ANNEX S

Preliminary Design of a New Municipal Solid Waste Disposal Site Development Project (Level-2)

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S Preliminary Design of a New Municipal Solid Waste Disposal Site Development Project (Level-2)

S.1 Preliminary Design

S.1.1 Design Conditions

a. Introduction

The municipality has one landfill (La Joya) which is located 5 km southwest of the city center. The La Joya landfill is located to the south of a crater. It is feared that the leachate from the landfill may contaminate the groundwater because the crater is directly connected to the groundwater. To make matters worse, there are some tap water wells belonging to INAA downstream of the creater.

Therefore, it is strongly recommended to terminate the La Joya landfill's operation and to develop a new landfill. In this study, the work for selecting a site was conducted, where upon San Jose de la Viuda (SJV) was selected as the new MSW disposal site.

This chapter presents the preliminary design for the proposed new sanitary landfill at SJV. The main items considered and examined in this chapter are as follows:

- Current conditions of SJV.
- Waste composition and amount dealt with in the future.
- Preliminary design.
- Operation.

b. Location and Current Conditions

b.1 Location

The site "San Jose de la Viuda (SJV)", is located 5 km north from the center of Granada City, to the east of the highway (Granada-Santa Rosa), and 1 km from the shoreline of Lake Nicaragua. The coordinates of the site's center are approximately 11°58'20"N, 85°57'20"W. The altitude is around 35m to 45 meters above sea level. (See Figure S-1.)

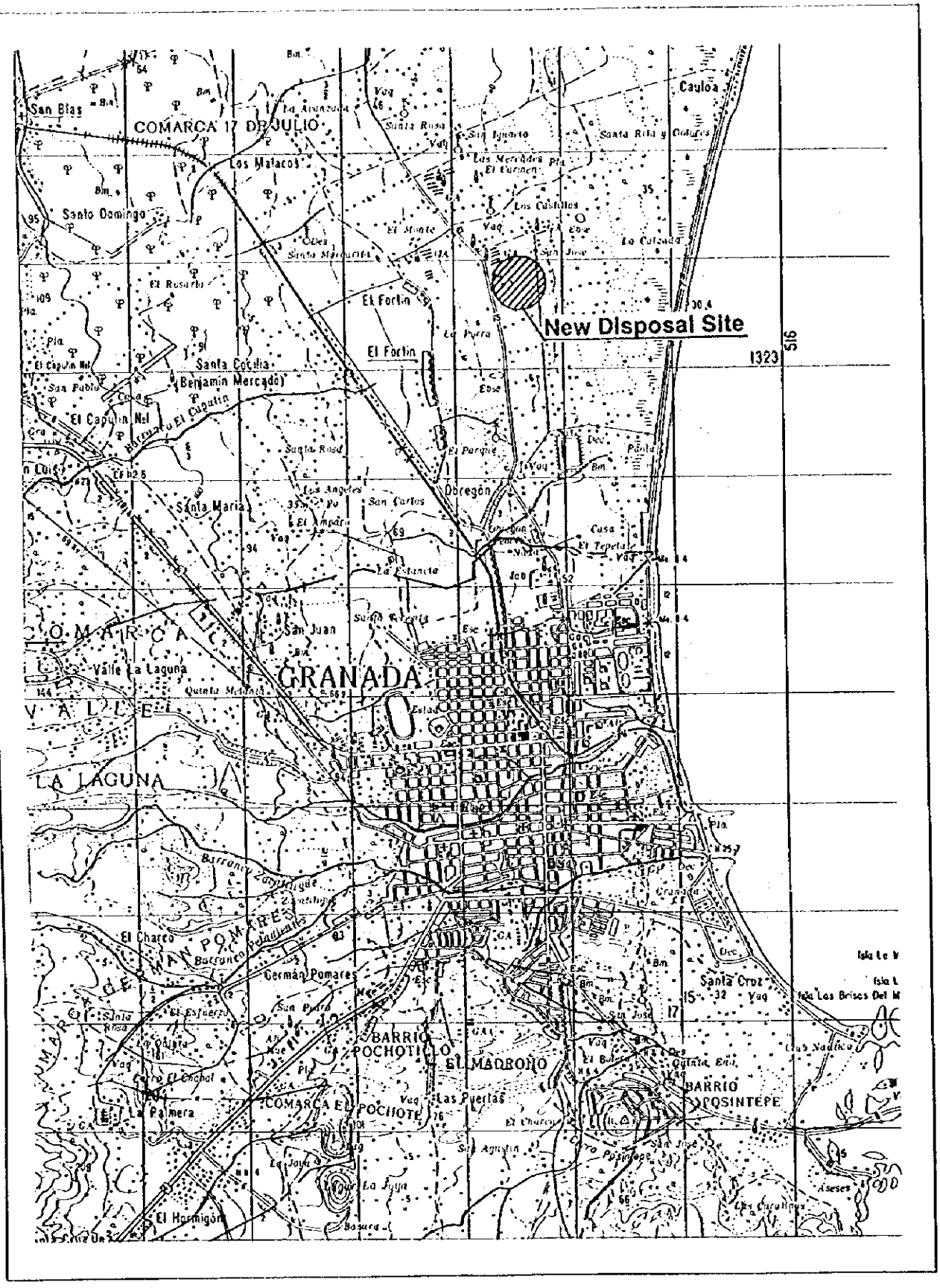
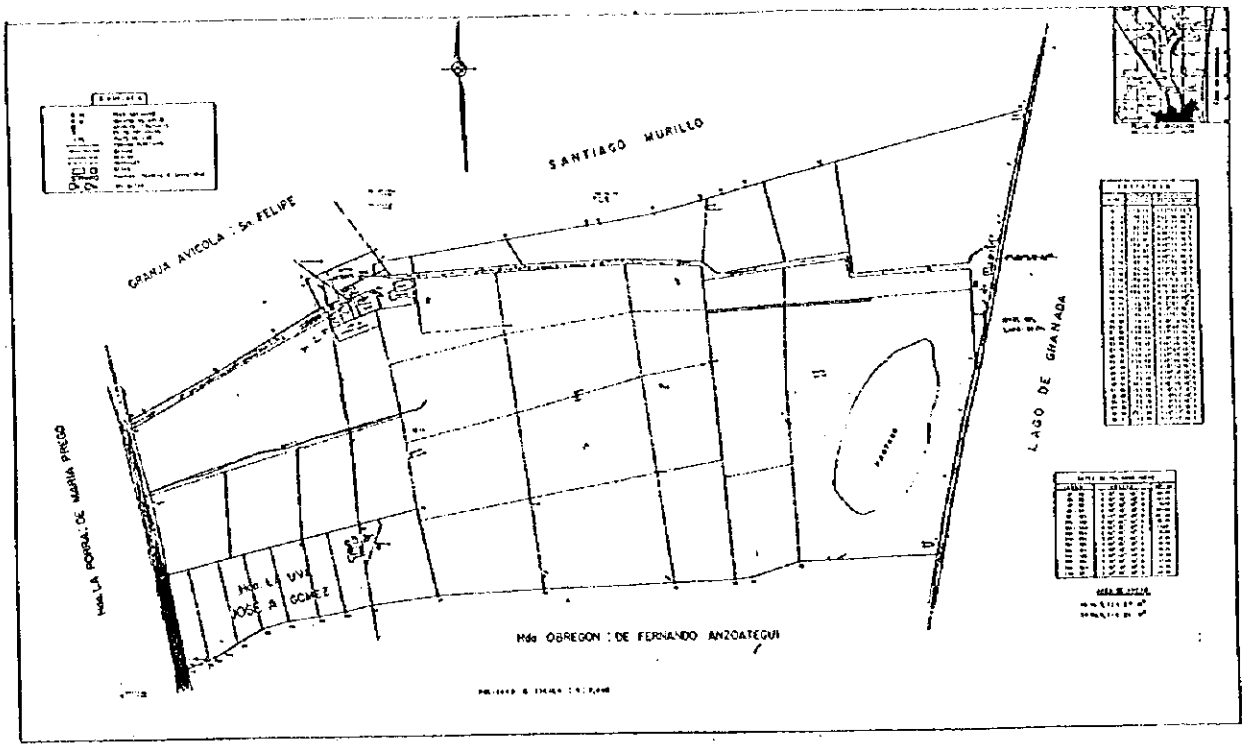


Figure S-1: Location Map of the New Disposal Site (San Jose de la Viuda)



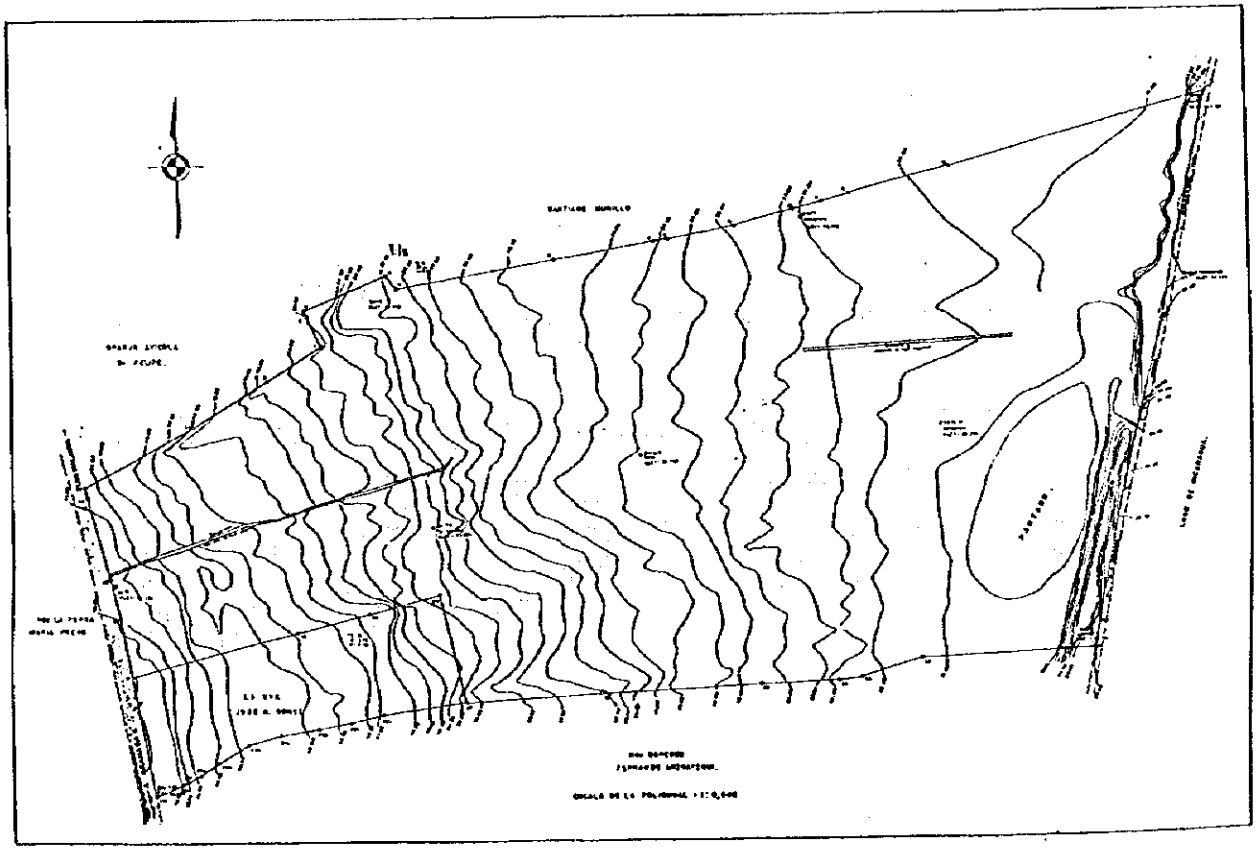


Figure S-2: Topographical Map of San Jose de la Viuda

b.2 Land Use

The site used mainly for cattle breeding and partially for agricultural purposes. The surrounding areas are used in a similar way. There is swampy area across the woods the east of the site. In addition, there is a poultry farm bordering the north of the property.

b.3 Weather Conditions

Temperature, Precipitation and Evaporation

The mean temperature is 26°C, the mean precipitation is 1,517 mm/year and the mean evaporation is 1,561 mm/year.[1]

b.4 Geological Conditions

The study team conducted the borling survey in order to lean the hydrogeological conditions of the site in July and August in 1997.

The site expands at an elevation of 35 m to 45 m. The groundwater level exists around 2 to 10 m below the ground level. The site selected for the initial landfill section (2001-2005) has its groundwater table about 3.5m below. Future landfill sections (2006 onward) could have the groundwater table deeper than that.

The surface layer (0 to 1.5m) of the proposed SJV site is made up of clay and silt that overlies a layer of sandy silt and volcanic deposits that extends to depth. The surface layer is relatively permeable with a permeability coefficient ranging from 2.08E-5 to 7.0E-5 cm/sec.

b.5. Road Condition to the Site

The road connecting the city and the site is enough for two-way traffic and the condition is substantial. The improvement works could only be grading of the existing one and laying of asphalt pavement.

b.6 Public Utilities

The site and the surrounding areas have no access to tap water, sewage nor telephone service, meanwhile, electric service is available.

b.7 Expected Life Span

The expected life span of the new disposal site is around 30 years. Although the site is a flatland, the use of the site as a landfill is limited by the groundwater level and the distance to the lake and to the poultry farm. Taking these factors into consideration, around 40 ha is planned for the new disposal site. This area is expected to operate for 30 years.

c. Disposal Amount and Type of Waste

The landfill is expected to receive the following types of waste:

- Household waste (kitchen, garden waste)
- Commercial waste (restaurants, other shops)
- Institutional waste

[1] At the Masaya meteorological station, data by INETER.

- Market waste
- Street sweeping waste
- Parks and green areas cleansing waste
- Other waste (construction and demolition waste, non-hazardous industrial waste, non-infectious/non-hazardous hospital waste, etc.)

The waste expected to be disposed at the new landfill mostly consists of household waste, then, a substantial portion (around 80%) of organic matter.

Disposal of hazardous and chemical wastes shall not be allowed on the landfill. These types of waste must be treated to become inert and safe enough to be dealt with in the landfill before being disposed. The landfill will not receive the following types of waste:

- Hazardous and toxic waste from industries, commerce, institutions etc.
- Infectious waste, syringes, etc. from hospitals, clinics and dentists.
- Radioactive waste.
- Liquid waste

Table S-1 and Table S-2 show future waste generation and disposal amount.

