G.4 Selection of Candidate Disposal Sites

G.4.1 Selection of Potential Candidate Sites by the Nicaragua Coordinating Committee

The Nicaragua coordinating committee selected five candidate sites before the meeting on the inception report was held. There were no specific guidelines for the selection of these five sites.

G.4.2 Examination of Potential Candidate Disposal Sites

According to the flow diagram for site selection works, the Study Team examined the potential of the candidate disposal sites selected by the Nicaraguan Coordinating Committee based on the following guidelines (see Table 4.2a).

- possibility of land acquisition
- possibility of obtaining neighborhood consensus
- compatibility with regional development plan
- economic feasibility
- environmental acceptability

Table G.4.2a (1) Examination of Potential Candidate Disposal Sites

Item	1. Acahualinca	2. Santa Ana	3. Cuajachillo
1. Possibility of Land Acquisition			
1a. Land use restriction	No	To be negotiated with Cooperative & MARENA	To be negotiated with Cooperative & MARENA
1b. Land ownership	Municipality and Private land	2 Cooperatives	2 cooperatives
1c. Necessity of compensation	Necessary but a little	Necessary	Yes
1d. Other considerations	–	Site is in the another municipality	No
2. Possibility of Acquiring Neighborhood Consensus			
2a. Necessity of neighborhood consensus	No	Yes	Yes
2b. Necessity for site to be unseen	Yes	No	No
2c. Necessity for isolation from noise, dust and odor	Yes	No	No
2d. Other conditions	Water pollution of Lake Managua	No	No
3. Compatibility with Regional Development Plans			
3a. Compatibility with development plans	No	No	No
3b. Conformity with City Master plan and Land use plan	No	No	No
3c. Direction of urbanization towards sites	No	No	Yes
3d. Other considerations	No	No	No
4. Economic Feasibility			
4a. Location of site (distance from main generation area)	4 km	17 km	15 km
4b. Area of site (ha)	80 ha	150 ha	60 ha
4c. Life expectancy (years)	more than 15 years	more than 15 years	more than 10 years
4d. Availability of covering soil	Available within the site	Available with in the site	Available within the site but volume is limited
4e. Availability of public services	Electricity: yes Water supply: yes	Electricity: Yes Water supply: No	Electricity: Yes Water supply: Yes
4f. Present conditions of site	Wilderness	Forest and cultivated land	Forest and cultivated land
4g. Technical consideration	Water pollution of lake Managua	Dike to be constructed cross the valley	leachate protection is required
4h. Benefits of site upon completion	Present disposal site	Isolated land from the residential area	none
5. Environmental Acceptability			
5a. Risk of drinking water pollution	No	No	Yes
5b. Risk of surface water pollution	No	No	No
5c. Risk of flooding	No	No	No
5d. Risk of ground water pollution	No	Yes	Yes
5e. Distance from other public facilities	500 m (From oil refinery)	Far (no need to consider)	Far
5f. Distance from densely populated areas	1 km	Far (no need to consider)	Far
5g. Hazards from dust, noises and odor	Yes	No	Yes
5h. Land use of adjacent area	Wilderness and sod	Wilderness and cultivated land	Cultivated land
5i. Slope stability	No	No	No
5j. Terrestrial vegetation and wildlife	No	No	No
5k. Impact on Natural landscape	Not so strong impact	Yes	Yes
5l. Historic places or structures	No	No	No
5m. Religious places or structures	No	No	No

Table G.4.2a (2) Examination of Potential Candidate Disposal Sites

Item	4. San Judas	5. Villa Fontana	6. Esquipulas
1. Possibility of Land Acquisition			
1a. Land use restriction	Near the residential area	No	No
1b. Land ownership	Cooperative and private	1 Cooperative and private	4 cooperatives
1c. Necessity of compensation	Yes	Yes	Yes
1d. Other considerations	–	Access road run through the school zone	Good cultivated land
2. Possibility of Acquiring Neighborhood Consensus			
2a. Necessity of neighborhood consensus	Yes	Yes	Yes
2b. Necessity for site to be unseen	Yes	Yes	Yes
2c. Necessity for isolation from noise, dust and odor	Yes	Yes	Yes
2d. Other conditions	No	No	The site located near the Ground water way
3. Compatibility with Regional Development Plans			
3a. Compatibility with development plans	No	No	No
3b. Conformity with City Master plan and Land use plan	Housing, Highway	No	near the drinking waster resource
3c. Direction of urbanization towards sites	Yes	No	Yes
3d. Other considerations	Private housing development	No	On the direction of urbanizing
4. Economic Feasibility			
4a. Location of site (distance from main generation area)	7 km	9 km	13 km
4b. Area of site (ha)	100 ha	80 ha	60 ha
4c. Life expectancy (years)	more than 15 years	more than 15 years	more than 10 years
4d. Availability of covering soil	Not available within the site	Not available within the site	Not available
4e. Availability of public services	Electricity: Yes Water supply: Yes	Electricity: Yes Water supply: Yes	Electricity: Yes Water supply: Yes
4f. Present conditions of site	Cultivated land	cultivated land	Cultivated land and sod
4g. Technical consideration	New access road is required	Leachate should be treated	New access road is required
4h. Benefits of site upon completion	Near the collection service area	Near the collection service area	none
5. Environmental Acceptability			
5a. Risk of drinking water pollution	Yes	Yes	Yes
5b. Risk of surface water pollution	No	No	No
5c. Risk of flooding	No	No	No
5d. Risk of ground water pollution	Yes	Yes	Yes
5e. Distance from other public facilities	comparatively close	comparatively close	comparatively close
5f. Distance from densely populated areas	comparatively close	comparatively close	comparatively close
5g. Hazards from dust, noises and odor	Yes	Yes	Yes
5h. Land use of adjacent area	Residential and cultivated land	Residential and cultivated land	Residential cultivated land
5i. Slope stability	No	No	No
5j. Terrestrial vegetation and wildlife	No	No	No
5k. Impact on Natural landscape	Yes	Yes	Yes
5l. Historic places or structures	No	No	No
5m. Religious places or structures	No	No	No

G.4.3 Field Reconnaissance

The field reconnaissance was carried out by the Study Team to get enough data for the evaluation of the 6 candidate disposal sites. The location of each candidate disposal site and the relevant information are presented in this section.

a. Site No.1 **Acahualinca**

aa. Location: Northwest of the urban area of Managua city District 2 (see Figure 4.3a)

ab. Year of Evaluation: June, 1994

ac. Ownership: Public and Private

ad. Total Area: 120 ha (including present disposal site)

ae. Type of Terrain: Flat

af. Present Land Use: Waste dump site, abandoned

ag. Availability of Coverage Materials:

The waste coverage material is available in the site. There are two hills within this candidate site where the coverage material may be extracted form. The present waste dumping activities takes the cover soil from the eastern hill. The total amount of cover soil to be required, based on the map on a scale of 1:10,000, is estimated at approximately 1.3 million m^3.

ah. Accessibility:

The access condition from the waste collection area to this site is very good. The construction of new roads leading to the landfill site is not required because the site is located at the northwest end of the urban area. The distance from the center of Managua is 4 km and all roads from Managua leading to this site are asphalt paved or concrete paved.

ai. Land use:

To the north of this site is Managua lake, while to the south is a hill. Total area of this candidate disposal site is estimated at approximately 120 ha.

Approximately 40 ha of land at the eastern part of the candidate site is already being used for waste disposal. The remaining part is abandoned. Approximately 250 scavengers are living in this area.

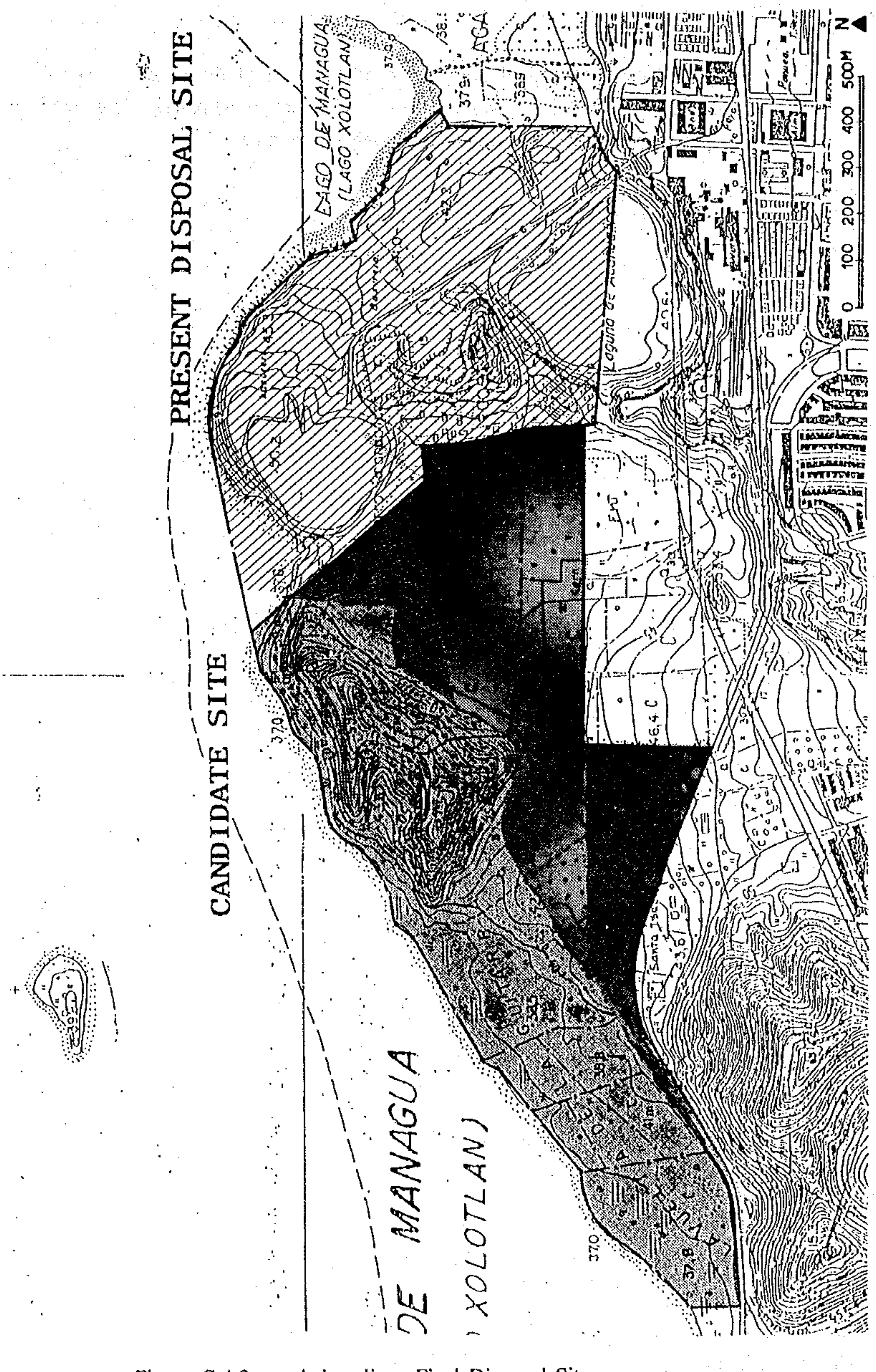

Figure G.4.3a Achaualinca Final Disposal Site

b.	**Site No.2**	**Santa Ana**
ba.	**Location:**	Western side of Managua mountain range where Villa El Carmen is located; the distance from the center of Managua is 17km (see Figure 4.3b)
bb.	**Year of Evaluation:**	June, 1994
bc.	**Ownership:**	Private (Corporative)
bd.	**Total Area:**	150 ha
be.	**Type of Terrain:**	Hilly
bf.	**Present Land Use:**	Forest and cultivated land

bg. Availability of Coverage Materials:

Coverage material can be extracted within this candidate site. There are three big ridges in the site which branch off into smaller sections. The cover soil can be supplied from these branches. The volume of soil extracted from the branches is supposedly enough for sanitary landfill.

bh. Accessibility:

500m of access road should be widened and paved. The total distance from the center of Managua to the site is 17 km. 16.5km of road from Managua to the junction is paved with asphalt, while the remaining 500m is unpaved. The road alignments do not include any sharp horizontal and vertical curves. The first 16.5 km is wide enough to enable the passage of a large trailer.

bi. Others:

This site is located on the hills at the western side of the Managua mountain range. The effects of using this site as a disposal site should be considered as any flow will move towards the pacific ocean.

