a.2 NOM-083-ECOL-1996

In this section, the site conditions are screened according to each of the requirements stated in the NOM-083-ECOL by examining countermeasures which are needed for the site conditions to meet with the requirements (See Table H-52).

Table H-52: Consideration of NOM-083-ECOL

Issues stated in the norm	Site conditions	Necessity of counter-measures	Consideration/ countermeasures
General aspects			
The minimum distance of 3,000m should be secured from an airport where turbine engine airplanes are operated.	The distance to the nearest airport is about 10km.	No need.	Countermeasures are unnecessary.
The minimum distance of 1,500m should be secured from an airport where reciprocating engine airplanes are operated.	The distance to the nearest airport is about 10km.	No need.	Countermeasures are unnecessary.
The right of way of highways, railroads, main and secondary roads must be respected.	Autopista to Texcoco runs about 1.0km south of the site. It will be used for waste transportation.	Necessary.	U-turn part is to be widened to avoid adverse influence on traffic on the autopista, when waste transportation trucks come into and go out of the access road.
Sites should not be located in natural protected areas.	The site is not in a natural protected area.	No need.	Countermeasures are unnecessary.
The right of way of federal public works should be respected, such as oil and gas pipelines, electric power pylons, water pipes, etc.	An gas pipe line is laid in the ground at the south-west of the site. However, it is out of the site.	No need.	A map (Figure H-20) shows the location of pipe installment.
The minimum distance of 1,500m should be secured from an edge of a residential area.	The nearest residential area is 2.2km away from the west border of the site.	No need.	Countermeasures are unnecessary.
Hydrological aspects			
The site must be outside of a flood plain with return periods of 100 years.	The site is not located in such a flood plain.	No need.	Countermeasures are unnecessary.
The municipal solid waste final disposal site will not be located at swamps, salty marshes and similar places.	The groundwater level is about 0.7m from the surface, and the water has salinity. But the site is not swamp/marsh.	No need.	Countermeasures are unnecessary.
The minimum distance of 1,000m should be secured from surface water bodies which have capacities for the 10 year return period rainfall.	The site is next to 'Dren Texcoco Norte' which is a sewer of municipal waste water. So this is not surface water body.	No need.	Countermeasures are unnecessary.

Issues stated in the norm	Site conditions	Necessity of counter-measures	Consideration/ countermeasures
Geological aspects			
The site must be located at a minimum distance of 60 meters away form active faults.	No fault is observed in the site and with in 60 from the site.	No need.	Countermeasures are unnecessary.
The site must be located outside of areas with unstable banks where soil movements may happen.	The site's subsoil is highly compressible clay as Etapa IV.	Necessary.	Landfill slope is to be inclined properly to avoid failure.
The zones, where serious settlements may happen, which lead to land fractures and increase risk of water-bearing strata pollution, must be avoided.		Necessary.	Impermeable liner is to be installed to avoid water-bearing strata pollution.
Hydrogeological aspects			
Infiltration rate to a water-bearing stratum must be less than $3x10^{-10}$ sec^{-1}.	The groundwater level is about 0.7m under the surface, but the water can not be used for potable water due to its high salinity.	Necessary.	Landfill bottom (impermeable) liner will be installed to avoid seepage of leachate to the surroundings.
The minimum distance, from the site to water extraction wells for domestic, industrial, irrigation and livestock farming use that are still operating or abandoned, must be 500m.	There are about 30 wells which were used for salt making in the site.	Necessary.	Well casings are needed to be removed, then sealed properly.

a.3 Access

Since it is necessary for waste transportation trucks ($70m^3$ truck trailers) to use part of the 'Autopista Mexico Texcoco' to reach the site, a certain agreement with an authority which is in charge of the autopista may be needed. Technically, the U-turn part should be widened enough for the trucks to go through easily, then to avoid adverse influence on traffic.

Waste transportation trucks will come from the autopista. There are two roads connecting the site to the autopista. One is running along the west border of the site, and its length from the site to the autopista is about 1.5km. The other runs along the east border, and the length to the autopista is about 0.6km. Both of roads do not have enough width of about 4m for the waste transportation trucks. Therefore, whichever road is used as an access road, expansion work is necessary.

There are some buildings of CNA at the entrance of the former road, and a gas pipeline (See Figure II-20) is laid around the south-west corner of the site. On the other hand, only a gate and a small building to watch the gate exist at the entrance of the latter road. Consequently, it is recommended to use the latter road as an access road from the autopista to the site in order to avoid adverse influence on the buildings and the gas pipeline on the former load and make costs of the access road construction cheaper.

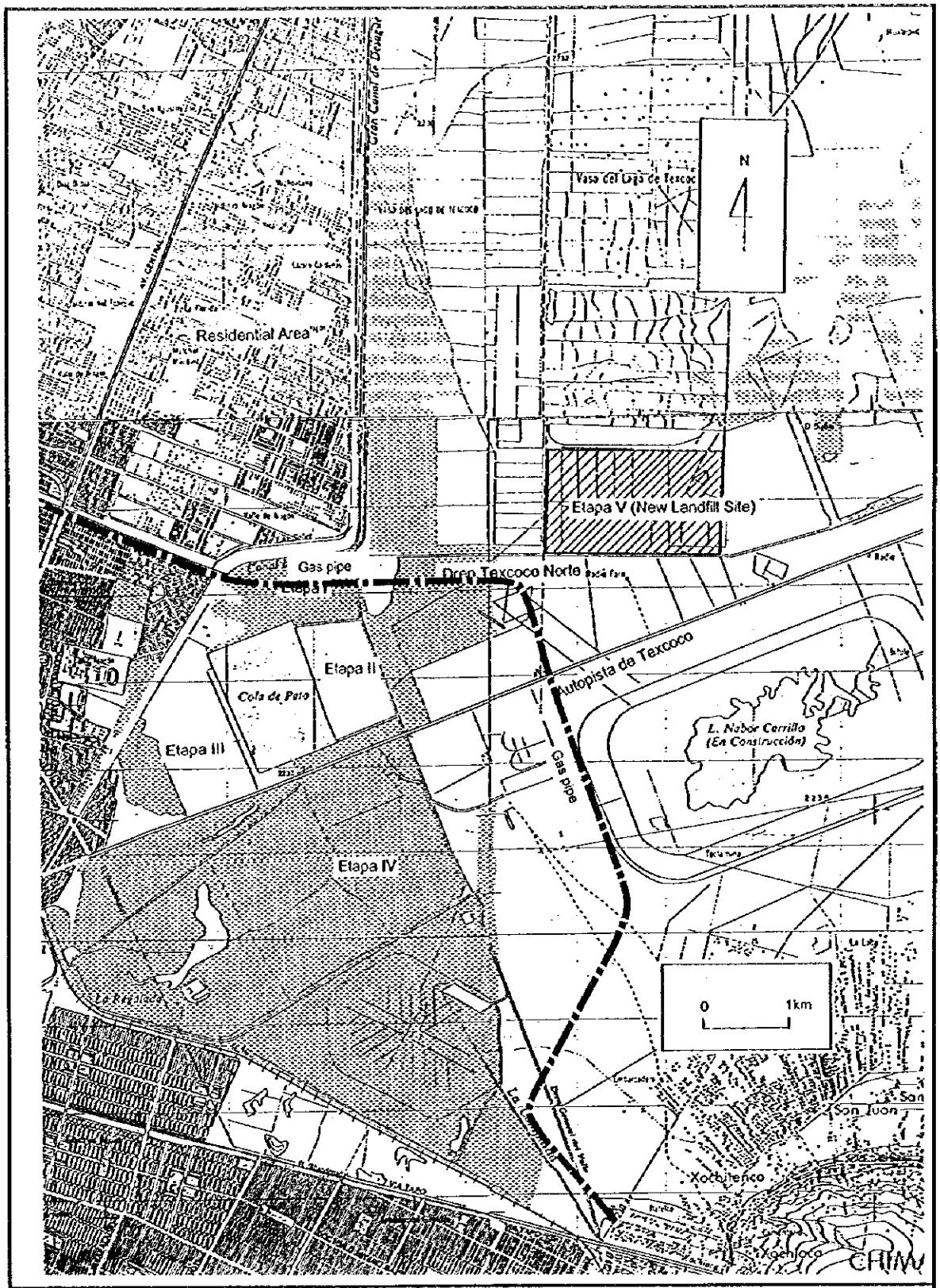


Figure H-20:

Location of Gas Pipline

KOKUSAI KOGYO Co., Ltd.

a.4 Physical Impact of Proposed Landfill Development

In the same way as the Etapa IV landfill site, this candidate site for a new landfill is located on a highly compressible clay layer of the ex-Texcoco area. Therefore, influence on a canal flowing along the site, influence on the impermeable liner and influence on stability of the landfill slope are examined on the basis of a geological survey conducted during the 2nd study work in Mexico.

a.4.1 Geological Survey

i. Objectives of the Survey

The objectives of the geological survey is to acquire soil data of the site in order to examine the technical feasibility of New Landfill Development.

ii. Survey Items

The survey was carried out at Bordo Poniente Etapa V. The number of borings and survey items are shown in Table H-53.

Table H-53: Work Quantity of Soil Survey at Etapa V

Survey Items	Survey Contents
Boring	0 to 40 m deep: 4 bore holes 0 to 60 m deep: 1 bore hole
Soil tests	liquid limit, plastic limit, unit weight, consolidation, grain size, water content, tri-axial compression

iii. Results of the Survey

The groundwater levels are shown in Table H-54, and the soil characters acquired by the survey are summarized in Table H-55.

Table H-54: Groundwater level of Etapa V

Site	Bore hole number	Groundwater level (m)
Etapa V	SM-1	0.35
	SM-4	2.30
	SM-5	0.80

Table H-55: Results of Soil Survey at Etapa V

Characters \ Location	SM-1		SM-2		SM-3		SM-4		SM-5			
	36.1-36.7m	39.7-40.3m	6.0-7.0m	33.3-34.3m	4.8-5.8m	12-12.6m	3.0-3.9m	18.9-19.5m	12.0-12.9m	18.6-19.2m	24.0-24.6m	55.0-55.6m
Type of soil (Visual observation)	clay	clay	clay	clay	clay	clay	clay	clay	clay	clay	clay	silty clay
Specific gravity	2.85	2.99	2.82	2.77	2.85	2.82	2.99	2.86	2.86	2.91	2.94	2.96
Unit weight (ton/m^3)	1.29	1.30	1.16	1.24	1.47	1.31	1.14	1.14	1.20	1.20	1.25	1.32
Void ratio	4.58	6.20	12.30	8.40	2.51	4.90	14.20	9.95	8.70	5.97	6.21	4.10
Degree of Saturation (%)	95.0	103.0	103.0	106.0	83.4	99.8	100.0	97.0	99.0	97.0	98.0	92.0
Water content (%)	152.0	136.0	447.1	321.7	83.4	173.7	398.0	302.0	281.0	147.0	193.0	129.0
Liquid limit (%)	140.7	158.8	354.0	244.8	108.8	259.0	443.0	356.0	320.0	148.0	202.0	134.0
Plastic limit (%)	31.7	33.4	29.8	32.7	34.2	33.8	78.8	33.2	32.7	25.6	24.1	31.0
Plasticity index (%)	109.0	125.4	324.2	212.1	74.6	225.2	364.2	322.8	287.3	122.4	177.9	103.0
Tri-axial undrained C (ton/m^2)	9	0.4	1	2	0.03	0.16	0	0	0.05	1.4	0	5
Angle of internal friction (deg.)	9	1	3	6	1	0	5	7	0.5	0.29	5	11
Simple compression qu (ton/m^2)	14.4	6.3	0	5.8	1.0	0.98	0.15	0.85	0.9	2.3	0.9	14.3
N value	0	0	0	0	0	0	0	0	0	0	0	15
Coefficient of consolidation (cm^2/s)	0.02	0.0091	0.0021	0.0067	0.0071	0.0105	0.0025	0.0063	0.0765	0.0199	0.0071	0.1294

iv. Findings

The surface stratum at the site is occupied with 45m thick clayey lacustrine deposit, which is divided into three layers by two sandy layers located at 32m and 37m in depth respectively. Almost all N values of the stratum show 0, zero. A stable layer of which N value shows more than 50 exists below the depth of 45m. The lacustrine deposit shows considerably high natural water contents of from 130 to 450% and low unit weight of about 1.20 ton/m^3. Therefore, it is judged that the lacustrine is considerably soft clay according to the soil surveys result.

a.1.2 Landfill Development Influence on Dren Texcoco Norte

Examination of influence on the canal, Dren Texcoco Norte, which is flowing the south side of the site, caused by the New Landfill Development was carried out by using soil data acquired through the soil survey. Conditions set for estimation of subsoil settlement and the results of the examination are presented below.

i. Conditions for Estimation of Influence

Data on soil layers at SM-1 bore hole are employed for the estimation. The lacustrine layer is subdivided into 8 layers as shown in Table H-56. The waste load is assumed to be the one when the landfill becomes 24m high and the unit weight of waste after initial compression at the landfill is assumed to be 0.8 ton/m^3. And two cases are set depending on whether buoyancy caused by the groundwater is considered or not. Case 1 ignores such buoyancy, on the other hand, Case 2 takes buoyancy into consideration.

Table H-56: Subsoil Conditions

Layer	Thickness of layer (m)	Unit weight (ton/m^3)
1	5.0	1.14
2	5.0	1.23
3	5.0	1.25
4	5.0	1.17
5	5.0	1.25
6	6.8	1.25
7	0.7	1.60
8	4.1	1.24

Note: The water level is assumed at 0m depth, because the groundwater level at SM-1 was 0.35.

ii. Results of the Estimation

The results are schematized in Figure H-21. The result of Case 1, without consideration of the buoyancy, is that the final subsoil settlement (theoretical maximum) will be 13.82 m in the landfill center which may cause 5mm settlement at the 100m off-set drainage canal. Meanwhile, the final subsoil settlement (theoretical maximum) of Case 2, with consideration of the buoyancy, will be 9.35m in the landfill center which may cause 2mm subsidence at the 100m off-set drainage canal.

The duration of settlement was also estimated. The result shows that it will take 3 to 4 years to reach 60% settlement (See Table H-57). Therefore, it is recommended that

enough interval should be secured before waste placement on a next lift, i.e., alternate use of Etapa IV and V is recommended.

Table H-57: Duration of Settlement

Consolidation (%)	10	20	30	40	50	60	70	80	90	100
Duration (days)	19	74	186	384	726	1378	2667	5072	9879	-
Settlement (m)	1.38	2.76	4.14	5.52	6.91	8.29	9.67	11.05	12.44	13.82

(See Data L of Data Book)

iii. Influence on the Canal (Dren Texcoco Norte)

The results show that the maximum subsoil settlement will be 13.82m and the minimum one be 9.35m. However, this estimation assumes that water contained in the subsoil is drained due to the waste load pressure under the theoretically most favorable condition without any impedance. Therefore, the actual subsoil settlement should be fairly smaller than the estimated ones as mentioned in the Vertical Expansion Plan. **In conclusion, the estimation shows only 5mm subsidence of the drainage canal under the theoretical maximum subsoil settlement caused by the New Landfill Development. So, it can be said that the New Landfill Development will not pose a serious problem on the drainage canal structure.**

a.1.3 Landfill Development Influence on the Impermeable Liner

Figure H-22 schematizes the subsoil settlement. The part of liner under the first lift's slope will undergo the largest tensile stress. The tensile stress can be expressed as 1.1% in elongation terms (48.26m/48m=1.0054, i.e., 0.54% of stretch, taking into consideration the stretch of two-dimension, $48.26^2/48^2=1.011$, i.e., 1.1% of stretch, see Figure H-22). This would be absorbed in the tensile performance of the impermeable liner.