Table S-1: Forecast of Waste Generation Amount

Unit : ton/day

Items	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Household Waste	72.1	75.6	79.3	83.1	87.9	91.4	95.9	100.5	105.4	110.5
Restaurant	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.4	1.4	1.5
Other Shop Waste	1.1	1.2	1.2	1.33	1.4	1.4	1.5	1.6	1.6	1.7
Institutional Waste	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4
Market Waste	3.7	3.9	4.1	4.3	4.5	4.8	5.0	5.2	5.5	5.8
Street Sweeping Waste	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7
Bulky Waste	1.0	1.0	1.1	1.2	1.2	1.4	1.5	1.6	1.7	1.8
Sub-total	80.3	84.2	88.5	92.7	97.5	102.0	107.1	112.2	117.6	123.4
Other Waste	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.4	2.4	2.5
Total	82.5	86.4	90.7	95.0	99.8	104.3	109.5	114.6	120.0	125.9

Table S-2 : Forecast of Waste Stream

Unit : ton/day

Items	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Waste Generation	80.3	84.2	88.5	92.7	97.5	102.0	107.1	112.2	117.6	123.4
Recycling at Generation	7.0	7.4	7.7	8.1	8.5	8.9	9.4	9.8	10.3	10.8
Waste Discharge	62.8	66.2	70.1	73.9	78.2	82.3	86.9	91.7	96.7	102.0
Self-disposal	10.5	10.6	10.7	10.7	10.8	10.8	10.8	10.7	10.6	10.6
Collection Amount	56.5	59.6	63.1	66.5	70.4	82.3	86.9	91.7	96.7	102.0
Illegal Dumping	6.3	6.6	7.0	7.4	7.8	0	0	0	0	0
Recycling at Disposal Site	0	0	0	0	0	0	0	0	0	0
Other Waste	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.4	2.4	2.5
Final Disposal Amount	58.7	61.8	65.3	68.8	72.7	84.6	89.3	94.1	99.1	104.5

d. Landfill Volume

Table S-3 shows yearly and accumulated final disposal amount, based on the waste stream (see Table S-2).

Table S-3: Final Disposal Amount

Items	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Final Disposal	1000ton/year	21.4	22.6	23.8	25.1	26.5	30.9	32.6	34.3	36.2	38.1
	1000m³/year	26.8	28.3	29.8	31.4	33.1	38.6	40.8	42.9	45.3	47.6
2001-2010	1000ton	21.4	44.0	67.8	92.9	119.4	150.3	182.9	217.2	253.4	291.5
2001-2010	1000m³	26.8	55.1	84.9	116.3	149.4	188.0	228.8	271.7	317.0	364.6
Covering Soil	1000m³/year	5.4	5.7	6.0	6.3	6.6	7.7	8.2	8.6	9.1	9.5
2001-2010	1000m³	5.4	11.1	17.1	23.4	30.0	37.7	45.9	54.5	63.6	73.1
Waste + Soil	1000m³/year	32.2	34.0	35.8	37.7	39.7	46.3	49.0	51.5	54.4	57.1
2001-2010	1000m³	32.2	66.2	102.0	139.7	179.4	225.7	274.7	326.2	380.6	437.7

Note: ASG of waste after compaction is 0.8ton/m³.
Covering soil is 20% to waste amount in volume.

As the landfill will be used for long term, around 30 years, the landfill capacity is set based on the waste disposed from 2001 to 2010.

Waste volume disposed is as follows:

2001 to 2005 : 179,400 m³ (inc. cover soil)

2006 to 2010 : 253,300 m³ (inc. cover soil)

Total : 437,700 m³

Landfill area for 10 years operation has the capacity of 468,000 m³. As 5 years operation is subject to this preliminary design, a 3.5 ha landfill section (175m x 200m) is set for 5 years operation.

S.1.2 Preliminary Design

a. Access Road

Though the access road from the urban area to the site (Grenada - Santa Rosa) is in a rather good condition, a part of it from the north of the urban area to the site will be paved to ensure an efficient transportation and to avoid additional dust impacts. The construction works do not need substantial earth movement works, just grading of present road and paving works will be sufficient for the road improvement.

Width of the pavement: 4.0 m
Length: approximately 3.0 km

b. Enclosing Structure

An embankment surrounding the landfill will be built, with the purpose of defining the area, and to avoid the leachate efflux exit and the intrusion of surface runoff from its surrounding area. It will have a height of 3m, with a width at the top of 5 m and a slope with a gradient of 3 to 1.

c. Drainage System

Elimination of possible entry of stormwater to the landfill site is of fundamental importance to avoid the increase of the leachate volume generated in the waste disposal area. For these pluvial currents an open ditch, 2 m of wide, 0.5 m deep and 1,600 m long will be built. The collected waters will be disposed into the wetland.

Inactive cells for future landfill should be isolated with small dikes in order to prevent rainwater therein to flow in the active cell.

d. Environmental Protection Facilities

d.1 Fence

The fence will restrict the access of the scavengers and animals to the site. The fence installed around the site will be of mesh type and will have a height of 2m and a length of about 2,600m. Scattering of waste from the landfill site will be prevented by mobile fences near the active cells and by tall trees planted as a buffer zone. Therefore waste scattering beyond the buffer zone will be minimal. In addition to those measures, the fence around the project site will function as final barrier for flying waste.

d.2 Buffer Zone

The planting of fast growing eucalyptus trees at the circumference of the landfill site, 20 meters wide, will also work to prevent the scattering of litter such as plastic bags and furthermore will function as a vegetation screen (visual shield) that will improve the aesthetic landscape view and avoid possible impact by offensive odor and noise.

d.3 Gas removal

To remove the landfill gases carefully from the landfill site, vertical chimneys will be installed with perforated concrete pipes, of 200 mm in diameter, every 40 m (pitch to both north-south and east-west directions).

d.4 Monitoring Borehole

To confirm whether and how leachate is going to contaminate the local groundwater, 35m deep monitoring wells with a diameter of 100mm will be installed in 6 points.

e. Building and Accessories

e.1 Reception Area

The reception area will be paved with asphalt, comprised of a site office, a weighbridge, a tire washing pit and a gate, and equipped with electric lighting facilities.

e.2 Asphalt Pavement

From the entrance, 30m length is paved at 7.0m width. And, the area in front of the site office is paved 120m length at 15.0m width.

e.3 Site Office

The site office (approximately 100m^2) shall have a control room and facilities for staff and management.

The control room shall be constructed and equipped with facilities, that enable easy control and registration of incoming vehicles. The computerized weighbridge system enables detailed registration; this is indispensable for appropriate SWM.

The facilities are as follows:

- a control room furnished with a computer for the weighbridge.
- a changing room.
- toilets and showers.
- cooking facilities.
- a storeroom.

e.4 Weighbridge

A weighbridge shall be constructed on weighing cells in a concrete structure, 3 x 12m. The recorded weight of a full vehicle will be transmitted to the computer in the site office.

e.5 Tire Washing Pit

The refuse collection vehicles should pass through the tire washing pit before leaving the site to avoid carrying the dirt back into the city. The pit should be a concrete structure, 4 x 15m.

e.6 Gate

An 8m wide gate should be installed at the entrance of the site.

e.7 Parking and Washing Yard

The parking and washing yard should be mainly for heavy equipment for the landfill operation. A section of the yard should have a roof (7 x 15m). This yard should also be available for the refuse collection vehicles to park.

e.8 Approach Road

For the refuse collection vehicles reaching the active filling area (waste disposal site), this approach road should be constructed. Its width should be 7.0m and 440m long, paved with gravel.

e.9 Internal Access Road

This water access road should be for maintenance of the enclosing structure and ditches. Its width should be 3.0m and 770m long , paved with gravel.

f. Water Supply

In view of a possibility of local groundwater contamination, INAA's water supply system is to be provided for the present groundwater users in the project adjacent areas.

- main distribution pipeline : PVC 75mm(Length 7.5 km)
- sub-distribution pipeline : PVC 25mm(Length 3.0 km)
- number of connections : 30 households and 1 factory

g. Outline of the Disposal Site

The outline of the disposal site's layout is shown in Table S-4.

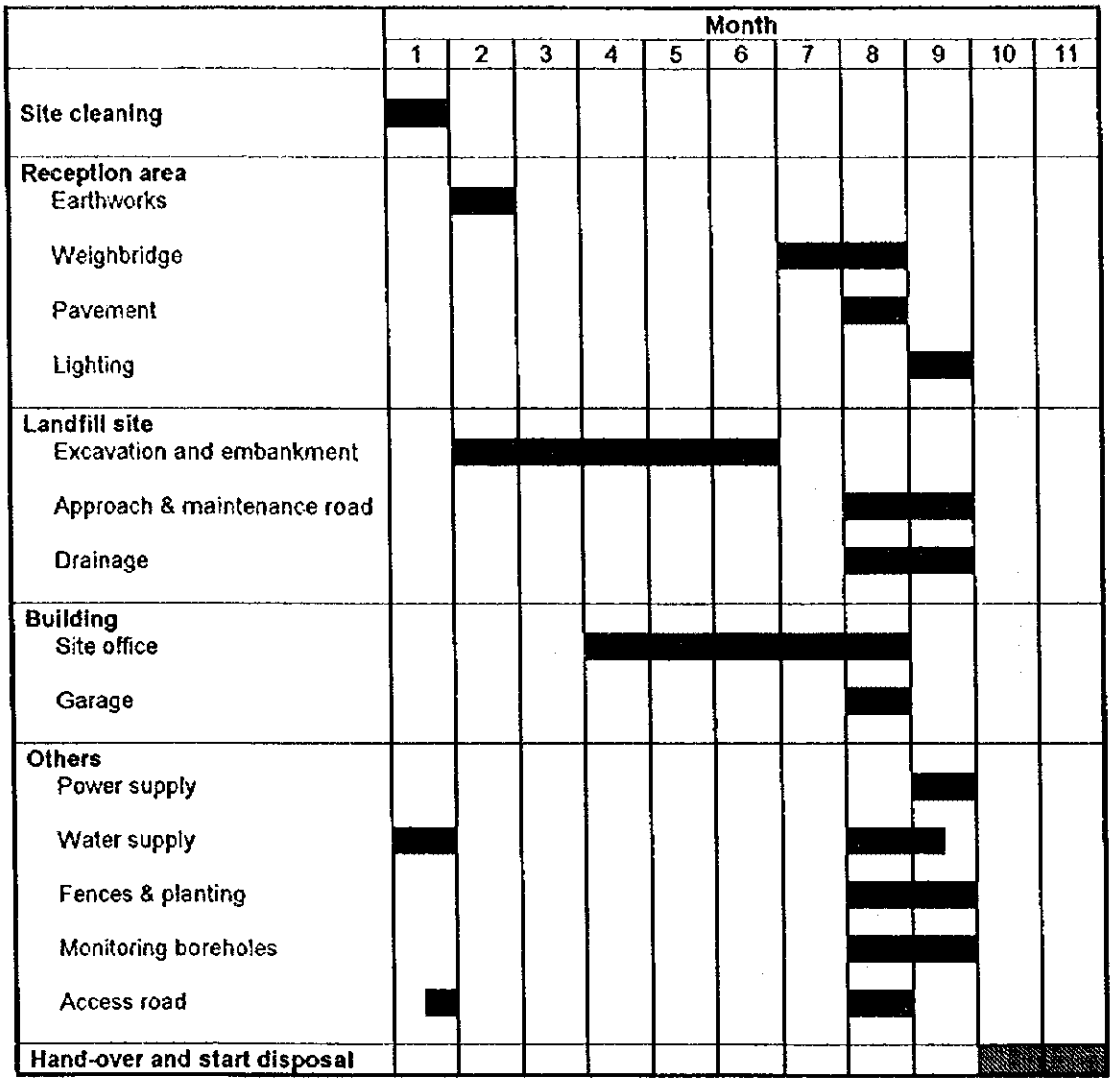
Table S-4: Outline of the Disposal Site

Items	Description
Land Area	around 40 ha
Access road (from the city to the site)	asphalt paved: width 4.0m, length 3 km
Reception area	asphalt paved: width 7.0m, length 30m; width 15.0m, length 120m, Site office: approximately 100 m^2 Weighbridge: 1 set: 3 x 12m Tire washing pit: 1 set: 4 x 15m 8m wide gate: 1 set electric lighting water and power supply
Parking and washing yard	600m^2, roof: 7 x 15m
Approach road (in the site)	gravel paved: width 7.0m, length 440m
Maintenance road	gravel paved: width 3.0m, length 770m
Enclosing structure of landfill	width 10m, height 2m, length 700m
Gas removal	perforated concrete pipe ϕ200mm at 40m intervals
Surface drainage	vee type lined ditch: width 2m, length 1,600m
Fence	2m height fence: length 2,600m
Planting (buffer zone)	eucalyptus nos. :3,000
Monitoring boreholes	6 boreholes: depth 35m
Water supply	PVC 75mm: 7.5km, 25mm: 3.0km, Connection: 30 households & 1 factory

h. Time Schedule for Construction Works

The following time schedule provides a summary of the construction works.

Table S-5: Time Schedule for Construction Works



i. Operation of the Disposal Site

i.1 Crew and Equipment Plan

The following personnel and equipment are required to operate the sanitary landfill.

Table S-6: Required Clew and Equipment for the Sanitary Landfill

Personnel and Equipment	Number	Remarks
Personnel		
Site manager	1	
Waste controller	1	
Operator	2	
Driver	2	
Maintenance personnel	(1)	dispatched from the maintenance shop
Worker	1	
Security guard	2	
Total	9	
Equipment		
Bulldozer (219Hp)	1	
Excavator (83Hp)	1	
Tipper truck (8 ton)	1	
Sprinkler truck (6-7 ton)	1	
Total	4	

A Site Manager:

who has overall financial responsibilities and management duties, i.e.

- management and supervision of landfill operation, maintenance of landfill equipment, and performance of control procedures, e.g. registration of incoming waste and control of the groundwater.
- planning of the future extensions of the landfill, i.e. the construction of further landfill sections and preparation of new excavation areas for soil coverage.

An Incoming Waste Controller:

who undertakes the task of controlling the incoming waste by using the weighbridge system.

Equipment Operators and Truck Drivers:

for the operation of the sanitary landfill, one bulldozer for smoothing and compacting waste, one excavator for digging the daily cover soil, one tipper truck for transporting covering soil and one sprinkler truck for preventing waste and soil from scattering. Therefore, 2 operators and 2 drivers are required.

Maintenance Personnel for the Equipment:

conducts preventive maintenance of the equipment. However, they should be dispatched from the maintenance shop when required.

A worker:

to generally perform auxiliary functions.

Two Security Guards:

responsible for the security of the disposal site.

i.2 Daily Operation

The sanitary landfill will operate Monday through Saturday, from 8:00 a.m. to 5:00 p.m.

i.2.1 Registration and Control at the Weighbridge

All vehicles will have to be registered upon arrival at the site office. The information recorded at the weighbridge will include:

- Registration number of the truck
- Type of waste
- Quantity of waste
- Origin of the waste (district, address of industry, institution etc.)

The staff of the site office will undertake control of the waste. Special attention will be paid to chemical and hazardous wastes that are not allowed on the sanitary landfill. These types of waste should be rejected on inspection and if there are suspicious cases, it should be further examined during the unloading at the filling area.

After registration, vehicles should go to the unloading area directly. While being unloaded, the waste should be checked again by the operators of the landfill equipment. If the waste is unsuitable for the landfill, the truck driver is obliged to remove the waste from the landfill area.

It is recommended that construction and demolition wastes is placed at another area and stocked for construction of roads in the disposal site.

i.2.2 Waste Disposal and Daily Soil Coverage

The waste should be spread and compacted into 0.3m layers optimum compaction at the filling area should be achieved by the bulldozer. This work should be continued repeatedly up to approximately 3m high. Each day's wastes should form one cell, and be covered with 10-15 cm soil at the end of a day. The cell dimension should be 9m length, 4m width and 3m height, and the slope of working face a gradient of 3 to 1.

The soil for daily coverage excavated from areas where further landfill sections will be constructed should be stocked close to the filling area.

i.3 Control Procedures

To ensure that the landfill does not impose any negative impact on the surroundings, the sanitary landfill must be supervised regularly and monitored. Reports on the monitoring should be available at any time for inspection by authorities concerned.

