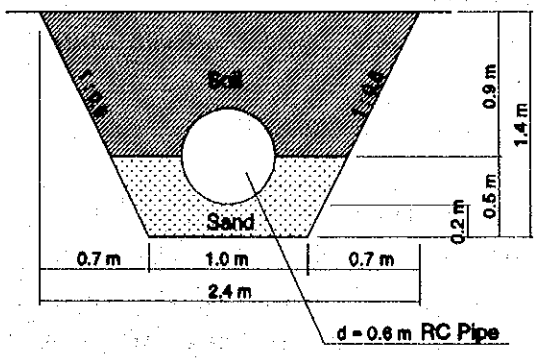
ii. Vertical leachate collection

The vertical leachate collection facility is used to quickly drain contaminated water contained in the waste layer downwards. In this plan, the vertical gas removal facility is also utilized as a vertical leachate collection facility.

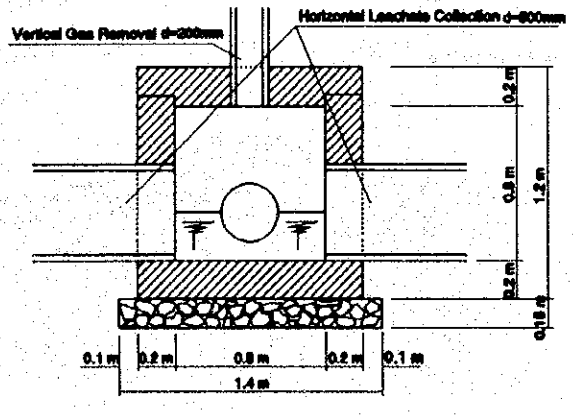
iii. Leachate drain pipe

The leachate drain pipe is used to expel liquid collected from the site's inner facilities.

The slope and the vertical gas removal facilities will be used as substitutes for vertical leachate collection facilities.



iii. Leachate inlet



cde. Leachate Circulation System

The purposes of a leachate circulation system are as follows:

- reduce total leachate amount and establish site boundary
- improve leachate quality
- reduce leachate head (pressure) in the landfill to prevent leachate from infiltrating the ground

The leachate generated by waste disposed is collected at the regulation pond and returned to the landfill site. The repetition of the leachate circulation process improves leachate quality and reduces leachate quantity by evaporation, microbial decomposition, etc..

The leachate circulation system consists of:

- a regulation pond
- a water pump and pipe for leachate return

i. Calculation of leachate quantity

(1) Conditions for calculation

i. precipitation data: 1983 to 1992 (10 years)
ii. evaporation data: 1983 to 1992 (10 years)
iii. adopted formula: $Q = 1/1000 \times I \times (C_1A_1+C_2A_2)$
iv. Landfill area:

Phase I = 188,000 m^2
Phase II = 217,000 m^2

Phase III =	152,000 m^2
Phase IV =	152,000 m^2
Total	709,000 m^2

v. Landfill operation: every 4ha.

Table J.1.3b Calculation of Percolation Coefficient

Month	(1): ave. monthly precipitation	(2): ave. of monthly evaporation	(3)=(2)x0.7 Possible Evapo-ration	C_1	C_2
	mm/day	mm/day	mm/day		
January	1	210	147	-	-
February	4	230	161	-	-
March	1	260	182	-	-
April	5	253	177	-	-
May	125	249	174	-	-
June	162	172	120	0.27	0.16
July	159	144	101	0.36	0.22
August	150	152	106	0.29	0.17
September	**203**	145	102	**0.50**	**0.30**
October	168	158	111	0.34	0.20
November	39	148	104	-	-
December	11	164	115	-	-
Average from Jun to October	168	154	108	0.36	0.22

(2) Calculation of leachate quantity

The quantity of leachate was estimated by using the maximum monthly precipitation average shown in above table.

- Maximum precipitation: 203 mm in September
- Discharged area: 4 ha (under landfilling)
  14.8 ha (landfill was completed)

Q = 1/1000 x 203mm x (0.5 x 40,000m^2 + 0.3 x 148,000m^2) / 30days
= 435.8 m^3/day

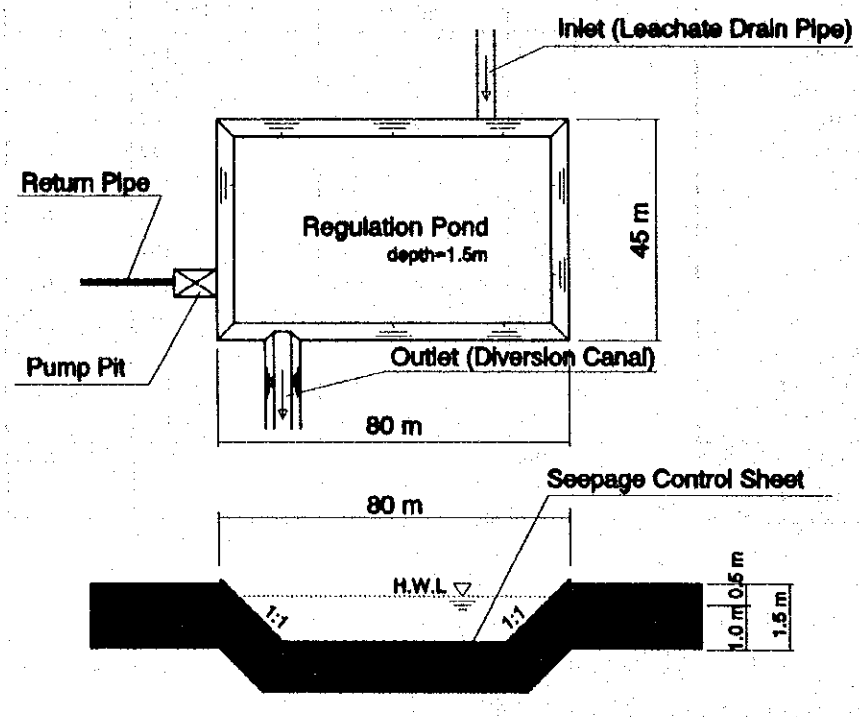
ii. Regulation Pond

A regulation pond is installed for the temporary storage of leachate. Leachate quantity fluctuates, depending highly on rainfall, and the capacity of the pond should be big enough to hold 7 days' volume of liquid during the wettest month. The required capacity of the regulation pond is calculated as follows.

Q = 435.8(m^3/day) x 7(days)
= 3,051 m^3

iii. Leachate return system

The water pump continuously returns leachate in the regulation pond to the landfill area. It takes 10 hours to return one day's volume of leachate back to the landfill area. The length of the cycling pipe is 500 m with a 20 m head. The design is for an immersed pump with a mouth diameter of 100 mm.



iv. Estimation of Leachate Discharge Amount

Leachate is usually circulated between the landfill site and the regulation pond. However, it is discharged to the Managua lake during heavy rain when the volume exceeds the capacity of the regulation pond.

- Leachate effluent system

The leachate effluent system is composed of

* water pumps
* water gate
* earth drain

* pipe culvert for intersection between road and stream

Design conditions to specify the above component of leachate effluent system are as follows:

. Maximum effluent volume: 3,051 m^3
. Time to discharge leachate: 24 hours

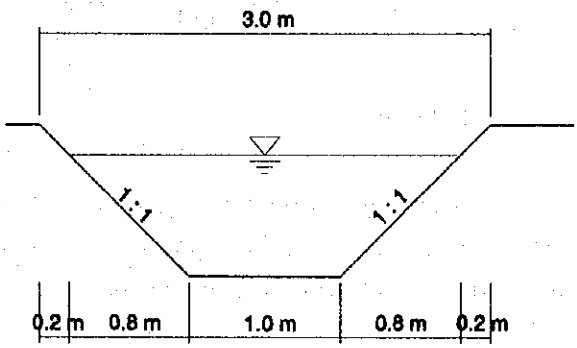
Design for water pump system

Required capacity of pump is calculated as follows:

3,051 m^3 ÷ 24 hours ÷ 60 min. = 2.119 m^3/min
2,119 m^3/min ÷ 60 sec. = 0.03531 m^3/sec

Design for open drain

Design conditions
- Roughness coefficient of earth drain: n = 0.025
- Design formula: Manning formula
- Dimensions



Calculation

S = 1.131 x 2 + 1.0 = 3.26 m
A = (2.6 + 1.0) x 0.8 x 1/2 = 1.44 m^2
R = A/S = 1.44/3.26 = 0.442 m

$$V = \frac{1}{0.025} \times 0.442^{\frac{2}{3}} \times \left(\frac{1}{40}\right)^{\frac{1}{2}} = 3.67 \ m/sec$$

Q = 1.44 x 3.67 = 5.284 m^3/ms

Although the flow capacity of the proposed earth drain is approximately five times the required capacity, this dimension seems to be appropriate in consideration of the difficulty in maintaining earth drains and the workability of the excavation method.

Design for pipe culverts

Design Condition

- Incline: I = 1/200
- Coefficient of concrete pipe: 0.015
- Formula: Manning formula
- Dimension: D = 0.6m pipe culvert

Calculation

$$A=\frac{\pi}{4}D^2\times\frac{1}{3}-\left(\frac{d}{2}cos60^o\times\frac{D}{2}sin60^o\times2\right)\times\frac{1}{2}=D^2\left(\frac{\pi}{12}-\frac{\sqrt{3}}{16}\right)=0.1535D^2=0.05$$

S = πD/3
R = 0.1466D = 0.08796

$$V=\frac{1}{n}R^{\frac{2}{3}}I^{\frac{1}{2}}=\frac{1}{0.015}\times 0.08796^{\frac{2}{3}}\times\left(\frac{1}{200}\right)^{\frac{1}{2}}=0.0932\ m/sec$$

Q = 0.055 x 0.932 = 0.051 m^3/sec

Although the flow capacity of the proposed pipe culvert drain is approximately twice the required capacity, this dimension seems to be appropriate in consideration of the difficulty in maintaining pipe culverts.

cdf. Seepage Control Facilities

One of the requirements for the 3rd sanitary landfill operation level is that leachate should not infiltrate the ground. In Japan, it is said that without seepage control facilities, leachate usually permeates the ground at a speed of 10^{-5} cm/sec.

The permeabilities of 3 samples taken at the locations shown in ANNEX D were measured to be more than 10^{-5} cm/sec, as shown in Table J.1.3c.

Table J.1.3c Permeability Test Data of ANPLS

Borehole No.	Permeability
B-1	3.09×10^{-3} cm/sec
B-2	1.51×10^{-4} cm/sec
B-3	4.75×10^{-4} cm/sec

The results of the permeability test proved the importance of adequate seepage control facilities.

Sheet and earth linings are the seepage control facilities considered for ANPLS. Their characteristics are as follows:

- Sheet lining

* material: thin lining made of plastic sheet or synthetic rubber
* function: sheet lining completely intercepts leachate seepage. Due to its thickness, however, the sheet lining can be easily destroyed if mounted with heavy equipment such as bulldozer.
* durability: sheet liner is assumed to be durable.

- Earth lining

* material: impermeable soil (less than 10^{-5} cm/sec.)
* function: earth lining can intercept leachate seepage.
* durability: if treatments such as surfacing, compacting of existing ground is not enough, the difference in ground level will cause a crack in the earth liner.

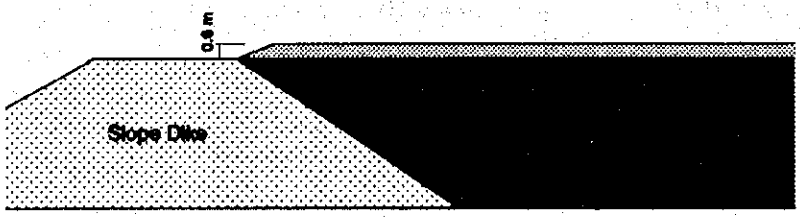
It is difficult to obtain impermeable soil materials for earthlining near the ANPLS, because the project area is geologically made up of volcanic soil which is permeable such as scolia. Even if a material meets the specified permeability ratio, the distance from the borrow pit to ANPLS would require expensive haulage and transport costs.

Accordingly, the sheet lining method was proposed as a leachate control facility.

cdg. Final Soil Cover

After landfilling operations are completed, final waste covering should be carried out and the soil cover should be thick enough to allow the use of the area without

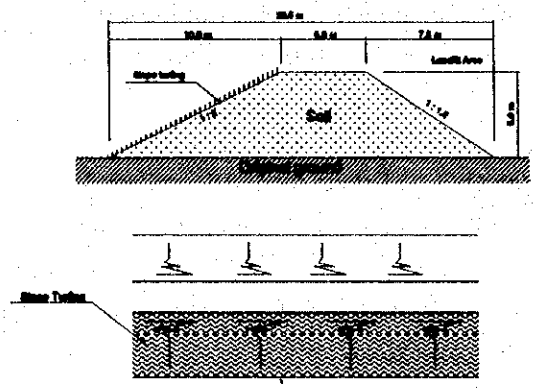
affecting the wastes dumped underneath. Although the required thickness of the final soil cover depends on the ultimate use, in this design the thickness was set at 60 cm.



The soil cover is planned to be obtained within the ANPLS using the soil of the hill in the landfill site.

cdh. Slope Turfing

This is to prevent slope erosion and to blend in with nature.



ce. Building and Accessories

These facilities include a site office, a truck scale, safety facilities, fire prevention facilities, storage building, monitoring facilities, car wash, etc.

cea. Site Office

The site office is estimated to require an area of $180m^2$ to accommodate a staff of 30 (excluding security guards) - that is $6m^2$ per person.

ceb. Truck scale with Computer

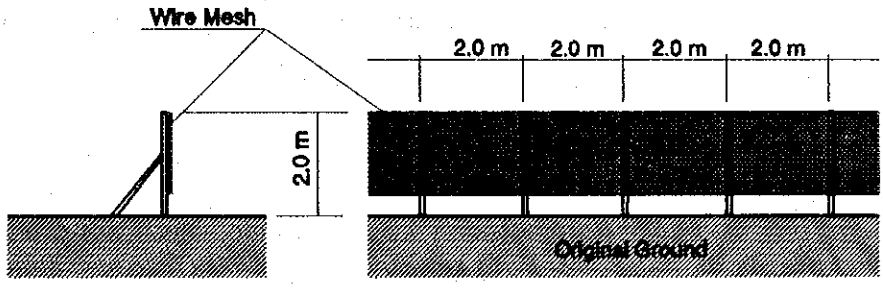
The collection of data on waste discharged at the disposal site is essential for proper solid waste management. Two units of computerized truck scale are planned to be installed at the entrance to weigh all cars, trucks, containers, etc., upon entering and leaving. The truck scale at the present disposal site entrance will be moved to the new site in addition to a new one.

cec. Fence

Fencing is necessary to control the disposal site properly for the following reasons:

- to control scavengers, intermediaries, etc.
- to protect the equipment, spare parts, etc.
- to protect the disposal site from illegal dumping

The dimension of the proposed fence is as follows:



ced. Water Supply System

A water supply system is necessary for firefighting which sometimes occur in a disposal site and for maintaining the site in good condition. Installation work of a water supply system was included in the preliminary design since none is provided near the site.

cf. Design and Supervision

Prior to the commencement of the construction of the disposal site, a detailed design work including investigation of site conditions has to be carried out. During construction of the site, supervision has to be carried out to maintain the required quality of work. The cost of the detailed design and supervision work, about 10 % of the direct construction cost, was included in the cost estimation.

d. Operation and Maintenance Plan

da. Landfill Plan

daa. Basic Policy

The following basic policies were sustained for the preparation of the landfill plan:

- to spread and compact solid waste sufficiently
- to minimize scattering of solid waste
- to minimize the diffusion of offensive odor
- to stabilize wastes as early as possible

Compaction of solid waste is necessary to prolong the service life of the landfill site, which is also helpful in reducing settlements after the completion of the landfill. Furthermore, the prevention of solid wastes from scattering and the diffusion of offensive odor is required in order to conserve the surrounding environment. In order to use the completed landfill site for other purposes, such as recreational or agricultural, early stabilization is necessary during landfill operation.

dab. Landfill Structure

The improved anaerobic sanitary landfill method, which was explained in section H.3.5, was adopted for the landfill structure.

dac. Landfill Method

The landfill methods are divided into three types; open dumping, sandwich, and cell method. The open dumping method can not mitigate offensive odors, generation of disease vectors and noxious insects, and also does not ensure proper compaction. Landfill methods are shown in Figure J.1.4e.