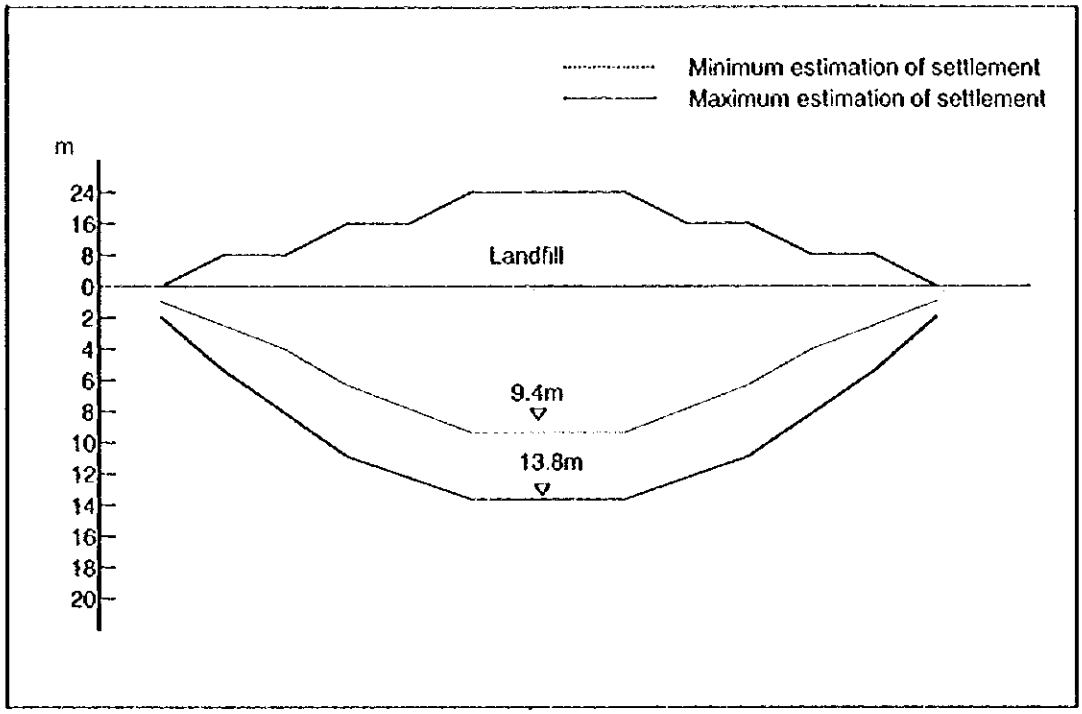


Figure H-21: Subsoil Settlement

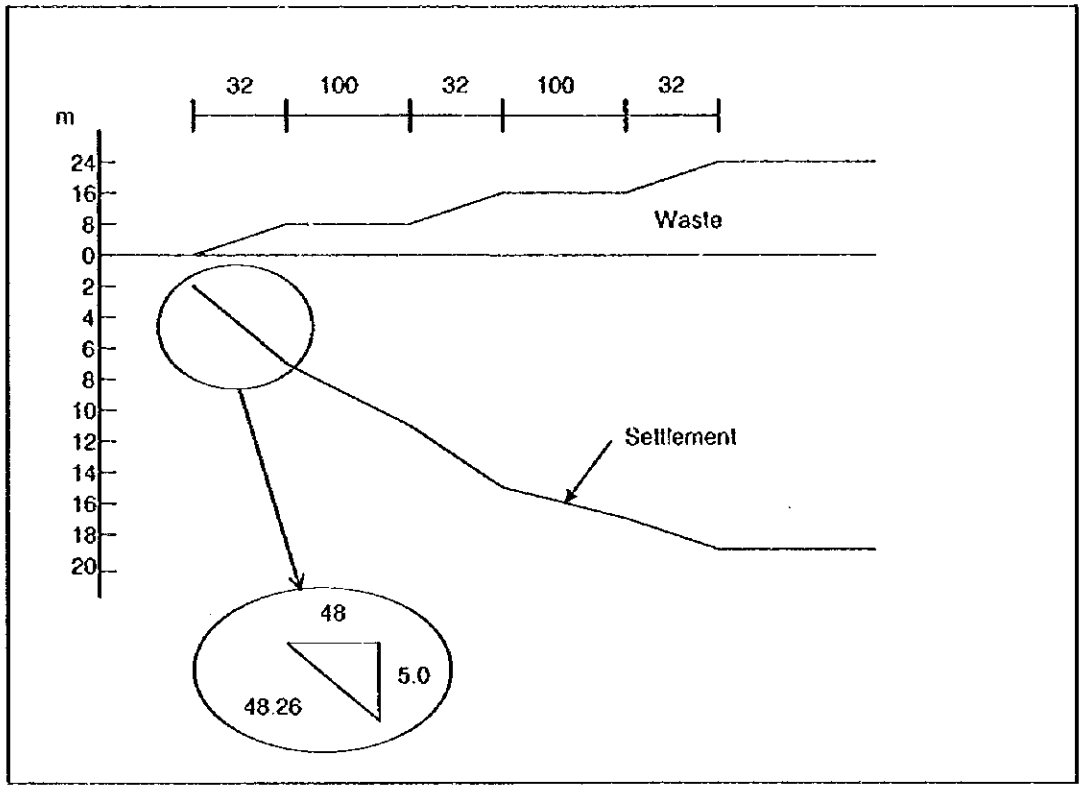


Figure H-22: Subsoil Settlement and Liner

a.1.4 Influence on Stability of Landfill Slope

The soil data presented in Table H-55 are employed in the Bishop Method for calculating the slope stability. The minimum factor of 0 to 8m elevation with a slope of 1 in 4 shows 0.920 which means that slope failure could occur as the minimum factor is less than 1.0. Although a slope failure has not happened in the existing landfill of Etapa IV of which slope is 1 in 4, a gentler slope of 1 in 6 is recommendable for the first lift of 0 to 8m elevation as the minimum safety factor of the slope exceeds 1.0.

On the other hand, minimum factors of other slopes exceed 1.0, therefore, the vertical expansion is viable from a viewpoint of landfill slope stability.

Table H-58: Result of Slope Stability Calculation (Etapa V)

Slope	Landfill Height	Minimum Safety Factor	Coordinates of the Rotational Slope		Radius of the Rotational Slip (m)	Resist Moment (ton-m)	Slip Moment (ton-m)
			X	Y			
1	0 to 8m (1:4)	0.920	15.00	15.00	29.91	1,668.55	1,812.72
1	0 to 8m (1:6)	1.044	25.00	25.00	41.55	3,632.08	3,478.33
2	8 to 16m	1.089	140.00	22.00	39.70	4,826.92	4,433.46
3	16 to24m	1.302	270.00	25.00	48.34	9,234.27	7,093.06

a.5 Waste Disposal Amount

Waste amount to be disposed of in Etapa V is shown with that of Etapa IV in the section of the 'Vertical Expansion Plan of Etapa IV' (See Table H-31).

b. Examination of Technical Alternatives

The items (intermediate cover, final cover, leachate disposal, and landfill gas disposal) examined in the Vertical Expansion Plan of Etapa IV can be applied to this New Landfill Development. In addition to them, landfill bottom liner configurations was examined in view of the requirement about infiltration rate to a water-bearing stratum.