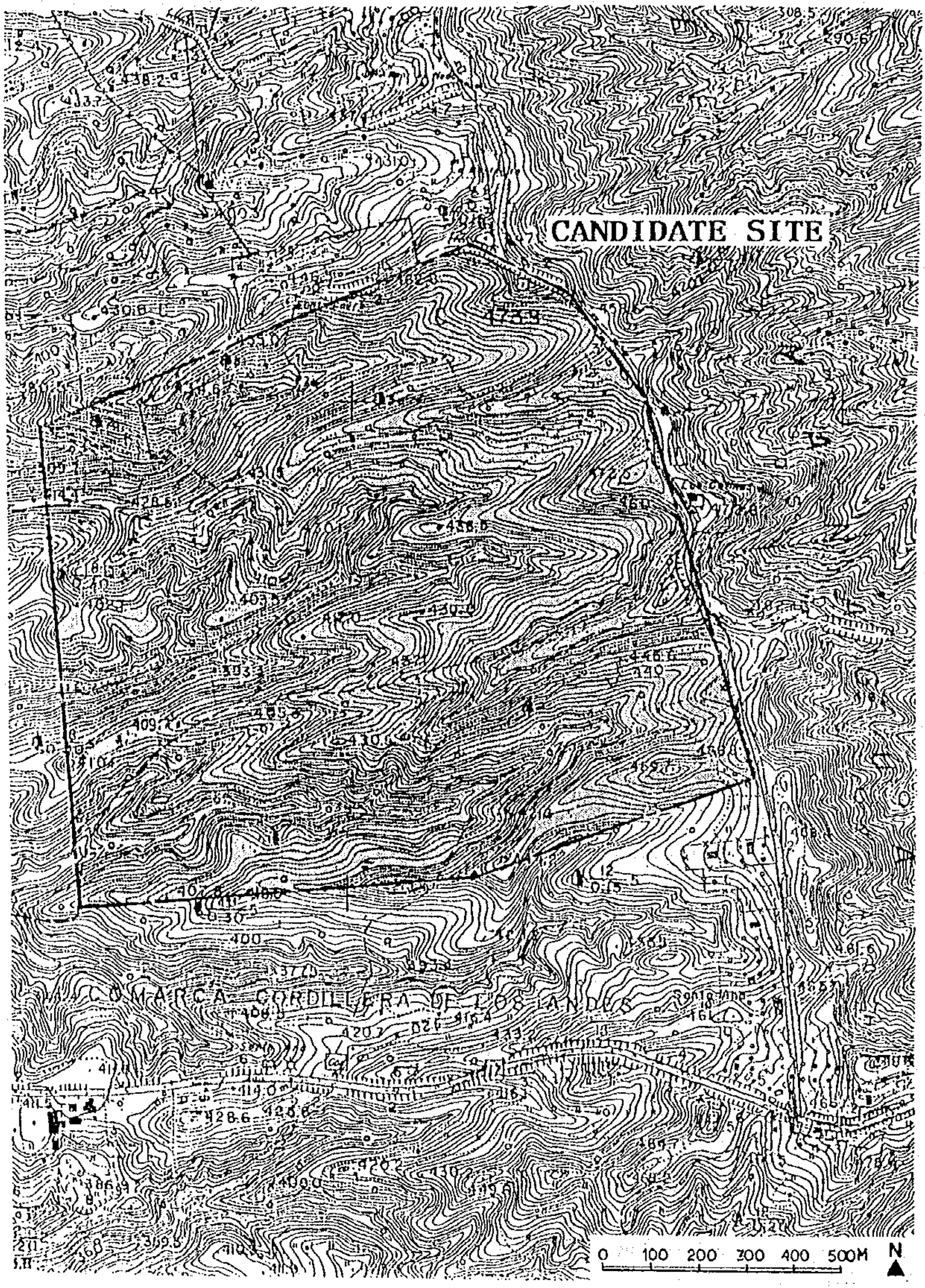

Figure G.4.3b Santa Ana Candidate Disposal Site

c.	**Site No.3**	**Cuajachillo**
ca.	**Location:**	15 km from the center of Managua. The site is on the eastern slope of the Managua mountain range. District 1 (see Figure 4.3c)
cb.	**Year of Evaluation:**	June, 1994
cc.	**Ownership:**	Private
cd.	**Total Area:**	60 ha
ce.	**Type of Terrain:**	Gentle slope (from 2 to 8 %)
cf.	**Present Land Use:**	Forest and cultivated land

cg. Availability of Coverage Materials:

The cover soil can be extracted within the site, but the amount is limited. The remaining amount of soil cover needed will have to be extracted from another pit.

ch. Accessibility:

The construction of a new access road is not required. The total distance from the center of Managua is 15.0 km; a 12 km national highway and 3 km municipal road. The national highway is paved with asphalt and the municipal road is paved with concrete. The national highway is wide enough to allow passage of large trailers. The municipal road is not wide enough to allow heavy traffic, needs a little improvement.

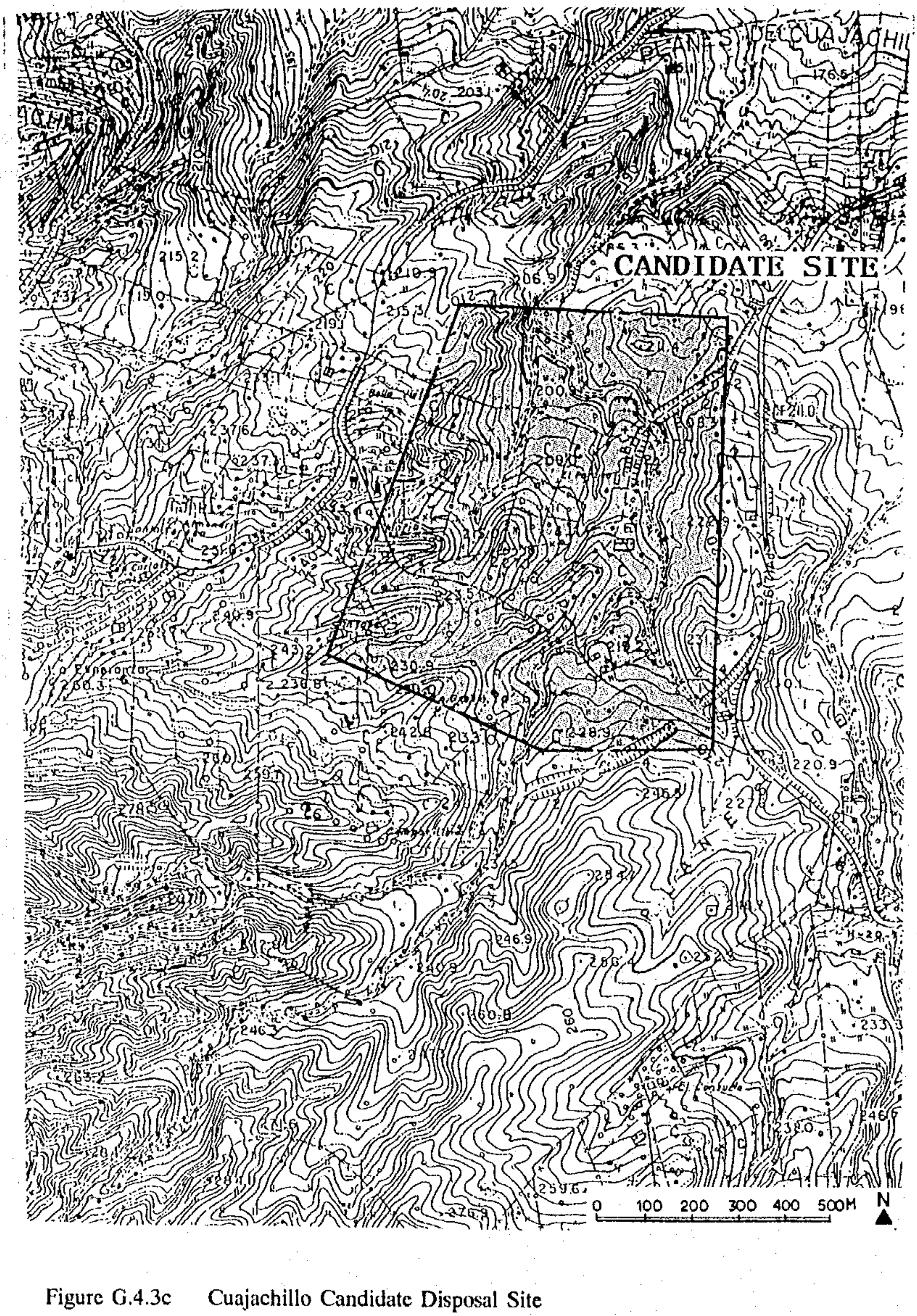

Figure G.4.3c Cuajachillo Candidate Disposal Site

d. **Site No.4** **San Judas**

da. **Location:** 2 km south from the Municipal offices District 3 (see Figure 4.3d)

db. **Year of Evaluation:** June, 1994

dc. **Ownership:** Private land

dd. **Total Area:** 100 ha

de. **Type of Terrain:** Gentle slope (8 %)

df. **Present Land Use:** A mixture of cultivated, sod and residential lands

fg. **Availability of Coverage Materials:**

Cover soil can be extracted within the site, but the volume is limited. In the early stage of land fill, the cover soil can be obtained from the hill located almost at the center of the site. The remaining amount will have to be taken from somewhere. The transportation of the borrow soil creates many problems, e.g., noise and dust pollution, because the access road runs though a residential area.

fh. **Accessibility:**

The construction of a new access road is required. The total distance from the center of the city is 7 km. The site is 1 km away from the main road. Therefore a 1 km road needs to be constructed. Since the candidate site is surrounded by a residential area, the access road will have to run through the residential area.