With the sandwich method, soil is spread to cover solid wastes horizontally buried. Where the landfill site is narrow, this method is effective, but if the site is wide, solid wastes are left uncovered for a couple days, resulting in the generation of offensive odors, etc..

With the cell method, soil is spread daily to cover solid wastes dumped. Through this method a highly compacted landfill can be obtained and this prevents scattering of solid waste, generation of offensive odor and the breeding of disease vectors and noxious insects.

It was confirmed that the cell method was effective to keep the sanitary condition good, and also ALMA could operate the cell method through sanitary landfill experiment. Therefore, the cell method should be applied.

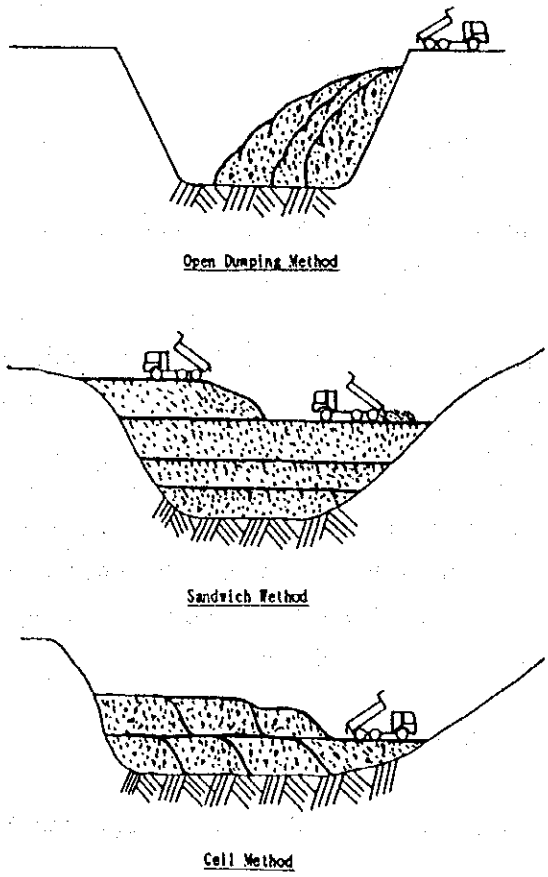
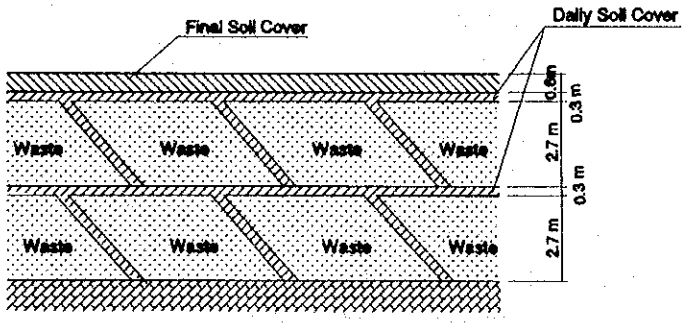


Figure J.1.3b Landfill Methods

dad. Cover Soil

Cover soil is to be placed as in the method shown above and the thickness of each layer should be is as follows:

- daily soil covering: 30 cm
- final soil covering: 60 cm (depending on the ultimate use)



The soil cover will be obtained within the ANPLS where is a hill with enough soil volume can be found. The quality of the soil obtained from this hill is supposedly not good for cultivation; the compost from the refuse can be used if available.

dae. Equipment Planning

i. Planning Conditions

It is essential to consider the following conditions to plan the landfill equipment to be acquired.

- Equipment with a big capacity to excavate and load.
- Equipment with a big capacity to crush and compact combustibles and non-combustibles.
- Equipment which can carry out daily soil covering.
- Equipment with a high capacity for compaction is necessary not only for the ultimate use of the site when completed, but also for the preservation of sanitary conditions as well as the lengthening of the life span of the disposal site.

ii. Required Works

The following works are required for operation of the ANPLS.

- for solid waste
  - . spreading
  - . leveling
  - . compaction

- for soil coverage
  - . excavation
  - . loading
  - . transportation
  - . unloading
  - . spreading
  - . leveling
  - . compaction

- for maintenance
  - . road maintenance
  - . drainage maintenance
  - . site maintenance

- for supervision
  - landfill operation
  - maintenance of site

iii. Equipment Selection

The following equipment was selected for operation and maintenance of landfill operation.

Bulldozer (21 tons)

Bulldozers carry out spreading, leveling and compaction of solid wastes and cover soil. This the 21 ton bulldozer is estimated to be capable of working on 240 m^3 of waste and soil per day, assuming a working rate of 8 hours/day. Working efficiency is estimated at 0.8. The work capacity per year is calculated as follows.

W = 240 m^3/day x 297 days x 0.8 = 57,024 tons/unit/year

In addition, this bulldozer will also be used for some maintenance work, e.g. repair of temporary road.

Landfill Compactor (20 ton class)

Landfill compactor is used for crushing and compacting the waste for the long-term use of the landfill site. It is said that a landfill compactor can reduce the volume of waste dumped into half. The number of landfill compactors to be included among the landfill equipment will be half of the bulldozer.

Wheel Loader (1.2m^3 class)

Wheel loader is used to load the soil for covering waste, road maintenance, etc. from the borrow pit in the ANPLS. A 1.2 m^3 bucket is proposed for efficient loading.

Dump Truck (10 ton)

Dump trucks are used to carry soil from the borrow pit to the disposal site. The average haulage distance is assumed at 1 km. Two dump trucks are considered for the landfill operation in 2000.

Motor Grader (130 PS)

Motor grader is used for leveling the cover soil, road surfacing and forming the earth drain beside the road in the landfill site. One motor grader is considered for the landfill operation.

Wheel Excavator

Wheel excavators will be used for maintenance work such as repairing roads, dredging open drains and repairing some facilities constructed in the dumping yard. Since flexibility is a requirement for these works, a wheel excavator will be included in the landfill equipment.

Water Tanker (5 m^3)

A water tanker will be required in order to store water needed to maintain the site in good condition i.e., by sprinkling water. The water tanker pumps up water from the pond and sprinkle water from its diffuser pipe while in motion. The water tanker is also necessary because it can be used to extinguish fires which sometimes occur at the dumpsite.

Pickup

A pickup is used to patrol the site and for the transport of workers and materials to the site.

Equipment Schedule

The equipment required for the operation of ANPLS is presented in Table J.1.3d.

Table J.1.3d Equipment Required for the Operation of ANPLS

Description	Unit	1998	1999	2000	2001	2002	2003	2004
Bulldozer (21tons)	unit	0	5	5	5	5	6	6
Landfill Compactor (20tons)	unit	0	3	3	3	3	3	3
Wheel Loader (1.2m^3)	unit	0	1	1	1	1	1	1
Dump Truck (10tons)	unit	0	2	2	2	2	2	2
Motor Grader (130PS)	unit	0	1	1	1	1	1	1
Wheel Excavator (0.7m^3)	unit	0	1	1	1	1	1	1
Water Tanker (5m^3)	unit	0	1	1	1	1	1	1
Pickup	unit	0	2	2	2	2	2	2
Description	Unit	2005	2006	2007	2008	2009	2010	
Bulldozer (21tons)	unit	6	6	7	7	8	8	
Landfill Compactor (20tons)	unit	3	3	4	4	4	4	
Wheel Loader (1.2m^3)	unit	1	1	1	1	1	1	
Dump Truck (10tons)	unit)	2	2	2	2	2	2	
Motor Grader (130PS)	unit	1	1	1	1	1	1	
Wheel Excavator (0.7m^3)	unit	1	1	1	1	1	1	
Water Tanker (5m^3)	unit	1	1	1	1	1	1	
Pickup	unit	2	2	2	2	2	2	

dc. Landfill Operations

The landfill operations are outlined below:

- Wastes are dumped as directed by the landfill operation staff.
- The dumped waste is spread, crushed, leveled and compacted by landfill compactor.
- After the landfill operations, the covering operations will be performed daily using the cell method.
- A second layer will be laid on the first in the same manner, extending towards the divider.
- Covering material will be laid on top of the second layer of landfill.
- A divider as well as gas and leachate removal facilities will be constructed in the adjacent area for the next landfill operations.

The landfill plan is summarized below.

- divider

The divider should always be directly adjacent to the almost completed landfill area.

- construction work

According to the progress of landfill works, the following should be constructed:

. divider
. gas removal facilities
. on-site road
. site ditch

- configuration of completed landfill area

To insure the immediate discharge of rainwater on the completed area, the following works shall be completed; these will all be paid for in US$.

. leveling
. temporary drain construction;
  main: lined with concrete
  branch: unlined

dd. Facilities Maintenance

dda. On-site maintenance

In order to execute landfilling in a safe, sanitary and effective manner, final disposal site facilities must be kept in good condition by proper maintenance.

i. on-site roads

The on-site roads in the final disposal site are to be constructed following the landfill operation. The on-site road is to be paved with gravel and compacted and the approach road with asphalt to avoid any problems for vehicles.

ii. fire prevention measures

The main causes of fire at the final disposal site can be the ignition and explosion of inflammable gases such as methane and combustible wastes, such as paper, set

alight due to glass wastes. Other causes are the ignition of landfill equipment fuel etc.. Although the on-site burning of inflammable gases is possible, it is unnecessary as a gas removal facility is installed at the disposal site. Fires caused by glass mates should be prevented by frequent soil covering.

iii. sanitation control

Rodents, flies, mosquitoes, disease vectors and birds very often swarm the final disposal site, which is a problem to be tackled. Therefore, it is essential to work out a measure to prevent breeding of disease vectors, insects etc., as much as possible. The most effective measure is to carry out daily covering of soil by the cell method, and it is important to prohibit solid wastes from being exposed and stagnant water from being produced. Only when absolutely necessary should insecticides be used and then only very sparsely.

A conceivable cause of offensive odor is solid wastes and its decomposition after landfilling. Odors caused by anaerobic decomposition is said to be more offensive than those caused by aerobic decomposition due to the volume and quality of generated gas. An effective measure is to thoroughly cover organic solid waste, which is the cause of offensive odor, and to aerate the landfill site by the immediate draining of rain water.

iv. waste scattering prevention

A fence will prevent waste from scattering outside the site, in addition to the constant monitoring and collecting of waste scattered within the site.

v. on-site maintenance (equipment)

The following is equipment required for effective on-site maintenance.

- disaster prevention: water sprinkler truck
- on-site patrol: inspection vehicle

ddb. Main facilities maintenance

At the final disposal site, the main facilities are the dike and drainage facilities. These facilities must be maintained in good condition as one breakdown could effect them all, resulting in mass damage.

i. The dike must be checked for any cracks or holes.

ii. The drainage system should be constantly monitored and cleaned out as it can be blocked up by sand, leaves, weeds and other objects.

ddc. Equipment maintenance

In order to perform maintenance for effective operations, if during periodic investigation problems are discovered, they should be analyzed and equipment should be repaired only by skilled engineers. Necessary spare parts should be kept in stock.

ddd. Hygiene and safety control

i. hygiene control

As the final disposal operations are outdoors, dust, odors, landfill gas etc. can badly affect the staff working in this already unfavorable environment. Hygiene control, as well as safety control, are assured by understanding the working conditions and improving certain aspects when necessary. Periodic health check-ups shall be performed and treatment given for any accidents. In addition, the staff should possess full knowledge of the location and access to the hospital in case of any emergency.

ii. safety control

Outbreaks of methane and fuel leakages from landfill equipment should be strictly controlled, and in order to prevent fires caused by carelessly thrown cigarette ends, a measure such as no-smoking should be taken at the landfill site. Of course, the staff will be well educated on disaster prevention.

de. Personnel Plan

dea. Organization structure

The organization structure for the operation of the ANPLS in 2000 is proposed as shown in Figure J.1.3c.

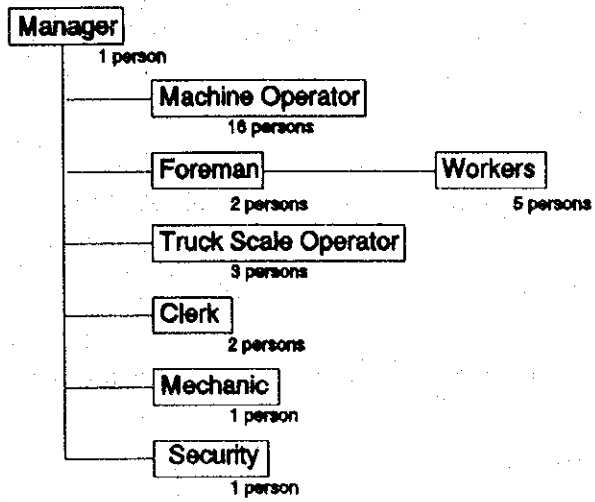


Figure J.1.3c Organization Chart of the ANPLS in 2000

- **Manager** (1 person)

The manager is responsible for operation of the ANPLS. He has the power to delegate jobs to all employees.

- **Assistant manager** (2 persons)

They patrol the landfill site to maintain sanitary conditions and to prevent contamination.

- **Truckscale operators** (3 persons)

They keep all records of waste and of incoming and outgoing trucks by operating truckscale.

- **Machine operator** (16 persons)

They operate equipment in the site.

- **Mechanic** (1 person)

Carry out minor repairs and periodical inspection for preventive maintenance

- **Worker** (5 persons)

Indicate areas prohibited to loading to the drivers of collection vehicles, and keep the space for compaction and covering activities from scavengers.

- **Clerk** (2 persons)

They do accounting and administration work for the ANPLS.

- **Security** (1 person)

They keep guard over equipment, instruments, etc. at night.

- **Manpower Disposition**

The manpower schedule for the ANPLS is presented in Table J.1.3e.

Table J.1.3e Manpower Disposition for the Acahualinca Newly Proposed Landfill Site

Description	unit	1998	1999	2000	2001	2002	2003	2004
Manager	person	1	1	1	1	1	1	1
Foreman	person	2	2	2	2	2	2	2
Truck-scale operator	person	3	3	3	3	3	3	3
Machine operator	person	4	9	16	16	16	17	17
Mechanic	person	1	1	1	1	1	1	1
Worker	person	5	5	5	5	5	5	5
Clerk	Person	2	2	2	2	2	2	2
Security		1	1	1	1	1	1	1

Description	unit	2005	2006	2007	2008	2009	2010	
Manager	person	1	1	1	1	1	1	
Foreman	person	2	2	2	2	2	2	
Truck-scale operator	person	3	3	3	3	3	3	
Machine operator	person	17	17	19	19	21	21	
Mechanic	person	1	1	1	1	1	1	
Worker	person	5	5	5	5	5	5	
Clerk	Person	2	2	2	2	2	2	
Security		1	1	1	1	1	1	

df. Environmental Monitoring

In the process of carrying out landfill work, a monitoring (or supervision) plan which includes water quality inspection and any scattering of solid wastes should be prepared in order to prevent the deterioration of the environmental conditions at the final disposal site.

i. Water quality monitoring

The following shall be monitored for water quality control:

- groundwater by existing wells
- surface water in surrounding drain
- leachate

ii. Waste monitoring

The following wastes shall be monitored:

- waste directly-hauled by the generators unacceptable industrial wastes, in particular
- scattered waste outside the site
- illegally dumped waste

e. Ultimate Use

ea. Basic Conditions on Ultimate Use

The following are basic potential hazards to be considered:

- problems related to settlement
- problems related to gas generation
- maintenance of completed landfills

eaa. Settlement

The settlement of wastes buried in the landfill is dependent on the thickness and composition of the waste, compaction of the material, moisture content, etc.. Studies have indicated that approximately 90% of the waste will settle in the first 5 years. The settlement of the other 10 percent will occur over a much longer period.

Settlement is classified into the following two types:

- settlement of refuse layers
- settlement of soft sub-soil layers

In accordance with the geological survey results, the ground of the proposed site is so steady that landfill activities will not cause the settlement of the sub-soil.

i. settlement of refuse layer

Settlement of refuse layer is caused by two factors:

- compaction
- decomposition

Compaction is caused by pressure from the upper waste layers due to overload and vehicle weight. The settlement rate by compaction varies according to material and water content.