Landfill Bottom Liner

The ground water (salty water) level in the site is as high as that in Etapa IV. 0.35 to 2.30m of water levels were observed in the geological survey conducted during the 2nd study work in Mexico. The NOM-083-ECOL requires that infiltration rate to a water-bearing stratum should be less than $3x10^{-10}sec^{-1}$. Although, whether the stratum containing salty water is a water-bearing stratum is disputable, the stratum is regarded as a water-bearing one. Because the existing landfill of Etapa IV, has an impermeable liner to avoid to mix leachate with such groundwater. Therefore, this new landfill site should also have an impermeable liner to get consensus.

Figure H-23 shows recommended liner configuration, which is the same configuration as that of Etapa IV. It is so simple that mis-installation would be minimum.

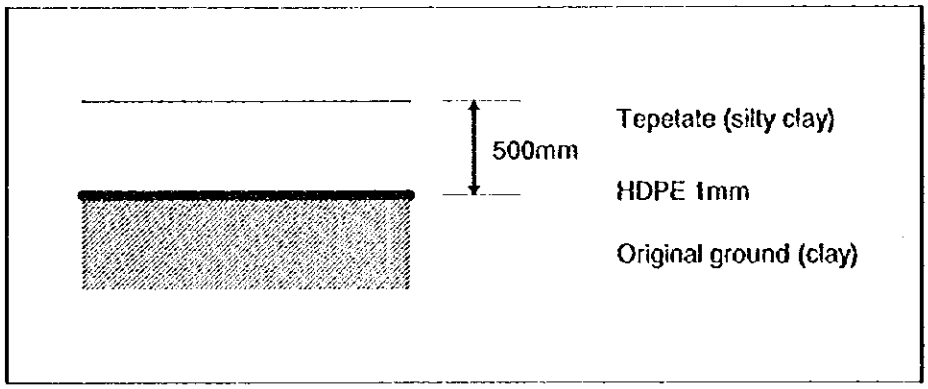


Figure H-23: Landfill Bottom Liner Configuration

c. Conceptual Design and Cost Estimates

Outline of the conceptual design for the Vertical Expansion Plan is presented below.

Table H-59: Outline of the Conceptual Design for A New Landfill Development

Items	Facilities
Area	Site area: 256ha Filling area: 194 ha
Landfill capacity	29,032,000m^3(23,226,000ton) is available for waste disposal.
Access	Access road: 605m Ring road: 5,950m at 0m elevation outer road: 5,950m inner road: 19,155m at 8m elevation outer road: 4,878m inner road: 11,743m at 16m elevation outer road: 3,854m inner road: 3,991m
Waste transport control facilities	gate: 1 (existing) weighbridge: 2 tire washing pit: 1 site office: 1 garage: 1 car park:1 parking area for heavy equipment and/or storage yard: 1
Leachate management	Leachate extraction wells concrete pipes with 600mm diameter: 15 nos. Leachate extraction and spray pumps: 15 nos. Leachate collection lines at 0m elevation: 25,105m at 8m elevation: 16,621m at 16m elevation: 7,845m

Items	Facilities
Landfill gas management	Gas extraction wells concrete pipes with 600mm diameter: 116nos. Gas extraction pipes - PVC200 at 0m elevation: 118 nos. at 8m elevation: 91 nos. at 16m elevation: 55 nos.
Surface water management	Daily/intermediate soil cover: 30cm (Compost is also usable.)
Monitoring	Monitoring items: -settlement of the landfill -leachate quality -landfill gas quality -groundwater -surface water Monitoring facilities -monitoring wells: 4 nos.
Aesthetic design	Mobile screen Daily/intermediate soil cover: 30cm (Compost is also usable.)
Closure and post-closure	Final soil cover: 60cm Greening by seeding the final cover with grass
Landfill equipment	Bulldozers (300hp class): 4 nos. Sprinkler trucks (15,000liter class): 2 nos. Excavators (85hp class): 2 nos.

c.1 Key Design Data

Key data for landfill design are the same as those of Etapa IV.

- bulk density of waste after compaction in landfill: 800kg/m^3
- operation schedule of landfill: 24 hours/day, 365 days/year
- life year of trucks and heavy equipment: 7 years
- life year of building and civil works: 30 years
- exchange rate: US$ 1.00 = 9.1pesos
- daily (intermediate) soil cover: 30cm
- final landfill elevation: 24m

c.2 Landfill Capacity

Capacity of the planed landfill is 30,242,000 m^3. Of the capacity, 29,032,000 m^3 will be occupied with waste and 1,210,000 m^3 with soil (See Table H-61 and Figure H-24).

All the waste disposed of in 2002, 2003 and 2004, and part of waste in 2007 are to be placed in the lift of 0-8m elevation. The rest of waste in 2007 and all waste in 2008 are to be disposed of in the lift of 8-16m elevation. The remaining capacity of the landfill after 2010 will be 7,598,000 m^3 for waste disposal, i.e., 6,078,000 ton of waste (See Table H-60).

It should be noted that the calculation of landfill capacity does not take the settlement of subsoil and waste into account.

Table H-60: Waste Disposal Amount in Etapa V

Unit: 1,000m^3

Elevation	Landfill capacity	Waste disposal amount						Remaining capacity
		2002	2003	2004	2007	2008	Total	
0-8m	14,720	4,511	4,366	4,231	1,612		14,720	0
8-16m	9,220				2,563	4,151	6,714	2,506
16-24m	5,092							5,092
Total	29,032	4,511	4,366	4,231	4,175	4,151	21,434	7,598

Table H-61: Landfill Capacity of Etapa V

Height (m)	Total volume (1,000m^3)	Waste volume (1,000m^3)	Soil volume (1,000m^3)
0	0	0	0
1	2,012	1,932	80
2	3,996	3,836	160
3	5,952	5,714	238
4	7,881	7,566	315
5	9,784	9,393	391
6	11,660	11,194	466
7	13,509	12,969	540
8	15,333	14,720	613
9	16,599	15,935	664
10	17,846	17,132	714
11	19,074	18,311	763
12	20,284	19,473	811
13	21,474	20,615	859
14	22,647	21,741	906
15	23,801	22,849	952
16	24,937	23,940	997
17	25,652	24,626	1,026
18	26,351	25,297	1,054
19	27,036	25,955	1,081
20	27,705	26,597	1,108
21	28,361	27,227	1,134
22	29,002	27,842	1,160
23	29,629	28,444	1,185
24	30,242	29,032	1,210