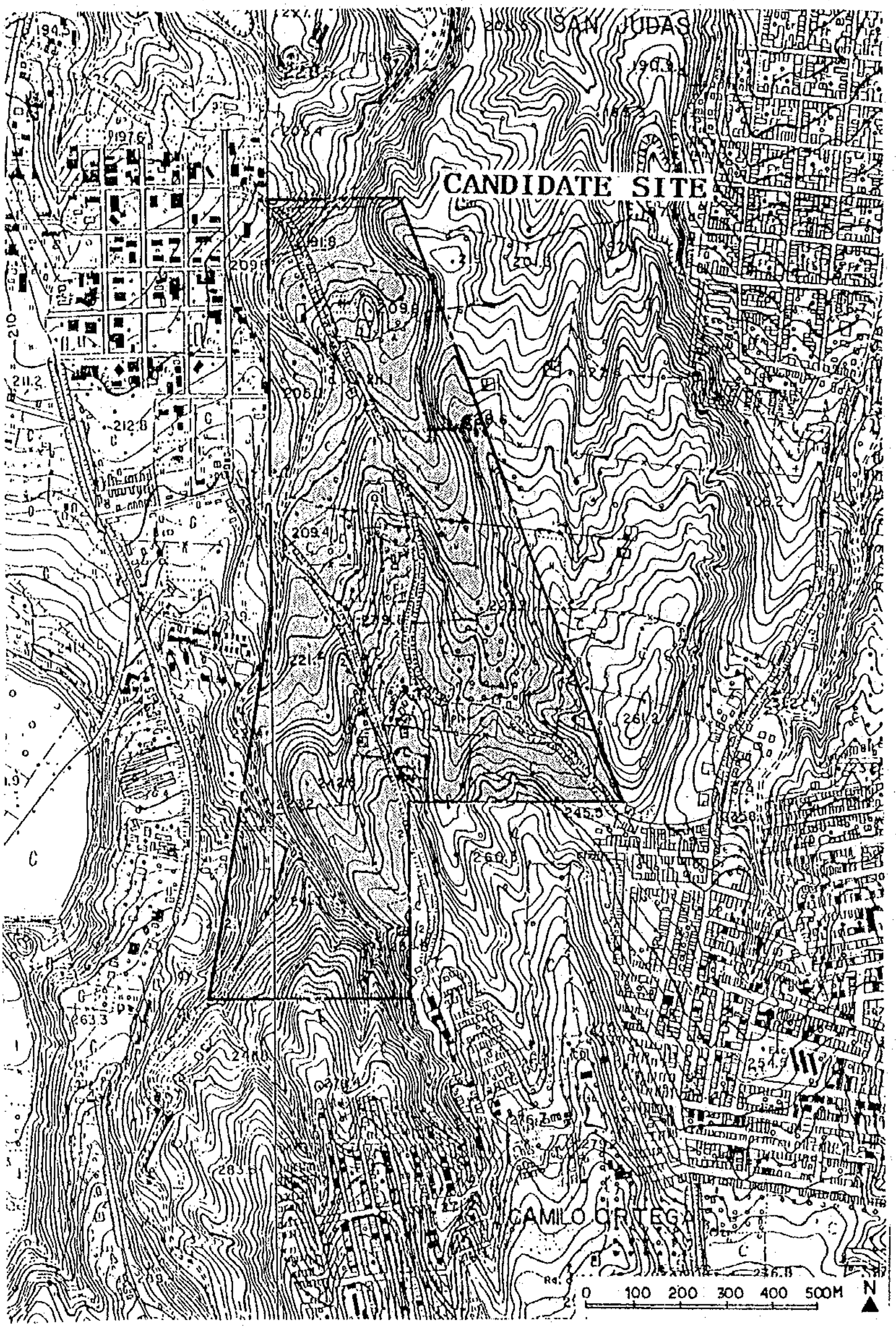

Figure G.4.3d San Judas Candidate Disposal Site

e. **Site No.5** **Villa Fontana**

ea. **Location:** 9 km south of the center of the city
District 5 (see Figure 4.3e)

eb. **Year of Evaluation:** June, 1994

ec. **Ownership:** Corporative and private lands

ed. **Total Area:** 80 ha

ee. **Type of Terrain:** Gentle slopes

ef. **Land Use:** Cultivated land

eg. **Availability of Coverage Materials:**

Cover soil can be extracted within the site, but the volume is limited. The remaining amount needed will be taken somewhere else.

eh. **Accessibility:**

This candidate site is the nearest site to the collection service area. The total distance of the access road from center of the city is 9 km; on 8.5 km existing road and 500 m (new) road. The width of a part of the existing road named avenue 19 from the Portezuelo road to the site is about 6 meters. This width is not wide enough for the 2 way traffic of heavy vehicles to allow the traffic of these vehicles, 3.5 km should be widened.
Avenue 19 runs through the school zone of UCA. The traffic for haulage of the waste will become so heavy that the protection from noise, dust etc. has to be considered.

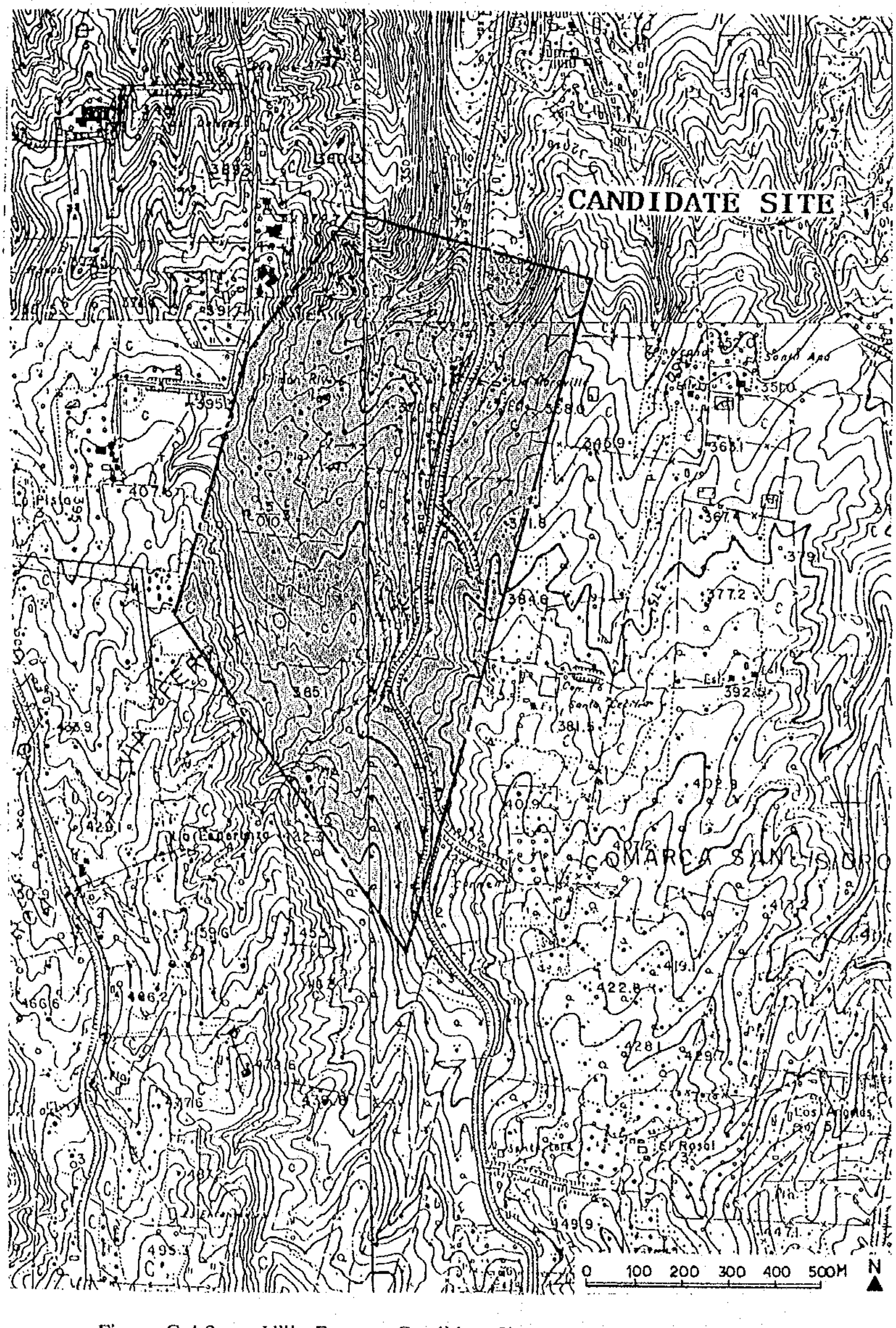

Figure G.4.3c Villa Fontana Candidate Site

f. Site No.6 Esquipulas

fa. Location: 13 km southeast of the center of Managua
District 5 (see Figure 4.3f)

fb. Year of Evaluation: June, 1994

fc. Ownership: 4 Cooperatives

fd. Total Area: 60 ha

fe. Type of Terrain: Flat

ff. Present Land Use: Pasture and cultivated land

fg. Availability of Coverage Materials:

Cover soil cannot be extracted within this site because of a very flat terrain. The nearest borrow pit is in the foot of a mountain, 6 km from the site. Therefore the equipment for haulage of the coverage soil is required.

fh. Accessibility:

The total distance from the center of Managua to the site through Masaya road is 13.0 km. The section between Masaya road and the site is 3 km long and unpaved – this road width cannot accommodate heavy traffic, and, therefore, should be improved.

fi. Risk of Groundwater Pollution

The location of this area is near the groundwater system and Sabana Grade, based on the 1993 JICA report. The water level is considered to be more than 70m. Only a very small amount of leachate is considered to leak from the disposal site – this is however difficult to prove. Considering that groundwater is used for drinking, a liner is required to protect groundwater from leachate seepage.