Little information is available on the decomposition of materials buried in a sanitary landfill. It is extremely difficult to predict the time required for complete decomposition. Many items, particularly paper, have been found unchanged in landfills that had been completed 15 to 25 years previously. The rate of decomposition is primarily dependent upon the moisture content and generally takes place at a very slow rate.

eab. Gas generation

Decomposition of the wastes will result in the production of gases, principally methane, carbon dioxide, nitrogen, hydrogen, and hydrogen sulfide. The rate of gas production will usually reach a peak within the first 2 years and then slowly taper off. Methane gas causes the most concern because of its flammable character.

A countermeasure for gas generation is construction of gas removal facilities such as installation of perforated pipes and gravel.

eac. Maintenance

Completed landfills generally require maintenance because of disparity in levels of settlement. Maintenance consists primarily of resloping the surface to maintain good drainage and filling in small depressions that result from uneven settlement.

eb. Ultimate Use Plan

eba. Possible ultimate use

As for the ultimate use of the completed site, after reclamation the land can be immediately used as a car park, golf course, farmland, park, playground etc.. One-storey rambling-type buildings can be constructed on the reclaimed land years later. It is difficult to grow tall trees in the reclaimed area due to the gaseous substances underneath and changes in temperature. Shrubs and herbs can be planted though.
Accordingly, it is really important to determine how thick the final waste cover shall be in consideration of the land use ultimately intended for the area.

i. as farmlands

One of the ultimate use of the completed site is for agricultural purposes by reclaiming swamps and mountainous areas (valley) to produce leveled ground suitable for farming. In order to use the land for farming, the selection of suitable final cover soil is required, and to make the thickness of the soil approximately 1 – 2 m. Additionally, in order to prevent crops from being affected by gases generated, it is essential to install a gas removal facility. Periodic inspection and maintenance are necessary because of distortion and deterioration of gas removal pipes and rain water drains due to settlement of the foundation. Because of the clogging of pipes which causes the spread of generated gas over the farmland, crops wither and die. In order to obviate negative effects caused by gases, periodic examinations should be conducted and necessary mitigation measures should be enforced.

ii. as sports facilities and parks

A number of disposal sites are used ultimately as soccer grounds, sports facilities and parks. In order to use the site for these facilities, it is easy to decide the nature and thickness of covering materials, as compared to that for agricultural purposes.

Considering that the public, including children and the elderly, use these facilities more often than they would farmland, one must pay attention in handling generated gas. Generated gas is treated by diverting it into the open air and burning, but if the released amount of gas, seepage and exhaust gas by burning is low, these gases remain in the utilized facilities. It is necessary to take the aesthetic aspects into account.

iii. as car parks

As for the ultimate use of the completed site as a car park, although the problems with rusting of cars caused by gas remains, the improvement measures for this use is easier than that for farmlands and parks. Inspection of gas removal facilities and generated gas should be conducted in the same manner as that in other uses, however a small number of problems still arise such as settlement.

ebb. Recommendations on ultimate use

Due to settling and gas problems, construction of buildings on completed landfill sites is not recommended for at least 15 years. Thus, the following ultimate uses are recommended.

A park for the surrounding inhabitants is recommended. The reasons are:

- a great contribution to the surrounding residents
- in harmony with the existing landscape
- compatible with the surrounding land use
- one of the least expensive methods of land use

f. Cost Estimates

fa. Construction Cost of the ANPLS

The preliminary drawings of the ANPLS are presented in Figure J.1.3a and J.1.3b. The construction cost of phase I was estimated based on the work quantities taken out from those drawings. The construction cost of the phase II and III were estimated based on the estimated cost of the phase I.

fb. O & M Cost

The O&M cost estimate was made based on the estimated number of required equipment and manpower.

fc. Land Acquisition Cost

The land proposed for the construction of the new disposal site had to be acquired because it was then (March 1995) privately owned. The land acquisition cost was not included in the cost estimation. The land acquisition cost was assumed to be C$ 2.8 million for 93 hectares (using official price = C$3.00/$m^2$).

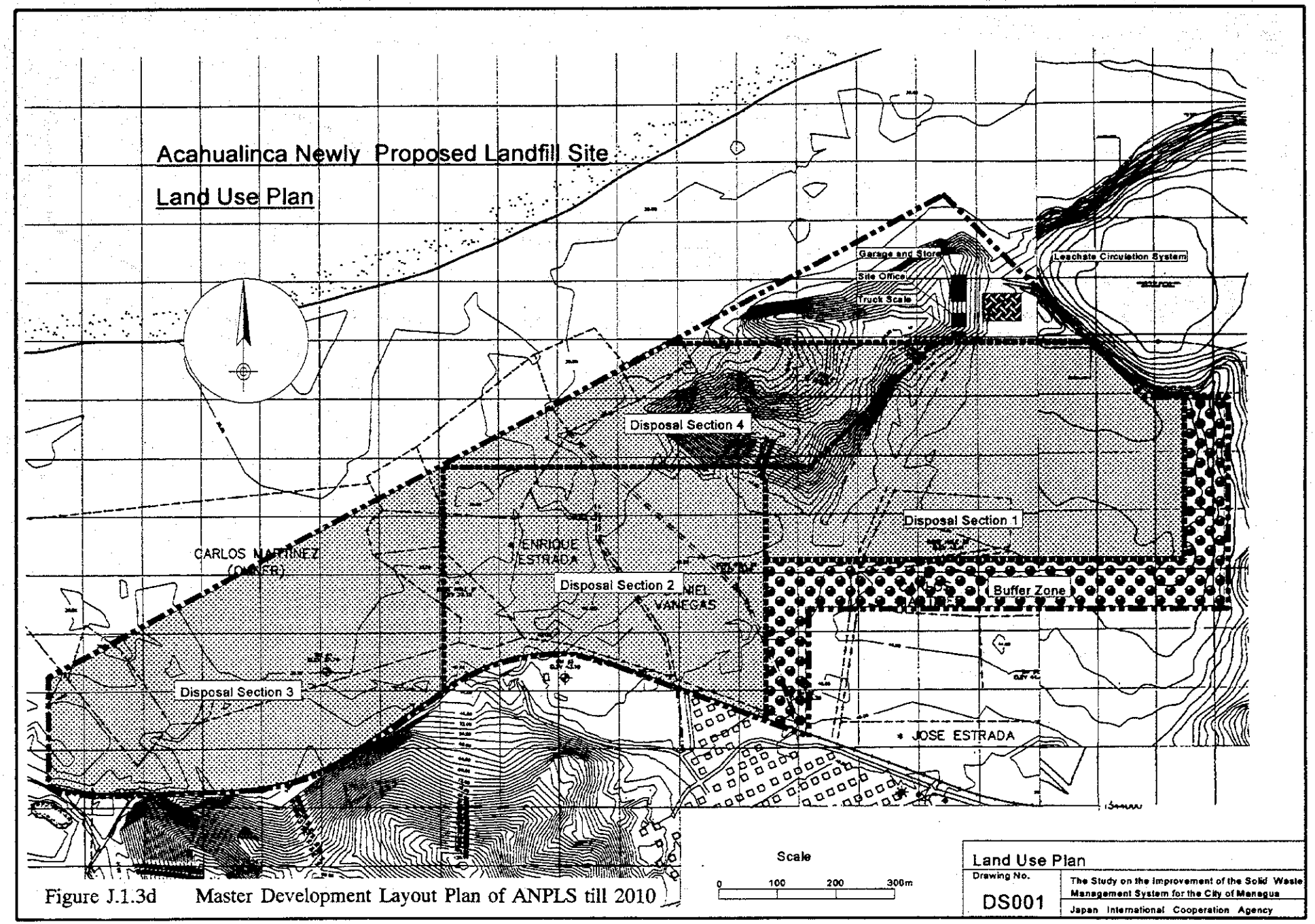


Figure J.1.3d Master Development Layout Plan of ANPLS till 2010

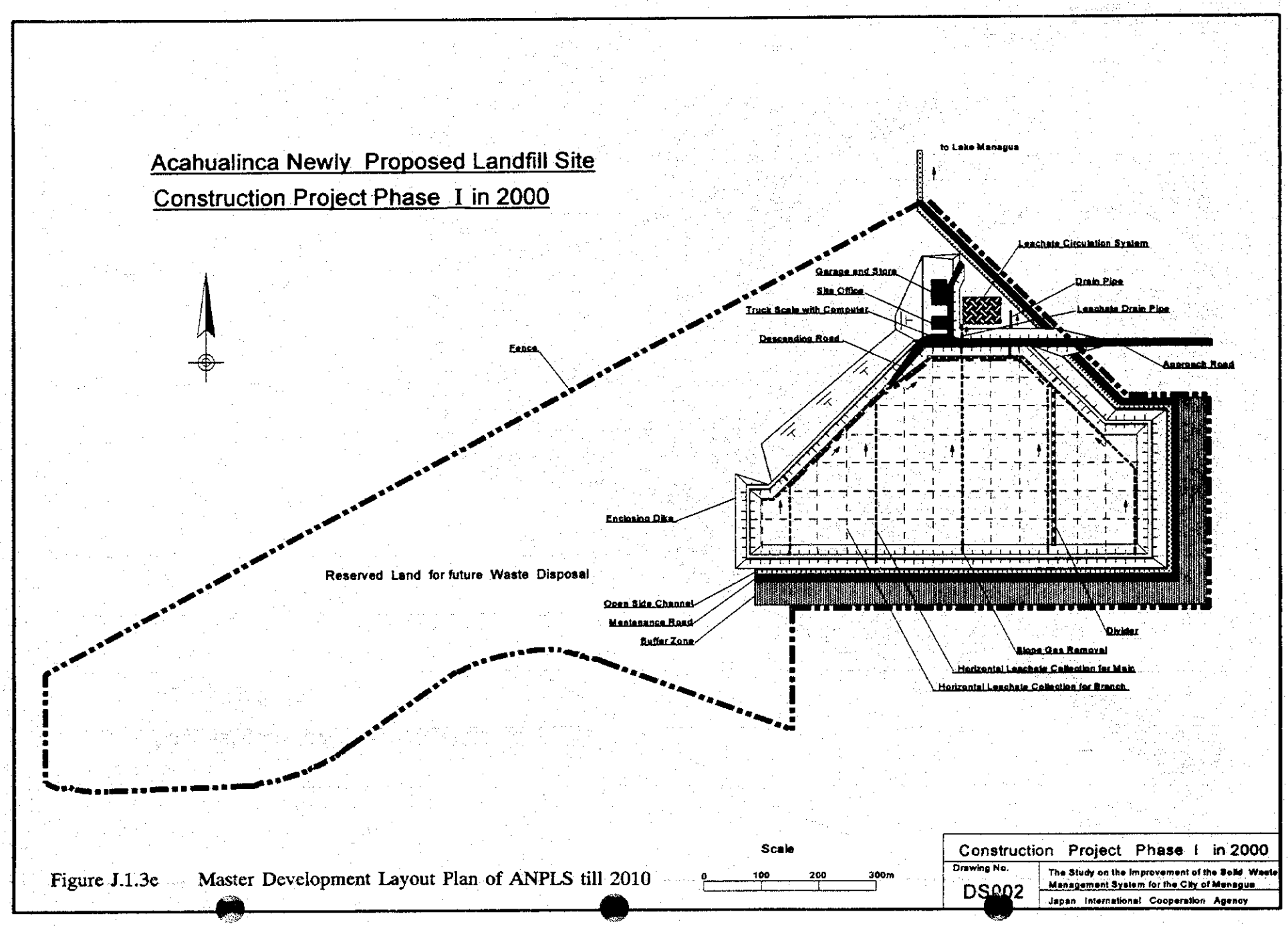


Figure J.1.3e Master Development Layout Plan of ANPLS till 2010

fcb. Construction Cost

The respective costs of each construction phase of the Acahualinca Newly Proposed Landfill Site are estimated as shown in Table J.1.3f.

Table J.1.3f Construction Cost by Phase in the Acahualinca Newly Proposed Landfill Site

No.	Items	Phase I (thou.C$)	Phase II (thou.C$)	Phase III (thou.C$)	Phase IV (thou.C$)	Total Cost from 1997 to 2010 (thou.C$)
1	**Site clearing and preparation**	**5,776**	**7,768**	**4,194**	**5,330**	**23,067**
2	**Enclosing structures**	**7,371**	**9,914**	**5,352**	**6,802**	**29,439**
2.1	Enclosing dike	7,272	9,780	5,280	6,710	29,042
2.2	Divider	99	134	72	92	397
3	**Drainage system**	**2,643**	**3,554**	**1,919**	**2,439**	**10,555**
3.1	Open side channel	616	828	447	568	2,460
3.2	On-site open drain	88	119	64	81	352
3.3	C-Pipe (I)	53	71	38	49	211
3.4	C-Pipe (II)	476	641	346	440	1,903
3.5	Under ground drain	166	223	121	153	663
3.6	Vertical drain	1,231	1,656	894	1,136	4,918
3.7	Diversion Canal	12	16	9	11	2
4	**Road**	**5,029**	**6,763**	**3,651**	**4,641**	**20,084**
4.1	Main approach road (asphalt paved)	2,721	3,659	1,976	2,511	10,866
4.2	Temporary road (gravel road)	1,793	2,412	1,302	1,655	7,161
4.3	Descending road	515	693	374	475	2,057
5.	**Environmental Protection Facilities**	**64,302**	**86,477**	**193,688**	**59,336**	**256,803**
5.1	Buffer zone	331	445	240	305	1,321
5.2	Litter scattering Prevention facilities	376	506	273	347	1,503
5.3	Gas removal facilities	226	304	164	209	903
5.4	Horizontal leachate collection for branch	4,433	5,962	3,219	4,091	17,705
5.5	Horizontal leachate collection for main	3,444	4,631	2,500	3,178	13,753
5.6	Leachate drain pipe	56	75	41	52	224
5.7	Leachate circulation system	1,832	2,465	1,331	1,691	7,318
5.8	Slope turfing	53,306	71,690	38,704	49,190	212,891
5.9	Monitoring facilities	276	371	200	254	1,101
5.10	Leachate treatment facilities	21	29	15	20	85
6	**Building and accessories**	**4,176**	**2,425**	**1,547**	**1,966**	**10,114**
6.1	Fence	2,143	2,425	1,547	1,966	8,081
6.2	Site office	653	0	0	0	652
6.3	Garage and store	512	0	0	0	512
6.4	Truck scale with computer	157	0	0	0	157
6.5	Furniture	397	0	0	0	397
6.6	Water & Electric Supply	315	0	0	0	315
7	**Miscellaneous**	**8,930**	**11,690**	**21,035**	**8,051**	**49,706**
8	**Contingency (15%)**	**14,734**	**16,773**	**30,181**	**11,552**	**73,240**
9	**Design and supervision (10%)**	**9,823**	**11,182**	**20,121**	**7,701**	**48,827**
	Total Construction Cost (mill.C$)	122.8	139.8	251.5	96.3	610.3

ecc. Operation and Maintenance (O&M) Cost

In compliance with the landfill level design, the estimated required quantities of equipment, labor, and materials are presented in Table J.1.3g.