The monitoring program should include issues described below.

i.3.1 Waste Control

Ongoing monitoring of waste is to be conducted at the weighbridge. Monthly and annual reports based on the registration of waste should be prepared.

i.3.2 Monitoring Program for Groundwater and Wetland Water

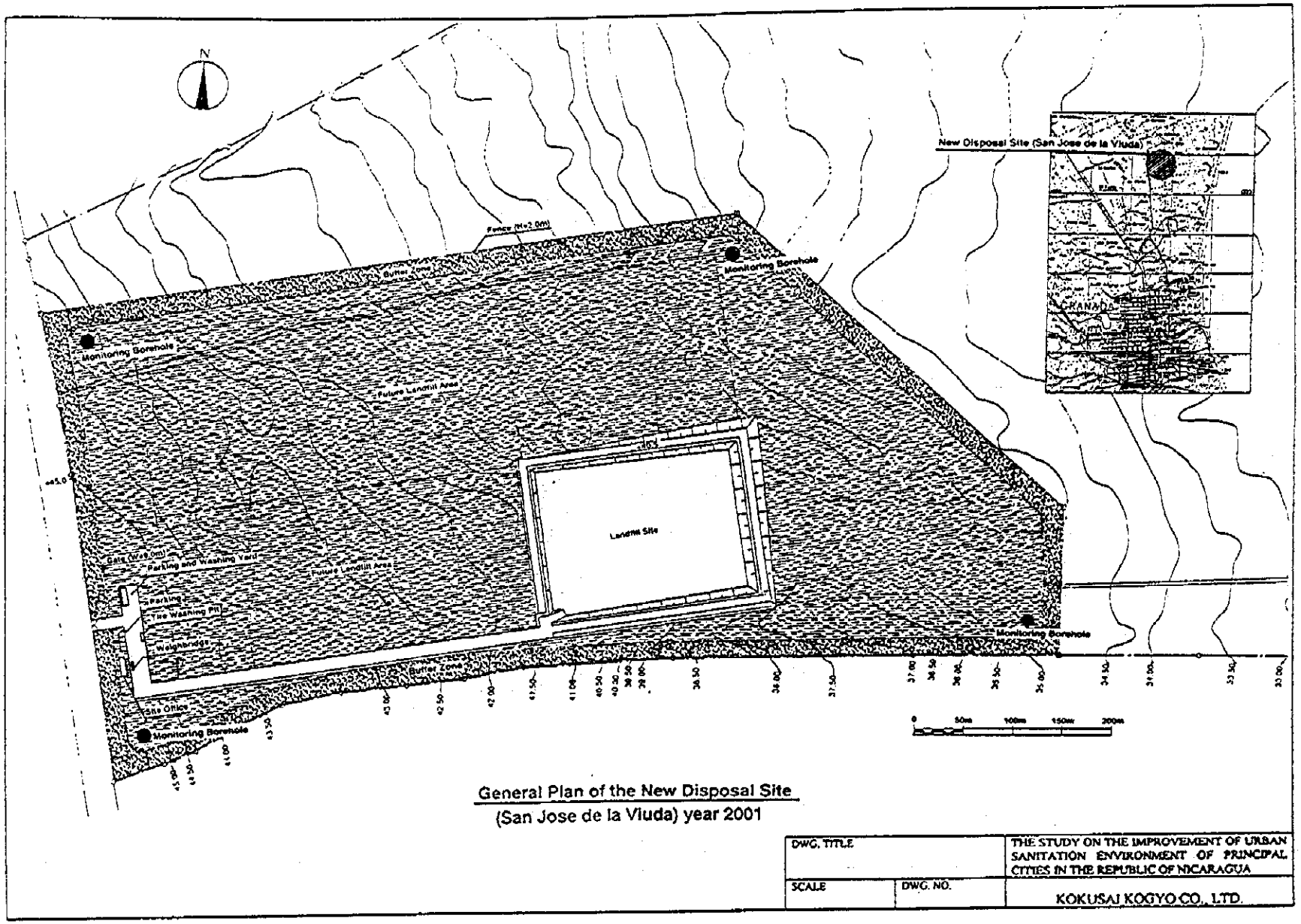
Monitoring should be carried out to closely watch for changes in the groundwater and wetland water qualities. The recommended monitoring program is described in Table S-7. The groundwater must be analyzed before the opening of the landfill for later reference.

Table S-7: Monitoring Item and Frequency for Groundwater and Leachate

	Groundwater and Wetland Water	Method
Color	once per week	on-site measurement
pH	once per week	on-site measurement
BOD	once per year	lab-test(contract-out)
COD	once per year	lab-test(contract-out)
SS	once per year	lab-test(contract-out)
Electric conductivity	once per week	on-site measurement
NH_4-N	once per year	lab-test(contract-out)
Cl^-	once per year	lab-test(contract-out)
SO_4^{2-}	once per year	lab-test(contract-out)
Fe	once per year	lab-test(contract-out)
E-coliform	once per year	lab-test(contract-out)

j. Ultimate Use of the Site

After landfill operation is completed, a hill of about 5.5 to 8.5m high will be formed. An ecological park with an observatory will be constructed on the hill, which will be integrated with surrounding natural resources such as Lake Nicaragua, the wetlands and forests. The observatory could also provide views of the volcanic mountains and the Lake around Granada City.



General Plan of the New Disposal Site
(San Jose de la Viuda) year 2001

DWG. TITLE		THE STUDY ON THE IMPROVEMENT OF URBAN SANITATION ENVIRONMENT OF PRINCIPAL CITIES IN THE REPUBLIC OF NICARAGUA
SCALE	DWG. NO.	KOKUSAI KOGYO CO., LTD.

Figure S-3: General Plan of SVJ Landfill Site (Before Operation)

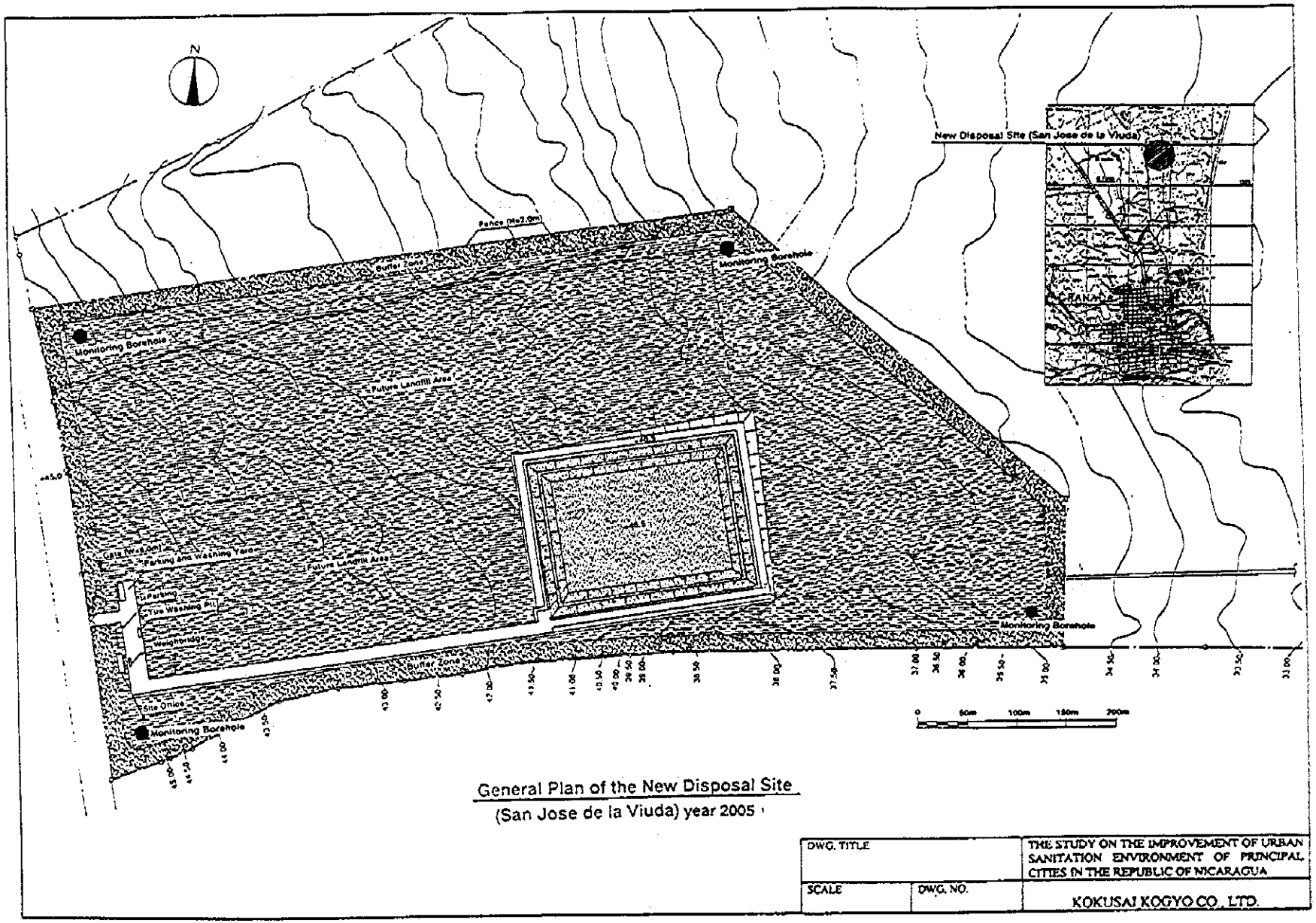


Figure S-4: General Plan of SVJ Landfill Site (After Filled)