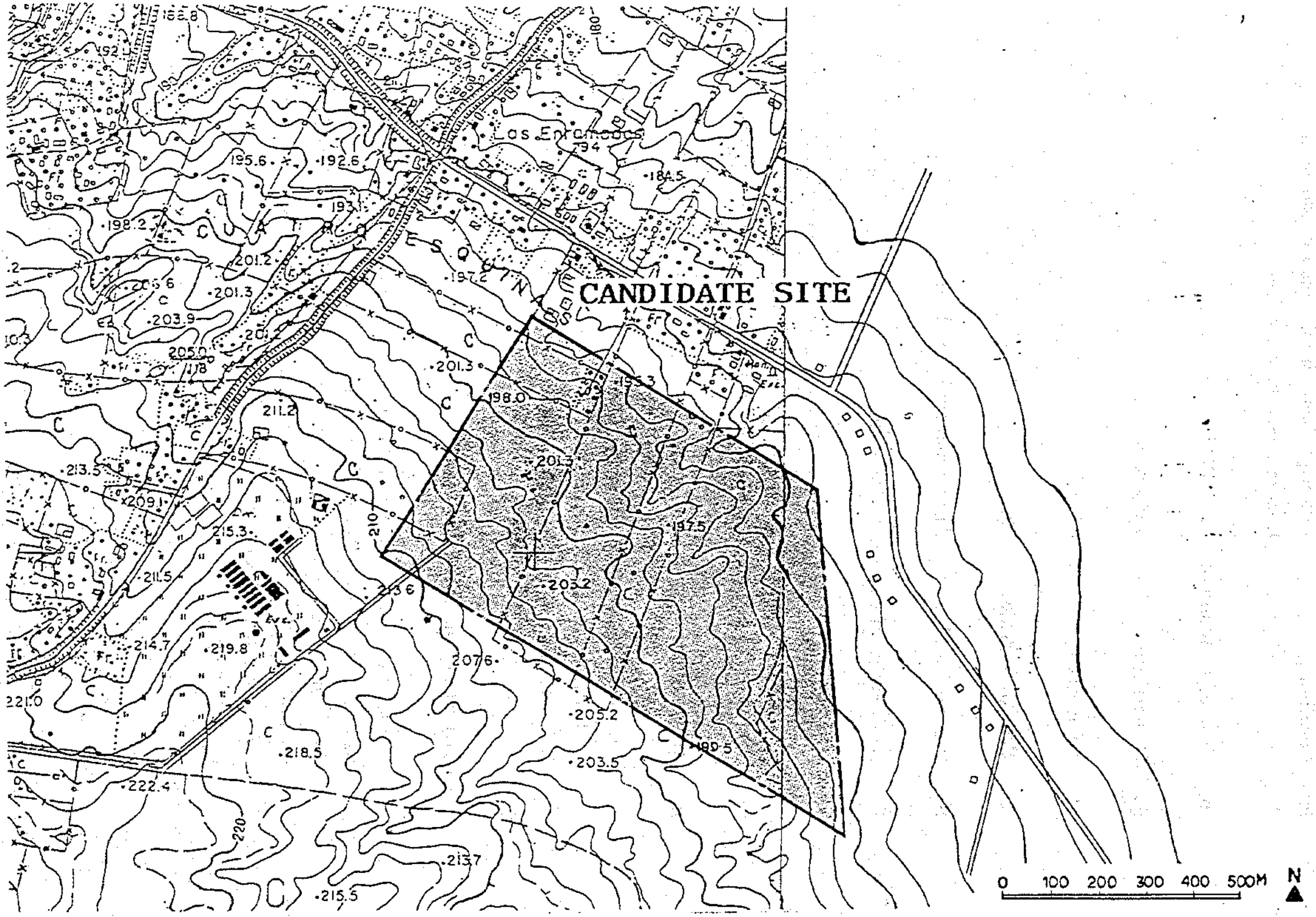

Figure G.4.3f Esquipulas Candidate Disposal Site

G.4.4 Environmental and Technical Evaluation

a. Method of Evaluation

aa. Project for Evaluation

The project to be evaluated will be the project for the construction of a final disposal site.

ab. Items and Method of Evaluation

The potential sites were evaluated by giving score points to each evaluation item, such as social environment and pollution, based on the data collected through field reconnaissance.

ac. Data used for the Evaluation

The following data were used for this evaluation.

- Topographical maps (1:10,000)
- Cadastral maps
- Aerial photos (1:40,000)

b. Method of Environmental Evaluation

ba. Items of the Environmental Evaluation

The items used for the environmental evaluation are presented in Table G.4.4a.

Table G.4.4a Environmental Evaluation Items and Indices

Evaluation Items	Description	Indicators
1. Social Environment		
. Social separation	. Separation of a community . Disconnection of a community road for commuting to schools and offices . Impact on the residential area	. Location and area of communities
. Forced removal	. Removal of a church and a cemetery	. Location and area of communities
. Religious matters		. Location of churches and cemeteries
	. Impact on schools and hospitals	. Existence of schools and hospitals
. Public facilities		. Visibility from the community roads
. Visibility of landfill site		. Existence of a observatory . Existence of scenic places
	. Whether inside of future urban area	. Location of the site
. Future land use near the site	. Compatibility with land use plan of the town plan	. Compatibility with the law
. Compatibility with other laws	. Other development plans in neighbors	
. Compatibility with other plans		. Compatibility with the other plans
2. Environmental Pollution		
. Waste pollution	. River water and ground water Drinking water	. Existence of a river . Existence of a well
. Odor		. Location and area of communities
. Noise		. Location and area of communities
. Vibration		. Location and area of communities
3. Natural Environment		
. Collapse of slope	. Collapse of slope Existence of steep slopes Existence of landslide places	. Condition of present topography
. Inundation		. Condition of present topography
. Flora	. Impact on existing flora	. Existence of natural forest
. Fauna	. Change of flora and land use	. Existence of natural forest
. Landscape	. Change of land use of the site	. Present land use

bb. Allotment of Point

Evaluation was carried by giving points. Two (2) is given to site with less environmental effect, (1) to those that will influence the environment in a medium scale, and (0) to the worst or environmentally destructive site.

The definition of words used in this survey are as follows:

- Urbanized area means the areas shown in Figure A.5.5c.
- The area of circumference refers to the area that may be influenced by the use of the final disposal site. The following distances were used for the area of circumference.
  - . Noise : 200 m
  - . Landscape : 400 m

The adopted rating system is presented in Table G.4.4b.

Table G.4.3b Adopted Rating System

Evaluation Indices	Point	Description
Compatibility with law	0 1 2	not compatible under arrangement compatible
Compatibility with other plans	0 1 2	not compatible under arrangement compatible
Location of site (A)	0 1 2	outside of the Study Area none inside of the Study Area
Location of site (B)	0 1 2	inside of the urbanized area within 400 m from the urbanized area outside of the urbanized area
Neighboring houses	0 1 2	houses exist within the site or many houses exist nearby. a few houses exist within 400 m from the site. no house within 400 m from the site.
Church	0 1 2	exist in the site. exist within 400 m from the site. not exist within 400 m from the site.
Cemetery	0 1 2	exist in the site. exist within 400 m from the site. not exist within 400 m from the site.
School	0 1 2	exist in the site. exist within 400 m from the site. not exist within 400 m from the site.
Medical facilities	0 1 2	exist in the site. exist within 400 m from the site. not exist within 400 m from the site.
Visibility from roads	0 1 2	the most areas of the site can be seen from the community road. some parts of the site can not be seen due to trees or buildings. the most areas of the site can not be seen from the community road.
Observatory	0 1 2	exist in the site. exist within 400 m from the site. not exist within 400 m from the site.
Scenic place	0 1 2	exist in the site. exist within 400 m from the site. not exist within 400 m from the site.
River, stream	0 1 2	exist in the site. exist within 400 m from the site. not exist within 400 m from the site.
Well	0 1 2	exist in the site. exist within 400 m from the site. not exist within 400 m from the site.
Present terrain	0 1 2	steep slope in the site gentle slope in or near the site flat land in the site
Natural forest	0 1 2	exist in the site. exist within 400 m from the site. not exist within 400 m from the site.
Present land use	0 1 2	natural land cultivated land waste land

c. **Method of Technical Evaluation**

ca. **Items for Technical Evaluation**

The items used for technical evaluation are as follows:

- Total available area for the site
- Availability of cover soil
- Accessibility of haulage route
- Road improvement cost
- Land acquisition cost

cb. **Rating System**

The evaluation result was expressed by giving points to each evaluation items. 2 points were given to the site which will have better conditions, 1 point given to the site with ordinary conditions and 0 to those in poor conditions. The rating criteria is presented in Table G.4.4c.

Table G.4.4c Rating Criteria

Evaluation Indices	Point	Description
Total available area for the site	0 1 2	≤ 50 ha 50 ha < A ≤ 100 ha > 150 ha
Availability of cover soil	0 1 2	Not available in the site Available in the site
Accessibility of haulage route	0 1 2	≥ 15 km 15 km > L ≥ 10 km < 10 km
Road improvement distance	0 1 2	> 15 km 15 km ≥ L > 10 km ≤ 10 km
Land acquisition cost	0 1 2	> 2.0 mill.C$ 2.0 mill.C$ ≥ V > 1.0 mill.C$ ≤ 1.0 mill.C$

c. Overall Evaluation on Candidate Disposal Sites

The results of the evaluation are presented in Table G.4.4d.

Table G.4.4d Evaluation Results

	Social Environment	Pollution	Natural Environment	Technical Aspect	Total Score	Rank
Acahualinca	21	7	5	5	38	1
Santa Ana	21	4	3	5	33	2
Cuajachillo	14	5	3	4	26	5
San Judas	15	2	3	4	24	6
Villa Fontana	18	5	3	5	31	4
Esquipilas	14	6	9	3	32	3

G.4.5 Evaluation of the Acceptability of the Location of the Disposal Site to the Citizens

The candidate sites were selected by the Municipality of Managua based on the possibility of land acquisition, the first priority requirement. The acception of the residents of the selected site is also very important.

The opinions of citizens when it comes to disposal site selection are usually as follows:

NIMBY	–	Not in my backyard
NIMFE	–	Not in my frontyard either
PITTBY	–	Put it in their backyard
NIMTOF	–	Not in my term of office
NIMEY	–	Not in my election year
LULU	–	Locally undesirable
YIMBY/FAP	–	Yes, in my back yard, for a price

The evaluation of the candidate sites, as shown in Table G.4.4a, was carried out by considering social and environmental impacts (pollution) and economic factors. The evaluation results led to the rating of the candidate sites, as shown in Table G.4.5a.

Table G.4.5a Rating of Selected Sites

Rank	Name of Site	Score
1	Acahualinca	38
2	Santa Ana	33
3	Esquipulas	32
4	Villa Fontana	30
5	Cuajachillo	26
6	San Judas	23

Based on the above evaluation, the Study Team recommends the following sites as candidate sites for the alternative study:

1. Acahualinca
2. Santa Ana
3. Esquipulas

ANNEX H

EXAMINATION OF TECHNICAL SYSTEM ALTERNATIVES

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ANNEX H EXAMINATION OF TECHNICAL SYSTEM ALTERNATIVES

H.1 Planning Framework

H.1.1 Goal, Targets and Strategy

a. Goal

For the formulation of the MSWM draft master plan, the following is proposed as the Master Plan objective:

> **[Development and Realization of a Beautiful and Sanitary Environment in the City of Managua towards the 21st Century through Citizens' Participation and Establishment of Self-sustainable Solid Waste Management]**

b. Targets

In order to realize the goal, the targets for the Municipality are set up and tabulated in Table H.1.1a.