Table J.1.3g Estimated Quantities for O&M of Disposal Site

Items	Description	unit	2000	2001	2002	2003	2004	2005
Machinery	Bulldozer 21 ton	unit	5	5	5	6	6	6
	Landfill Compactor 20 ton	unit	3	3	3	3	3	3
	Wheel Loader 1.2m^3	unit	1	1	1	1	1	1
	Dump Truck 10 ton	unit	2	2	2	2	2	2
	Motor Grader 130PS	unit	1	1	1	1	1	1
	Wheel Excavator 0.7m^3	unit	1	1	1	1	1	1
	Water Tanker 5m^3	unit	1	1	1	1	1	1
	Pickup	unit	2	2	2	2	2	2
Employee	Manager	person	1	1	1	1	1	1
	Foreman	person	2	2	2	2	2	2
	Track Scale Operator	person	3	3	3	3	3	3
	Machine Operator	person	16	16	16	17	17	17
	Mechanic	person	1	1	1	1	1	1
	Worker	person	5	5	5	5	5	5
	Clerk	person	2	2	2	2	2	2
	Security	person	1	1	1	1	1	1
Material	Insecticide	LS	1	1	1	1	1	1
	Fuel & Lubricant	LS	1	1	1	1	1	1
	Others	LS	1	1	1	1	1	1
Utilities	Water, Electricity	LS	1	1	1	1	1	1
Items	Description	unit	2006	2007	2008	2009	2010	
Machinery	Bulldozer 21 ton	unit	6	7	7	8	8	
	Landfill Compactor 20 ton	unit	3	4	4	4	4	
	Wheel Loader 1.2m^3	unit	1	1	1	1	1	
	Dump Truck 10 ton	unit	2	2	2	2	2	
	Motor Grader 130PS	unit	1	1	1	1	1	
	Wheel Excavator 0.7m^3	unit	1	1	1	1	1	
	Water Tanker 5m^3	unit	1	1	1	1	1	
	Pickup	unit	2	2	2	2	2	
Employee	Manager	person	1	1	1	1	1	
	Foreman	person	2	2	2	2	2	
	Track Scale Operator	person	3	3	3	3	3	
	Machine Operator	person	17	19	19	21	21	
	Mechanic	person	1	1	1	1	1	
	Worker	person	5	5	5	5	5	
	Clerk	person	2	2	2	2	2	
	Security	person	1	1	1	1	1	
Material	Insecticide	LS	1	1	1	1	1	
	Fuel & Lubricant	LS	1	1	1	1	1	
	Others	LS	1	1	1	1	1	
Utilities	Water, Electricity	LS	1	1	1	1	1	

J.1.4 Improvement of the Present Los Cocos Workshop

a. Design Conditions

aa. Introduction

Proper vehicle and equipment maintenance system is the key to a sound solid waste management, and can be realized through the formulation and provision of manuals. The maintenance system, however, can be effectively implemented with the provision of the right tools and facilities.

In Managua, the maintenance of MSWM vehicles and equipment is carried out at the Los Cocos workshop, which is located in a poorly structured building and equipped with limited tools and equipment, some of which area rundown or malfunctioning. Given these conditions, it goes without saying that the workshop renders very sloppy services.

Several suggestions are made therefore to improve workshop conditions and human and material resources.

ab. Design conditions

The MSWM vehicle and equipment operation and maintenance works are conducted in accordance with the following work share.

Table J.1.4a MSWM Vehicle and Equipment Operation and Maintenance Works

Work Items / Use of Equipment	Operation	Maintenance & Repair
1. Collection	ALMA, Private Sector	ALMA
2. Final Disposal	ALMA	ALMA
3. Administration	ALMA	ALMA

Consequently, this chapter also deals with the improvement plan for the present Los Cocos workshop.

ac. Lay-out modifications and enlargements of the present shed of the Los Cocos workshop

Presently, the most pressing problems at the workshop are:

- The maintenance services for vehicles and equipments are poor and are being made in the open yard.

- There are no water closets for the workers but only a makeshift cloak room without cabinets.

These problems can be immediately overcome through the enlargement of the present shed which measures 69.4 m^2. This section to be enlarge shall be the area alongside the present greasing and welding section. The mechanical section, after this enlargement, will occupy a total area of 242.5 m^2.

A 9.0 m^2 tool storage room will also be built in this area. The machines and tools in this area will be shared by the mechanic and welding sections. These machines and tools are the following:

Machines and Tools	Welding Section	Mechanic Section
- Welding Machine	2	-
- Bench Electric Grinder	1	-
- Wood Bench	1	-
- Metallic Bench	1	-
- Machinist Vise	2	-
- Oxy-Acetylene Welding	1	-
- Tool Box	2	2

Some machines and tools to be acquired for the mechanic section are as shown below:

Items	Quantities
- Bench	3
- Metallic Bench	1
- Bench Electric Grinder	1
- Machinist Vise n 8	2
- Compressed Air outlet	2
- Hydraulic Hanger	1
- Universal Drilling Machine	1

Some of the tools in the tool storage room shall be lent to the mechanics working in the workshop. These tools are as follows:

- Electric Drill
- Adjustable Wrench
- Adjustable Pipe Wrench
- Grip Plier
- Plier
- Ball Pen Hammer
- Screw Driver
- Allen Wrench
- Socket Wrench set
- Gear Puller
- Drill Set
- Screen Clamp
- Open End Wrench
- Box Wrench
- Combination Wrench
- Drain Plug Wrench
- Oil Filter Wrench
- Adjustable Hacksaw Frame
- Hacksaw Blade
- Torque Wrench
- Electric Soldering Iron
- Vernier Caliper

ad. Construction of a concrete paved area for washing, lubrication and inspection in the Los Cocos workshop

Taking into account the absence of a designated area or equipment for washing services, the paving of an area of 204 m^2 is proposed for this purpose.

This area shall be made of concrete and well drained, and shall be located alongside the shed with an inspection pit for the vehicles. This old pit shall be demolished and a new one made specially for vehicular inspection, lubrication and oil change.

A 6.0 m^2 storage room shall be constructed also for the washing and greasing equipment.

The following equipment and machines shall be acquired for the new greasing section in Los Cocos workshop:

- High pressure grease pump 1
- Hand oil pump 1
- Compressed air outlet 1
- High pressure water pump 1
- Hot water high pressure car washer 1
- Compressed air outlet 2

This area shall also be very well lighted so that the vehicles can also be washed at night.

For the greasing and lubricating activities, three more employees will be assigned to the night shift, under the following schedule:

- 1 (one) from 12:00 PM to 6:00 PM
- 2 (two) from 6:00 PM to 12:00 PM

Table J.1.4b Proposed Area to be Paved in 2000

Present Situation	Proposal
Surface Area: 651.36 m^2	204.00 m^2 – new construction and one pit for the greasing section 69.40 m^2 – enlargement of the present shed to house the mechanic section 30.00 m^2 – cloakroom and bathroom – new constructions

ae. Mobile Greasing and Lubrication Unit

In order to improve the preventive maintenance and fueling of earth moving machines in the sanitary landfill, the acquisition of a mobile greasing and fueling truck is proposed.

Only one truck, model Mercedes-Benz 1980, is carrying out this service and it is in bad condition.

The immediate acquisition of a new mobile lubrication and fueling truck for the earth moving machines is very important.

af. Enlargement of the present shed for container construction and maintenance in Los Cocos and new lay-out (for the year 2000)

All the containers used in the container collection system are under repair in this section and a few are newly built. Some vehicle repair services are also made in this section.

When the street sweeping operations will be handed over to the Public Cleansing Office, this section shall also be improved in order to render maintenance services to the litter carts that are currently being made in this shop.

The container construction and maintenance section shall also be enlarged in order to accommodate the body repair and painting activities to be introduced.

For this purpose, the area of 120 m^2 alongside the painting boxes and the body repair area shall be paved in concrete.

Table J.1.4c Improvement Plan of Container Construction and Maintenance Section

Section	Present (m^2)	Year 2000 (m^2)
- Offices	82.50	82.50
- Welding and Smithy	108.48	269.60
- Painting	59.00	90.00
- Paved area	0.00	120.00
Total	249.98	562.10

ag. Construction of a new shed in Los Cocos and new lay-out

The previous suggestions for improving the maintenance buildings at Los Cocos were restricted to minor extensions and to the rearrangement of several sections in order to upgrade the working conditions of the maintenance services.

For the year 2000 though, a new shed for the maintenance of vehicles and equipment shall be constructed.

This new shed will be constructed in Los Cocos, near the present one, taking advantage of the current constructions used by the administrative offices and the greasing section. Also the construction of a new pit for lubrication, inspection, etc.

shall be carried out.

The other areas occupied by the mechanic, vulcanization and welding sections shall be demolished. The area located between the new shed and the old one shall be paved in concrete to allow vehicles access to the shed and for the parking of the vehicles during quick repair services.

For these new workshops, several new machines and tools shall be acquired for the maintenance services. These machines and tools are listed in Table J.1.4d:

Table J.1.4d Machines and tools to be acquired for the Improved Los Cocos Workshop in 2000

Items	Quantities	Items	Quantities
Metallic Bench	01	Gear Puller	03
bench	08	Screw Clamp	04
Bench Electric Grinder	04	Open End Wrench Set	03
Machinist Vise No.8	04	Box Wrench	03
Battery Cable	01	Rigid Rack	04
Battery Hydrometer	04	Combination Wrench Set	03
Battery Tester	01	Compression Gauge	01
Battery Syringe	01	Hydraulic Gauge	01
Circuit Tester	01	Hydraulic Hanger	01
Wire Stripper	01	Nozzle Tester	01
Polyethylene Funnel	01	Drain Plug Wrench	02
Wood and Steel Covered Bench	01	Oil Filter Wrench	02
Iron Anvil	02	Oil Measure	02
Oxy-acetylene Welding	01	Adjustable Hacksawframe	05
Shearing machine	02	Hacksawblade	30
Polisher	02	Drill Set	02
Spray Gun	09	Solder	30
Compressed Air Outlet	02	Surface Plate	01
Air Impact Wrench	01	Tool Set Portable Type	01
High Power Wrench	01	Tool Set Heavy Duty Type	01
Wheel Nut Wrench	01	Grease Gun	02
Tire Service Tool Set	01	Torque Wrench	01
Grinding Wheel	03	Electric Soldering Iron	01
Wire Bush Bench	01	Chisel and Punch Set	01
Hydraulic Jack – 30 t.	02	V Block	10
Hydraulic Press – 150 t.	01	Vernier Caliper	01
Hydraulic Garage Jack	02	Fuelpump	01
Miled Tooth File	01	Steel Rule	02
High Pressure Water Pump	01	Iron Bench Level	01
Hot Water High Pressure Car Washer	01	Garage Lamp	01
Electric Drill	01	Hack Sawing Machine	01
Adjustable Pipe Wrench	05	Spray Mask (Respirator)	02
Adjustable Wrench	05	Exhauster for Painting Box	04
Grip Plier	05	Body-fender Tool Set	01
Plier	08	Engine Oil Pump	01
Ball Peen Hammer	05	Grease Gun	02
Screw Driver	07	Grease Pump	01
Allen Wrench Set (Hex Wrench)	02	automatic Tire Inflator	01
Welding Shield	04	Oil Flow Meter	01
Universal Drilling Machine	02	Water Tank	01
Tool Box	04	Battery Changing Cable	04
High Speed Abrasive Cut-off Machine	01	Fuel Tank	01
Socket Wrench Set 3/4	01	Safety Holder	05
Socket Wrench Set 1/2	01	Earth Clip	05

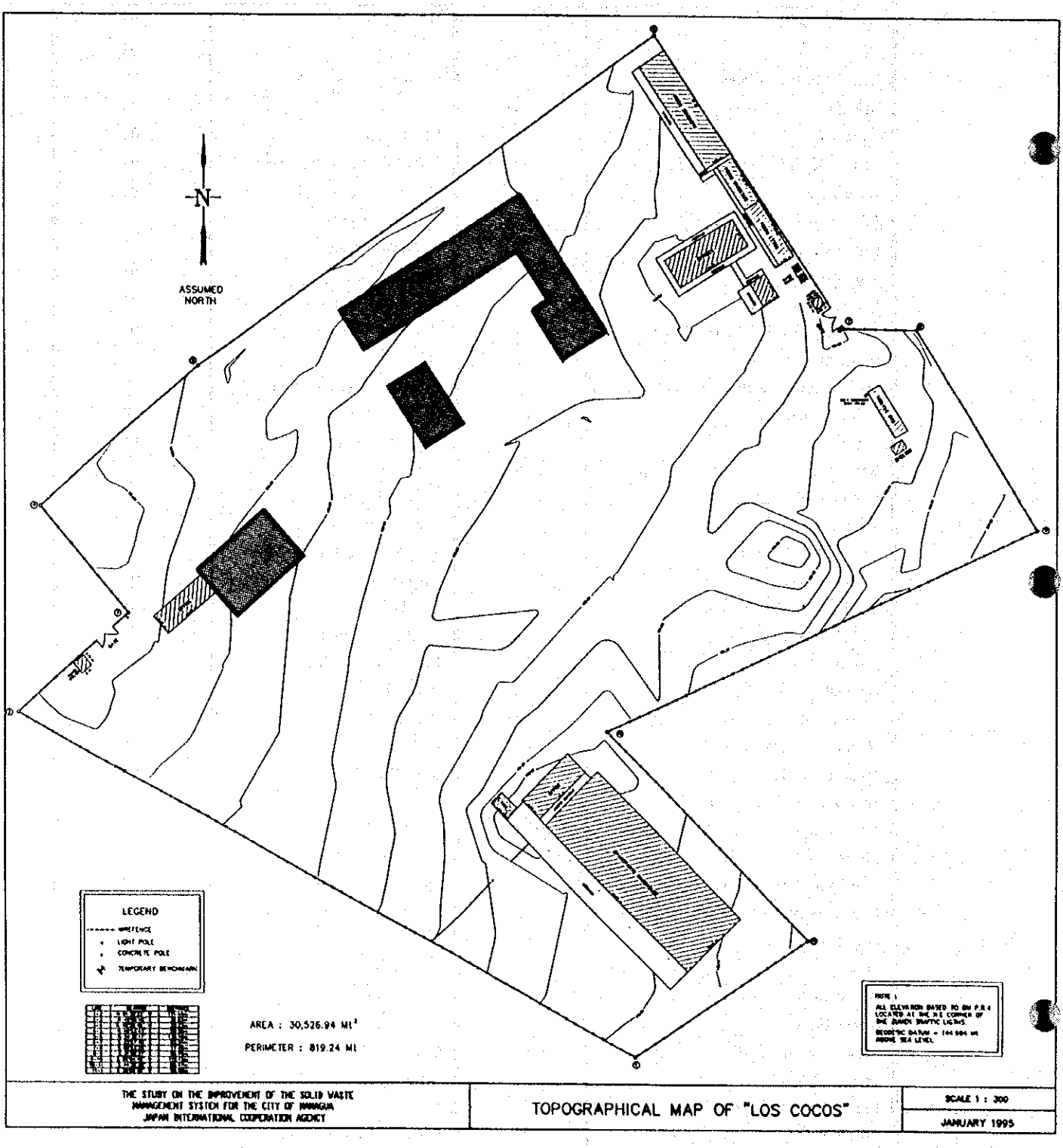


Figure J.1.4a Proposed Layout of Los Cocos in 2000

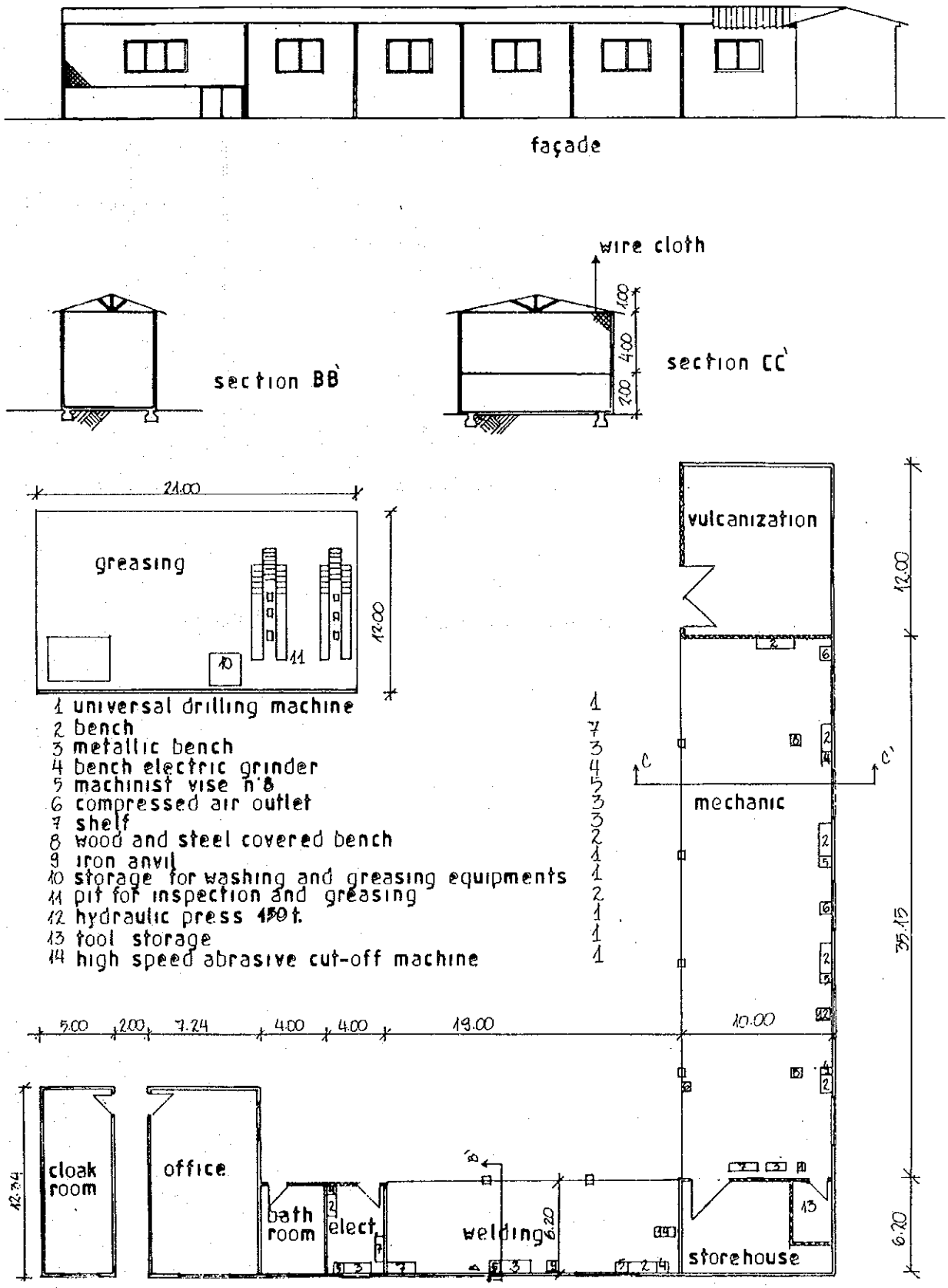


Figure J.1.4b Improvement Plan for Workshop Building (1)