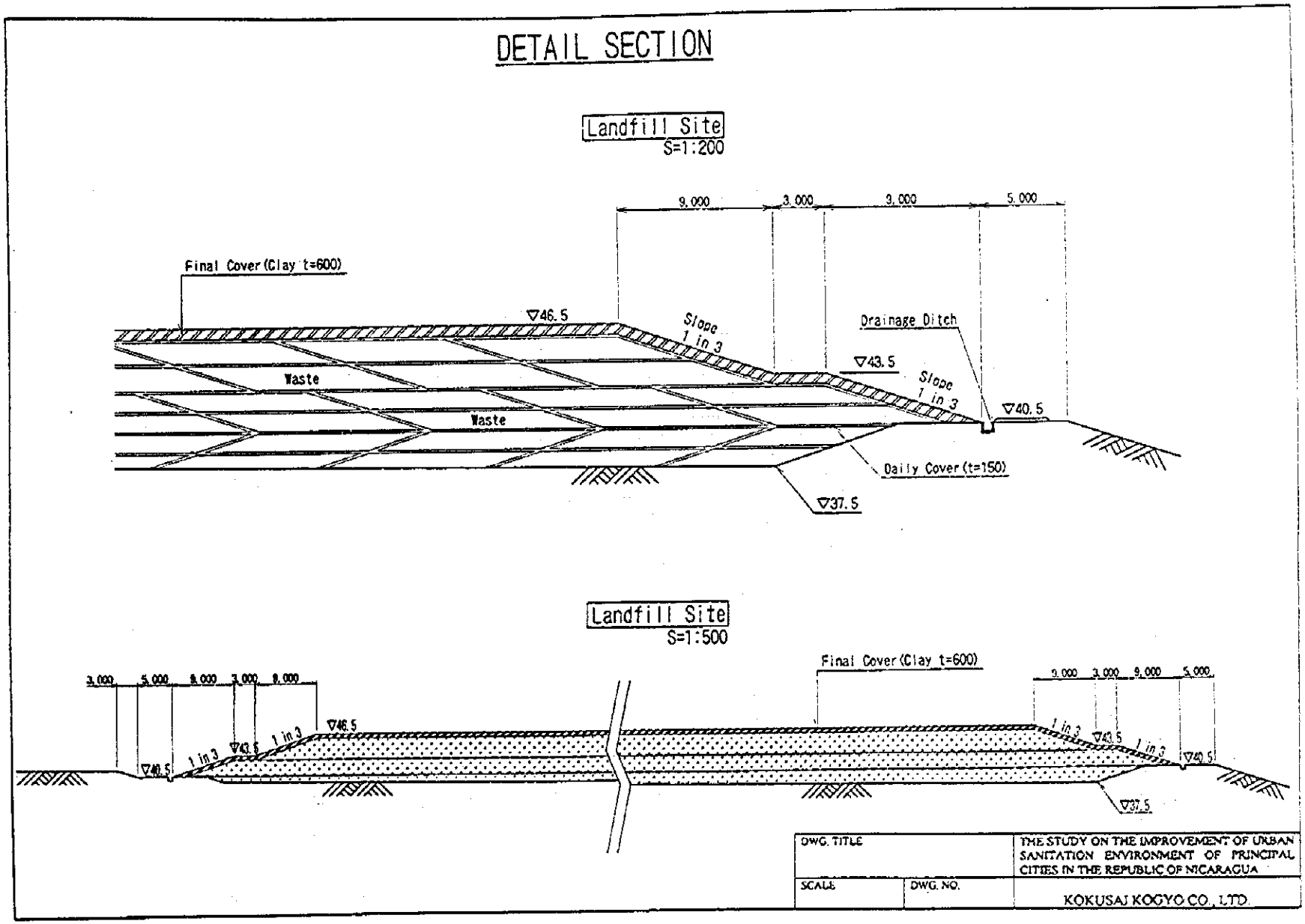


Figure S-5: Detail and Longitudinal Section of SVJ Landfill Site

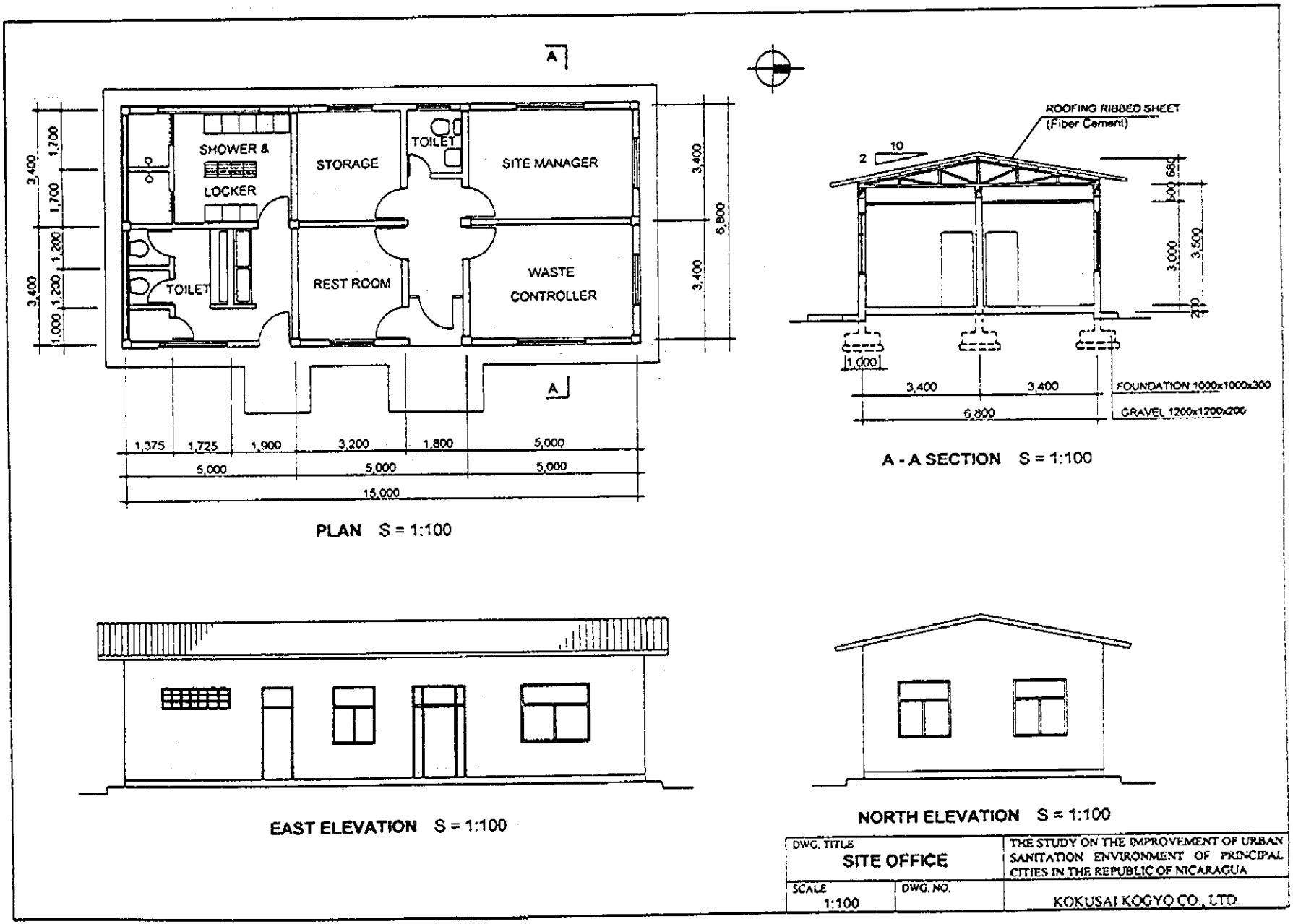
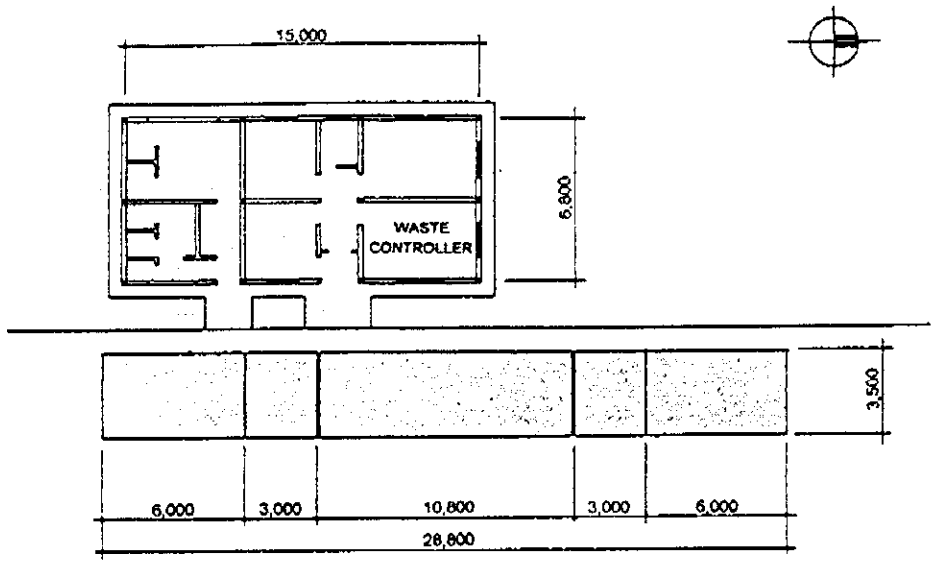


Figure S-6 : Detail Plan of Site Office



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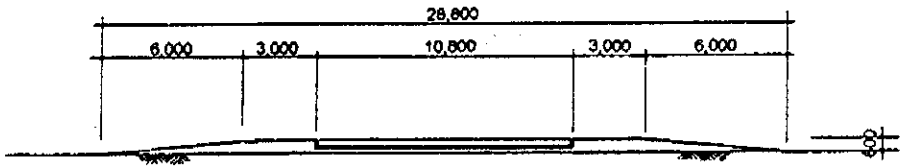

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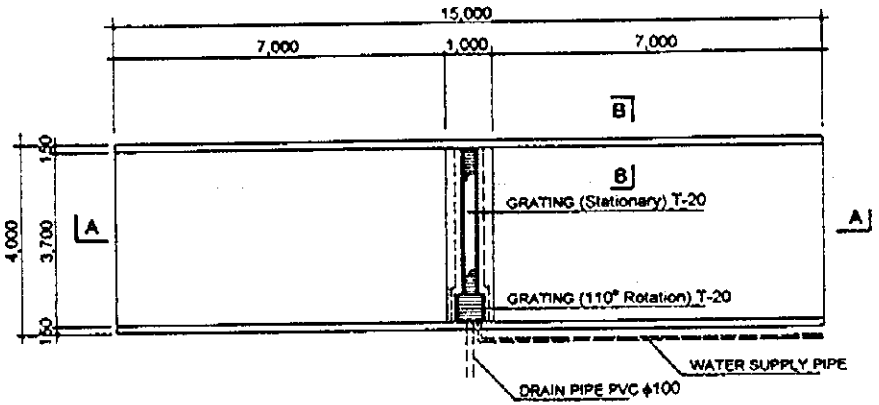
WEIGHTBRIDGE		
SCALE 1:200	DWG. NO.	KOKUSAI KOGYO CO., LTD.

Figure S-7: Weighbridge



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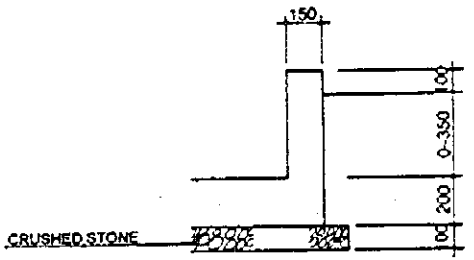

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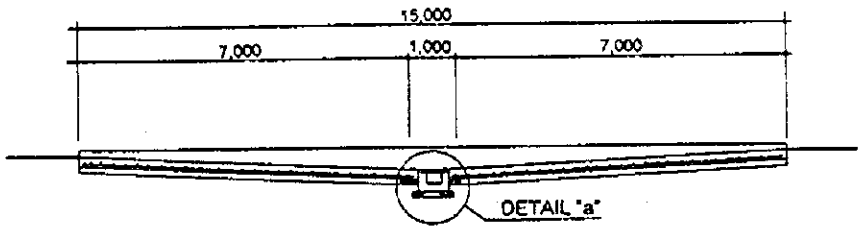

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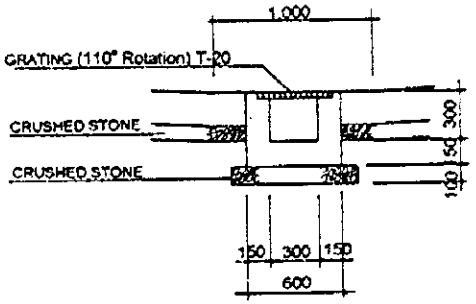

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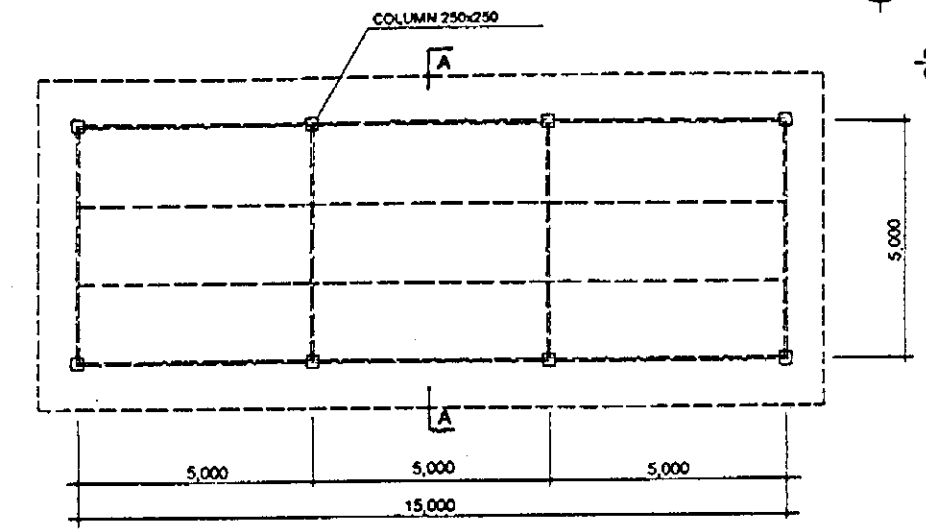
SCALE 1:20, 1:30, 1:100	DWG. NO.	KOKUSAI KOGYO CO., LTD.

Figure S-8: Tire Washing Pit



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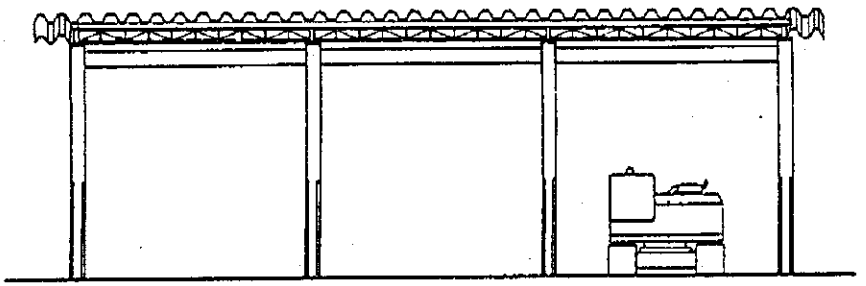

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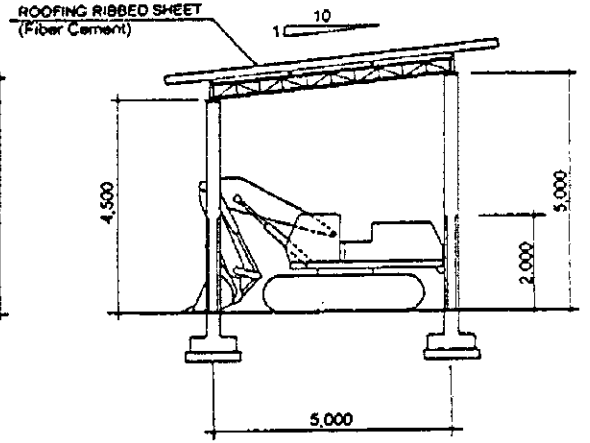

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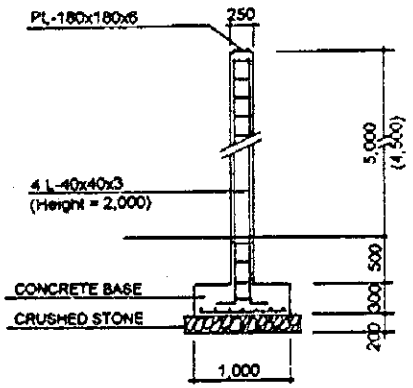

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SCALE 1:100, 1:50	DWG. NO.	KOKUSAI KOGYO CO., LTD.

Figure S-9: Parking Yard

S.2 Cost Estimation

S.2.1 Conditions of the Cost Estimate

Unit costs used in the preparation of the preliminary cost estimates were obtained from various sources, primarily, unit costs periodically published by the Ministry of Construction and Transport. Further data was obtained from Nicaraguan contractors and equipment suppliers, recent projects undertaken in the study area, and international sources.

An allowance of 10% of the basic cost estimate to cover physical contingency is reasonable, based on the degree of detail of the preliminary design. A further 25% is applied to cover overheads, and 10% for design and construction supervision.

Unit costs contained in the following table are those prevailing in September 1997; at the exchange rates, US$ 1 = ¥120 = C$9.6.

Table S-8: Unit Costs

Description	Unit	Unit Cost (C$)
Personnel		
manager	m.m	4,000
engineer, site manager	m.m	10,000
driver, operator, mechanic	m.m	2,000
accountant	m.m	4,000
secretary, clerk	m.m	2,000
collection worker, laborer, watchmen	m.m	800
Earthwork		
machine excavation, 200 m transport, and stockpiling of soil	m^3	55
construction of embankment, machine filling and compacting of soil	m^3	60
s/t/p clay lining material in 150 mm layers	m^3	133
Drainage		
s/t/p open stone and mortar drain, d=0.75m, w=2.0m	m	195
s/t/p open concrete drain, d= 1.0m, w=0.5m+0.5m	m	440
s/t/p ϕ200 mm perforated PVC drain	m	200
s/t/p 0.70m x 0.70m x 1.20m concrete pit, wall t= 0.175m	unit	6,000
Concrete work		
s/t/p reinforced concrete paving (200mm) on prepared gravel base (300mm) and subgrade	m^2	210
s/t/p reinforced concrete fc=180kg/cm², incl. formwork	m^3	750
s/t/p premixed concrete 180 kg/cm²	m^3	650
s/t/p premixed concrete 240 kg/cm²	m^3	730
Road work		
s/t/p concrete block paving and base preparation	m^2	120
s/t/p hot-mix asphalt and base preparation	m^2	125
s/t/p "piedra cantera" curb and channel	m	50
s/t/p gravel road (t=0.3m) and subgrade preparation	m^2	90
Miscellaneous		
s/t/p tube-well and submersible pump ϕ75mm, d=30m	unit	160,000
s/t/plant trees 2 to 5 m in height	tree	90
s/t/p gabion, 1m x 1m x 1.5m	m^3	241
s/t/p gas removal points, ϕ200mm perforated PVC, L=40m	no.	3,100
s/t/p gas monitoring well, ϕ100mm, d=40m	no.	15,000
s/t/p water supply pipeline, ϕ75mm	m	100
Basic materials		
diesel oil	gal	12
gasoline	gal	22
crushed rock	m^3	165
course aggregate	m^3	165
fine aggregate	m^3	30
sand	m^3	30
reinforcing bar	ton	7,170
timber	m^3	4,600

Note : m.m: man-month, s: supply of materials, t: transport, p: placement

S.2.2 Investment

a. Final Disposal Site

a.1 Construction Works

The following cost estimate is based on the preliminary design of the proposed Granada sanitary landfill carried out during the F/S. The basic difference between level 4 and level 2 is that the level 4 cost estimate is for a landfill with a clay lining layer and leachate treatment facilities. The level 2 landfill has no liner nor leachate treatment.