Table H.1.1a Targets for Collection, Street Sweeping, Public Cleansing and Final Disposal Services

		Unit	1994		2000		2010	
1.	Population (Urban Area)	Inhabitants		834,427		1,131,052		1,610,943
2.	Collection Coverage	% (inhabitants)	77.0	(642,100)	90.0	(1,017,947)	100.0	(1,610,943)
	Collection Area A	% (inhabitants)	66.7	(556,563)	66.7	(754,412)	66.7	(1,074,449)
	Collection Area B	% (inhabitants)	10.3	(85,537)	23.3	(263,535)	33.3	(536,444)
3.	Street Sweeping Distance	km		331		350		350
4.	Public Cleansing Area (Park & Green Area)	ha		16.7		45		45
5.	Sanitary Landfill Level	-		Level 1		Level 3		Level 4

c. Strategy Elements

The goal is to be specifically obtained through:

1. Establishment of a self-sustainable solid waste management system.

2. Provision of collection services in the urban area of the Municipality of Managua, including the illegal settlement area, and establishment of a reliable collection system under which regular services can be provided.

3. Construction of sanitary disposal sites employing sufficient measures for human and environmental protection.

4. Establishment of efficient street sweeping and public area cleansing systems.

5. Improvement of the Waste Fee System under the Beneficiary-Pay-Principle where service recipients pay waste fees and tipping fees established according to household financial capabilities.

6. Establishment of proper legislation and regulations through the modification and revision of existing ones.

7. Establishment of proper coordination among the several institutions on both national and municipal levels dealing with solid waste management, mainly to ensure legislation enforcement.

8. Establishment of roles befitting the organizations involved in solid waste management.

9. Strengthening management and administration systems.

10. Development of public participation and education programs.

11. Development of solid waste management human resources.

12. Securing funds for capital investment for the equipment and facilities necessary for the realization of the goal, specially during the time of take off.

d. Strategy for Collection Area Expansion

da. Present Conditions

In the urban area of Managua city, the subject area of the MSWM improvement plan, the distribution of collection and non-collection areas are 77.0% and 23.0%, respectively.

The collection area is divided into collection areas A and B according to the collection system provided. In collection area A, the curb collection system – the collection of wastes discharged by residents in front of their premises by compactor trucks (15.3m^3)– is practiced. Collection area B, on the other hand, is predominantly a squat area where infrastructure such as roads and electricity are poorly established. Wastes in this area are discharged in registered illegal dump sites (RIDS) and collected later on by municipal wheel loaders and dump trucks.

The non-collection area is mainly composed of makeshift settlements as in collection area B. Waste collection is not carried out in this area, however, due to the absence of suitable equipment.

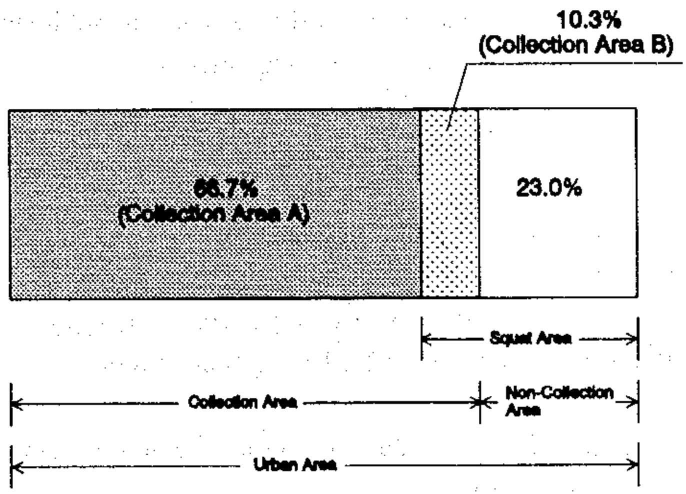

Figure H.1.1a Urban Area Definition in Terms of Collection Services

db. Forecast of Regional Structures

The population of the urban area is forecast to increase radically to 1.6 million, twice the present figure. The establishment of an infrastructure relative to the increase in population shall be a heavy burden to the municipality in consideration of present financial conditions. Accordingly, the master plan will assume that the percentage (66.7%) of the urban area population living in well developed areas will be the same in the future.

dc. Collection Area Expansion Strategies

The collection system employed in collection area A, a well developed area, will be modified, except for the use of compactor trucks. Collection area A is presently almost completely covered by collection services that expansion is not required. Services in Collection area B, however, should be extended.

The present collection system in area B is not suited to the environmental state of the area. The General Urbanization Plan of Managua classifies Area B into 2 categories: spontaneous and progressive settlement areas. The spontaneous settlement area has no vehicular access road and constitutes 60% of Area B. The progressive settlement area is constructed with a road mainly for vehicular access and constitutes 40% of Area B.

Given these conditions, expansion of collection services in Area B will involve the use of the container collection system in the spontaneous settlement area and the bell collection system in the progressive settlement area.

Collection System

Collection Area A: Curb collection system
Collection Area B:

- Spontaneous Settlement: Container collection system
- Progressive Settlement: Bell collection system

The implementation of a container collection system in collection area B will require the following from the residents:

- disposal of waste in the containers
- regular cleaning of the peripheral areas of the container
- inform the municipality if wastes other than household refuse is dumped, e.g. industrial and construction debris
- maintain a sanitary environment by sweeping streets and drains, picking up rubbish in public areas, avoid littering, etc

dd. Collection Fee

The expansion of the collection area will not be feasible without a properly established fee collection system in consideration of the present financial state of the municipality. Conclusively, the quality and quantity of the collection service are directly proportional to the waste fees. Charging of collection fees in collection area B is perceived to be difficult, however, because the majority of the residents are squatters.

To establish the beneficiary pay principle, the following waste fee system was planned:

- Collection Area A

  Waste collection, haulage and disposal fees will be collected from the residents.

- Collection Area B

  Waste collection fees will be collected from the residents. The expenses for haulage and disposal services will be appropriated from the general budget of the Municipality of Managua as a subsidy.

- Large Generation Sources

  Waste collection, haulage and disposal fees will be collected from large generation sources.

- Direct Haulage by Waste Producers

  Waste tipping fees will be charged to waste directly hauled to the disposal site by producers and contractors.

e. Strategy for Leachate Control at the Acahualinca Newly Proposed Landfill Site (ANPLS)

ea. Background

ANPLS was selected because it will not affect groundwater quality, the drinking water source, regardless of its proximity to Managua Lake, the final destination of groundwater flow.

However, the quality of leachate originating from the present Acahualinca disposal site is worse than the quality of Managua Lake according to the water quality survey. Although the cause and effect relationship is unclear, it is quite definite that leachate is one of the factors that contaminate Managua Lake.

On the other hand, it is common knowledge that the concentration of sewage load in Managua lake is considerably heavier than leachate from the landfill.

eb. Phased measures for leachate

Taking account of the above facts, adequate anti-contamination measures for

Managua Lake should be incorporated in the Master Plan.

The installation of water treatment facilities in ANPLS for leachate control is desirable, but because of the enormous capital it would require the following phased-measures for leachate control were proposed instead:

Year 2000: Sanitary Landfill Level 3

- the installation of liners for seepage control
- the installation of leachate collection, circulation and monitoring facilities.

Year 2010: Sanitary Landfill Level 4

- the installation of leachate treatment facilities

As previously mentioned, the measures for the improvement of the lake water quality will be focused on sewage treatment, because sewage concentration is higher than leachate making the effect of the latter minimal in comparison. Therefore, the most cost effective way to treat contaminated water entering the lake would be to construct a sewage plant, and to treat the waste leachate at the same plant, since its reduced volume will not affect the capacity or production of the plant. Financially, this will minimize the capital required for the improvement of the water quality of Managua lake.

H.1.2 Target Year and Population

a. Target Year

The master plan shall cover the period between 1995 to 2010. Upon consideration of the limited resources of the municipality for SWM, the goal of the master plan shall be pursued in a stepwise manner.

The period of the plan may be divided into the following three stages and the target year will be finalized during the study process with the Nicaraguan side.

Table H.1.2a Target Year

Category of Plan	Target Year
Master Plan	1995 - 2010
Medium Term Improvement Plan	2001 - 2010
Short Term Improvement Plan for F/S	1997 - 2000
Immediate Improvement Plan	Present - 1996

b. Population Forecast in the Study Area

Population is the most essential factor in the formulation of the Study for the improvement of SWM and the physical development plan for the municipality of Managua.

Population projections are basic data for development planning and estimation of future solid waste generation amount for the improvement of SWM. Population statistics, which is directly related to the solid waste collection coverage, was carefully discussed with ALMA which decided to adopt the Study Team's present population base to project future population and plans on SWM.

The future district population and urbanized area are projected as shown in Table H.1.2b.

A population growth of 5.2% was assumed from 1994 to 2000 and 3.6% for the period between 2000 - 2010. Given these growth rates, the population of Managua municipality is projected to increase 1.4 times the present population by 2000 and 1.9 times by 2010, reaching a total of 2,069 million inhabitants.

Table H.1.2b District Population Projection by Target Year

District	1994		2000		2010	
	Total	Urban	Total	Urban	Total	Urban
D1	92,890	63,556	125,911	86,149	179,333	122,701
D2	134,696	134,696	182,578	182,578	260,044	260,044
D3	195,410	134,833	264,875	182,764	377,258	260,308
D4	204,711	204,711	277,483	277,483	395,215	395,215
D5	209,045	144,241	283,357	195,516	403,582	278,471
D6	220,855	152,390	299,365	206,562	426,382	294,204
D7	14,261	0	19,331	0	27,532	0
Total	1,071,868	834,427	1,452,900	1,131,052	2,069,347	1,610,943

Source: Population estimates of the Study Team based on data provided by CSE and ALMA

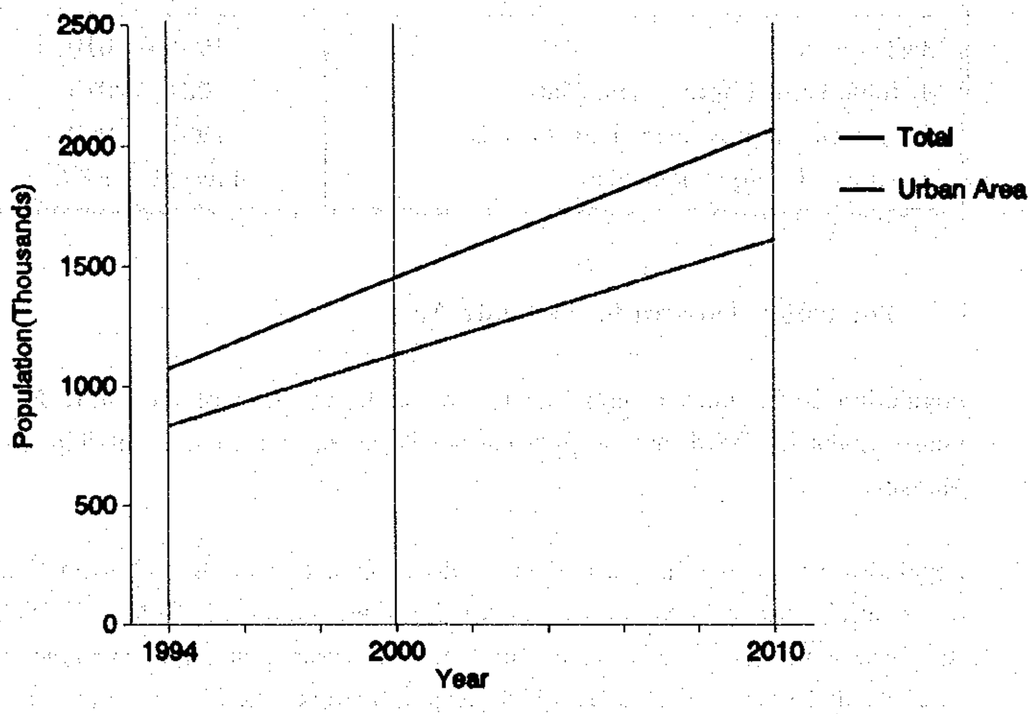

Figure H.1.2a Population Growth in the Study Area

H.1.3 Future Waste Amount and Composition Forecast

a. Forecast Conditions

aa. Types of waste

The different types of waste in this study are:

i. MSW

- household waste
- commercial waste
- market waste
- institutional waste
- street sweeping waste
- hospital waste (non–infectious waste)
- park and green area waste (parks and green areas)

ab. Target Years for the Forecast

The target years for the forecast of waste amount and composition are as follows:

2000 : The target year for the first priority project.
2010 : The target year for the master plan.

ac. Factors Affecting Waste Increase and Composition

The following factors will have an influence on the future generation of waste and its composition:

- social welfare and the financial capacity of individual consumers/families
- industrial technology
- importation

Forecasting is difficult to conduct in Nicaragua due to the lack of previous data on waste amount and composition. Economically, the wastes of Nicaragua should identify with the developing state of the country (e.g., GDP growth).

b. Forecast on Future Waste Amount

ba. Forecast Methodology

For the type of wastes to be forecast, the following assumptions were made:

baa. Household waste

Waste generation will be projected as follows:

[Waste generation] = [Generation Rate] x [Population]

baaa. Increase in generation rate

To determine the relationship between GDP and the generation of waste, the increase in welfare services was taken into account. Although a direct connection is not anticipated, some aspects indicating further analysis may be identified.

GDP increase is expected to have a large impact on the generation of waste per capita of developing countries than of developed countries. Also, at a certain welfare level, increase in GDP remarkably changes the composition of waste.

Japan has fine statistics enabling the analysis of the relationship between GDP and waste generation in a developing economy (1963 - 1970) and a developed economy (1975 - 1988). Data in the years 1970 - 1975 are excluded due to fluctuations resulting from the implementation of a new waste disposal and public cleansing law and economic recession and instability caused by the oil crisis.
Based on data for the period between 1963-1970, a developing economy can be characterized as follows:

- Average increase in waste generation per capita: 5.789 %/year
- Average increase in GNP *: 10.438 %/year

* GNP was used due to unavailability of GDP.

Based on these figures, we assume that the changes in GDP affect waste generation as it renders the developing economy flexibility (60-55 of GDP - change in %).

The GDP of Nicaragua (taken from the 1994 constant) is supposed to develop as follows:

1994	+ 3.0%
1995 - 1998	gradually to +5.0%
1999 - 2000	+5.0%
2001 - 2005	+4.5%
2006 - 2010	+4.0%

Annual rise in GDP would result in increased waste generation due to improved welfare services. And the increase in waste generation per capita per year is, estimated as:

Table H.1.3a GDP Growth Rate and Increase in Generation Ratio

Year	GDP Growth Rate	Increase in Generation Ratio
1994	3.0	-
1995	3.5	1.925
1996	4.0	2.200
1997	4.5	2.475
1998	5.0	2.750
1999	5.0	2.750
2000	5.0	2.750
2001	4.5	2.475
2002	4.5	2.475
2003	4.5	2.475
2004	4.5	2.475
2005	4.5	2.475
2006	4.0	2.200
2007	4.0	2.200
2008	4.0	2.200
2009	4.0	2.200
2010	4.0	2.200
Average	-	2.389

The table indicates a constant increase of 2.4% in waste generation per capita per year in the planning period 1995 - 2010.

baab. Increase in population

Population change is the factor that directly influences waste generation the most. The estimated annual population growths in the Study Area planning period are tabulated in Table H.1.2b.

bab. Commercial, market, institutional and hospital waste

Present generation amount of waste is forecast to increase in accordance with GDP growth rate.

bac. Street sweeping and park & green area wastes

The present generation rate of street sweeping and park and green area wastes is forecast to be fixed. These waste amounts will increase in accordance with the expansion of areas covered by street sweeping and public area cleansing services.

bad. Other waste

Other wastes, i.e., industrial waste, directly hauled waste and illegally dumped waste, will increase in accordance with GDP growth rate.

bb. Waste Amount Forecast

The forecast on MSW and other waste will be made based on the above-mentioned assumptions. The household waste generation ratio in the Study Area was roughly estimated based on the 1994 generation ratio, and tabulated in Table H.1.3b. The results of the forecast are shown in Table H.1.3c.

Table H.1.3b Forecast on Household Waste Generation Ratio

	Unit	1994	2000	2010
Household Waste	g/person/day	664	769	969

Table H.1.3c Forecast on Waste Generation Amount

(unit: ton/day)

Generation Source		1994	2000	2010
MSW	Household Waste: Area A	369.6	580.1	1,041.2
	Household Waste: Area B	184.5	289.7	519.8
	Commercial Waste: Restaurants	25.4	33.1	50.3
	Commercial Waste: Others	0.4	0.4	0.4
	Market Waste	26.0	33.9	51.4
	Institutional Waste	2.3	2.9	4.0
	Hospital Waste	6.3	8.3	12.5
	Street Sweeping Waste	16.5	17.4	17.4
	Park & Green Area Waste	1.4	3.8	3.8
	Directly Hauled Waste	33.6	43.4	65.8
	Sub-total	666.0	1,013.0	1,766.6
ISW	Industrial Waste	8.9	11.6	17.5
	Directly Hauled Waste	5.1	255.8	387.7
	Illegally Dumped Waste (from RIDS)	188.0	-	-
	Sub-total	202.0	267.4	405.2
Total		868.0	1,280.4	2,171.8

Note: Industrial waste amount is limited to Municipal collection.
Illegally dumped waste amount is limited to Municipal collection.
Illegally dumped waste was forecast using directly hauled waste figures.

c. Forecast on Waste Composition

ca. Forecast on Waste Composition

A change in the composition of waste is expected due to the marketing of new products and a different consumption pattern.

Table H.1.3d compares the results of the WAC survey on household waste and MSW composition with the 1991 data of Rio de Janeiro, Brazil, by the Applied Research Center of COMLURB (Rio de Janeiro Municipal Public Cleansing Company), 1987 data of Penang, Malaysia, 1972 data of Tokyo, Japan, and the 1993 data taken in Asuncion, Paraguay.

Table H.1.3d Comparison of MSW Composition Data

unit:%

	Managua, Nicaragua 1994		Penang ** Malaysia 1987	Tokyo Japan 1972	Rio de Janeiro Brazil 1991	Asuncion Paraguay 1993
	Household Waste from WACS	MSW * from WACS				
1. Combustibles	**75.09**	**76.22**	**88.1**	**89.0**	**79.1**	**72.8**
Kitchen Waste	34.86	34.80	32.8	25.9	33.9	37.4
Paper	5.37	7.07	25.5	35.6	27.1	10.2
Textile	1.87	1.94	3.4	3.2	2.7	1.2
Plastic	3.88	4.00	11.2	6.9	12.7	4.2
Grass and Wood	27.11	26.35	14.4	–	2.0	19.2
Leather and Rubber	2.00	2.06	0.8	0.8	0.7	0.6
Others	–	–	–	16.6	–	–
2. Non-Combustibles	**24.91**	**23.78**	**12.0**	**11.0**	**20.4**	**27.2**
Metal	1.69	1.77	2.6	3.7	3.1	1.3
Glass	2.91	2.91	1.4	7.3	2.2	3.5
Ceramic and Stone	8.07	7.60	0.2	–	0.4	2.5
Others(soils, etc.)	12.24	11.50	7.8	–	14.7	19.9
Total	100	100	100	100	99.5	100
Apparent Specific Gravity (kg/m^3)	200	200	190	N.A	209	215

Note: WACS : Waste Amount and Composition Survey
* : The figure shows the composition of MSW
** Source : "Solid Waste Management Study for Pulau Penang and Seberang Perai Municipalities, August 1989, JICA"

Since there are no available data in the Study Area, the analysis was focused on the comparison of data provided by the WACS and other countries assuming that changes in waste composition would generally result in the following waste characteristics inherent in a developed economy:

- increase in the ratio of combustibles and decrease in non-combustibles
- decrease in the ratio of kitchen waste and increase in paper and plastics
- decrease in the ratio of grass and wood and increase in metal and glass
- decrease in apparent specific gravity

Referring to Table H.1.3d, the frame of the waste composition in 2010 is set as follows:

- paper and plastic ratios will increase up to 11% and 7%, respectively

- ratio of grass and wood will decrease down to 23% due to reduction of vegetation in the urban area
- ratio of soil (others) will decrease down to 9% due to increase in paved roads
- only minor changes are observed in other items

Table H.1.3e shows the forecast MSW composition in the Study Area.

Table H.1.3e Forecast MSW Composition

unit:%

Composition	1994	2000	2010
1. Combustibles	**76.22**	**78**	**80**
Kitchen Waste	34.80	35	35
Paper	7.07	9	11
Textile	1.94	2	2
Plastic	4.00	5	7
Grass and Wood	26.35	25	23
Leather and Rubber	2.06	2	2
2. Non-Combustibles	**23.78**	**22**	**20**
Metal	1.77	2	2
Glass	2.91	3	3
Ceramic and Stone	7.60	7	6
Others (Soils, etc.)	11.50	10	9
Total	100.0	100	100

Note: MSW here excludes street sweeping and bulky wastes.

cb. Forecast on Calorific Value

cba. LCV of the physical composition of each waste category

The following calorific values were measured in the WACS:

- for combustibles mixed from 8 generation sources, i.e. residential areas (high, middle and low income), markets, commercial areas (restaurants and others), institutions and road
- for each combustible item from the middle income residential area

The calorific value of wastes differs according to physical composition and how much moisture, combustible and ash it contains, and the ratio of combustible waste and ash depends on the physical changes that take place. Table H.1.3f shows our survey data on mixed combustibles and the 1972 data on Japan.

Table H.1.3f Comparison of the Three Contents and LCV

	1994 JICA Study		Japan (1972)
	Household	MSW	
Moisture content (%) Combustible content (%) Ash content (%)	37.27 27.97 34.76	37.42 28.64 33.94	54.1 31.4 14.5
Lower Calorific Value Measured (kcal/kg)	1,045	1,092	1,165

The above 1994 data obtained by the JICA Study Team are weighing average figures of mixed wastes, taking the waste generation ratio by each category into account. The moisture content of each data ranges between 10% – 50%. The lower calorific value was determined by taking into account the possibility that the physical composition may vary, because the moisture content is forecast to remain constant.