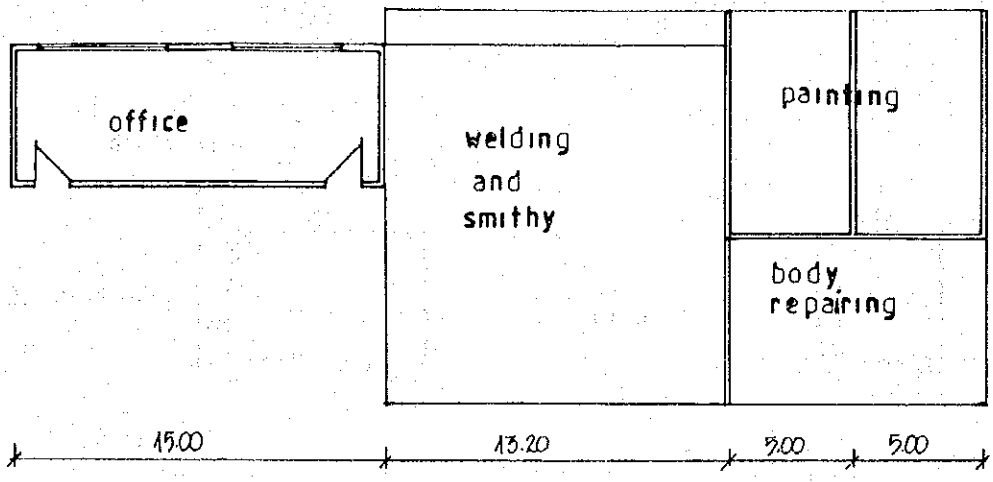


Figure J.1.4c Improvement Plan for Workshop Building (2)

ah. Maintenance staff requirements

Vehicle maintenance work is basically carried out by assigning one worker to do the repair services of 3 vehicles.

To estimate the required number of staff, this was use as a basis.

Presently, all the vehicles and machines being used for collection and disposal are stationed at the Los Cocos workshop, which houses a total of 102 trucks and earth moving machines and 8 light vehicles.

The repair and maintenance services of these vehicles and equipment are being made by 33 workers, that is 3 or more than 3 vehicles per worker.

After the construction of the Greasing Section, it will be necessary to add 3 new workers to the manpower of this section (from 4 to 7 workers) and also to add one worker to the vulcanization section, in order to cope with the many punctured tires each morning.

All this will bring the total manpower to 37 workers, and there will be 1 worker for every 2 to 3 vehicles.

In the year 2000 there will be 117 vehicles and machines for the refuse collection, street sweeping and disposal activities. In this case it will be necessary to employ 40 workers for the maintenance services.

Table J.1.4e Labor force at Los Cocos Workshop

Section	1995	2000
- Administration	2	3
- Mechanical Repair	16(1)	18
- Vulcanization	6+1(3)	6
- Greasing	4+3(2)	6
- Electrical Repair	4	4
- Welding	3	3
- Body repair & painting	4	3
Total	39+4	43

Notes:
(1) 8 mechanics and 8 helpers
(2) 3 more workers in the greasing section after the construction of the paved area and service expansion
(3) for better tire repair services

Table J.1.4f Maintenance staff

Year	No. of Vehicles and Machine	Workers	Remarks
1995	110	37	
2000	117	40	Manager and 2 Clerks shall be added

ai. Training needs for the maintenance works

For staff training, the Public Cleansing Office shall provide courses in the following areas:

i. Drivers and Supervision Personnel

- Safe driving
- Traffic regulations for the drivers and transport supervisors
- Accident communication procedures for drivers and transport supervisors
- Methods, techniques and procedures for daily inspections, including the necessary forms the drivers, mechanics, electricians, helpers, have to fill up
- Getting acquainted with vehicle structure and functions for the drivers
- Advanced training courses on the operation of new vehicles and equipments

In order to render these courses, the technical staff of the Public Cleansing Head Office shall be prepared to act as instructors. Also, the participation and support of the equipment and vehicles manufacturers shall be requested in order that they provide manuals, films etc.

ii. For the maintenance staff

- Lubrication
- Engine overhaul and adjustment
- Front axle repair and adjustment
- Back axle repair
- Transmission gear repair (clutches, gear boxes and differentials)
- Brakes system
- Electrical system
- Adjustments of the hydraulic system
- Hydraulic pumps, hydraulic drives and cylinders and valves overhaul

aj. Vehicle and Machine identification

For the effective control of vehicles and equipments operations, the vehicles and equipment will be identified by numbers. Numeric identifications as in the format presented ahead, shall be painted on both sides of a vehicle and at the rear of truck bodies.

The format shall follow the following pattern:

XX - XX - XX
(1) (2) (3)

(1) The first two digits represent the specific identification digit established for the following groups of vehicles or equipment:

01 - automobiles, jeeps
02 - pick-ups
03 - vans
04 - dump trucks
05 - flat bed trucks
06 - water tank trucks
07 - mobile lubrication and fueling trucks
08 - compactor trucks
09 - road sweepers
10 - hoist trucks
11 - roll-on roll-off trucks
12 - tractor trucks
13 - mobile workshops
14 - wheel loaders
15 - bulldozers
16 - compactor trucks
17 - excavators
18 - pulling cart tractors
19 - motor graders
20 - dump trailers
21 - dump carts

(2) The next two digits stand for:

- the cargo capacity in cubic meters in the case of the compactor trucks, dump trucks, flat bed trucks, water tank trucks, dump trailers, etc..
- the capacity of passengers in the case of automobiles, jeeps, pick-ups, vans,

etc

- the cargo capacity in cubic meter of the container in the case of the hoist trucks, roll-on, roll-off trucks, etc.
- the manufacturers model, in the case of earth moving equipment

Example:

08 - 15 : identifies a compactor truck with a 15 cubic meter capacity
15 - 06 : identifies a D6 model bulldozer

(3) The last two digits represent the identification figure in chronological order of the vehicles and machines at the time of purchase.

Example:

08 - 15 - 10 : identifies the tenth acquired 15 cubic meter compactor truck

J.1.5 Promotion of Public Awareness, Cooperation and Participation

a. Introduction

Public awareness, cooperation and participation are necessary to realize the target defined in the Master Plan. These are very important not only for the MSWM activities but also for the citizen themselves, for improvement of the sanitary environment.

The activities for promotion of public awareness, cooperation and participation shall be done by municipality. The public communications assistant, which is a proposed section to be established in the municipal organization as described in the equipment and staff to carry out these activities are proposed as follows.

b. Required Equipment

The promotion activities of public awareness, cooperation and participation shall be carried out all over the project area. Also it must be considered that large number of people do not have TV set. Therefore, a 4-wheel drive station wagon with a video is proposed.

c. Required Number of Staff

Table 1.5a Required Number of Staff

Items	Required Number of Staff
- Manager	1
- Assistant manager	1
- Driver	1
- Worker	3
- Clerk	1

J.1.6 Summary of Preliminary Design for the Priority Projects

a. Required Number of Equipment

The number of equipment which were planned to be used for MSWM operations based on the analysis result of section J.1 are summarized in Table J.1.6a.

Table J.1.6a Proposed Equipment

Items	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Collection Service													
- Compactor 15.3m³	5	10	55	55	55	55	55	50	45	24	24	24	24
- Compactor 15.3m³ + container lift	1	3	3	3	3	3	3	3	4	4	4	4	5
- Hoist Truck for 7.0m³ container	10	20	20	21	22	23	25	26	27	29	34	39	45
- Container 1.0m³	135	270	270	276	283	290	297	305	312	319	327	335	344
- Container 7.0m³	65	131	131	139	147	155	163	172	182	191	223	258	297
- Dump Truck 8m³	3	6	6	6	6	6	6	6	6	6	6	6	6
- Wheel Loader 0.7m³	1	3	3	3	3	3	3	3	3	3	3	3	3
- Motor Grader 103 PS	0	1	1	1	1	1	1	1	1	1	1	1	1
- Pickup	3	6	6	6	6	6	6	6	6	6	6	6	6
Public Cleansing Service													
- Compactor 15.3m³ + Container list	1	2	2	2	2	2	2	2	2	2	2	2	2
- Hoist Truck for 7.0m³ Container	1	1	1	1	1	1	1	1	1	1	1	1	1
- Pickup	1	2	2	2	2	2	2	2	2	2	2	2	2
Disposal Operations Service													
- Bulldozer 21ton	0	5	5	5	5	6	6	6	6	7	7	8	8
- Landfill Compactor 20ton	0	3	3	3	3	3	3	3	3	4	4	4	4
- Wheel loader 1.2m³	0	1	1	1	1	1	1	1	1	1	1	1	1
- Dump Truck 10m³	0	2	2	2	2	2	2	2	2	2	2	2	2
- Motor Grader 130PS	0	1	1	1	1	1	1	1	1	1	1	1	1
- Wheel Excavator 0.7m³	0	1	1	1	1	1	1	1	1	1	1	1	1
- Water Tanker 5m³	0	1	1	1	1	1	1	1	1	1	1	1	1
- Pickup	0	2	2	2	2	2	2	2	2	2	2	2	2
Maintenance Service													
- Mobil Workshop	0	1	1	1	1	1	1	1	1	1	1	1	1
- Maintenance Equipment in Los Cocos	0	1	1	1	1	1	1	1	1	1	1	1	1
Public Communications Assistants													
-Station Wagon with VIDEO	1	1	1	1	1	1	1	1	1	1	1	1	1

b. Manpower Schedule

The manpower which were planned to conduct the MSWM operation based on the analysis result of the section J.1 are summarized in Table J.1.6b.

Table J.1.6b Summary of Manpower Schedule

Items	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Collection Service													
- Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Foremen	6	6	6	6	6	6	6	6	6	6	6	6	6
- Driver	25	74	78	79	79	80	80	80	80	57	62	66	71
- Worker (collector)	61	34	194	195	193	194	190	188	186	113	118	120	123
- Clerk	3	3	3	3	3	3	3	3	3	3	3	3	3
Public Cleansing Service													
- Assistant Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Foreman	6	6	6	6	6	6	6	6	6	6	6	6	6
- Driver	3	5	5	5	5	5	5	5	5	5	5	5	5
- Worker (Collector)	5	8	8	8	8	8	8	8	8	8	8	8	8
- Street Sweeper	225	230	234	234	234	234	234	234	234	234	234	234	234
- Park Cleaner	104	104	113	113	113	113	113	113	113	113	113	113	113
- Clerk	2	2	2	2	2	2	2	2	2	2	2	2	2
Disposal Operations Service													
- Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Foreman	2	2	2	2	2	2	2	2	2	2	2	2	2
- Truck-scale Operator	3	3	3	3	3	3	3	3	3	3	3	3	3
- Machine Operator, Driver	4	9	16	16	16	17	17	17	17	19	19	21	21
- Mechanic	1	1	1	1	1	1	1	1	1	1	1	1	1
- Worker	5	5	5	5	5	5	5	5	5	5	5	5	5
- Clerk	2	2	2	2	2	2	2	2	2	2	2	2	2
- Security	1	1	1	1	1	1	1	1	1	1	1	1	1
Maintenance Service													
- Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Mechanic	3	10	18	18	18	18	18	18	18	18	18	18	18
- Driver	0	1	1	1	1	1	1	1	1	1	1	1	1
- Worker (Assistant)	6	14	21	21	21	21	21	21	21	21	21	21	21
- Clerk	2	2	2	2	2	2	2	2	2	2	2	2	2
Public Communications Assistants													
- Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Assistant Manager	1	1	1	1	1	1	1	1	1	1	1	1	1
- Driver	1	1	1	1	1	1	1	1	1	1	1	1	1
- Worker	3	3	3	3	3	3	3	3	3	3	3	3	3
- Clerk	1	1	1	1	1	1	1	1	1	1	1	1	1

J.2 Institutional System

J.2.1 Administration and Organization

a. Administration

The administration of the Solid Waste Management system in Managua by the year 2000 will remain in the hands of the Municipality, regardless of the proposed participation of the private sector in a significant segment of the Municipal Solid Waste Management activities.

Being universally acknowledged as a public health concern, urban solid wastes management shall always be administered by public officials.

In the case of Managua, the administration of the system will continue to be controlled by the Municipal Government basically through the Public Cleansing Office, which is under the Public Works and Maintenance Head Office. Although some activities related to collection or street cleansing may be executed by other government agencies or private enterprises, the ultimate responsibility and authority shall remain, all the time, with the Public Cleansing Office.

It is important to note, however, that the cleanliness of a city is the result of the combined efforts of several persons and institutions. Therefore, the participation and cooperation of the various government bodies, private concerns and non-governmental associations involved with the solid waste problem is essential for the accomplishment of a clean and healthy city.

The public cleansing operations will be exclusively carried out by the Public Cleansing Office from the year 2000, including the street sweeping activities presently conducted by the District offices.

b. Organization

The organizational structure of MSWM in Managua is as follows:

Municipal Solid Waste Management System

Responsible Institution	Organizational Role
Municipal Government	General Supervision Legislation Enforcement Property Tax Collection
Public Cleansing Office	Refuse Collection (area "B") Refuse Disposal Street Cleaning Vehicle and Equipment Maintenance Operational Planning and Control Fee Collection (partial)
Government Concessionaires	Refuse collection (area "A") Fees Collection (partial)
Private Enterprises	Secondary Maintenance on vehicles Fees and Taxes Payment (partial)
Citizens	Preparation of refuse for collection Litter Control Primary Collection (area "B") Fees and Taxes Payment

The organizational structure of the Public Cleansing Office is as presented in ANNEX I "Master Plan". This structure shall be fully operational by the year 2000, with all positions occupied by appropriate public officials.

J.2.2 Privatization

The role of the private sector in the MSWM in Managua will be intensified as a trend in this direction has been perceived, not only in Managua but also in other Latin American cities.

In the case of Managua, the private sector will be mainly carrying out collection of refuse produced in collection area "A", which, by the year 2000 will be wholly serviced by the concessionaires. The concessionaires will be granted the collection of household waste in the most affluent sections of Managua as well as the fee collection of the households serviced.

Privatization by concession will be carried out mainly due to the three reasons below:

- Managua has a surplus of collection trucks as a result of foreign donations.
- Concession will provide the Public Cleansing office with income, as a result of equipment leasing conditions in the concession contract.
- The Municipality has shown a very weak capacity to collect taxes and fees. This is not expected to happen with the concessionaire.

The role of the private collectors working on the secondary collection system that is being designed for collection area "B" is also very important to privatization. Although these workers are not usually recognized as formal entrepreneurs such as a part of the private sector, they are, in fact, vital components of the collection organization and should be given recognition.

Yet, there are other activities to be supplied by the private sector that should not be overlooked, such as:

- Vehicles and equipment supply along with their spare parts and accessories.
- Vehicles and equipment maintenance and repair (those that cannot be made in the Los Cocos workshop)
- Materials, goods and utilities supply
- Purchase and processing of recycled material
- Participation in public environmental campaigns

Finally, it should also be stressed that the public sector, represented by the citizens and enterprises, is the ultimate entity accountable for funding the MSWM system

through the payment of fees and taxes.