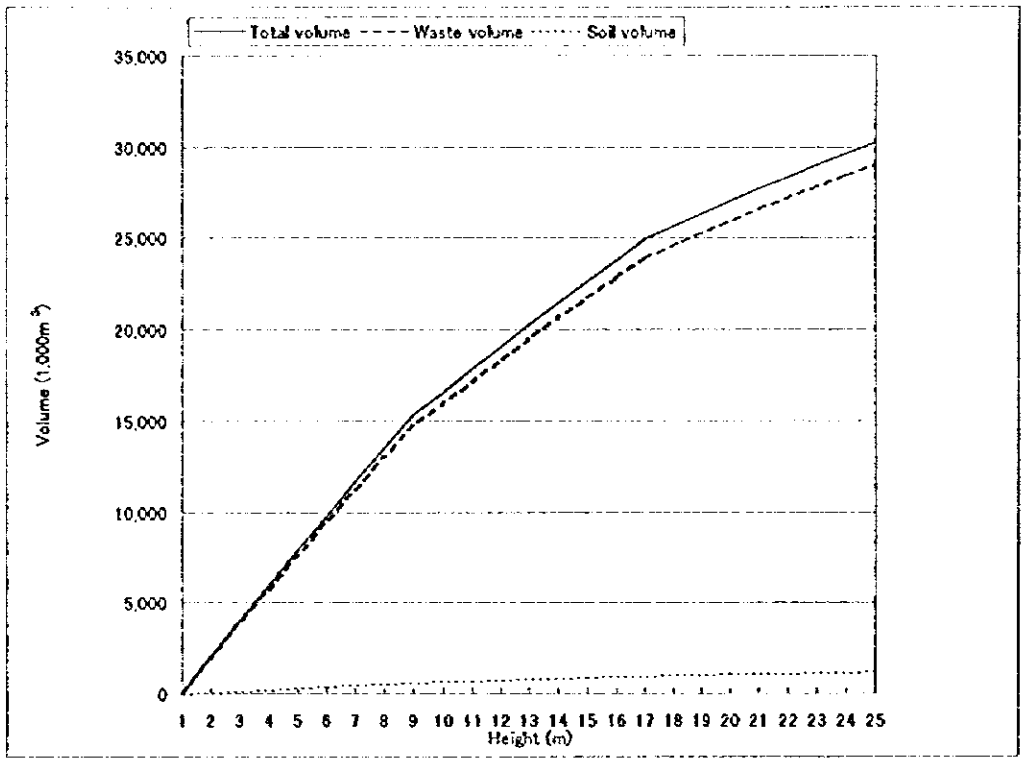


Figure H-24: Height - Volume Curve (Etapa V)

c.3 Site Preparation

When the site is prepared for landfill, it is important to properly seal the salt making wells on the site in order to avoid potential risk of leachate to deeply infiltrate into the stratum under the landfill. Bentonite or other equivalent materials will be used to seal them.

c.4 Access

i. Access to the Site

An access road of 605m will be constructed from the Autopista to the site. The road has dimensions of:

- Carriage width: 20.0m
- Sidewalk width: 4.0m at both sides
- Shoulder width: 1.0m at both sides
- Pavement: asphalt t =10cm, gravel t =40cm

ii. Access in the Site

A ring road will be constructed along the filling area at 0m elevation. The road functions as a main road in the site, and connects the access road to inner roads. Also the ring road will be utilized as a maintenance and monitoring road. In order to access to waste unloading areas, inner roads in the filling area at 0m elevation will be constructed.

At 8m and 16m elevation, inner roads and outer roads establish a network to secure accessibility to waste unloading areas.

Dimensions of the ring road:

- Carriage width: 20.0m
- Sidewalk width: 4.0m at both sides
- Shoulder width: 1.0m at both sides
- Pavement: asphalt t =10cm, gravel t =40cm

Dimension of the inner and outer road:

- Carriage width: 9.0m
- Shoulder width: 0.5 m at both sides
- Pavement: volcanic porous rocks or equivalent material, t =30cm

c.5 Landfill Layout

The landfill has facilities to operate sound waste disposal management. The facilities proposed are:

- a gate.
- weighbridges (2) and a control room.
- a tire washing pit.
- a site office.
- a garage.
- a car park.
- a parking area for heavy equipment and/or a storage yard.

Layout of the landfill are shown in Figure II-25, and waste transport control facilities are presented in Figure II-26.

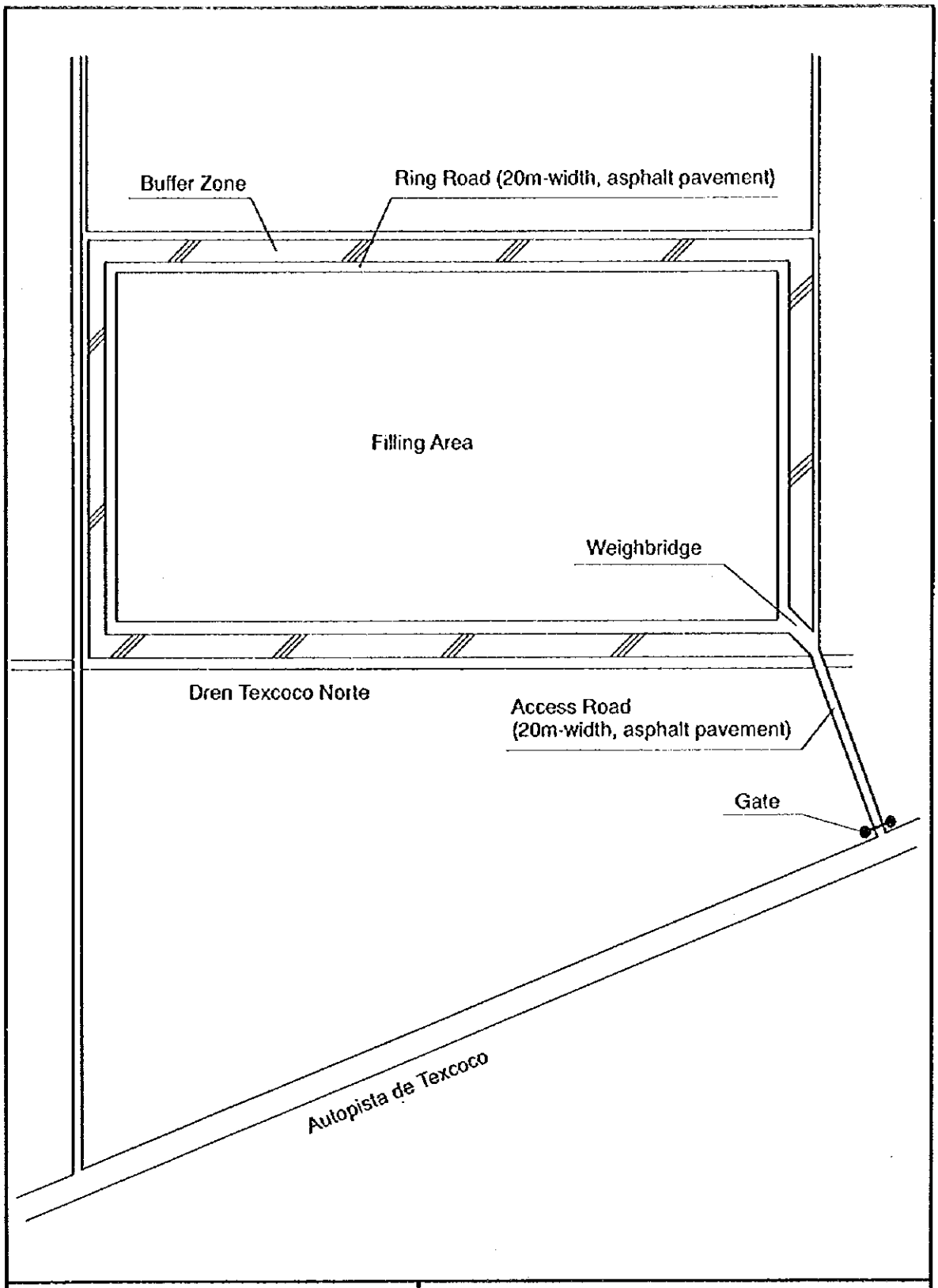


Figure H-25:

Landfill Layout of Etapa V

KOKUSAI KOGYO Co., Ltd.