Table S-9: Investment Cost of Construction of Final Disposal Site

Item	unit	unit cost (C$)	Phase I (2000)		Phase II (2005)	
			quantity	cost	quantity	cost
Access road from city to site						
asphalt paving	m²	125	12,000	1,500,000	-	-
Site buildings and administration area						
site clearing	m²	6	57,500	345,000	-	-
entrance area, asphalt pavement	m²	125	2,200	275,000	-	-
site office	m²	1,800	100	180,000	-	-
weighbridge, 3 x 12m	wb	660,000	1	660,000	-	-
tire washing pit, 4 x 15m	pit	8,000	1	8,000	-	-
8m wide gate	gate	3,500	1	3,500	-	-
power supply		-	-	15,000	-	-
water supply system		-	-	150,000	-	-
parking, washing area, reinforced conc. pav. t=210mm	m²	210	600	126,000	-	-
approach road, within site, gravel road, w=15m, L=410m	m²	90	8,880	799,000	-	-
on site road, gravel road, w=3m, L=1600m	m²	90	6,930	623,700	-	-
2m high fence	m	100	2,600	260,000	-	-
planting of buffer zones	tree	90	3,000	270,000	-	-
Sanitary landfill						
construct embankment	m³	20	7,700	154,000	4,620	92,400
construct embankment using imported soil	m³	60	13,020	781,200	7,812	468,720
excavation of soil	m³	55	7,700	423,500	4,620	254,100
open concrete drain, single type	m	300	1,080	324,000	-	-
surface drainage, V type concrete lined drain	m	170	1,600	272,000	1,500	255,000
gas removal, perforated ϕ200mm, d=40m	point	3,100	36	111,600	36	111,600
monitoring borehole, ϕ100, 30m	point	15,000	6	90,000	-	-
SUB TOTAL				7,371,700		1,181,820
PHYSICAL CONTINGENCY				737,170		118,000
TOTAL DIRECT COST				8,108,870		1,299,820
OVER HEAD				2,025,025		325,000
TOTAL CONSTRUCTION COST				10,133,895		1,624,820
DESIGN AND SUPERVISION				1,013,390		162,482
TOTAL PROJECT COST				11,147,285		1,787,302
LAND ACQUSITION COST	ha	15,000	40	600,000	0	0
TOTAL				11,747,285		1,787,302
PHASE I + PHASE II				13,534,587		

a.2 Equipment

a.2.1 Investment Schedule of Landfill Equipment

The landfill equipment procurement schedule, determined in previous sections, is summarized in Table S-9. From this table, the following investment schedule is made.

Table S-10: Procurement Schedule

Items	2000	2001	2002	2003	2004	2005
Bulldozer (219 Hp)	1	-	-	-	-	-
Excavator (83 Hp)	1	-	-	-	-	-
Tipper truck (8 ton)	1	-	-	-	-	-
Sprinkler truck (6-7 ton)	1	-	-	-	-	-

Table S-11: Investment Schedule

Unit : C$ 1,000

Items	2000	2001	2002	2003	2004	2005
Bulldozer (219 Hp)	1,639	-	-	-	-	-
Excavator (83 Hp)	979	-	-	-	-	-
Tipper truck (8 ton)	407	-	-	-	-	-
Sprinkler truck (6-7 ton)	572					
Total	3,597	-	-	-	-	-

S.2.3 Operation and Maintenance Costs

a. Operation Costs

The operation costs consist of the cost of diesel fuel consumed by the landfill equipment (e.g., bulldozer, excavator, etc.), and labor: landfill equipment drivers, waste controller, workers, and supervisors.

The fuel costs were calculated assuming the equipment will operate for six (6) days a week, fifty two (52) weeks per year.

Table S-12: Required Operation Quantities of the Final Disposal Site

Items		2000	2001	2002	2003	2004	2005
Fuel	Diesel (1,000 C$)	-	108	116	120	126	135
Labor							
	Site manager	-	1	1	1	1	1
	Waste controller	-	1	1	1	1	1
	Operator	-	2	2	2	2	2
	Driver	-	2	2	2	2	2
	Worker	-	1	1	1	1	1
	Security guard	-	2	2	2	2	2
	Total	-	9	9	9	9	9

Table S-13: Required Operation Costs of the Final Disposal Site

Unit : C$ 1,000

Items	2000	2001	2002	2003	2004	2005
Fuel	-	108	116	120	126	135
Labor	-	203	203	203	203	203
TOTAL	-	311	319	323	329	338

b. Maintenance Costs

The maintenance costs for the final disposal site have been broken down into two costs: 1) landfill equipment maintenance costs; and 2)water quality monitoring cost.

The landfill equipment maintenance cost is estimated to be 20% of the landfill equipment investment cost. This cost covers general operation costs (electricity, water supply, spare parts, lubricants, periodic building maintenance, etc.) of the landfill site.

Table S-14 : Required Maintenance Costs

Unit : C$ 1,000

Items	2000	2001	2002	2003	2004	2005
Landfill	-	103	103	103	103	103
Monitoring	-	10	10	10	10	10
TOTAL	-	113	113	113	113	113

S.2.4 Project Cost Summary

Table S-15 summaries the project cost schedule from 2000 to 2005 to implement the complete priority project.

Table S-15: Project Cost Summary

Unit : C$ 1,000

	2000	2001	2002	2003	2004	2005	Total
Investment cost							
Facility	13,184	-	-	-	-	-	13,184
Equipment	3,597	-	-	-	-	-	3,597
Investment total	16,781	-	-	-	-	-	16,781
Operation & Maintenance cost							
Operation cost	-	311	319	323	329	338	1,620
Maintenance cost	-	113	113	113	113	113	565
O & M total	-	424	432	436	442	451	2,185
Total	16,781	424	432	436	442	451	18,921

ANNEX T

EIA for the SJV Site
(Level-2)

Contents

List of Tables

List of Figures

T EIA for the SJV Site (Level-2)

T.1 Introduction

T.1.1 Introduction

This investigation (study) is an Environmental Impact Study for the New Municipal SW Disposal Site Development Project **(level-2 Landfill)** at in the SJV site. The Study was carried out from June to August, 1997 by the JICA Study Team in collaboration with the Biomasa Project, Rupap/UNI.

a. Background

An Environmental Impact Assessment (EIA) is compulsory under the Nicaraguan legislation (Decree No. 45-94). It was judged in view of the Decree No. 45-94 that the New Municipal SW Disposal Site Development Project in the SJV site should be subject to an EIA. Works required for EIA and the contents of the works are defined in this regard as the Initial Environmental Examination (IEE).

The Ministry of Environment and Natural Resources (MARENA) issued a "General Guideline for Proposal Elaboration: Terms of Reference for an Environmental Impact Assessment of Municipal Sanitary Landfills" for the Study in response to the Team's request in February 1997 (hereinafter referred to as MARENA's TOR). Meanwhile, the Team also referred to JICA's Environmental Guidelines[1] as a supplement to the IEE works.

T.1.2 IEE Steps

The IEE consisted of the following steps:

Step-1 General screening and scoping assessments were made based on MARENA's TOR and using JICA's Environmental Guidelines as a supplement. In other words, all environmental items were listed for the Scoping.

Step-2 Te Scoping were carried out for the SJV site in order to identify the environmental items that require an Environmental Impact Assessment (EIA) for the F/S. In other words, Each environmental item listed based on MARENA's TOR and JICA's Guidelines were initially evaluated (i.e., to rank the foreseeable impacts of each environmental item in a concise and rapid manner).

Step-3 Consequently, the contents of the EIA (i.e., required works) and possible environmental conservation/mitigation measures were proposed for each scoped environmental item (i.e., ranked as A, B or C).

Step-4 Finally, works required for EIA wre summarized. (see Table T-1)

[1] Environmental Guidelines for Infrastructure Projects No. VI Solid Waste management, JICA, Sept 1992

a. List of Works Required for EIA (Step-4)

Works required for EIA are listed in the table below.

Table T-1: List of Works required for EIA

Work No.	Description of Works Required for EIA
1	Topographical Survey
2	Geological Survey
3	Hydrological Survey
4	Traffic Survey
5	Noise and Vibration Survey
6	Baseline Odor Survey
7	Baseline Water Quality Survey
8	Baseline Air Quality Survey
9	Baseline Soil Pollution Survey
10	Baseline Fauna and Flora Survey
11	Economic Survey
12	Land Use Survey
13	Risk Assessment of the Landfill Site
14	Meteorological data collection and analysis
15	Urban Development Plan
16	Water Use in area
17	Landscape assessment with photomontage
18	Cultural property survey
19	Estimation of construction waste (from the project)
20	Research on location and availability of soil suitable for use as impermeable liner and coverage

T.1.3 Scope of the EIA Study

As a consequence of the IEE previously above, works required for the EIA were summarized. In response to that, a set of Environmental Baseline Surveys (e.g., Topographical Survey, Geological Survey, Hydrological Survey, Traffic Survey, Noise and Vibration Survey, Odor Survey, Water Quality Survey, Air Quality Survey, Soil Pollution Survey, Fauna and Flora Survey, etc.) were carried out. Detailed results of the Environmental Baseline Survey are presented in Chapter 8 of the Data Book: Volume V.

The outcome of the Environmental Baseline Survey served, not only for the examination of the preliminary design of the project, but also for this EIA. This report (Environmental Impact Assessment for SJV New Municipal SW Disposal Site **(level-2 Landfill)**) is outlined in line with the terms of reference (TOR), presented by the Ministry of the Environment and Natural Resources (MARENA), which principally consisted of:

- Description of the Project.
- Limits of the Influence Area.

- Environmental Situation of the Influence Area.
- Analysis of the Environmental Impacts .
- Mitigation Measures.
- Environmental Management Program.
- Forecast of the Environmental Quality of the Influenced Area.

T.2 Legislative Requirements

T.2.1 Administration and Organization on the USE

The Republic of Nicaragua is a state structured in four central powers: Executive branch (Central Government), Legislative branch (National Assembly), Judicial and Electoral branch. The municipalities are the political / administrative units of the state, structured in a Municipal Council and in an executive branch (Mayors), all of them elected directly by the people.

The municipalities are constituted politically and have administrative and financial autonomy. This constitutional autonomy is expressed in the Law of Municipalities (Law of Municipalities No. 40-88), in the Municipal Financing Plan (Municipal Arbitration Plan) ratified by the Central Government in the Decree No. 455-89, for all the municipalities, except Managua.

The municipalities have their own authority that can be shared with the national institutions (such as ministries and institutes).

In addition, the municipalities can assume responsibilities of the Central Government, with the respective incomes, as part of the decentralization policy. The municipalities can also be associated among themselves to develop or cooperate in common projects.

T.2.2 National Institutions linked with the USE

Some ministries and autonomous national institutions, linked directly to the Presidential Cabinet (Ministry of the Presidency), are substantially involved with the USE:

- Health (Health Ministry - MINSA).
- Environment and Natural Resources (Ministry of the Environment and Natural Resources - MARENA).
- Agriculture and Livestock (Ministry of Agriculture and Livestock - MAG).
- Economy and Development (Ministry of Economy and Development - MEDE).
- Construction and Transportation (Ministry of Construction and Transportation - MCT).
- Municipal Development (Nicaraguan Institute of Municipal Promotion - INIFOM).
- Aqueducts and Sewers (Nicaraguan Institute of Aqueducts and Sewers - INAA).
- Territorial Studies (Nicaraguan Institute of Territorial Studies - INETER).
- Technical (Technological National Institute - INATEC).

Universities and non-governmental organizations, play an important role in the improvement of the USE and their contributions could be increased in this context. The MINSA extends its action and operates in coordination with all the municipal

governments through the Local Systems of Integrated Attention (SILAIS - Ministerial Resolution No. 96, January 14, 1992).

MARENA extends its action over fifteen departments, RAAN, RAAS and several delegations in the municipalities.

MAG, MEDE and MCT extend their specific activities at a local level through their departments, which are specific but with a strong impact on environmental conservation.

INIFOM was created in 1990 to improve the capacity of USE improvements and to promote municipal development. The Executive Council includes 34 mayors; their executive organizations and departmental coordination is located in the nine regions.

INAA, in addition to the operational activities, under the Law of Organization of the INAA (Decree No. 123-79) was granted the right to fix procedures and specifications for the design, construction and the operation of urban and rural systems, which could be running under public water services and wastewater. INAA operates through different regional administrations throughout the country.

INETER (1981) has been linked to the MCT since 1991; it is in charge of the studies, classification and physical resource inventories, as well as the physical planning of the land use in the national territory.

INATEC (1990) is the entity that provides professional and technical support in the environmental and health sectors.

T.2.3 General Law of the environment and the natural resources

The Nicaraguan Movement of Environmentalists (MAN), presented to the Legislative Branch, the Original Preliminary Design of the General Law of the Environment and Natural Resources in September 1993, which was approved by the National Assembly in March 1996. This Law was enforced in May 24 of the same year.

The entry in force of this law provides the Nicaraguan Society a legal instrument, with which better efforts can be developed in favor of a healthy environment and a sustainable development in harmony with nature. In Chapter II, Section IV of this law: OF PERMITS AND ENVIRONMENTAL IMPACT EVALUATION, outlines:

Art. 25. The projects, unit works, manufacturing/industrial activity or any other activity which by its characteristics could produce deterioration of the environment or natural resources, will have to obtain, prior to its execution, an Environmental Permit, granted by the Ministry of Environment and Natural Resources. The Regulation establish as a specific list.

Art. 26. The activities, and works of public or private projects with national or foreign investors, during its pre-investment phase, execution, extension, rehabilitation or re-conversion, will remain subject to the studies and evaluations of environmental impact, as requirement for the granting of the Environmental Permit.

Art. 29. The permission obliges those who are granted to:

1. Maintain the controls and recommendations established for the execution or accomplishment of the activity.
2. Assume the administrative, civil and legal responsibilities of the damages which are caused to the environment.
3. Observe the arrangements established in the procedures and special regulations in force.

In Chapter III, "NON-HAZARDOUS SOLID WASTES", outlines:

Art. 129 The mayors will operate the compilation systems, treatment and final disposal of non-hazardous solid wastes of the municipality, observing the official procedures issued by the Ministry of the Environment and Natural Resources and the Ministry of Health, to protect the environment and public health.

T.3 Description of the Project

The description of the following clauses was elaborated according to the terms of reference, delivered by the MARENA and in the order established in it.

T.3.1 Principle of the Project (Level-2)

This project (level-2 landfill structure) has a principle that:

- impermeable bottom liner is not employed for the landfill structure; and
- water supply (INAA) system is provided to the residents and industries in the project neighboring area to compensate local groundwater contamination by infiltrating leachate.

T.3.2 Detailed Description

T.3.2.1 Location of San Jose de la Viuda (SJV)

The proposed site San Jose de la Viuda (SJV) is north of Granada City. Its altitude is between 35 and 45 meters above sea level. (see Figure T-1).

The access road (Granada to Santa Rosa) to the site is a gravel road which is passable all year round.