J.2.3 Regulations and Enforcement

It is forecast that Managua will have Sanitary Codes or Guidelines and enforcement activities by the year 2000.

The Sanitation Code shall characterize what is considered "urban solid waste", set the government responsibilities and duties as well as those of the citizens. It shall also set fines for those that do not comply with their obligations and state an appeal procedure for those who do not agree to the fines imposed to them.

It is advisable also that the Municipality of Managua acknowledge what is being done at the national level by MARENA – the Ministry of National Resources and the Environment, with regard to Solid Waste legislation, in order to integrate and harmonize national and municipal legislations.

The enforcement activities will be carried out by a trained group of public officials of the municipality under the supervision of the Public Cleansing Office.

An effort shall also be sought in order to involve and integrate other government agencies in the enforcement activities such as those that have been done with the National Policy and the Health Inspectors of the Health Ministry.

It is important to note that the enforcement program assures the people that the government sector is complying with their responsibilities and duties. By this time, the citizens of Managua are more environmentally aware as a result of the public environmental education programs carried out.

J.2.4 Training of Personnel

Employees from all department levels should be exposed to training activities on a regular bases.

Depending upon the opportunities and efforts of the administration, part of the employees shall have had some kind of training by year 2000.

Universities do not offer solid waste management as a course in the under graduate

area, but rather as special short courses usually for post-graduates. Latin American and United States institutions offer some of theses short courses. Officials in charge of the Public Cleansing Office in Managua should be encouraged to take these courses.

These short courses usually offer packages of subjects that best fit the needs of the applicants. In the case of Managua, special emphasis shall be placed on solid waste legislation and ordinances, operational control management, planning efficient routes design, special handling of hazardous wastes and medical wastes.

Workshop personnel should be made to take courses on vehicles and equipment maintenance and repair. These courses shall be supplied primarily by the dealers and suppliers of the vehicles and equipments in use at the Public Cleansing Office.

Further details about these courses can be found in the chapter on Vehicles and Equipment Maintenance.

Public officials should also be encouraged to participate in seminars and conferences on solid waste management. The knowledge and the ability to make a comparison of experiences and practices in other cities and institutions greatly benefits the managers in charge of the solid waste collection and disposal.

J.3 Estimation of Project Cost

J.3.1 Conditions on Cost Estimation

a. Executing Bodies

Cost estimation was executed based on the proposed executing bodies presented in Table J.3.1a.

Table J.3.1a Executing Bodies of MSWM

Projects	Fund Raising and Repayment	Construction and Procurement	Operation
1. Collection Service			
1-1. Collection	ALMA	ALMA	ALMA Private Comp.
1-2. Street Sweeping	ALMA	ALMA	ALMA
2. Construction of ANPLS	ALMA	ALMA	ALMA
3. Improvement of Los Cocos Workshop	ALMA	ALMA	ALMA
4. Promotion of Public Awareness	ALMA	ALMA	ALMA

b. Life Span

The following life spans were used for equipment replacement planning and cost estimation.

Table J.3.1b Summary of Life Years

Category	Item	Life years	Salvaged Value
Equipment	Heavy Equipment	7	10 %
	Container	5	10 %
Machinery	Truck Scale, etc.	15	0 %
Building	Site Office, etc.	15	0 %
Civil Works	Ordinary civil works	30	0 %
	Section consumed by disposal	disposal period	0 %

c. Maintenance Cost

Maintenance costs taken into account for cost estimation are presented in Table J.3.1c.

Table J.3.1c Rate of Annual Maintenance Costs

Category	Item	Rate of Maintenance Cost
Equipment	Compactor Truck, 15.3 m^3	5 %
	Compactor with lift	5 %
	Hoist Truck, 7.0 m^3	5 %
	Container 1 m^3	2 %
	Container 7 m^3	2 %
	Dump Truck 10 m^3	5 %
	Water Tanker 5 m^3	5 %
	Pickup	5 %
	Bulldozer 21 ton	10 %
	Landfill Compactor	10 %
	Wheel loader	10 %
	Motor Grader	10 %
	Excavator	10 %
	Mobil Workshop	5 %
	Station Wagon	5 %
Workshop	Building	0 %
	Building	0 %
	Equipment	2 %

d. Fuel and Lubricant

Fuel and lubricant cost was assumed at C$ 0.82/km based on current operations.

e. Contingency

Fifteen percent (15%) of the investment was taken into account as price contingency and physical contingency.

J.3.2 Project Cost

a. Investment Cost

aa. Procurement Schedule of Equipment by Priority Project

Table J.3.2a Procurement Schedule of Equipment by priority project

Items	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1. Collection & Public Cleansing Service													
1.1 Collection													
- Compactor 15.3m³	5	5	45	0	0	0	0	0	0	24	0	0	0
- Compactor 15.3m³ + container lift	1	2	0	0	0	0	0	1	3	0	0	0	1
- Hoist Truck for 7.0m³ container	10	10	0	1	1	1	2	11	11	2	6	6	7
- Container 1.0m³	135	135	0	6	7	142	142	8	13	14	150	150	17
- Container 7.0m³	65	66	0	8	8	73	74	9	18	17	105	109	48
- Dump Truck 8m³	3	3	0	0	0	0	0	3	3	0	0	0	0
- Wheel Loader 0.7m³	1	2	0	0	0	0	0	1	2	0	0	0	0
- Motor Grader 103 PS	0	1	0	0	0	0	0	0	1	0	0	0	0
- Pickup	3	3	0	0	0	0	0	3	3	0	0	0	0
1.2 Public Cleansing Service													
- Compactor 15.3m³ with Container list	1	1	0	0	0	0	0	1	1	0	0	0	0
- Hoist Truck for 7.0m³ Container	1	0	0	0	0	0	0	1	0	0	0	0	0
- Pickup	1	1	0	0	0	0	0	1	1	0	0	0	0
2. Disposal Operations Service													
- Bulldozer 21ton	0	5	0	0	0	1	0	0	5	1	0	1	1
- Landfill Compactor 20ton	0	3	0	0	0	0	0	0	3	1	0	0	0
- Wheel loader 1.2m³	0	1	0	0	0	0	0	0	1	0	0	0	0
- Dump Truck 10m³	0	2	0	0	0	0	0	0	2	0	0	1	0
- Motor Grader 130PS	0	1	0	0	0	0	0	0	1	0	0	0	0
- Wheel Excavator 0.7m³	0	1	0	0	0	0	0	0	1	0	0	0	0
- Water Tanker 5m³	0	1	0	0	0	0	0	0	1	0	0	0	0
- Pickup	0	2	0	0	0	0	0	0	2	0	0	0	0
3. Maintenance Service													
- Mobil Workshop	0	1	0	0	0	0	0	0	1	0	0	0	0
- Maintenance Equipment in Los Cocos	0	1	0	0	0	0	0	0	0	0	0	0	0
4. Public Communications Assistants													
- Station Wagon with VIDEO	1	0	0	0	0	0	0	1	0	0	0	0	0

ac. Estimation of Investment Schedule

Table J.3.2b Investment Schedule of ALMA by Priority Project

unit: mill.C$

Items	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1. Improvement of the collection and public cleansing system													
1.1 Collection	15.8	19.0	75.4	2.0	2.0	10.2	11.4	18.1	24.6	29.3	19.1	19.4	14.2
1.2 Public Cleansing	2.6	1.5	-	-	-	-	-	2.6	1.5	-	-	-	-
Sub-total in C$ mill.	18.4	20.5	75.4	2.0	2.0	10.2	11.4	20.7	26.1	29.3	19.1	19.4	14.2
(Sub-total in US$ mill.)	2.58	2.88	10.60	0.28	0.28	1.43	1.60	2.91	3.67	4.11	2.68	2.73	1.99
2. Construction of ANPLS													
1.1 Construction	71.6	51.2	-	-	-	46.6	46.6	46.6	-	-	83.8	83.8	83.8
1.2 Landfill equipment	-	25.8	-	-	-	2.1	-	-	25.8	5.1	-	3.0	2.1
Sub-total in C$ mill.	71.6	77.0	-	-	-	48.7	46.6	46.6	25.8	5.1	83.8	86.8	85.9
(Sub-total in US$ mill.)	-	10.81	-	-	-	6.84	6.55	6.55	3.62	0.72	11.78	12.20	12.10
3. Improvement of Los Cocos workshop													
1.1 Construction	5.2	3.6	-	-	-	-	-	-	-	-	-	-	-
1.2 Equipment	-	2.7	-	-	-	-	-	-	0.5	-	-	-	-
Sub-total in C$ mill.	5.2	6.3	-	-	-	-	-	-	0.5	-	-	-	-
(Sub-total in US$ mill.)	0.73	0.88	-	-	-	-	-	-	0.08	-	-	-	-
4. Promotion of public awareness, cooperation and participation													
Sub-total in C$ mill.	0.7		-	0.1	-	-	0.2	0.5	-	0.1	-	-	0.2
(Sub-total in US$ mill.)	0.10	-	-	0.02	-	-	0.02	0.08	-	0.02	-	-	0.02
Total Cost in C$ mill.	95.9	103.8	75.4	2.1	2.0	58.9	58.2	67.8	52.4	34.5	102.9	106.8	100.3
(Total Cost in US$)	13.47	14.57	10.6	0.3	0.28	8.27	8.17	9.54	7.37	4.85	14.46	14.93	14.11

b. O & M Cost by Priority Project

Table J.3.2c Summary of O & M Cost by Priority Project

unit: mill.C$

Items	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
1. Improvement of the collection and public cleansing system											
1.1 Collection Service	10.47	10.59	10.64	10.76	10.85	10.64	10.50	8.29	8.88	9.41	10.12
1.1.1 Fuel & Lubricant	1.85	1.88	1.90	1.93	1.96	1.98	2.00	2.03	2.19	2.33	2.52
1.1.2 Maintenance	4.33	4.39	4.45	4.51	4.62	4.42	4.28	3.30	3.58	3.87	4.28
1.1.3 Personnel Exp.	4.29	4.32	4.29	4.32	4.27	4.25	4.23	2.97	3.11	3.20	3.32
1.2 Public Cleansing Service	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26
1.2.1 Fuel & Lubricant	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
1.2.2 Maintenance	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19
1.2.3 Personnel Exp.	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96	4.96
Sub-total in mill.C$	15.73	15.85	15.90	16.02	16.11	15.9	15.76	13.55	14.14	14.67	15.38
(Sub-total in mill.US$)	2.21	2.23	2.23	2.25	2.26	2.23	2.21	1.90	1.99	2.06	2.16
2. Construction of ANPLS											
2.1 Fuel & Lubricant	2.35	2.35	2.35	2.55	2.55	2.55	2.55	3.07	3.07	3.29	3.29
2.2 Maintenance	0.34	0.34	0.34	0.37	0.37	0.37	0.37	0.44	0.44	0.48	0.48
2.3 Personnel Exp.	0.99	0.99	0.99	1.01	1.01	1.01	1.01	1.04	1.04	1.07	1.07
2.4 Landfill Works	2.31	2.44	2.57	2.71	2.86	3.02	3.17	3.33	3.59	3.86	4.16
2.5 Leachate treatment	-	-	-	-	-	-	-	-	-	-	3.29
Sub-total in mill.C$	5.94	6.12	6.25	6.64	6.79	6.95	7.10	7.89	8.14	8.71	12.30
(Sub-total in mill.US$)	0.84	0.86	0.88	0.93	0.95	0.98	1.00	1.11	1.14	1.22	1.73
3. Improvement of Los Cocos Workshop											
3.1 Fuel & Lubricant	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
3.2 Maintenance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
3.3 Personnel Exp.	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Sub-total in mill.C$	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
(Sub-total in mill.US$)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
4. Promotion of public awareness, cooperation and participation											
4.1 Fuel & Lubricant	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
4.2 Maintenance	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.3 Personnel Exp.	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49	0.49
4.4 Video Part	0.17	0.18	0.18	0.18	0.21	0.21	0.21	0.23	0.23	0.23	0.23
Sub-total in mil.C$	0.67	0.69	0.69	0.69	0.71	0.71	0.71	0.74	0.74	0.74	0.74
(Sub-total in mill.US$)	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Total Cost in mill.C$	23.41	23.68	23.86	24.37	24.63	24.27	24.01	23.20	24.04	25.14	29.46
(Total Cost in mill.US$)	3.29	3.33	3.35	3.42	3.46	3.41	3.37	3.26	3.38	3.53	4.14

J.3.3 Project Cost

The project cost is as summarized in Table J.3.3a.

Table J.3.3a Initial investment Cost of the Priority Projects

Project	Executing Bodies	Description	Total Amount (mill.C$)	Local Portion (mill.C$)	Foreign Portion (thu.USD)
Improvement of Collection System	ALMA	Total Project Cost	114.33	-	16,071
		Sub-total	110.23	-	15,495
		- Collection Service * Procurement of equipment for collection service: Compactor, Compactor with lift, Hoist Truck, Container 1.0m³ and 7.0m³, Dump Truck, Wheel loader, Motor Grador, Pickup			
		Sub-total	4.10	-	576
		- Public Cleansing Service * Procurement of equipment for public cleansing works: Compactor with lift, Hoist Truck			
Construction of ANPLS	ALMA	Total Project Cost	148.57	20.52	17,999
		Sub-total	122.78	20.52	14,374
		- (Land Acquisition 93ha.) - Construction of ANPLS (Phase I) * Capacity: 2,600,000 m³ * Design life year: 6 years * Target landfill operation: Level 3 * Facilities: Site office, Garage, Truckscale, Fence, Dike, Leachate circulation facilities, etc.	(not included)		
		Sub-total	25.79	-	3,625
		- Equipment * Procurement of equipment for landfill operation: Bulldozer, Landfill compactor, Wheel Loader, Dump truck, Motor Grader, Wheel excavator, Pickup			
Improvement of Los Cocos Workshop	ALMA	Total Project Cost	11.50	0.88	1,492
		sub-total	8.84	0.88	1,118
		- Construction of Workshop Building * Facilities: Enlargement of maintenance shed, Container shed, Pavement			
		Sub-total	2.66	-	374
		- Equipment * Procurement of maintenance equipment: Maintenance machine and tools, Mobil workshop			
Promotion of Public Awareness, Cooperation and Participation	ALMA	Total Project Cost	0.68	-	96
		- Equipment * Procurement of equipment for public education: Station wagon with VIDEO set			
Total Projects Cost			275.08	21.40	35,648

J.4 Project Evaluation

J.4.1 Evaluation Method

a. Outline of the Project

The following projects were selected as priority projects for the short term improvement plan of the MSWM in Managua.

i. Improvement of the collection and public area cleansing system

- Extension of collection service area
- Establishment of public cleansing system
- Establishment of adequate operation and maintenance system
- Provision of collection equipment

ii. Construction of sanitary landfill at the proposed site in Acahualinca

- Land expropriation
- Construction of approach road
- Construction of enclosure dike
- Installation of leachate circulation system
- Provision of landfill equipment

iii. Improvement of the present Los Cocos workshop

- Construction of workshop building
- Provision of maintenance equipment

iv. Promotion of public awareness, cooperation and participation

- Provision of promotional tools and equipment

The social, environmental and financial effects of the projects were evaluated.

b. Social Evaluation

The social evaluation of each project was conducted on the basis of the following factors:

- creation of jobs
- improvement of the public health in the study area
- appropriateness of technology
- improvement of technical level
- impacts on cleansing service workers
- recovery of degraded areas
- conformity with the city structure
- equality of service level

c. Environmental Evaluation

The effects of the projects, except the promotion of public awareness, cooperation and participation, on the environment were evaluated using the assessment items in the JICE.

The habitat factors subject to EIA were determined by forming a matrix showing their relationship with the environmental impact factors of the project, based on the details of the Project and the surrounding environmental condition.

The preliminary surveys and assessments carried out were substantial but few, in light of the fact that they were taken for the basic plan.

d. Economic and Financial Evaluation

The methods used to evaluate the economic and financial impacts is shown in Table J.4.1a.