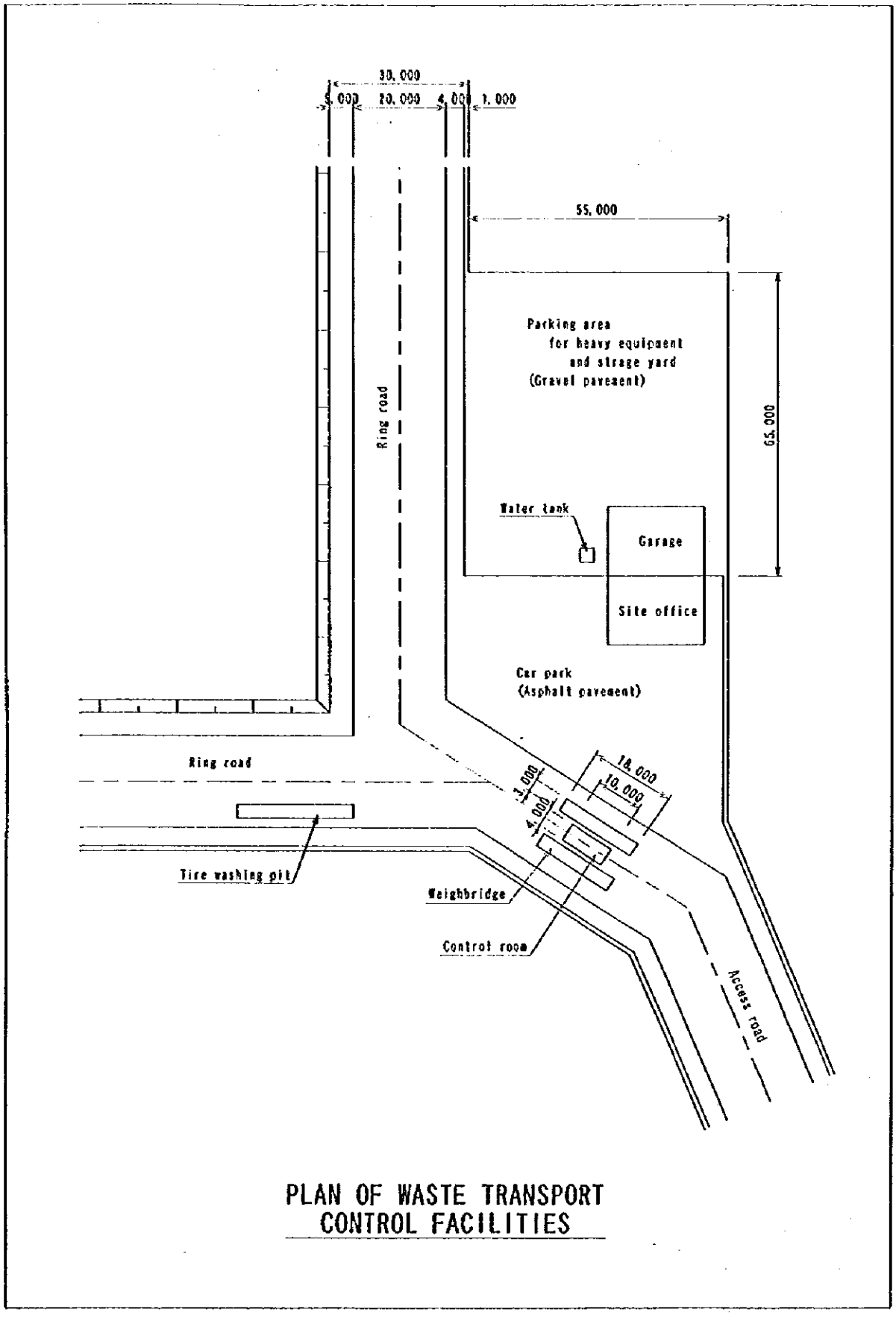


Figure H-26: Plan of Waste Transport Control Facilities

c.6 Leachate, landfill Gas and Surface Water Management

Management of leachate, landfill gas and surface water is to take the same manner as that of Etapa IV (Refer these sections in the Vertical Expansion Plan of Etapa IV).

15 submergible pumps will be installed in order to spray estimated 196,000m^3/year of leachate.

c.7 Monitoring

Monitoring should be conducted in order:

- to know condition of waste decomposition.
- to know environmental quality.
- to reflect data monitored to future landfill plans.

i. Monitoring of Waste Decomposition

Monitoring the settlement of the landfill is important in this site. Settlement will be caused by decomposition of waste and subsidence of the subsoil. Data obtained by this monitoring can be useful for the future landfill operation and land use after closure.

In addition to the monitoring of settlement, it is recommendable to monitor leachate and landfill gas quality which can show the progress of waste decomposition. The recommended monitoring program is shown in Table H-62.

ii. Monitoring of Environmental Quality

This monitoring will be conducted in view of environmental protection. It is recommended to monitor the quality of:

- groundwater at upstream and downstream of the site.
- surface water of drainage canals around the site at upstream and downstream.

In order to get samples of groundwater, four monitoring wells with 40m in depth are to be installed around the landfill because direction of the groundwater under the site is indefinite. The recommended monitoring program is presented in Table H-62.

iii. Recording of Monitoring Data

Data obtained should be recorded in a proper manner, e.g., use of an uniform style of recording sheet, and appropriate date keeping during operation and after closure.

Table H-62: Recommended Monitoring Program

Subject	Monitoring item	Frequency (per year)
Settlement	Elevation of lift(s)	1
Landfill gas	Temperature	2
	CH_4	2
	CO_2	2
	N_2	2
	O_2	2

Monitoring item	Frequency (per year)		
	Leachate	Groundwater	Surface water
Temperature	2	1	1
Color	2	1	1
pH	2	1	1
BOD_5	2	1	1
COD	2	1	1
T-N	2	1	1
T-P	2	1	1
Cl^-	2	1	1
CN	1	1	1
Cd	1	1	1
Cu	1	1	1
Pb	1	1	1
Cr(VI)	1	1	1
Hg	1	1	1
As	1	1	1

c.8 Aesthetic Design Consideration, Closure and Post-closure Care

The same manner as Etapa IV will be taken, such as mobile screens, daily soil cover, final cover, etc. What should be noted for the design of Etapa V is that 70m width of buffer zone is to be secured in order to mitigate harmful effects of landfilling on the surroundings.

c.9 Landfill Equipment and Operation

The same equipment and the same manner of operation as Etapa IV will be employed in Etapa V. The equipment will be used alternately in Etapa IV and Etapa V.

c.10 Sequence of BP-V Construction

In view of current problems related with leachate in the BP-IV, improvement in design and construction sequence should be elaborated for the BP-V project. The bottom impermeabilization should be a holistic: i.e., it should be continuous from one cell to another and to the roads bottom as well and its outer anchorage should be in such an elevation that the leachate generated from the buried wastes should always be contained in the holistic bottom impermeabilization.