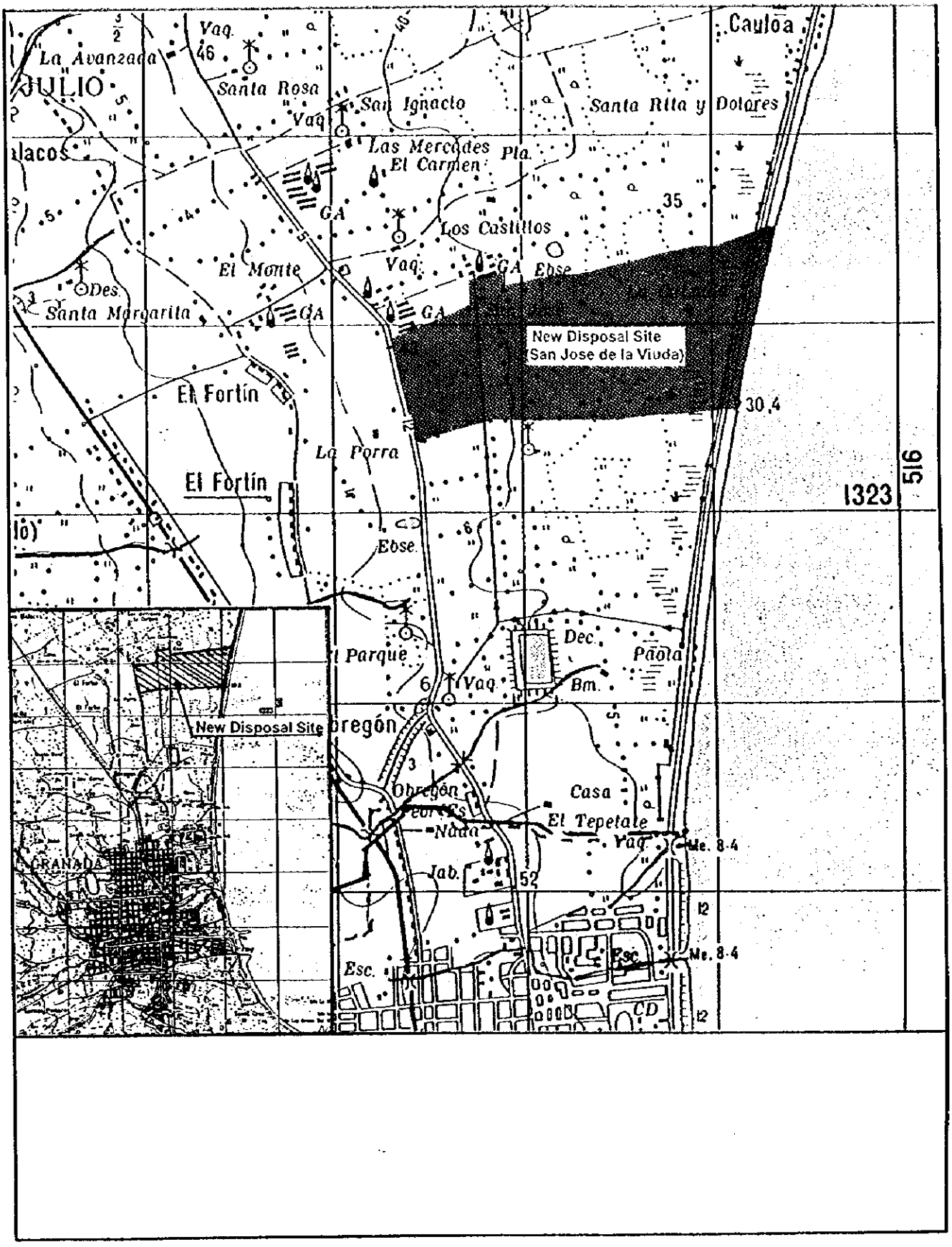


Figure T-1: Location of San Jose de la Viuda

T.3.2.2 Total Area of the facilities

The total area of the facilities will be 40 hectares, 21ha of which will be for the sanitary landfill and 19ha for the establishment of the buffer zone, the leachate treatment lagoon, the office and parking area, the monitoring well, as well as the borrow pit of the covering soil. With this large area, the sanitary landfill will have enough capacity to operate for 30 years.

T.3.2.3 General plan of the Sanitary Landfill

The general plan of the sanitary landfill is presented in Figure T-2.

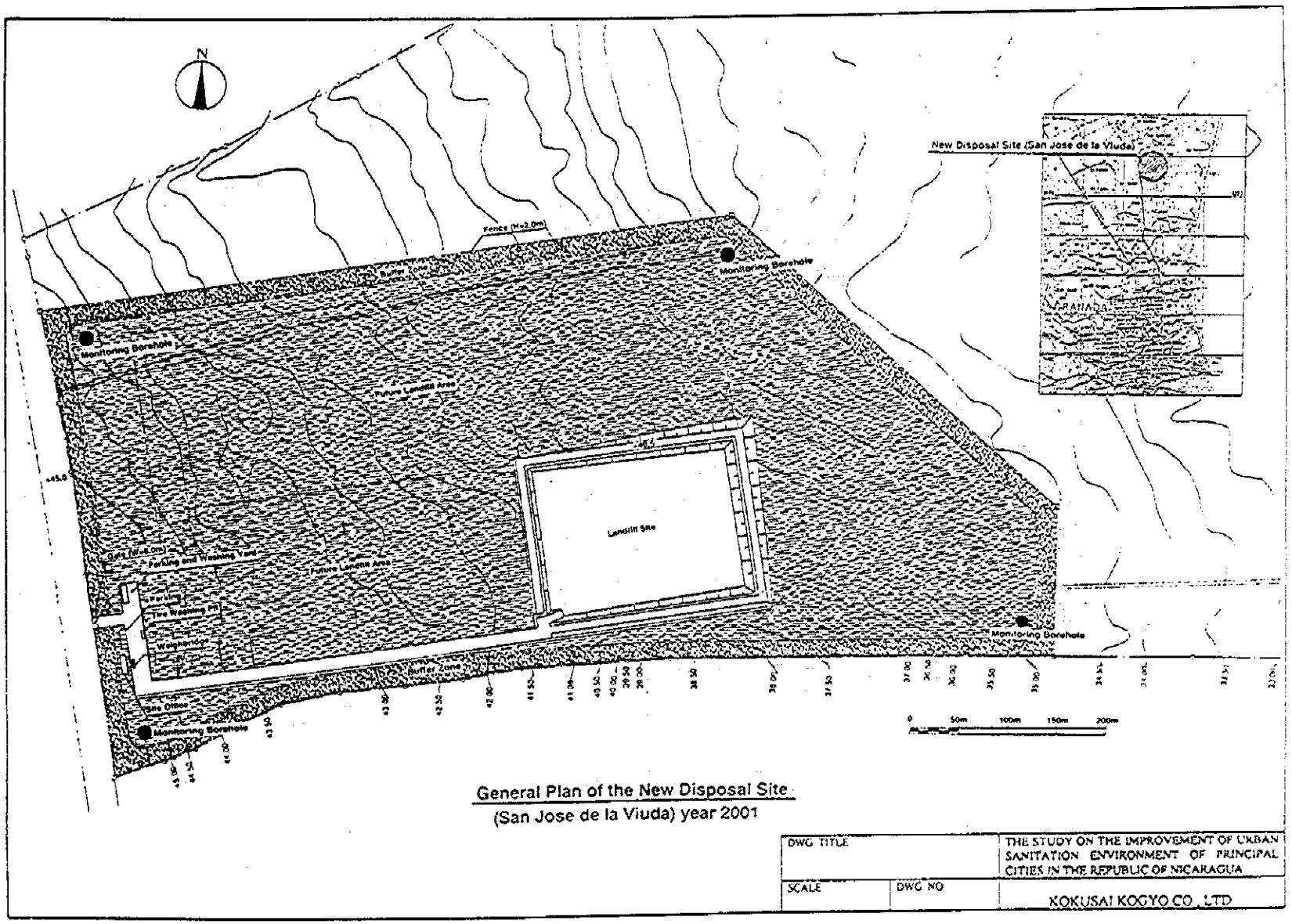


Figure T-2: General Layout Plan of the SJV Project

T.3.2.4 Objective of the Project

The objective of the project is: to dispose of domestic solid waste generated in Granada City at feasible costs and in a sanitary appropriate manner, without causing negative impacts to public health and to the environment.

T.3.2.5 Technical Justification

Granada City is intersected by three creeks running from east to west (Arroyos Pancasan-Villa Sandino, Aduana and Zacalitague), that should be solely act as a waterway for stormwater to flow into Lake Nicaragua. However, these creeks also serve as illegal dumping sites, where a large population settled along these creeks which, dump their solid waste. The Solid Waste are dragged and carried directly to the shores of the lake, resulting in its pollution, the progressive deterioration of the sanitary condition of the city and the creation of an unhygieninc environment of high epidemiological risk for the surrounding population due to the presence of flies, mosquitoes, rodents and other vectors.

For approximately 12 years, Granada has reliyed on a solid waste open dumping ground known as "La Joya". The site is located 4 kilometers from the city and a kilometer to the west of the highway toward Nandaime. Its location is also several hundred meters upstream from the INAA's well fields which supply Granada City with drinking water. The leachate generated in the open dumping site throughout the years, represent a potential pollution risk for the ground water and thus, for the people of Granada.

In this project, a technique which will not cause damage to the environment nor nuisances or danger to the public will be employed. This will be achieved by employing engineering principles of a "sanitary landfill **(with level-2)**": i.e., to install an impermeable bottom clay liner for the landfill structure in order to control and treat the leachate generated and to cover the disposed solid waste layer with soil, daily, in order to avoid the waste from scattering and proliferation of disease transmitting vectors in the site.

T.3.2.6 Economic Justification

Although the construction of the sanitary landfill does not generate a direct economic benefit for the municipality, it will lead to environmental conservation and avoid the pollution of Granada City and environs, and thus improve the health of the population, both of which can be considered as social benefits.

T.3.2.7 Design of the Sanitary Landfill

Studying the topographic and geological conditions of the SJV site, etc., the design of the sanitary landfill that employs level-2 landfill structure i.e., sanitary landfill with dyke and daily soil coverage over disposed waste.

T.3.2.8 Technology to be Employed

The technology that will be used during the operation of the sanitary landfill is described below:

- Construction of an approach road to the site.

- Establishment of an operational inspection system, control and recording, of the incoming wastes.
- Placing of sufficient daily soil coverage on the solid waste layers, to prevent fire outbreaks, diffusion of foul odor and proliferation of vermin.
- Establishment of a physical boundary for the solid waste disposal site.
- Separation of the active landfill cells with a dike.
- Establishment of a drainage system to divert stormwater that flows on the surrounding area and to reduce the leachate generation volume.
- Construction of environmental protection facilities, such as a buffer zone, inspection of incoming solid waste and landfill gas removal facility, in order to reduce the direct impact to the surroundings.
- Construction of landfill gas vents and leachate collection facilities to create the necessary conditions for a semi-aerobic landfill structure and to control the gaseous emissions.
- Creation of amenities for the staff at the site.
- Installation of leachate collection system.
- Construction of leachate treatment lagoon.
- Installation of leachate monitoring facilities.
- Installation of stone lining for drainage.
- Water spraying for dust prevention.

T.3.2.9 Volume of Solid Waste to be Disposed

Table T-2 shows the amount to be disposed per annum during the F/S period.

Table T-2: Final Disposal Amount

Items	Unit	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Final	1000ton/year	21.4	22.6	23.8	25.1	26.5	30.9	32.6	34.3	36.2	38.1
Disposal	1000m^3/year	26.8	28.3	29.8	31.4	33.1	38.6	40.8	42.9	45.3	47.6
2001-2010	1000ton	21.4	44.0	67.8	92.9	119.4	150.3	182.9	217.2	253.4	291.5
2001-2010	1000m^3	26.8	55.1	84.9	116.3	149.4	188.0	228.8	271.7	317.0	364.6
Covering Soil	1000m^3/year	5.4	5.7	6.0	6.3	6.6	7.7	8.2	8.6	9.1	9.5
2001-2010	1000m^3	5.4	11.1	17.1	23.4	30.0	37.7	45.9	54.5	63.6	73.1
Waste + Soil	1000m^3/year	32.2	34.0	35.8	37.7	39.7	46.3	49.0	51.5	54.4	57.1
2001-2010	1000m^3	32.2	66.2	102.0	139.7	179.4	225.7	274.7	326.2	380.6	437.7

Note: ASG of waste after compaction is 0.8ton/m^3.
Covering soil is 20% to waste amount in volume.

T.3.2.10 Non-acceptable Waste

The entry of hazardous and/or infectious waste from factories or medical institutions shall not be permitted at the new sanitary landfill. The following types of waste shall not be rejected:

- Hazardous and toxic waste from factories, shops, institutions, etc.
- Infectious waste (such as syringes) from hospitals surgeries and dental clinics.
- Radio-active waste.
- Liquid waste.

T.3.2.11 Total Area of the Sanitary Landfill

The total of the landfill area will be about 21 hectares for 30 years' operation (i.e., about 3.5 hectares is required for a landfill operation period of in 5 years).

T.3.2.12 Total Area to be Developed

The total area to be developed will be about 40 hectares, 21ha of which will be utilized as the actual solid waste disposal and 19 ha will be for the construction of the buffer zone, leachate treatment lagoons, the office and parking area, the monitoring well, as well as the borrow pit for the dairy cover soil over the waste disposed.

T.3.2.13 Lifetime of the Sanitary Landfill

The total life span of the 21 hectares SJV sanitary landfill site will be 30 years. Each section of approximately 3.5 hectares will serve for about 5 years landfill operation, after which the section will be closed and receive a final coverage of impermeable top liner and vegetation to cover it. Therefore, the life span of one landfill section will be designed for 5 years.

T.3.3 Construction and Installation Stage

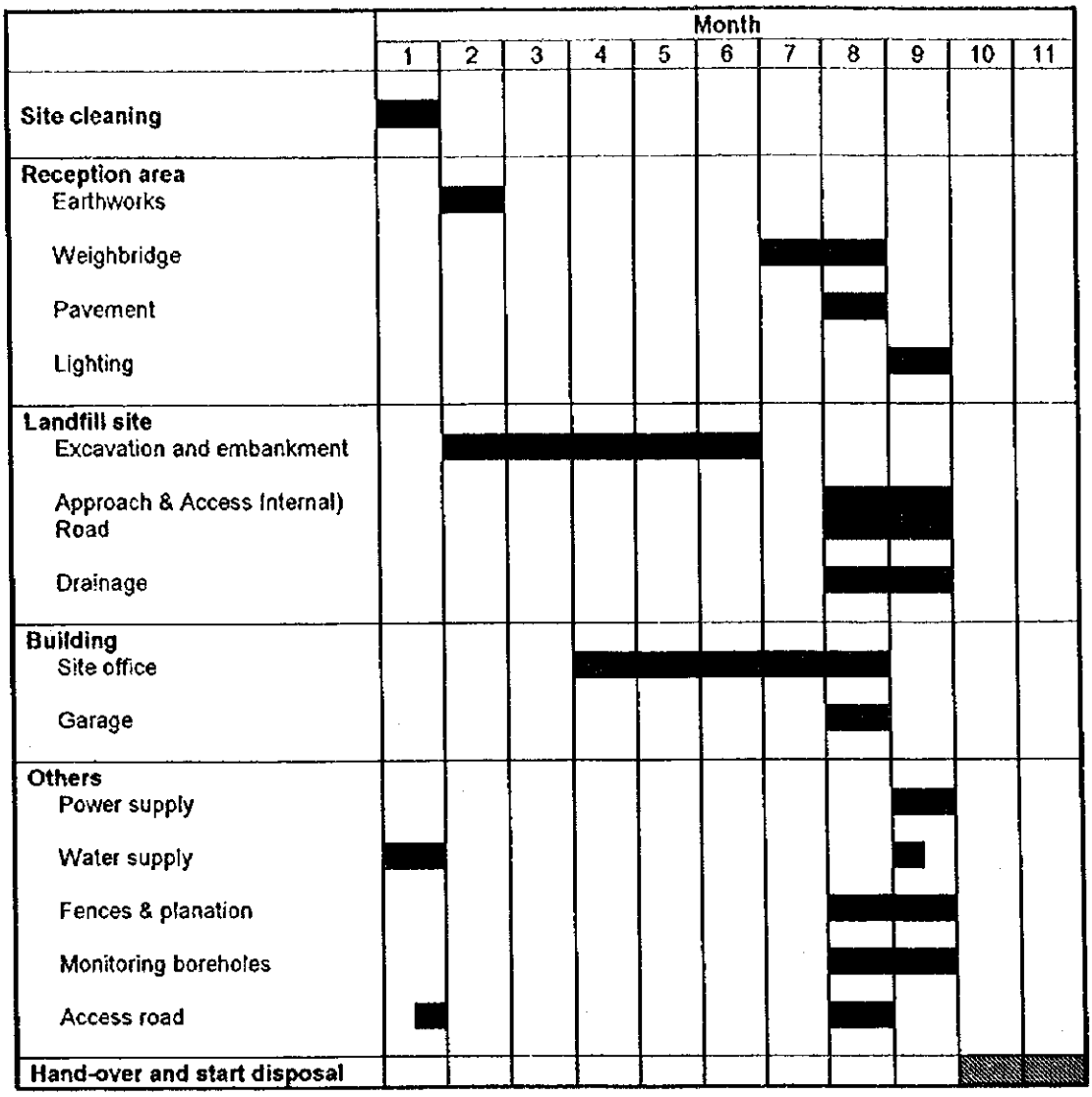
T.3.3.1 Origin, Qualification and Number of Laborers to be Employed

Due to the fact that the Sanitary Landfill still is not in its construction stage, it is not possible to determine the origin, qualification and number of laborers to be employed.