Table J.4.1a Economic and Financial Evaluation Methods

Projects		Financial evaluation	Economic evaluation
1.	Improvement of Collection and Public Area Cleansing System	Quantitative evaluation	Quantitative evaluation Qualitative evaluation
2.	Construction of ANPLS	Quantitative evaluation	(Cost minimum) Qualitative
3.	Improvement of Los Cocos Workshop	to be evaluated along with the project for the important of collection and public area cleansing system	Quantitative evaluation Qualitative evaluation
4.	Promotion of Public Awareness, Cooperation and Participation	to be evaluated alone with the project for the improvement of collection and public area cleansing system	Quantitative evaluation Qualitative evaluation
5.	Overall Evaluation	Continuity of MSWM (financial share of the municipality and citizens)	

da. Financial Evaluation

The method used to calculate the cash flow of the projects whereupon an F/S will be carried out is outlined below:

Table J.4.1b Revenue and Expenditure Items of the Cash Flow for the Financial Evaluation

Items	Sources	Execution Body	Revenue to ALMA	Expenditure from ALMA
Collection & Haulage	Collection Area A	ALMA	-Waste Fee	-Investment and O&M of Vehicles
		Private	-License Fee -Rental Fee -Tipping Fee (Partially)	-Investment and maintenance cost of Vehicles
	Collection Area B	ALMA	-Waste Fee(partially)	-Investment and O&M of Vehicles
	Large Generation Sources (LGS)	ALMA	-Waste Fee	-Investment and O&M of Vehicles
	Street Sweeping	ALMA	-(Property Tax)	-Investment and O&M of Vehicles
Final Disposal		ALMA	-Tipping Fee* (Collection Area A LGS)	-Investment and O&M of Facilities, Vehicles and Equipment

* Tipping fee collected as part of waste fee from Area A, large generation sources and direct haulage such as companies and shops which are charged a fee at the disposal site.

db. Economic Evaluation

Table J.4.1c Economic Evaluation

Project for Evaluation	Improvement of Collection Services	Final Disposal Site	Workshop Improvement	Promotion of Public Cooperation
Benefits (B)	curtailment of cost for removal of illegally dumped waste		curtailment of investment and O&M cost because services provided by concessionaires are 30% more efficient than the municipality's	
	facilitation of residential participation			curtailment of street sweeping services cost
	improved living environment, improved public health and sanitation, attracts tourists, higher land market values	better sanitary environment, improved public health and sanitation, groundwater preservation, prevent waste scattering	help improve the efficiency of collection services in area A	increase in area B residents willingness to pay curtailment of drain cleansing fee, fee for disposal of illegally dumped waste, fee for the cleansing of streets and public and green area
Cost (C)	investment, O&M costs	investment, O&M costs	investment, O&M costs	formulation of pamphlets and videos, personnel costs, transportation costs, material costs

J.4.2 Evaluation of Improvement Project for the Collection and Public Area Cleansing System

a. Social Evaluation

The ultimate objective of the improvement of the collection system is to create a clean living environment in the urban area of Managua City to safe guard public health.

This objective will be reached basically through:

- improvement of solid wastes collection services
- extension of collection area
- improvement of street sweeping activities
- improvement of refuse disposal operations

Aside from the objectives, this project is also estimated to bring about the following:

- Creation of jobs, technical as well as unskilled ones

- Improvement of public health in the area; health condition of residents is directly related to the cleanliness of public spaces and effectiveness of refuse collection services.

- Improvement of the technical level of Nicaraguan professionals, mostly engineers, but also technicians.

- Improvement of working conditions for unskilled laborers, primarily on matters related to safety and hygiene.

- Recovery of degraded areas making them useful to the community, as in the case of the existing municipal landfill.

- General improvement in landscape, be it in the urbanized areas or open green spaces.

The quantitative evaluation of these outcomes is rather difficult since many of them have strong psychological components that are immeasurable. Qualitatively, the improvement of collection system is feasible because it will bring about the above-mentioned results. In addition, the proposed plan is appropriate in terms of technology because the system is widely practiced in the Study area and causes little problem. Furthermore, the implementation of the project will contribute to equality of cleansing service level in the area since it aims at the extension and commencement of services.

Nevertheless, a quantitative evaluation will be made on the social outcomes of the project based on:

i. accountability of the new jobs that will be created

ii. employee survey, seeking the opinion of the municipal laborers and technicians on the improvement of the services

iii. public opinion survey, similar to the one made at the beginning of the project

iv. evaluation of public health status by specific indicators

b. Environmental Evaluation

ba. Assessment Method

The habitat factors subject to EIA were determined by forming a matrix showing their relationship with the environmental impact factors of the project, based on the details of the Project and the surrounding environmental condition.

The preliminary surveys and assessments carried out were substantial but few, in light of the fact that they were taken for the basic plan.

bb. Project Outline

bba. Collection Area Expansion

The 1994 collection rate was 76%. The target collection rate for 2000 is 90% and 100% for 2010.

bbb. Establishment of Public Cleansing System

Aside from waste collection, roads and drains will be cleaned and constructed, respectively, for the sanitation of the study area.

bbc. Establishment of Adequate Operation and Maintenance System

The vehicles to be assigned for collection services will be chosen properly and maintenance works will be adequately carried out to smoothly implement collection activities.

bc. Determination of Habitat Factors and Environmental Impacts Factors

The following are the two environmental impact factors determined from the above data:

- Operation of new collection vehicles for the new collection area
- Construction of a new waste disposal site

The habitat factors that may come about with the operation of new collection vehicles are [air pollution with the emission of exhaust gas], [noise] and [vibration], and [bad odors] may be generated with the construction of a new waste disposal site.

bca. Air Pollution:

The target maximum collection frequency in the new collection area, which is predominantly a residential area, is thrice a week and the number of collection vehicles assigned to this area will be limited to a few. Conclusively, these vehicles will only emit a small amount of exhaust gas which will not be enough to cause significant air pollution.

bcb. Noise:

The small number of collection vehicles to be operated in this area will not produce loud noise.

bcc. Vibration:

The small number of collection vehicles to be operated in the area will not cause extreme vibration.

bcd. Bad Odors:

The new collection area is predominantly a residential area, whereby the container and bell collection system will be implemented.

The areas assigned for container arrangement are presently heaped with waste. The placing of containers will therefore eliminate heaping practices, and with a twice or thrice or thrice a week collection, further improvement can be attained.

Bell collection is a system that entails the ringing of a bell to inform the residents of the arrival of the collection vehicle for their wastes. This particular system prevents the accumulation of waste.

To a great extent, these collection systems will prevent the generation of bad odor in the collection area.

Consequently, these 4 habitat factors were not considered for EIA.

bd. Environmental Survey and Assessment

Originally, environmental surveys and assessments are carried out for the two environmental impact factors aforementioned. But since they will not considerably result in the 4 habitat factors given above, none will be carried out.
Conclusively, MSWM is considered to have none of the given impacts.

be. Environmental Protection Measures

MSWM is assessed to have no adverse impact on the environment. However, this assessment was made assuming that the residents will carry the collection system out exactly as planned. To successfully uphold this assessment, environmental protection measures in the form of education programs that would completely inform the residents of the waste disposal plan and objectives should be adopted therefore.

c. Economic and Financial Evaluation

ca. Economic Evaluation

caa. Quantitative Evaluation

The curtailment of collection costs for illegally dumped waste in area B will be considered a tangible benefit of the collection improvement project. Accordingly, the reduction of the collection cost of waste dumped illegally along streets, parks and channels will be considered a benefit.

- As a result of the time comparison between street cleansing work and collection works for illegally dumped waste, one fourth of present unit cost for street and park cleansing is used to determine the unit benefit for the collection of waste dumped illegally.

- The economic internal rate of return (EIRR) is estimated at 24.1% if the investment and O&M costs for new collection services necessary for residents in area B are regarded as costs. This figure proves the economic feasibility of the project.

cab. Qualitative Evaluation

The following items are the subjects for qualitative evaluation:

- Improvement of public health
- Contribution to prevention of the generation of dengue fever, malaria, cholera etc. through elimination of waste heaping practice
- Promotion of public participation in cleansing services
- Promotion of tourism
  (improvement of sanitary condition and beautification of Managua is related to tourism)
- Rise of land costs
  (improvement of sanitary condition and beautification of the area is associated to the rise of land cost due to rapid infrastructure improvement.)

cb. Financial Evaluation

Cleansing costs of area B will be mainly taken from waste fees from area A residents, which shall be collected based on the "beneficiary pay principle", because area B residents have a limited capability to pay. The rest will be covered by large generation sources, and ALMA.

R/E (Revenue/Expenditure) is 0.80 at a discount rate of 0%, if initial investment costs are excluded in the revenues.

Assuming that initial investment costs are financed by grant aid from foreign countries and regarded as revenues, the Financial Internal Rate of Return (FIRR) will be 9.8%, thereby concluding the project as financially feasible.

J.4.3 Construction Project of the Acahualinca Proposed Landfill Site

a. Social evaluation

The effects of the project on the society or community were evaluated and the following are the benefits assumed to result from these effects:

i Creation of jobs, technical as well as unskilled ones

ii Improvement of the public health of residents near the Acahualinca present disposal site: - health condition of residents is directly related to the

cleanliness of public spaces.

iii Improvement of the technical level of Nicaraguan professionals, mostly engineers, but also technicians.

iv Improvement of working conditions of unskilled personnel, basically on matters related to safety and hygiene.

v Recovery of degraded areas making them useful to community, as in the case of the Acahualinca landfill.

vi General improvement in landscape, be it in the urbanized areas or open green spaces.

The quantitative evaluation of most of these outcomes is rather difficult since many of them have strong psychological components that are immeasurable.Quantitatively, the construction of the Acahualinca Newly Proposed Landfill Site is feasible because it will bring about the above-mentioned benefits.

b. Environmental evaluation

ba. Assessment Methods

The habitat factors subject to EIA were determined by forming a matrix showing their relationship with the environmental impact factors of the project, based on the details of the project and the surrounding environmental condition.

The preliminary surveys and assessments carried out were substantial but few, in light of the fact that they were taken for the basic plan.

bb. Project Outline

The construction of the final disposal site will be carried out in 4 phases and the areas to be reclaimed per construction phase are shown in Table J.4.3a.

Table J.4.3a Project Outline

	Construction Period (year)	Landfill Period (year)	Landfill Area (ha)	Buffer Zone (ha)	Total Area (ha)	Capacity (m^3)
Phase I	1998 - 1999	2000 - 2005	18.8	5.9	24.7	2,600,000
Phase II	2003 - 2005	2006 - 2010	21.7	6.6	28.3	3,000,000
Phase III	2008 - 2010	2011 - 2013	15.2	4.8	20.0	2,100,000
Phase IV	2011 - 2013	2014 - 2016	15.2	4.8	20.0	2,100,000
Total			70.9	22.1	93.0	9,800,000

bba. Land Expropriation

The area directly adjacent to the shoreline will not be included in the acquisition.

bbb. Construction of Approach Road

i The road used by the present Acahualinca disposal site will be extended for future use.
ii The road will be widened to 8 m and extended for another 1km, from the present truck scale to the landfill site.

bbc. Construction of Enclosure Dike

i A dike will be constructed in each phase.
ii The dike will be 6m high with a banking gradient of 1 : 2.
iii Turfing will be carried out on the dike slope.

bbd. Installation of Leachate Circulation System

i A (sheet) lining will be placed inside the dike.
ii A leachate collection pipe will be installed at the area where the lining is placed.
iii Collected leachate will be circulated within the disposal site by using a pump.
iv Daily waste covering will be carried out to prevent scattering, generation of harmful insects and bad odor.
v Soil in street sweeping wastes will be used for waste covering.
vi Gas release pipes will be installed to accelerate aerobic decomposition for the immediate stabilization of the landfill site.
vii Final waste covering material will be extracted from the small hilly area within the disposal site.

bbe. Provision of Landfill Equipment

To adequately carry out landfill works, a bulldozer, landfill compactor, wheel loader, dump truck, motor grader, wheel excavator, water tanker and a pickup will be provided.

bc. Determination of Habitat Factors and Environmental Impact Factors

Given the details aforementioned, the following items were determined as the environmental impact factors (a) during the landfill works and (b) after the landfill works:

(a) During the landfill works:

Generation of bad odors from leachate discharge –
The leachate circulation system pond may emit bad odors

Extraction of soil for waste covering –
The extraction of soil from the small hilly area within the disposal site will alter the landscape

(b) After the landfill works

Leachate Discharge –
Discharge of water coming from the leachate treatment facilities into Managua Lake

Conclusively, [bad odors], [landscape] and [water quality] are the habitat factors determined by this study.

bd. Environmental Survey and Assessment

bda. Bad odors

i. Survey Method

Qualitative surveys will be carried out to establish the relationship of the leachate circulation pond site, protection measures and prevailing wind direction.

ii. Survey Results

The leachate circulation pond will be constructed at the northernmost part of the

final disposal site where the nearest residences are approximately 250 meters to the southeast; there is also a village 600 meters south of the area. The wind blows from the are, and there are no residences within a distance of 3 km west of the pond.

Accordingly, the construction of a circulation pond in this site will hardly affect the southeast and southside residents. Despite the fact that the wind moves toward it, the same conclusion was made for the westside residential area due to its considerably dispersed layout.

bdb. Landscape

i. Survey Method

Qualitative surveys on land use conditions in the final disposal site vicinity will be carried out.

ii. Survey Result

The proposed landfill site is bordered by Managua Lake to the north and the present disposal site to the east. The southern part of the area is adjacent to an agricultural pasturage, a 90m elevated hill and a part of a residential area. To the west, it is adjacent again to an agricultural pasturage which extends to a steeply sloping hill. PENINSULA DE CHILTEPE is the only scenic spot near the proposed landfill site, and can be viewed in all its grandeur from the memorial statue established halfway up the road passing by the steeply sloping hill, which connects Managua City and Ciudad Sandino.

The exploitation of the small hill within the proposed disposal site for excavation of waste covering material will not in anyway affect the landscape as it is covered by the mountains adjacent to the lake. It is also possible to view the entire proposed site area 3km to the west at the plateau selected for the installation of the water tank. Although the small hill forms the greenbelt of the hinterland towns, it does not really contribute much to the scenery.

Conclusively, this activity will not adversely affect the landscape of the area.

be. Environmental Protection Measures

As aforementioned, it is judged that these activities will have little impact on the surrounding environment. Nevertheless, the following protection measures are necessary to minimize such impacts:

bea. Bad Odors

The generation of bad odors can be further minimized by the proper operation of leachate circulation system and avoidance of storing leachate for long periods of time

beb. Landscape

From the memorial statue, the fill located within the ANPLS that will disappear in the future, cannot be viewed but the proposed landfill site can be seen. Although the impact of landfill activities on the present topographical condition ca be ignored, the impacts on landscape shall be considered because the ground surface will be altered with the extraction of soil for waste covering. The following are proposed as environmental protection measures:

- Daily covering of waste to restrict waste exposure.

- Turfing on the slope to create an area in harmony with nature.

c. Economic and financial evaluation

ca. Economic Evaluation

caa. Qualitative Evaluation

Sanitary landfill level 3 should be at the very least carried out to protect the environmental conditions of Lake Managua. This landfill level introduces the use of a leachate circulation system.

The use of a sheet lining for leachate circulation is an additional expense to the estimated construction cost. Nevertheless, the following situations are expected to result from its use:

- Counter-act the contamination of Managua Lake
- Improve public health and sanitation
- Groundwater preservation

The following effects are expected from daily waste covering activities and the construction of a buffer zone:

- Prevent waste scattering
- Sanitary improvement of the disposal site's surrounding environment

The collection services under independent fund reserves for a sustainable SWM operation would inevitably raise the tipping fee. Operations, for example the prevention of illegal dumping, should be smoothly carried out in accordance with the law.

cb. Financial Evaluation

The operation of the new landfill site is considered feasible based on financial evaluations carried out until 2010, which indicate and R/E of over 1%.

However, evaluations carried out until 2016 indicate an R/E of less tan 1% once the Acahualinca newly proposed disposal site becomes fully utilized. A feasibility study should be carried out again should a waste treatment plant is to be constructed.

J.4.4 Evaluation of the Project for the Improvement of the Los Cocos Workshop

a. Social Evaluation

The main objective of the improvement of the Los Cocos workshop is to keep the rate of operation of equipment used for MSWM high by strengthening its maintenance capability.