In order to attain a holistic impermeability and to carry out efficient landfilling operation and leachate management for the BP-V project, the following components should be carried out in an appropriate sequential manner:

a. Site preparation work
b. Impermeabilization

c. Leachate collection and drainage line along outer road slope bottom
d. Inner road on impermeabilization
e. Leachate collection and drainage line on the inner road slope bottom
f. East-west inner roads and leachate drainage line
g. Construction of leachate suction pit with vertical pump-up shaft
h. Off-limits marking around suction pits
i. Landfilling operation (0.0 meter to 8.0 meter elevation)
j. Approach road (from 0.0 meter to 8.0 meter elevation) construction
k. Expansion of vertical shaft and landfilling of off-limits marking area
l. Leachate pump-up and spray (and/or impound) at 8.0 meter elevation

c'. Outer road and leachate drainage line along it (8.0 meter elevation)
d'. Inner road (8.0 meter elevation) construction
e'. Inner road as leachate collection and drainage line (8.0 meter elevation)
f'. East-west inner roads and leachate drainage line
g'. Extension of vertical pump-up shaft (8.0 meter elevation)
h'. Off-limits marking around vertical shafts (8.0 meter elevation)
i'. Landfilling operation (8.0 meter to 16.0 meter elevation)
j'. Approach road (from 8.0 meter to 16.0 meter elevation) construction
k'. Expansion of vertical shaft and landfilling of off-limits marking area
l'. Leachate pump-up and spray (and/or impound) at 16.0 meter elevation

c''. Outer road and leachate drainage line along it (16.0 meter elevation)
d''. Inner road (16.0 meter elevation) construction
e''. Inner road as leachate collection and drainage line (16.0 meter elevation)
f''. East-west inner roads and leachate drainage line
g''. Extension of vertical pump-up shaft (16.0 meter elevation)
h''. Off-limits marking around vertical shafts (16.0 meter elevation)
i''. Landfilling operation (16.0 meter to 24.0 meter elevation)
j''. Approach road (from 16.0 meter to 24.0 meter elevation) construction
k''. Expansion of vertical shaft and landfilling of off-limits marking area
l''. Leachate pump-up and spray (and/or impound) at 24.0 meter elevation.

a. Site Preparation Earthwork

Meanwhile, the formation level of the outer road should be determined so that the outer road is passable in all weather condition, in addition to what mentioned above (i.e., the anchorage level should be high enough for containing the leachate inside the cells even if when its generation fluctuates with precipitation etc.).

In this context, it is recommended that when the cells' bottom impermeabilization is assumed to be placed on the 0.0 meter elevation, the outer anchorage of the impermeabilization should be on about 1.50 meter elevation.

Therefore, the site preparation earthwork should take place before impermeabilization work, in which the cells' bottom should be smoothly leveled as the 0.0 meter elevation, and the embankment for the outer road be formed with the dimensions of: top width about 30 meter on the 1.50 meter elevation, with 1:2.0 slope.

b. Impermeabilization

The impermeable liner should be **anchored** at about 4.0 meter off-set from the inner top edge of the outer road embankment with sufficient anchorage length and depth and should be extended from the anchorage point to: 4.0 meter width flat embankment top, its inner slope, and toward the cell area. For the liner protection, tepetate should be placed on the road part (50 cm thick in avoiding possible damage by traffic), the inner slope (30 cm thick) and the cell area (50 cm thick).

c. Outer Road Construction

The embankment of the outer road has the top width about 30 meter consisting of 20 meter road width and 5 meter width sidewalk on both sides. The 20 meter road should be an asphalt pavement on a crushed stone road base layer. All inner edge of the inner sidewalk should receive **asphalt bituminous treatment** in order to comply satisfactory impermeabilization for the containment of leachate inside the cells and to protect the bottom of landfill slope from possible rainwater erosion in a long period of landfill service life.

c.1 Leachate Collection and Drainage Lines Along Outer Road Slope Bottom

It is recommended that the leachate collection and drainage lines should form a holistic net. Therefore, as the outer ring of the leachate drainage net, the inner slope and bottom of the outer road should receive gabion of porous volcanic rocks **(30 cm thick)**.

d. Inner Road on Impermeabilization

The initial inner road should be extended from the south end outer road on the E-coordinate: **E-120.00** (which is **120 meter** west offset from the east end outer road) northward, in order to enclose the first cell with four roads (1.0 km east end out road, 120 meter south end road from E-0.00 to E120.00, 1.0 km initial inner road on E-120.00, and 120 meter north end road from E-0.00 to E-120.00).

The second inner road, with the same manner for the initial inner road, should be constructed on the E coordinate E-240.00 northward from the south end outer road. The third should be on E-360.00 and the fourth on E-480.00 etc. Consequently, total **15 south-north** inner roads in total will be constructed.

The 2nd cell is enclosed with the 1st and 2nd inner roads, the 3rd cell with the 2nd and 3rd inner roads.

Dimensions of the inner road should be: 10 meter width on the road top at 1.0 meter elevation and 1:2.0 slopes on both sides.

e. Leachate Collection and Drainage Lines on the Inner Road Slope

Porous volcanic rocks with a sectional dimension of about **2.0 meter width by 50 cm height** should be provided as a leachate drainage line along the inner road slope. The **leachate drainage line** should always be allocated at the **western slope** of inner roads, since the eastern slope first receive the wastes to be disposed of and the inner road should be indispensable for constructing the leachate suction pits and vertical pump-up shafts.

Consequently **15 south-north** leachate drainage lines in total on the inner road western slope bottom will be constructed.

f. East-West Inner Roads and Leachate Drainage Line

With an objective of appropriately integrating the outer ring leachate draining line and **15 south-north** leachate drainage lines on the inner road western slope bottom, it is proposed to provide two (2) numbers of east-west leachate draining lines with an interval of **350** meters.

In this context, two (2) numbers of east-west inner roads with an interval of **350** meters should be constructed. The **east-west leachate drainage line** should be allocated at the **northern slope** of the roads, since the southern slope first receive the wastes to be disposed of and the inner road is utilized for constructing the leachate suction pits and vertical pump-up shafts.

By allocating two **east-west** inner roads, the 1st Cell is divided into three cells of: **1A, 1B** and **1C** from south to north. In the same manner, the 2nd Cell is divided into: **2A, 2B** and **2C.**

g. Construction of Leachate Suction Pit with Vertical Pump-Up Shaft

As the BP-V site is also located on a flat plain area, the leachate collection system can not employ gravity draining to a treatment (e.g., evaporation lagoon/regulation pond, biological or physical-chemical treatment). Therefore, it is recommended to install suction pits (with vertical pump-up shaft) on porous volcanic leachate draining lines on **0.5 meter elevation** with an appropriate interval with each other. The interval of suction pits are recommended to be, as the vertical shafts for pumping up leachate can also be utilized as biogas removal facilities (i.e., chimneys).

The suction pits with vertical shafts should be constructed prior to the landfilling operation nearby. The vertical shaft, in the initial instance, should be constructed up to such an elevation (e.g. about up to 3.0 meter elevation) that the works can be easily carried out with an access from the inner road elevation.

h. Off-limits Marking around Suction Pit

In order to avoid damage to the suction pits and half-extended vertical shafts by trailers and landfill machinery, off-limits marking with temporary poles and colorful plastic tape fencing should be provided encircling the suction pits with a sufficient radius distance.

i. Landfilling Operation (0.0 to 8.0 meter elevation)

The landfilling operation in the BP-V should be started from the **1A** cell to northward, then the **1B** and **1C** cells.

When the **1A** cell is landfilled, the area enclosed with four (4) roads should be landfilled northward from the south end outer road. Embankment shaping and soil cover operations should also be proceeded northward from the south end outer road.

When the **1B** cell starts to be landfilled:

- the 110 meter section of the **east-west** inner road between 1A and 1B cells

should also be landfilled at the same time except the "off-limits marking area" around the suction pits.

When the **1C** cell starts to be landfilled,

- the 110 meter sections on north end outer roads

should also be landfilled, except the "off-limits marking area" around the suction pits, in order to form final shaping of northern slope from the northern outer road to 8.0 meter elevation.

When the **2A** cell starts to be landfilled northward,

- the 350 meter section of the **south-north** inner road between 1A and 2A cells

should also be landfilled at the same time except the "off-limits marking area" around the suction pits.