T.3.3.2 Construction Program Scheduled for Each Activity

The implementation program is shown in Table T-3.

Table T-3: SJV Project Implementation Program



T.3.3.3 Buildings and Infrastructure of the Sanitary Landfill Project

The buildings and infrastructure that will be constructed, for the proper operation of the Sanitary Landfill are presented in Table T-4 below.

Table T-4: Outline of the Disposal Site

Items	Description
Land Area	around 40 ha
Access road (from the city to the site)	asphalt paved: width 4.0m, length 3 km
Reception area	asphalt paved: width 7.0m, length 30m; width 15.0m, length 120m, Site office: approximately 100 m^2 Weighbridge: 1 set: 3 x 12m Tire washing pit: 1 set: 4 x 15m 8m wide gate: 1 set electric lighting water and power supply
Parking and washing yard	600m^2, roof: 7 x 15m
Approach road (in the site)	gravel paved: width 7.0m, length 440m
Access road	gravel paved: width 3.0m, length 770m
Enclosing structure of landfill	width 10m, height 2m, length 700m
Landfill liner	clay liner: thickness 150cm; sand layer: thickness 60cm
Leachate collection	perforated PVC pipe: ϕ200mm; open main ditch
Leachate treatment	regulation pond : 6,000 m^3, facultative lagoon : 5,700m^2, maturation pond : 1,250m^3
Gas removal facilities	perforated concrete pipe ϕ200mm at 40m intervals
Surface drainage	vee type lined ditch: width 2m, length 1,600m
Fencing	2m high fence: length 2,600m
Planting (buffer zone)	eucalyptus trees :3,000
Monitoring borehole	4 boreholes, 35m deep

T.3.3.3.1 Access Road

Though the access road from the urban area to the site (Grenada - Santa Rosa) is in a rather good condition, a section from the north of the urban area to the site will be paved to ensure efficient haulage and to avoid additional generation of dust clouds. The construction works do not need substantial earth movement works, only the grading of present road and paving works will be sufficient for its improvement.

Width of the pavement: 4.0 m
Length: 3.0 km approximately

T.3.3.3.2 Entrance Control Area

The entrance control area will be paved with asphalt and will comprised of a site office, a weighbridge, a tire washing pit for departing vehicles, a gate provided with electric lighting. Electricity will be supplied to the site.

a. Area with Asphalt

The entry road 30 m long with a width of 7.0 m will be paved at the entrance area an area 120 m by 15 m will be paved in front of the office.

b. Office

The office, approximately 100m^2, will have a control room and furnishing (office equipment) for the staff and the manager of the sanitary landfill. The control room will

be built and provided with equipment to carry out easy control and record of the incoming vehicles.

The site office will have the following facilities:

- a control room equipped with a computerized weighbridge
- a changing room
- toilets and showers
- cooking facilities
- a storeroom.

c. Weighbridge

A weighbridge on weighing cells will be installed in a concrete structure of 3 x 12 m and the data on the weight of the vehicles will be transmitted to the computer connected to the weighbridge .

d. Washing Pit

The waste collection vehicles should pass through the washing pit before leaving the site to avoid polluting the highway on return to Granada City. The washing pit will be a concrete structure of 4m x 15m.

e. Gate

A gate, 8 m wide, will be installed at the entrance of the project site.

T.3.3.3.3 Parking and Washing Area

The parking and washing area will be mainly for the heavy landfill equipment that operate in the site. A small section of this area (7 x 15 m) will be roofed. Furthermore this area can serve as a parking lot for the solid waste collection vehicles.

T.3.3.3.4 Approach Road

An approach road for the incoming waste collection vehicles, will be built up to the active landfill cell. This route will be 7m wide with a length of 440m, paved with gravel.

An internal access road will be constructed for maintenance of the enclosing structure, ditches and the leachate treatment lagoons. It will be 3.0m wide and 770m in length, paved with gravel.

T.3.3.3.5 Enclosing Structure of the Sanitary Landfill

An embankment surrounding the landfill will be built, for the purpose of defining the landfill area, and to prevent the outflow of leachate and thus the intrusion of surface runoff from its surrounding area. It will have a height of 3m, with a width of 5m at the top and a slope with a gradient of 3 to 1.

T.3.3.3.6 Gas Removal

To remove the landfill gases carefully from the landfill site, vertical chimneys of perforated concrete pipes will be installed, 200 mm in diameter, placed every 40 m (pitch to both north-south and east-west directions).

T.3.3.3.7 Surface Drainage

The elimination of stormwater that would enter the landfill site is of fundamental importance to avoid the increase of the leachate volume generated in the waste disposal area. For the drainage of stormwater, an open ditch, 2 m wide, 0.5 m deep and 1,600 m in length will be built. The collected stormwaters will be diverted to the wetlands in the eastern side of the project site.

Inactive cells for future landfill should be isolated with small dikes in order to prevent stormwater intrusion into the active cell. Stormwater from inactive future cells will be collected through leachate collection pipelines and separately discharged to a stormwater drainage system nearby, in order to minimize leachate generation by preventing the stormwater form inactive cells to flow into the active leachate collection system.

T.3.3.3.8 Fence

The fence will restrict the access of the scavengers and animals to the site. The fence installed around the site will be of mesh type and will have a height of 2m and a length of about 2,600m. Scattering of waste from the landfill site will be prevented by mobile fences near the active cells and by tall trees planted as a buffer zone. Therefore, scattering of waste out of the buffer zone will be minimal. In addition to these measures, the fence around the project site will function as final barrier to flying waste.

T.3.3.3.9 Buffer Zone

The planting of fast growing trees (e.g., eucalyptus) at the circumference of the landfill site with a width of 20 meters, will also work to prevent the scattering of litter such as plastic bags and furthermore will function as a vegetation screen (visual shield) that will improve the view of the landscape and avoid a possible impact by foul odor and noise.

T.3.3.3.10 Monitoring Wells

Four (4) monitoring wells (2 wells up stream and 2 down stream) will be installed at the same time as the construction of the sanitary landfill, which will be 35m deep, in order to monitor any changes in the ground water quality.

T.3.3.4 Existing Land use and Owners of the Site

The land owned by Mr. William Gomez stretches eastward approximately 500m from the access road (Granada-Santa Rosa) with a width of about 100m, boarding the south of the proposed SJV project site. The entrance and approach road to landfill cell will lie on this land. Presently, there is a farm house including a reach cattle a small poultry farm and a well which serves as a water supply for the livestock. In the event that the project is executed, it will be necessary to purchase all the property of Mr. William Gomez.

The rest of the land required for the project (SJV final disposal site) is owned by Mr. Alberto Vasquez Gomez and some cooperative members. Approximately 300m north from the site boundary of the project, there is a house, with an area of about 50 m^2 with a poultry farm and a well , in which the farm manager (Mr. Jose Antonio Gomez Guevara) resides with his family. In the event that the project is executed, it will be necessary to purchase the land of Mr. Alberto Vasquez Gomez (and the cooperative member) which falls on the project site. Meanwhile, it will be possible that the present

cattle rearing and some agricultural production can be continued on a reduced scale on the rest of their land.

T.3.3.5 Existing Facilities Adjacent to the Site

In the area to the north and east of the project site (the remaining land owned by Mr. Alberto Vasquez Gomez and the cooperative), cattle rearing and some agricultural production will be continued on a reduced scale.

Further north at about 700 m to the north of the first landfill cell, the poultry farm "San Felipe" is located. This poultry farm produces about 11 million pounds of chicken meat per year which is mainly exported to neighboring countries it also has a poultry breeding barn with about 270,000 live animals at the time of the assessment (August 1997).

T.3.3.6 Distance of the Existing Settlements Close to the Project Area

The nearest community "El Fortin" is located 750 m to the south of the site. Approximately 1 km to the northeast of the project site, a small village, Kauloa, is located.

T.3.3.7 The Objectives of the Project with the Development Plans of the Municipality

Granada does not have an updated development plan, it only has the Urban Development Regulatory Plan (UDRP) of 1982. This plan was begun by the consortium Esprinsa-Johnson on the request of the Vice-ministry of Urban Planning (VMPU) in 1978.

This plan substituted the existing plan, published in the official newspaper "La Gaceta" Issue No. 97 on May 10, 1973. Urban development seems to follow the trend indicated by the UDRP. Therefore, new urbanization in the north of the city is not expected. The main urban expansion is expected along the highway that goes to Masaya and Managua (northwesterly direction), and also along the highway which goes to Nandaime (southwesterly direction).

Therefore, it can be stated that the site is in accordance to the development plans of the municipality.

T.3.4 Operation and Maintenance Stage

T.3.4.1 Population to be Served (Service Coverage Rate)

From the year 2001 to 2005, a collection rate of 90% is expected in the urban area, being increased to 100% as from the year 2006.

T.3.4.2 Operational Plan of the Landfill

The following staff and equipment are required to operate the landfill.

STAFF AND EQUIPMENT	NUMBER	REMARKS
Staff		
Manager	1	
Waste controller	1	
Machines Operators	2	
Drivers	2	
Maintenance personnel	(1)	Dispatched from the maintenance department of the municipality
Worker	1	
Security guards	2	
Total	9	
Equipment		
Bulldozer	1	
Excavator	1	
Tipper truck	1	
Water tanker	1	
Total	4	

T.3.4.2.1 Manager

The manager will be in charge of the overall financial and management duties, for example:

- Management and supervision of the landfill operation, maintenance of equipment, and control practices (e.g., registration of incoming waste and monitoring of the groundwater).
- Planning of the future sanitary landfill extensions, as well as the construction of further landfill sections and preparation of new excavation areas for daily cover soil.

T.3.4.2.2 Waste Controller

The waste controller will undertake the task of controlling incoming waste, using the weighbridge system.

T.3.4.2.3 Equipment Operators and Drivers

For the operation of the sanitary landfill, a bulldozer will be used for leveling and compacting waste, one excavator for digging the daily cover soil, one tipper truck for transporting the covering soil and one water tanker to spray the landfill and prevent dust from rising during the soil covering operation. Therefore 2 operators and 2 drivers will be required.

T.3.4.2.4 Maintenance Personnel for the Equipment

The maintenance personnel will conducts preventive maintenance of the equipment. This person should be dispatched from the maintenance department of the municipality, whenever it is necessary.

T.3.4.2.5 Worker

This person will be in charge of general auxiliary duties.

T.3.4.2.6 Security Guards

The security guards will be in charge of the safety of the sanitary landfill, as well as restricting the entrance of unauthorized persons to the site, in order to ensure their safety. The sanitary landfill will operate five days a week, Monday through Saturday, from 8:00 a.m. to 5:00 p.m.

T.3.4.3 Control of the "Scavengers"

Due to the fact that the facilities at the sanitary landfill is going to be fenced off and a gate installed at the entrance, the entrance of scavengers will be restricted.

T.3.5 Handling and Disposal of the Liquid Waste and Emissions

T.3.5.1 Sources of Gaseous Emissions

A solid waste landfill can be conceptualized as a biochemical reactor, in which solid waste and water are the major inputs, and landfill gas and leachate the principal outputs. Solid wastes placed in a sanitary landfill undergo a number of simultaneous and interrelated biological, chemical and physical changes. The most important biological reactions occurring in landfills are those related to the degradation of organic material in municipal SW generation of landfill gases and, eventually, leachate.

Important chemical reactions that occur within the landfill include: ionization and suspension of landfill materials; biological conversion products in the liquid percolating through the waste, evaporation and vaporization of chemical compounds and water as landfill gas, absorption of volatile and semi-volatile organic compounds into the deposited material, dehalogenation and decomposition of organic compounds, and oxidation-reduction reactions affecting metals and the solubility of metal salts. Among the most important physical changes in landfills are settlement caused by compaction and decomposition of the deposited materials.

The production of the principal landfill gases (CO_2 and CH_4) is thought to occur in, more or less five sequential phases. Each of these phases is described briefly below.

Phase I - Initial Adjustment. Phase I is the initial adjustment phase in which the organic biodegradable components in municipal solid waste begin to undergo bacterial decomposition soon after they are placed in a landfill. In phase I, biological decomposition occurs under aerobic conditions because a certain amount of air is trapped within the landfill. The principal source of both the aerobic and the anaerobic organisms responsible for waste decomposition is the soil material that is used as a daily and final cover. Sludge form digested wastewater treatment plants, disposed of in many municipal solid waste landfills, and recycled leachate are other sources of micro organisms.

Phase II - Transition Phase. In phase II, identified as the transition phase, oxygen is depleted and anaerobic conditions begin to develop. As the landfill becomes anaerobic, nitrate and sulfate which can serve as electron acceptors in biological conversion reactions are often reduced to nitrogen gas and hydrogen sulfide. The anaerobic conditions can be monitored by measuring the oxidation/reduction potential.

Reducing conditions sufficient to bring out the reduction of nitrate and sulfate occur at about - 50 to 100 mV. As the oxidation/reduction potential continues to decrease, the

microorganisms responsible for the conversion of the organic material in municipal solid waste to methane and carbon dioxide begin the three-step process in which complex organic material is converted to organic acids and other intermediate products as described in phase III.

In phase II, the pH of the leachate, if formed, starts to drop due to the presence of organic acids and the effect of the elevated concentrations of CO_2 within the landfill.

Phase III -Acid Phase. In phase III, known as the acid phase, the bacterial activity initiated in phase II is accelerated with the production of significant amounts of organic acids and lesser amounts of hydrogen gas. The first stage in the three-step process involves the enzyme-mediated transformation (hydrolysis) of higher-molecular-mass compounds (e.g., lipids, organic polymers, and proteins) into compounds suitable for use by microorganisms as a source of energy (respiration) and (anabolism) production of cellular matter.

The second step in the process (acid-genesis) involves the biological conversion of the compounds resulting from the first step into lower molecular-weight intermediate compounds as typified by acetic acid (CH_3COOH) and small concentrations of fulvic acid and other more complex organic acids. CO_2 is the principal gas generated during Phase III. Smaller amounts of hydrogen gas (H_2) is also be produced. The microorganisms involved in this phase, described collectively as non-methanogenic, consist of facultative and obligate anaerobic bacteria. These microorganisms are often identified in the literature as acidogens or acid formers.

Because of the acids produced during phase III, the pH of the liquids held within the landfill will drop. The pH of the leachate, if formed, will often drop a value of 5 or lower because of the presence of the organic acids and the effect of the elevated concentrations of CO_2 within the landfill. The biochemical oxygen demand (BOD_5), the chemical oxygen demand (COD), and the conductivity of the leachate will increase significantly during phase III due to ionization of the organic acids in the leachate.

Also, because of the low pH values in the leachate, a number of inorganic constituents, principally heavy metals, will become soluble during phase III. Many essential nutrients are also removed form the leachate in phase III.