The higher calorific value (HCV) in dry base of each combustible component of waste from the middle income residential area was also measured and used to calculate the lower calorific values (LCV's) shown in Table H.1.3g.

Table H.1.3g HCV in Dry Base and LCV in Wet Base of Each Combustible Waste

	Higher Calorific Value in Dry Base (kcal/kg)	Lower Calorific Value in Wet Base (kcal/kg)
Kitchen Waste	3,640	780
Paper	4,440	2,630
Textile	4,390	1,880
Plastic	9,280	6,690
Grass & Wood	3,320	1,450
Leather & Rubber	5,680	4,600

The LCV of wastes was calculated by the following formula:

$$LCV = (RGa^{*1} * 780 + RPa^{*2} * 2{,}630 + RT^{*3} * 1{,}880 + RPl^{*4} * 6{,}690$$

$$+ RGr^{*5} * 1{,}450 + RL^{*6} * 4{,}600)/100$$

RGa^{*1}; Ratio of kitchen waste in wet weight (%)
RPa^{*2}; Ratio of paper in wet weight (%)
RT^{*3}; Ratio of textile in wet weight (%)

RPl*4; Ratio of plastic in wet weight (%)
RGr*5; Ratio of grass and wood in wet weight (%)
RL*6; Ratio of leather and rubber in wet weight (%)

cbb. Lower calorific value forecast

Using the above mentioned formula, the future LCV of MSW is estimated by multiplying the LCV in Table H.1.3g by the ratio of the future physical composition shown in Table H.1.3e.

In case a separate collection system will not be introduced, the LCV of mixed waste is estimated as shown in Table H.1.3h.

Table H.1.3h Forecast on Lower Calorific Value

Year	Lower Calorific Value (kcal/kg)
	Mixed
1994	1,238
2000	1,336
2010	1,494

d. Future Waste Stream

da. Forecast Conditions

daa. Source recycling

The rate of food waste recycled (about 3% of the generation amount) at generation sources will be maintained till 2010.

dab. Self-disposal (collection service area)

Since the same kind of housing style (detached houses) will still be common in the future, the self-disposal rate (about 13% of the generation amount) is estimated to remain the same until 2010. Consequently, the self-disposal amount is calculated by the formula below.

$$SA = GA \times 0.13$$

SA: Self-disposal amount (ton/day)

GA: Generation Amount

0.13: Self disposal rate as percentage of generation amount

dac. Self-disposal (non-collection service area)

Self-disposal amount in non-collection area is calculated using the following formula:

SA (non) = GA(non) x 0.13

SA (non) : Self-disposal amount in non-collection area (ton/day)

GA(non) : Generation amount in non-collection area (ton/day)

dad. Discharge

The waste discharge amount is obtained using the following formula:

DA = WGA - SRA - SA - SA (non)

DA : Discharge amount (ton/day)

WGA : Waste generation amount (ton/day)

SRA : Source recycling amount (ton/day)

dae. Recycling other than at sources

Recycling will be popularized and its importance will be further acknowledged as the GDP growth rate escalates.

daf. Other waste

Other wastes hauled to the disposal site will increase in accordance with the GDP growth rate.

dag. Landfill

The landfill amount is calculated by the formula below.

LA = DA - RA + OWA

LA: Landfill amount (ton/day)

RA: Amount of recycling other than at sources (ton/day)

OWA: Other waste amount (ton/day)

dah. Apparent specific gravity

Apparent specific gravity of waste after compaction at the final disposal site is 0.8.

db. Future Waste Stream

The future waste streams are presented in Table H.1.3i and Figure H.1.3a.

Table H.1.3i Waste Stream in Managua in 1994, 2000 and 2010

Category		Unit	Year		
			1994	2000	2010
MSW	a.Generation	ton/day	871.0	1,013.0	1,766.6
	b.Self Disposal	ton/day	185.2	196.4	223.3
	c.Recycling at Generation Source	ton/day	16.7	26.2	47.0
	d.Collection	ton/day	433.5	747.0	1,430.5
	e.Directly Hauled MSW	ton/day	36.6	43.4	65.8
ISW	f.ISW collected by the Municipality	ton/day	8.9	11.6	17.5
	g.ISW from RIDS	ton/day	188.0	0.0	0.0
	h.Directly Hauled ISW	ton/day	5.1	255.8	387.7
i.	Recycling	ton/day	12.8	20.1	36.4
j.	Waste amount at Final Disposal Site per day	ton/day	656.3	1,037.7	1,865.1
k.	Waste amount at Final Disposal Site per year (jx365)	ton/year	239,550.0	378,761.0	680,762

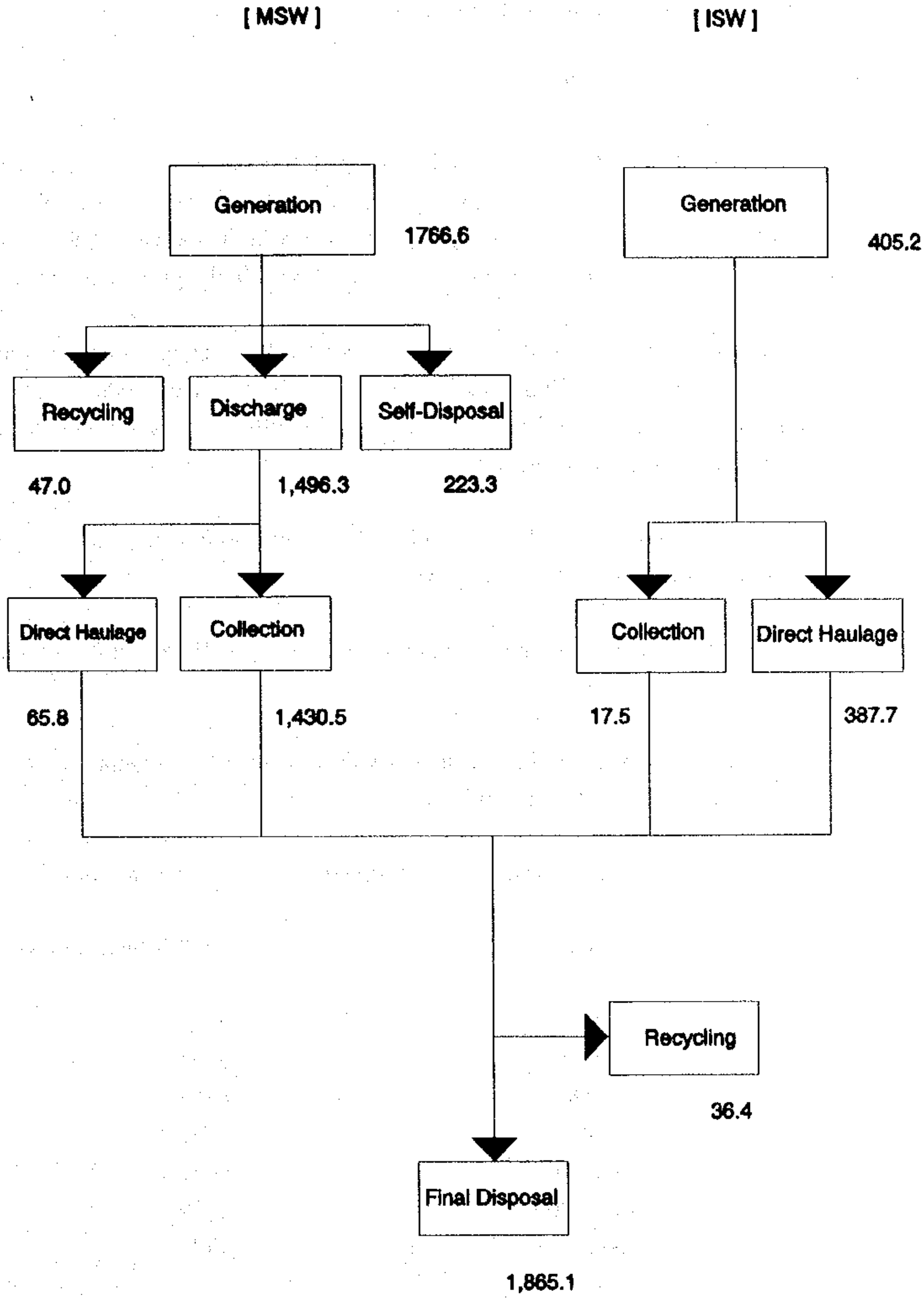

Figure H.1.3a Waste Stream in 2010 in the Study Area (unit : ton/day)

H.1.4 Other Pre-conditions

a. Economic and Financial Conditions

aa. Economic Growth Rate

It is very difficult to forecast the future economy of Nicaragua because the country is presently amidst a shift to a market economy. Further, even the use of trend figures of economic variables to describe future scenarios is too risky because for a long period of time the country has been under a controlled regime and civil war.

The formulation of the SWM Master Plan necessitates forecasting future economic figures to estimate waste volume and economic capability, factors relevant to the estimation of the required SWM cost. Therefore, the following assumptions on the future GDP and GRDP were made:

- The actual GDP growth rate will increase to more than 3.5% as the population increase rate exceeds 3%.

- The positive changes in the economy of Nicaragua in 1994 will bring about a 2% to 3% growth rate.

- The development plans for Nicaragua will aim for a 5% economic growth rate in the 1994 - 1995 period.

Based on the above assumptions, the GDP growth rate forecast is as follows:

Year	GDP growth rate/year
1994	3.0%
1995	3.5%
1996	4.0%
1997	4.5%
1998-2000	5.0%
2001-2005	4.5%
2006-2010	4.0%

In 1992, Managua made up 50% of the GDP, a contribution estimated to increase to 55% by the year 2000. This figure will be adopted until the year 2010 in the Study.

The estimated increase is attributable to the belief that urbanization will attract migrants from rural areas and encourage the convergence of tertiary industries in Managua City.

Based on the above reasons, the main GDP and GRDP figures per annum were calculated as shown in Table H.1.4a.

Table H.1.4a Master Plan Framework

Item	Unit	1992	1994	1995	2000	2005	2010
GDP	mill.US$	1,686.0	1,724.4	1,784.8	2,245.4	2,798.2	3,404.5
Share of Managua	%	50.0	51.3	51.9	55.0	55.0	55.0
GRDP in Managua	mill.US$	843.0	883.8	925.9	1,235.0	1,539.0	1,872.5
Population of Managua	thou-sands	971.3	1.071.9	1,127.6	1,452.9	1,733.9	2,069.3
GRDP per capita	US$	867.9	824.5	821.1	850.0	887.6	904.9

ab. City Finance and Family Income Estimates

The budget of the city of Managua and the income of families in the city are assumed to be proportional to the GRDP growth rate; increase in city budget is proportional to the total GRDP growth and increase in family income is proportional to the GRDP growth per capita.