The project will also bring about other benefits to the community. These main benefits are mainly the following:

- Creation of jobs, technical as well as unskilled ones
- Improvement of the technical level of Nicaraguan professionals, mostly engineers, but also includes technicians
- Improvement of working conditions of unskilled personnel, primarily on matters related to safety and hygiene
- Support the improvement of the collection system, and sanitary landfill operation in ANPLS

The quantitative evaluation of most of these outcomes is rather difficult since many of them have strong psychological components that are immeasurable. Qualitatively, the improvement of the Los Cocos workshop is feasible because it will bring

about the above-mentioned benefits.

b. Environmental Evaluation

ba. Assessment Method

The habitat factors subject to EIA were determined by forming a matrix showing their relationship with the environmental impact factors of the project, based on the details of the Project and the surrounding environmental condition.

The preliminary surveys and assessments carried out were substantial but few, in light of the fact that they were taken for the basic plan.

bb. Project Outline

bba. Construction of Workshop Building

- A one story workshop will be constructed at the building site.
- The building site will not be subject to any extension or expansion work.

bbb. Provision of Maintenance Equipment

The following equipment and their respective quantity will be provided by the year 2010:

Bulldozer (21 tons)	8
Landfill Compactor (20 tons)	4
Wheel Loader ($1.2m^3$)	1
Dump Truck (10 tons)	2
Motor Grader (130 PS)	1
Wheel Excavator ($0.7m^3$)	1
Water Tanker ($5m^3$)	1
Pickup	2

bc. Determination of Habitat Factors and Environmental Impact Factors

Based on the details aforementioned, the environmental impact factors are [operation of construction vehicles] and [transport of construction materials] during construction work, and [increased repair and maintenance services due to increase in machineries and equipment] after the completion of construction work.

The habitat factors that may be influenced by these impact factors are [air quality], [noise], [vibration], [traffic safety].

bca. Air Quality

The operation of construction vehicles, vehicles for material transport and equipment maintenance may pollute the air.

Since this activity involves the construction of a new workshop at the existing workshop site, only a small number of construction vehicles will be used for the preparation of the site. Construction vehicles will not affect air quality therefore.

bcb. Noise

The operation of a small number of vehicles will not produce loud irritable noises.

bcc. Vibration

The operation of a small number of vehicles will not produce damaging vibrations.

bcd. Traffic Safety

Increase in vehicular traffic may affect traffic safety conditions especially since there are a lot of houses within the vicinity of Los Cocos. The effect will be minimal however, since the project will only cause a slight increase in traffic volume.

Conclusively, these habitat factors were not subject to EIA.

bd. Environmental Survey and Assessment

Originally, environmental surveys and assessments are carried out for the environmental impact factors aforementioned, but since they will not seriously bring about the given habitat factors, none will be carried out in this study.

Conclusively, this project will not have a significant impact on the surrounding environment.

be. Environmental Protection Measures

Although the construction works are forecast to have no adverse impact on the environment, they are irrefutably bound to increase traffic volume. Accordingly, the

following environmental protection measures are proposed:

- Assignment of a traffic regulator at the entrance and exit of Los Cocos to secure safety of traffic
- To educate drivers on safe driving measures and make sure they practice these measures
- To satisfactorily maintain the vehicles to mitigate the following factors that may come about because of construction vehicle operation: air pollution, generation of noise and vibration

c. Economic and financial evaluation

ca. Economic Evaluation (Qualitative Evaluation)

Sanitary landfill level 3 should be at the very least carried out to protect the environmental conditions of Lake Managua. This landfill level introduces the use of a leachate circulation system.

The use of a sheet lining to upgrade the leachate treatment system will require additional expenses as compared to a system without lining. Nevertheless, the following advantages are expected from its use:

- Prevent the contamination of Lake Managua
- Improve public health
- Preservation of groundwater quality as potable water

The following effects are expected from daily waste covering activities and the construction of a buffer zone:

- Prevent waste scattering
- Sanitary improvement of the disposal site's surrounding environment

The management and operation of the final disposal site under independent fund reserves would inevitably raise the tipping fee. If the tipping fee is higher than expected, people tend to dump waste illegally. Therefore, indirect support for the operation through new legislation is necessary to prevent illegal dumping.

cb. Financial Evaluation (Quantitative Evaluation)

If the foreign portion of the initial investment for the construction of the new landfill site is financed by a grant aid from a foreign country, it will be financially

feasible with an FIRR of 29.6%. If the project is financed by loans, however, the FIRR will only be 1.5%.

Nevertheless, R/E is estimated at 0.83 at a discount rate of 0% based on the financial evaluation of the Acahualinca Newly Proposed Landfill Site, from 2011 to 2016, taking into account the construction of leachate treatment facilities for landfill level 4.

Regarding the final disposal site after 2011, a feasibility study should be carried out again should a waste treatment plan is to be constructed.

J.4.5 Promotion Project of Public Awareness, Cooperation and Participation

a. Social Evaluation

Word-of-mouth communication of ideas and comments will undoubtedly remain our most effective form of education. For this reason, demonstration of certain new methods of solid waste management is particularly valuable.

The ultimate objective of the above projects is to create a clean living environment in the urban area of Managua City, for public health protection. These projects were selected to achieve the target indicated in the Master Plan as projects to be done by 2000.

Promotion of public awareness, cooperation and participation will not directly affect MSWM. But this project is expected to bring about the following effects:

- Prevention of illegal dumping
- Improvement of the public health in the area: health condition of residents is directly related to the cleanliness of public spaces and effectiveness of refuse collection services
- Recovery of degraded areas making them useful to the community, as in the case of the existing municipal landfill
- Establishment of an MSWM under the supervision of the citizens and municipality
- Establishment of a waste fee collection system for a sound MSWM

The public promotion project is feasible because this project together with the other 3, will bring about other benefits too:

b. Environmental Evaluation

The environmental impact assessment for the "Promotion of Public Awareness, Cooperation and Participation" was not carried out because this project only involved in the provision of audio visual tools (television, video machines, booklets) for environmental and sanitary public education.

c. Economic and financial evaluation

ca. Economic Evaluation

caa. Quantitative Evaluation

The improvement of the workshop will lengthen the life span and improve the operation rate of collection vehicles.

The realization of the proposed improvement of Los Cocos workshop is indispensable to reduce collection expenses of a private collection company. At the same time, it will guarantee a reliable collection service and achieve the improvement of the collection service.

The quantitative evaluation of the project for the improvement of Los Cocos workshop regards as benefits the reduction in investment and O&M costs which will contribute to increased service efficiency brought about by privatization.

Collection efficiency by privatization will be improved step by step between 2000 and 2010. Finally, a benefit of C$ 6.0 million in 2010 can be expected, which is a 30% improvement over the 1994 figure.

As a result, with an EIRR of 12.5% (investment and O&M costs were taken as expenditures) the project is judged financially feasible.

cab. Qualitative Evaluation

The improvement of the Los Cocos workshop is expected to raise the operation efficiency of ALMA's collection vehicles and street sweeping services.

Moreover, the provision of a collection service at regular intervals will increase the residents' willingness-to-pay.

cb. Financial Evaluation

The R/E until 2010 is only 0.82 at a discount rate of 0%, assuming that investment is financed by foreign grant aid; this figure can be regarded as revenue.

As discussed in the economic evaluation, the improvement of the workshop is essential for the smooth operation of cleansing services in Managua. Therefore, this project is financially feasible when evaluated jointly with the collection and public area cleansing system improvement projects.

J.4.6 Overall Financial Evaluation

The results of IRR are summarized in Table J.4.6a, which concludes the necessity of the four projects.

Table J.4.6a Results of the Economic and Financial Evaluation of the Priority Projects

Project	Economic Evaluation			Financial Evaluation			
	Benefits (B)	Cost (C)	EIRR (%)	Revenue	Expenditure	FIRR by Project (%)	FIRR of 3 combined Projects
(1) Improvement of Collection and Public Area Cleansing System	Eliminates expenses for the removal of illegally dumped waste	Investment 1), O&M Cost	24.1%	- Waste fee - License fee - Rental fee	Investment 1), O&M of vehicles	9.8	9.0
(2) Improvement of Existing Los Cocos Workshop	Curtailment of investment and O&M Costs as services of private concessionaires are more efficient than the municiaplity's	Investment 1), O&M cost	12.5%	-	Investment 1), O&M	-	
(3) Promotion of Public Awareness, Cooperation and Participation	Eliminates expenses for the removal of illegally dumped waste	Investment 1), O&M cost	34.0%	-	Investment 1), O&M	-	
(4) Construction of Proposed New Landfill Site	Eliminates expenses for the removal of illegally dumped waste	Investment 1), O&M cost	-	- Tipping fee	Investment 1), O&M of facilities, vehicles and equipments	29.6	

Note: 1) Foreign Portion of Initial investment is assumed to be financed by foreign Subsidies.

a. Overall Evaluation of the 3 Projects Proposed for Area B

Assuming the initial investment is financed by a foreign grant aid, the projects for improvement of collection services, Los Cocos workshop and promotion of public participation and cooperation activities are judged financially feasible, with a 9.0% FIRR.

b. Financial Evaluation of Private Companies for Concession

The FIRR of private companies is estimated at 7.7% considering that the services of concessionaires will be 30% more efficient than ALMA's and that they will be granted tipping fee discounts of 60% for the period 2000-2004 and 30% for the 2005-2009 period.

c. Area A Financial Capability

The generation sources in Area A are financially capable of paying the imposed collection fees, which will also partly subsidize the cleansing service for Area B.

It is estimated that the collection fees will be within 1% of the household income of in Area A until 2009. (Refer to Figure 10.6.4a).

The leachate treatment facilities will be upgraded to level 4 in the year 2010 for the new landfill site, slightly rising the collection fees imposed on the residents. Therefore, it is necessary to review the project's financial evaluation after 2011 as indicated in the financial evaluation for the ANLPS construction project.

d. Municipal Financial Capability

If the initial investment cost is financed by subsidies from the central government or grant aid from foreign countries, part of the collection fee will be reserved internally as funds, which will enable ALMA to shoulder the budget for the second and third investments.

In this case, cleansing costs shared by ALMA will decrease gradually from C$ 19.2 in 2000 to C$ 13.2 million in 2010. As a result, cleansing costs in relation to ALMA's budget will go from 7.6% in 1998, the highest value, to 3.4% in 2010 (Refer to Figure 10.4.6b). Conclusively, this proves that ALMA can sustain MSWM expenses on its own.

If a loan covers most of the initial investment costs, the waste collection fees will be used repay it. ALMA will then be obliged to obtain another loan to finance the second and third investments, thereby incurring a total debt of C$ 300 million (refer to Figure 10.4.6c).

Table J.4.6b shows the revenue and expenditure plan of the 3 projects.

Table J.4.6b Revenue and Expenditure of the project for the Improvement of the Collection System, including Workshop Improvement and Promotion of Public Cooperation (1998 – 2000)

unit: mill.C$

	Revenue						Expenditure			Discount Rate 9%	
	Residents of Area B	Residents of Area A	Large Generation Sources	Subsidy from ALMA	Maintenance Fee from Private Concession	Sub-total	Investment	O&M cost	Sub-total	Revenue	Expenditure
1998	0.0			20.5		20.6	21.0	2.5	23.5	20.6	23.5
1999	0.1			25.6		25.7	26.0	3.5	29.5	23.6	27.1
2000	0.5	3.0	3.0	3.0	1.2	10.6	0.0	5.3	5.3	8.9	4.5
2001	0.6	3.1	3.1	3.1	1.2	11.0	1.7	5.5	7.2	8.5	5.6
2002	0.7	3.2	3.2	3.2	1.2	11.4	1.8	5.8	7.6	8.1	5.4
2003	0.8	3.3	3.3	3.3	1.2	11.9	7.2	6.0	13.2	7.7	8.6
2004	1.0	3.4	3.4	3.4	1.2	12.4	7.1	6.4	13.4	7.4	8.0
2005	1.7	2.6	2.6	5.2	1.2	13.2	14.8	6.6	21.4	7.2	11.7
2006	1.9	2.7	2.7	5.4	1.2	13.8	15.0	6.7	21.7	6.9	10.9
2007	2.1	2.7	2.7	5.3	0.0	12.8	8.0	6.2	14.2	5.9	6.5
2008	2.7	3.0	3.0	6.1	0.0	14.9	15.4	7.2	22.6	6.3	9.5
2009	3.4	3.5	3.5	7.1	0.0	17.5	17.4	6.4	23.9	6.8	9.2
2010	5.1	3.7	3.7	7.4	0.0	19.9	12.2	7.5	19.7	7.1	7.0
2011						0.0	(41.5)		(41.5)	0.0	(13.5)
Total	20.7	34.1	34.1	98.4	8.4	195.8	105.7	79.1	184.8	125.0	125.0

R/E 1.000067

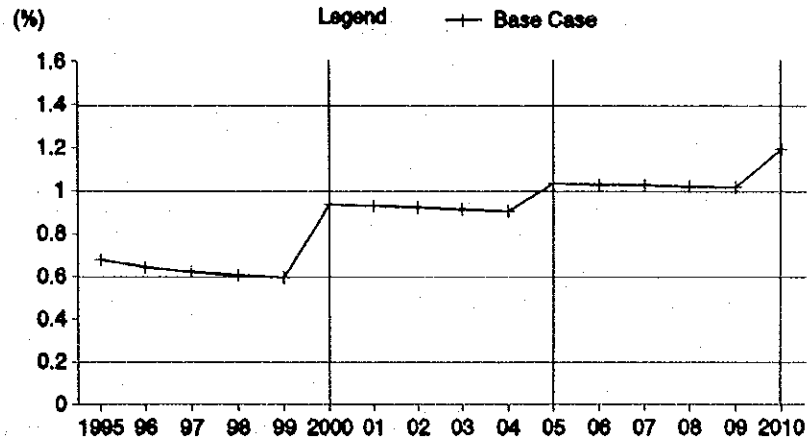


Figure J.4.6a Share of Waste Fee in Residential Income unit: %

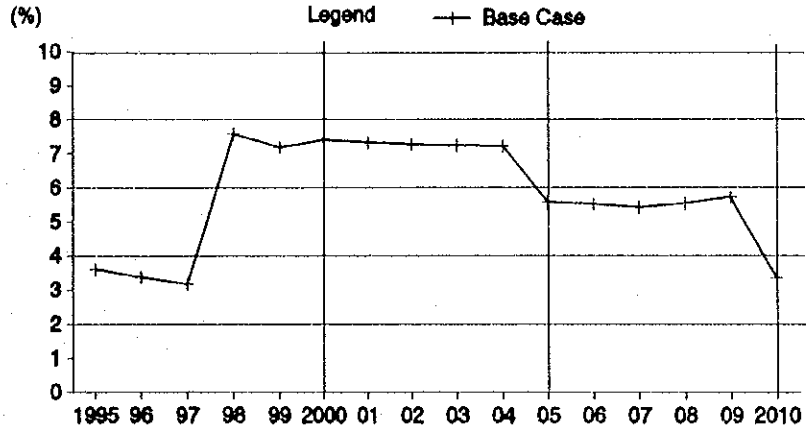


Figure J.4.6b Share of SWM in Municipal Budget unit: %

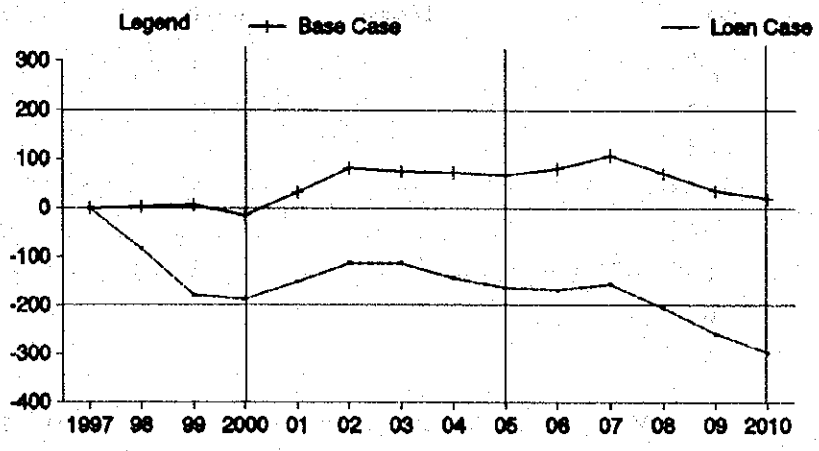


Figure J.4.6c Reserved Fund / Total Debt unit: mill.x10^2C$