If leachate is not recycled, the essential nutrients will be lost from the system. It is important to note that if leachate is not formed, the conversion products produced during phase III will remain within the landfill as dissolved constituents and in the water held by the waste as defined by the "field capacity".

Phase IV - Methane Fermentation Phase. In phase IV, known as the methane fermentation phase, a second group of microorganisms which converts the acetic acid and hydrogen gas formed by the acid formers in the acid phase to methane (CH_4) and CO_2 becomes more predominant. In some cases, these organisms will begin to develop toward the end of phase III.

The bacteria responsible for this conversion are strict anaerobes and are methanogenic. Collectively, they are identified in the literature as methanogenes or methane formers. In phase IV, both methane and acid fermentation proceed simultaneously, although the rate of acid fermentation is considerably reduced.

Because the acids and the hydrogen gas produced by the acidogens have been converted to CH_4 and CO_2 in phase IV, the pH within the landfill will rise to more neutral values in the range of 6.8 to 8. In turn, the pH of the leachate, if formed, will rise, and the concentration of BOD_5 COD and the conductivity value of the leachate will be reduced. With higher pH values, fewer inorganic constituents are soluble; as a result, the concentration of heavy metals present in the leachate will also be reduced.

Phase V - Maturation Phase. Phase V, known as the maturation phase, occurs after the readily available biodegradable organic material has been converted to CH_4 and CO_2 in phase IV. As moisture continues to filter through the waste, portions of the biodegradable material that were previously unavailable will be converted.

The rate of landfill gas production diminishes significantly in phase V, because most of the available nutrients have been removed with the leachate during the previous phases and the substrates that remain in the landfill are slowly biodegraded. The principal landfill gases evolved in phase V are CH_4 and CO_2. Depending on the landfill closure measures, small amounts of nitrogen and oxygen may also be found in the landfill gas. During the maturation phase, the leachate will often contain higher concentrations of humic and fulvic acids, which are difficult to process further, biologically.

The duration of the individual phases in the production of landfill gas will vary depending on the distribution of the organic components in landfill, the availability of nutrients, the moisture content of waste, liquid filtration through the waste material, and the degree of initial compaction.

For example, if several loads are compacted together, the carbon/nitrogen ratio and the nutrient balance may not be favorable for the production of landfill gas. The production of landfill gas will be retarded if sufficient mixture is not available.

Increasing the density of the material placed in the landfill will decrease the availability of moisture to some parts of the waste and thus reduce the rate of biodecomposition and gas production.

T.3.5.2 Gaseous Emissions Types

Gases found in landfills include ammonia (NH_3), carbon dioxide (CO_2), carbon monoxide (CO), hydrogen (H_2), hydrogen sulfide (H_2S), methane (CH_4), nitrogen (N_2), and oxygen (O_2). The production of principal landfill gases are a result of the anaerobic biological decomposition of biodegradable organic fractions of the municipal solid waste in the landfill. The typical percentage distribution of the gases found in the landfill is tabulated in Table T-5.

As shown in Table T-5, methane and carbon dioxide are the principal gases produced from the anaerobic decomposition of the biodegradable organic waste components in municipal solid waste. When methane is present in the air at concentrations between 5 and 15 percent, it is highly explosive. Because only limited amounts of oxygen are present in a landfill when methane concentrations reach this critical level, there is little danger that the landfill will ignite.

However, methane levels in the explosive range can be formed in landfill gas emissions off-site and is mixed with air. The concentration of these gases that may be expected in the leachate will depend on their partial pressure in the gaseous phase in contact with the leachate.

Table T-5: Typical Constituents and Characteristics of Landfill Gas

Component	Percentage (dry volume basis)
Methane	45-60
Carbon dioxide	40-60
Nitrogen	2-5
Oxygen	0.1-1.0
Ammonia	0.1-1.0
Sulfides, disulfides, mercaptans, etc.	0-0.1
Hydrogen	0-0.2
Carbon monoxide	0-0.2
Trace constituents	0.01-0.6
Characteristic	**Value**
Moisture content	Saturated
Specific gravity	1.02-1.06
Temperature, °F	100-160
High heating value, BTU/std ft^3	475-550

Table T-6: Distribution Percentage of Landfill Gases during the First 48 Months

Time interval since cell completion, months	Average percent per volume		
	Nitrogen N_2	Carbon dioxide CO_2	Methane CH_4
0-3	5.2	88	5
3-6	3.8	76	21
6-12	0.4	65	29
12-18	1.1	52	40
18-24	0.4	53	47
24-30	0.2	52	48
30-36	1.3	46	51
36-42	0.9	50	47
42-48	0.4	51	48

T.3.5.2.1 Variation in gas production with time

The overall rate at which the organic material in a landfill is decomposed biologically will, as noted previously, depend on the distribution of the organic components in landfill, the availability of nutrients, the moisture content of waste, the filtration of liquid through the landfill, and the degree of initial compaction. Under normal conditions, the rate of decomposition of organic wastes disposed in a sanitary landfill, measured by gas production reaches its peak within the first 2 years and then slowly tapers off, continuing in many cases for periods up to 25 years or more.

T.3.5.2.2 Movement of Main Landfill Gases

Under normal conditions, gases produced in soils are released to the atmosphere by means of molecular diffusion. In the case of an active landfill, the internal pressure is usually greater than atmospheric pressure and landfill gas will be released by both convection (pressure-driven) and diffusion. Other factors influencing the movement of landfill gases include the absorption of the gases into liquid or solid components and the generation or consumption of a gas component through chemical reactions or biological activity.

Although most of the methane escapes to the atmosphere, both methane and carbon dioxide have been found at concentrations up to 40 percent each, at lateral distances of up to 400 ft from the edges of unlined landfills. Methane concentration over 5 percent have been measured at a distance of 1000 feet. Carbon dioxide, on the other hand, which is about 1.5 times as dense as air and 2.8 times as dense as methane, tends to sink the bottom of the landfill. As a result, the concentrations of carbon dioxide in the lower portions of a landfill may be high for years.

T.3.5.3 Gas Removal

In order to exhaust landfill gas quickly, gas removal pipes (perforated concrete pipes 200 mm in diameter) will be installed at 40 m intervals. Gas removal pipes are also laid at the side slope of the landfill site to avoid landfill gas accumulation.

T.3.5.4 Identification of Leachate

Leachate may be defined as liquid that has percolated through solid waste and has extracted dissolved or suspended materials. In most landfills, leachate is composed of the liquid that has entered the landfill from external sources, such as surface drainage and rainfall and the liquid produced from the decomposition of the wastes, if any.

T.3.5.5 Variations in Leachate Composition

It should be noted that the chemical composition of leachate will vary greatly depending on the age of landfill and the history of events preceding the time of sampling. For example, if a leachate sample is collected during the acid phase of decomposition, the pH value will be low and the concentrations of BOD_5, TOC, COD, nutrients and heavy metals will be high.

If, on the other hand, a leachate sample is collected during the methane fermentation phase, the pH will be in the range from 6.5 to 7.5, and the BOD_5, TOC, COD and nutrient concentration values will be significantly lower. Similarly the concentrations of heavy metals will be lower because most basic metals are less soluble at neutral pH values. The pH of the leachate will not only depend on the concentration of the acids that are present, it will also depend on the partial pressure of the CO_2 in the landfill gas which is in contact with the leachate.

The biodegradability of the leachate will also vary with time. Changes in the biodegradability of the leachate can be monitored by checking the BOD_5/COD. Initially, the BOD_5/COD ratios will be in the range of 0.5. Ratios in the range from 0.4 to 0.6 are taken as an indication that the organic mater in the leachate is readily biodegradable. In mature landfills, the BOD_5/COD ratio drops so that leachate from mature landfills typically contains humic and fulvic acids which are not readily biodegradable.

T.4 Limit of the Influence Area

T.4.1 Definition of the Limits

With respect to the current land use and the environmental quality, the area that is going to be developed for the construction and operation of the sanitary landfill including area required for the buffer zone and other related facilities.

With respect to the groundwater contamination by leachate, the limits of the influence area will be mainly extended eastward from the landfill cells. The limits should be identified by monitoring wells located around the landfill site.

With respect to the traffic increase, vibration and noise in the zone, it can be said that its effects will be limited to the project site and the access road (Granada-Santa Rosa) from the junction of the city boundary (Chico Tripa Grocery) to the project site entrance.

T.4.2 Justification of the Limits of the Influence Area

a. Project Site Influence Area

Forty (40) hectares of land currently in use will be affected, because these areas will no longer be used as cattle ranches, nor would they be used for any agricultural purpose. The areas adjacent to the project site will not be affected by the noise and vibration produced by the heavy machinery operating at the site, due to the construction of the buffer zone (fast growing tree planting), which will lessen the impact of these parameters.

The possible local groundwater contamination by leachate is to be compensated with a new provision of water supply (INAA) system for the residents and industries in the project neighboring area. The new water supply provision area will be wider than the estimated influence area of groundwater contamination.

There will be no dust increase in the zone, because the access road on which the waste collection vehicles travel will be paved. Also, the landfill site will be provided with a water tanker with a sprinkler in order to control the dust that could be produced during landfill operations.

Due to daily soil covering of the solid waste, there will be no foul odors generated nor proliferation of diseases transmitting vectors. With respect to solid waste scattering to the surroundings, with the installation of a mobile fence at active landfill cells, buffer zone composed tall trees and the construction of the fence bordering the project site, there will be no waste scattered out of the site.

The poultry farm, located approximately 700m to the north of the landfill cell, will not be influenced by any factors generated by the operation of the sanitary landfill, such as noise, vibration, dust or odors, due to is distance and to the fact that the prevailing wind direction is from the east; the form is located at the far north of the site proposed for the construction of the Sanitary Landfill.

b. Access Road Influence Area

The asphalt pavement of the access road (Granada-Santa Rosa) up to the project site will reduce problems of: noise, dust and vibration. In spite of the fact that the traffic on

the access road will be increased by entry of waste collection vehicles, the impact with respect to noise, dust and vibration will be reduced considerably by the pavement.

The traffic on the access road will increase slightly due to the waste collection vehicles. However, its negative impact will be negligible compared with the current total traffic volume, and will be counterbalanced by the beneficial impact of the road improvement to neighbors (e.g., IUCASA, Cartosol, Avicola San Felipe etc.).

T.4.3 Impacts on the Water Bodies and Ecosystems

The surface layer of the proposed SJV site is relatively permeable with a permeability coefficient ranging from 2.08E-5 to 7.0E-5 cm/sec. Since the proposed landfill structure does not employ bottom impermeable liner, impacts of groundwater contamination by leachate is envisaged.

Present groundwater users near the project site are: the Avicola San Felipe (drinking and slaughter purposes) and cattle raising farmers (cattle raising use only). The negative impacts of possible local groundwater contamination could be mitigated by providing INAA's water supply system to those groundwater users.

Groundwater gradient at the project site is about 0.2% to 0.6% west to east i.e., toward the Lake Nicaragua. Although it is not known at this moment whether and how much the pollutants are retained at the wetland or reaches to the lake, there could possibly be an impact of contaminating the lake by leachate. Behavior of groundwater contamination should be monitored.

With respect to the local ecosystems, the area where the sanitary landfill is projected is used for cattle rearing and no endangered/rare plant species are found in the are. Although surface vegetation of the project area will be removed at the construction stage, effect on the micro-climate of the area will be negligible due to afforestation of the buffer zone.

T.5 Environmental Situation of the Influence Area

The present environmental situation of the influence area (i.e., SJV site) were identified through the Environmental Baseline Survey. The outcome of the Environmental Baseline Survey are detailed herewith. Measurement locations of the Environmental Baseline Survey are indicated in Figure T-3 overleaf.

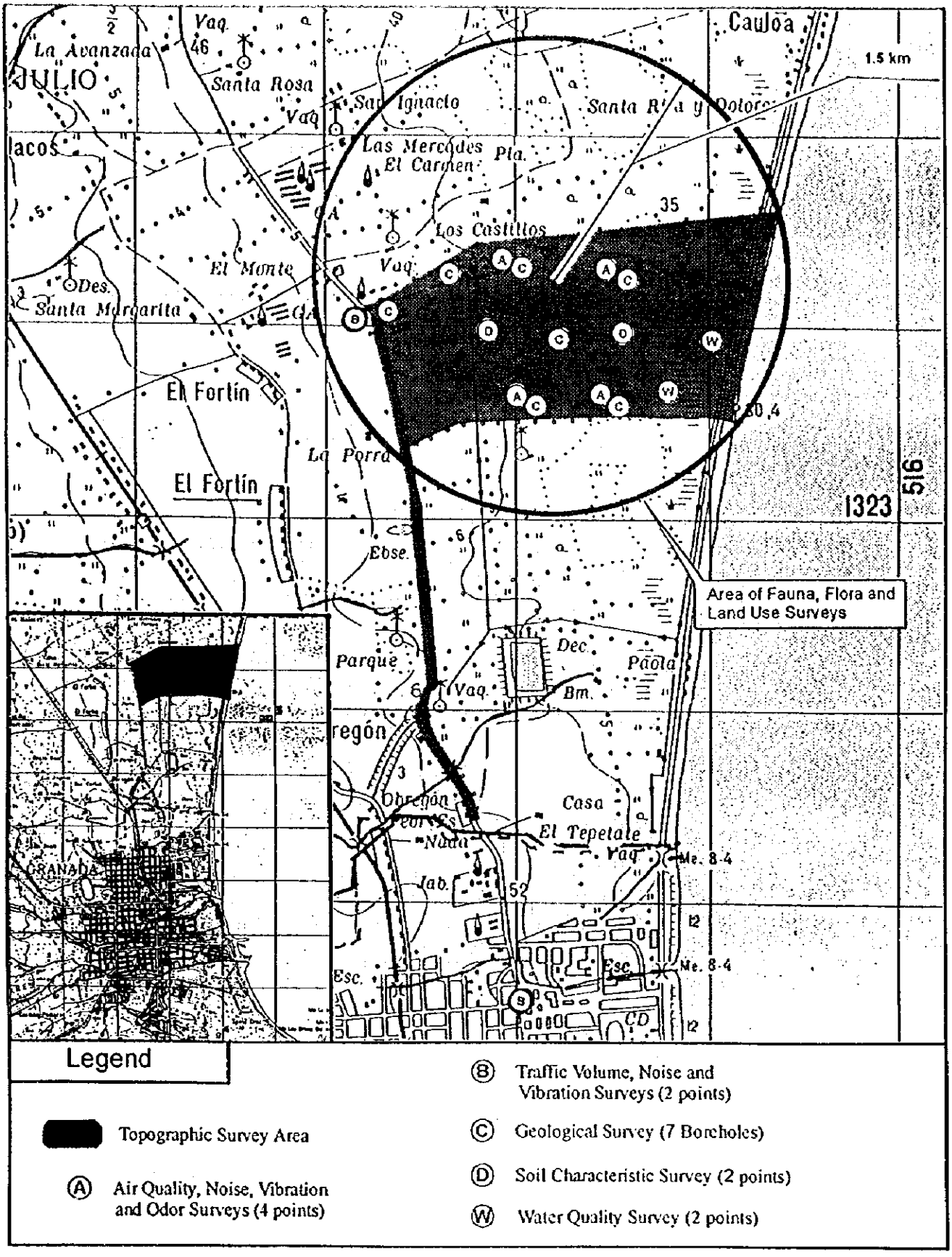


Figure T-3: Environmental Baseline Survey Measurement Location