Table H.1.4b Financial State of Managua Municipality and Family Income

	Unit	1992	1994	1995	2000	2005	2010
Budget of Managua	mill.US$	33.5	33.1	34.7	46.2	57.6	70.1
Family Income	US$/month	389.6	370.1	368.6	381.6	389.4	406.2

b. Conditions for Cost Estimation

All cost estimates are conducted taking the following into account:

- The prices and foreign exchange rate are based on the January 1995 rate.

  US$ 1.00 = C$ 7.1183

- Inflation is not taken into account.

- Local laborers whose wages are under C$ 25,000/year are not obliged to pay income tax, but 12.5% social security charge is deducted from the wage.

- Prices for equipment not available in Nicaragua reflect Japanese price levels. These will be presented in CIF prices in C$.

Unit prices for earthworks, concrete works, buildings, etc., were based on the information given by the Ministry of Construction, Managua Municipality and private construction companies.

Table H.1.4c Unit Prices Available in Managua in June 1994

DESCRIPTION	UNIT	PRICE
1. Salary, including 12.5% Social Securities Charge		
- manager	C$/pers	4,666
- engineer	C$/pers	3,033
- mechanic	C$/pers	1,604
- driver & clerk	C$/pers	1,410
- worker	C$/pers	992
2. Earthworks		
- Excavation and Compaction: hauling distance = 0 to 50 m	C$/m³	30
- Excavation, haulage and compaction		
0 - 1km	C$/m³	34
1 - 5km	C$/m³	44
5 - 10km	C$/m³	54
10 - 15km	C$/m³	64
3. Drainage Works		
- Underground drain including excavation, supply & placing of gravel	C$/m	40
- Underground drain with perforated pipe, including excavation, supply & placing of perforated pipe (D=diameter) and filter material		
D = 100 mm	C$/m	180
D = 150 mm	C$/m	240
D = 300 mm	C$/m	440
- Open ditch w=3.0m, including excavation and shaping	C$/m	290
- Open ditch reinforced concrete w=3.0m, including all works	C$/m	2,600
- Concrete pipe D=600mm, including excavation, foundation, supply & placing concrete pipe and back fill	C$/m	770
- Concrete pipe culvert D=1,200mm, including excavation, foundation, supply and placing concrete pipe and backfill	C$/m	2,200
4. Pavement works		
- 5 cm asphalt concrete	C$/m²	130
- 20 cm mechanical stable gravel	C$/m²	
- 20 cm course gravel	C$/m²	
5. Concrete works, including material and formworks		
- Reinforced concrete	C$/m³	1,400
- Concrete	C$/m³	850
6. Building works		
- Garage - a steel structure with steel cladding; including foundation and concrete floor	C$/m²	1,300
- Office building - of reinforced concrete; including all works	C$/m²	2,300
7. Miscellaneous works		
- Fence - consists of 2m high galvanized wire mesh erected on galvanized steel posts each 2.5 m in diameter.	C$/m	270
- Gate - 8 m wide	C$/set	3,600
- Tree height = 2.5-3.0 m, including excavation, planting and all works	C$/piece	40
- Turfing - consists of supply of turf and soil and all works necessary	C$/m²	10
8. Materials		
- Diesel Oil	C$/lt	1.89
- Gasoline	C$/lt	4.00
- Gravel	C$/m³	94.30
- Sand	C$/m³	8.28
- Clay	C$/m³	7.50
- Cement	C$/45 kg	25.59
- Concrete		
150 kg/cm²	C$/m³	534.75
210 kg/cm²	C$/m³	570.85
- Reinforced bar	C$/kg	4.43
- Electric Power	C$/kwh	0.51

H.2 Work Flow of the Examination of Technical System Alternatives

H.2.1 System Components in MSWM

a. Technical System

The MSWM (Municipal Solid Waste Management) system consists of the technical and institutional systems. The technical system consists of the following sub–systems and their components as shown in Table H.2.1a

Table H.2.1a Contents of the Technical and Institutional System

Technical System			Institutional System
Technical System	Technical Sub-system	Sub-system Component	
Discharge and Storage	a. Source Separation	- Mixed discharge - Separate discharge	- Organization and Management
	b. Type of Storage Equipment	- Bags/sacks - Bucket - Public container	- Legislation and Enforcement
Collection and Haulage; (transportation)	a. Collection Frequency		- Finance (revenue source)
	b. Collection Method	- Mixed collection - Separate collection	- Public Cooperation
	c. Type of Collection Service	- Curb collection - Door to door collection - Bell collection - Public container collection	
	d. Collection Time	- Day collection - Night collection	
	e. Type of Collection vehicle	- Compaction Type - Detachable container type - Standard truck	
	f. Haulage System	- Motor vehicle - Railway - Water Haulage	
	g. Transfer Station		
Street Sweeping and Park and Green Area Cleansing	a. Cleansing Method	- Manual street sweeping - Mechanical cleaning - Vacuum cleaning - Flushing	
Intermediate Treatment	a. Incineration b. Composting c. Refuse Derived Fuel (RDF) d. Pyrolysis e. Ash Solidification f. Size Reduction g. Sorting		
Final Disposal	a. Final Disposal System	- Centralized disposal - Separate disposal	
	b. Method of Sanitary Landfill	Level 1 : Controlled tipping Level 2 : SL with daily cover Level 3 : SL with leachate circulation Level 4 : SL with leachate treatment	

Note: SL = Sanitary Landfill

Some sub-systems are very important but the necessity of the others, such as processing, depends on several factors such as local financial capability and waste characteristics.

The following Table H.2.1b explains the method of examination concerning each technical sub-system.

Table H.2.1b Examination Method of Technical Sub-systems

Sub-systems	Type A	Type B
- Discharge and Storage		O
- Collection and Haulage		O
- Street Sweeping and Public Area Cleansing		O
- Intermediate Treatment & Recycling	O	
. Incineration	O	
. Composting	O	
. Size Reduction	O	
. Sorting	O	
- Final Disposal		O

Note: A: Examination is to be made if the sub-system is necessary.
B: Examination is to be made on the type, method and facility to be used if the sub-system is an absolute necessity.

H.2.2 Selection Method of an Optimum Technical System

Alternative MSWM systems are a combination of various technical sub-systems as shown in Table H.2.1b. There are many technical sub-system alternatives which is a combination of various possible technical components.

Therefore, screening will be carried out concerning various alternative technical systems in the Master Plan Study Phase.

In view of the present MSWM in the Study Area, a goal is set to develop and realize a beautiful and clean living environment in the city of Managua. In addition, the establishment of a cost-effective MSWM system is an important issue in the formulation of the technical sub-system alternative, as the implementation of MSWM may be very costly.

Consequently, the following method is applied in the Study for the selection of an optimum technical system alternative for the Master Plan.

a. Selection of the Optimum Technical System

aa. Examination of Technical Sub-systems and Combination of Technical Components

Each sub-system alternative will be examined and the best option will be selected. For example, the optimum storage equipment for refuse containers for household waste will be selected from plastic bins, bamboo baskets, etc..

A comparative study on the different technical systems will be carried out by combining each sub-system.

ab. Selection of an Optimum System

An optimum technical system will be selected by evaluating the following aspects shown in Table H.2.2a.

Table H.2.2a Aspects for Evaluation of Technical System

No.	Aspects for Evaluation
i.	Technical point of view
ii.	Economic and financial points of view
iii.	Transactional facilitation points of view
iv.	Environmental points of view
v.	Overall evaluation

b. Selection of the Optimum Institutional System

After the selection of the optimum technical system, a study will also be conducted to formulate alternatives for the organizational, institutional and financial aspects best suited to the selected technical system. After the comparative study on the above-mentioned alternatives, an optimum MSWM system will be finally selected.

H.3 Work Flow

H.3.1 Work flow of the Examination of Technical System Alternatives

a. Work Flow of the Examination of Technical System Alternatives

aa. Study Flow Diagram of the Examination of Technical System Alternatives

The examination and selection works of the optimum technical system alternative are divided into two stages, that is, Stage A for the examination of technical sub-system components and Stage B for the selection of the optimum technical system alternatives for the city of Managua. The study flow diagram of these works is shown in Figure H.3.3a.

The work for Stage B will be conducted in H.5.

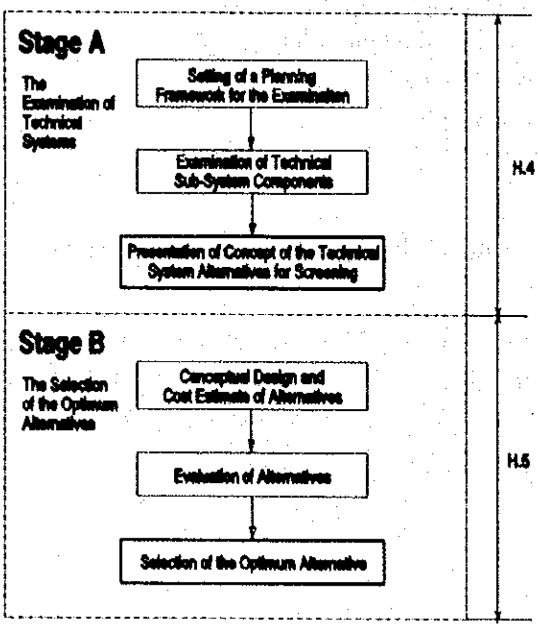

Figure H.3.3a Study Flow Diagram of the Examination of Technical System Alternatives

b. Stage A : Examination of Technical System Components

ba. Setting up of a Planning Framework for the Examination

The planning framework, i.e. target year, future population, forecast on waste amount and composition, future economic and financial conditions, etc., was set up for the examination work. The planning framework will be partially modified for the preparation of the Master Plan based on additional data to be obtained from future field studies.

bb. Examination of Technical Sub-systems

The MSWM technical system consists of several sub-systems, that is, collection and haulage, transfer, intermediate treatment, etc.. Each technical sub-system has various sub-system components, for example incineration, composting, RDF (Refuse Derived Fuel), etc., for intermediate treatment.

Various sub-system components are examined and primarily screened for the comparison of the technical system alternatives.

bc. Presentation of technical system alternatives

After the examination of each technical sub-system, a technical system alternative will be presented combining the selected items.

c. Stage B : Selection of the Optimum Alternative for the Master Plan

ca. Preliminary Design Cost Estimate of Technical System Alternatives

Preliminary design and cost estimate is carried out for each technical system alternative based upon the selected components of technical sub-systems.

cb. Evaluation of Alternatives

The least cost method is applied for the economic evaluation of technical system alternatives, because financial matters may carry more gravity in their implementation than other aspects. This method is acceptable as long as each technical alternative guarantees a certain level of environmental improvement.

However, the optimum alternative was approved to the decision by the Nicaraguan side at the time of the Interim Report (IT/R) discussion meeting. At the same time a discussion was conducted on the environmental, technical and social aspects of the technical alternative.

cc. Selection of Optimum Technical System Alternatives (Overall Evaluation of the Technical System Alternatives)

As a result of the overall evaluation of technical system alternatives, including the policies made during the IT/R meeting, the optimum technical system alternative for the MSWM Master Plan was selected.