When the **2B** cell starts to be landfilled northward:

- the 110 meter section of the **east-west** inner road between 2A and 2B cells.
- the 350 meter section of the **south-north** inner road between 1B and 2B cells.

should also be landfilled at the same time except the "off-limits marking area" around the suction pits.

When the **2C** cell starts to be landfilled northward:

- the 110 meter section of the northern outer road.
- the 350 meter section of the **south-north** inner roads.

should also be landfilled at the same time except the "off-limits marking area" around the suction pits.

The same manner of landfilling operation should be repeated for the other cells as well.

j. Approach Road to 8.0 Meter Elevation

An approach road (ramp) to the 8.0 meter elevation should be planned prior to any work to be implemented from the 8.0 meter elevation.

As the trailers pass the weighbridge located in the entrance of the BP-V site, the ramp is recommended to be located at the No. 1A Cell. The slope will have to be about 5.0% (8.0 meter lift on 160 meter approach) considering the trafficability in all weather condition.

The width of this ramp **(5% slope)** should be wide enough only to have **one-way** traffic of trailers. When the landfilling operation of 8.0 to 16.0 meter elevation takes place, traffic volume on the ramp becomes large, then at that time, this ramp (5% slope) should be exclusively used as ascending ramp and **another descending ramp (e.g. 10 to 15% slope)** will have to be provided at an appropriate location by that time.

k. Expansion of Vertical Shaft and Landfilling of Off-limits Marking Area

Works of vertical shafts expansion should be started, when landfilling (up to 8.0 meter elevation) operation nearby finishes.

This time, access for the works of "vertical shaft extension" and "off-limits marking area landfilling" should be from 8.0 meter elevation. These two types of works should **alternately** be raised by **a few meters height**, so that the vertical shaft expansion works can be easily and properly implemented.

l. Leachate Pump-Up and Spray (and/or Impound) on 8.0 Meter Elevation

When the off-limits marking area around vertical shaft is filled and flat 8.0 meter elevation areas are formed, leachate should be pumped up and sprayed (and/or impounded) at the flat area to be evaporated or re-infiltrated to the landfill.

m. Roads on 8.0 Meter Elevation

When the BP-V landfill is going to be raised above 8.0 meter elevation, the outer ring roads on 8.0 meter elevation should be maintained as "monitoring and maintenance" roads. In response to this concept, coordinates of the outer roads on 8.0 meter elevation should be determined.

After the landfill is raised from 8.0 to 16.0 meter elevation, inner roads on 8.0 meter elevation should be utilized as leachate drainage lines. Therefore, when the landfill is raised to 8.0 meter elevation, the inner roads should be constructed with volcanic porous rocks, which are estimated to be cheap as a road construction material, and it will later work as French drain of leachate. The volcanic porous rocks should be laid thick enough to attain trafficability of trailers on 8.0 meter elevation roads, since they lie on highly compressible buried wastes.

The inner roads on 8.0 meter elevation should be constructed just a little off-set from the vertical shafts, as the roads should later function as leachate drainage lines, the drainage lines of volcanic porous rocks on 8.0 meter elevation should be connected to the vertical shafts nearby.

n. Landfilling Sequence of 8.0 to 16.0 Meter Elevation

In general, it might be recommendable that the second level landfilling should be started from the central part to outer area considering to promote stable settlement and consolidation and further to reduce the small possibility of slope failure on 0.0-8.0 meter landfills by spending more time to allow consolidation of ground under slopes.

Meanwhile, when expecting better trafficability on 16.0 meter elevation roads in the future, the cell which receives an approach ramp from 8.0 meter to 16 meter elevation should be initially constructed in order to allow longer time for stable settlement and consolidation of the cell.

Therefore, it is recommended that the landfilling of 8.0-16.0 meter should start from the cell that will later receive the approach ramp (8.0 to 16.0 meter), which will be about 100 meter offset from the ascending ramp of 0.0 to 8.0 meter.

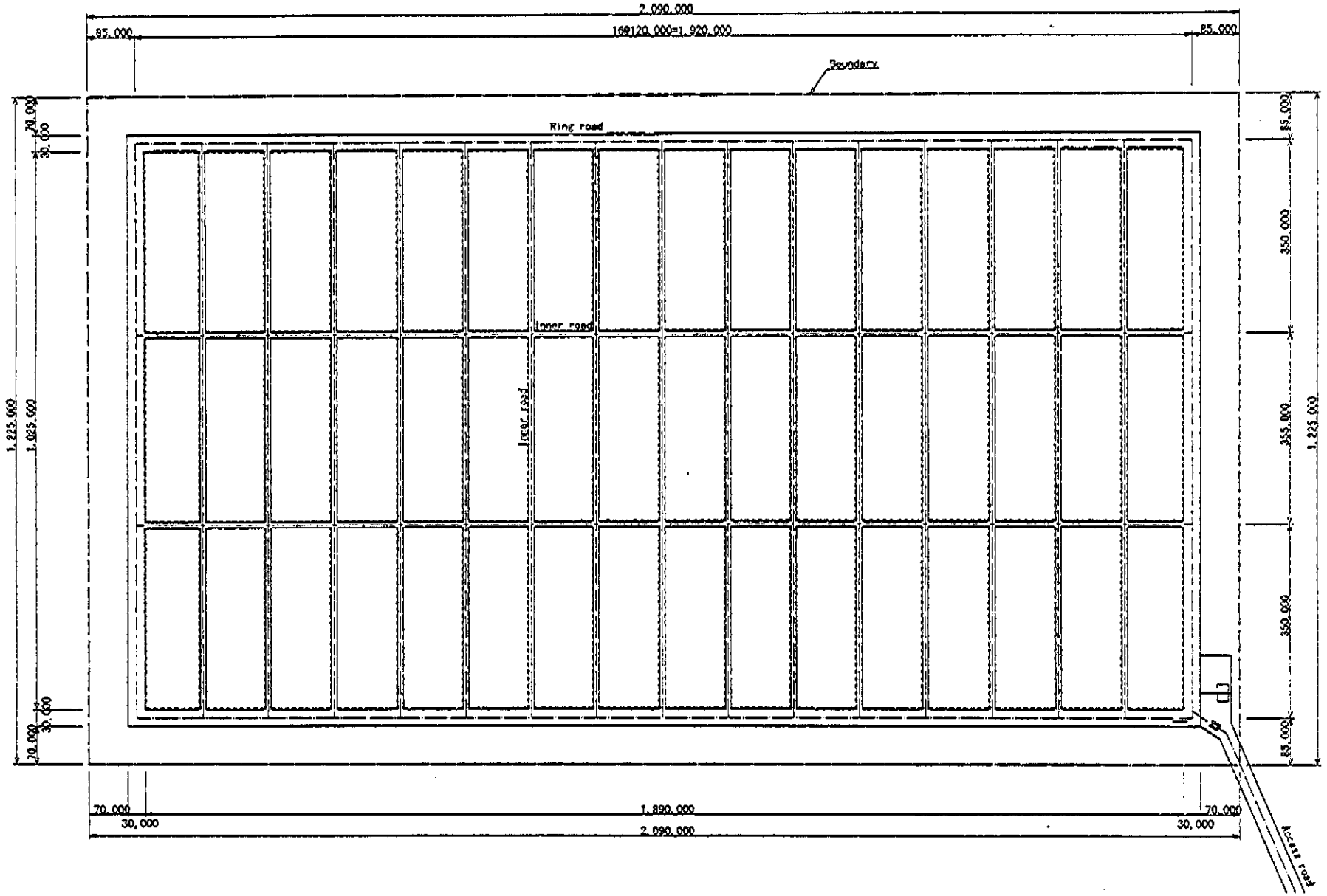


Figure H-27: Plan of First Lift (0m elevation)

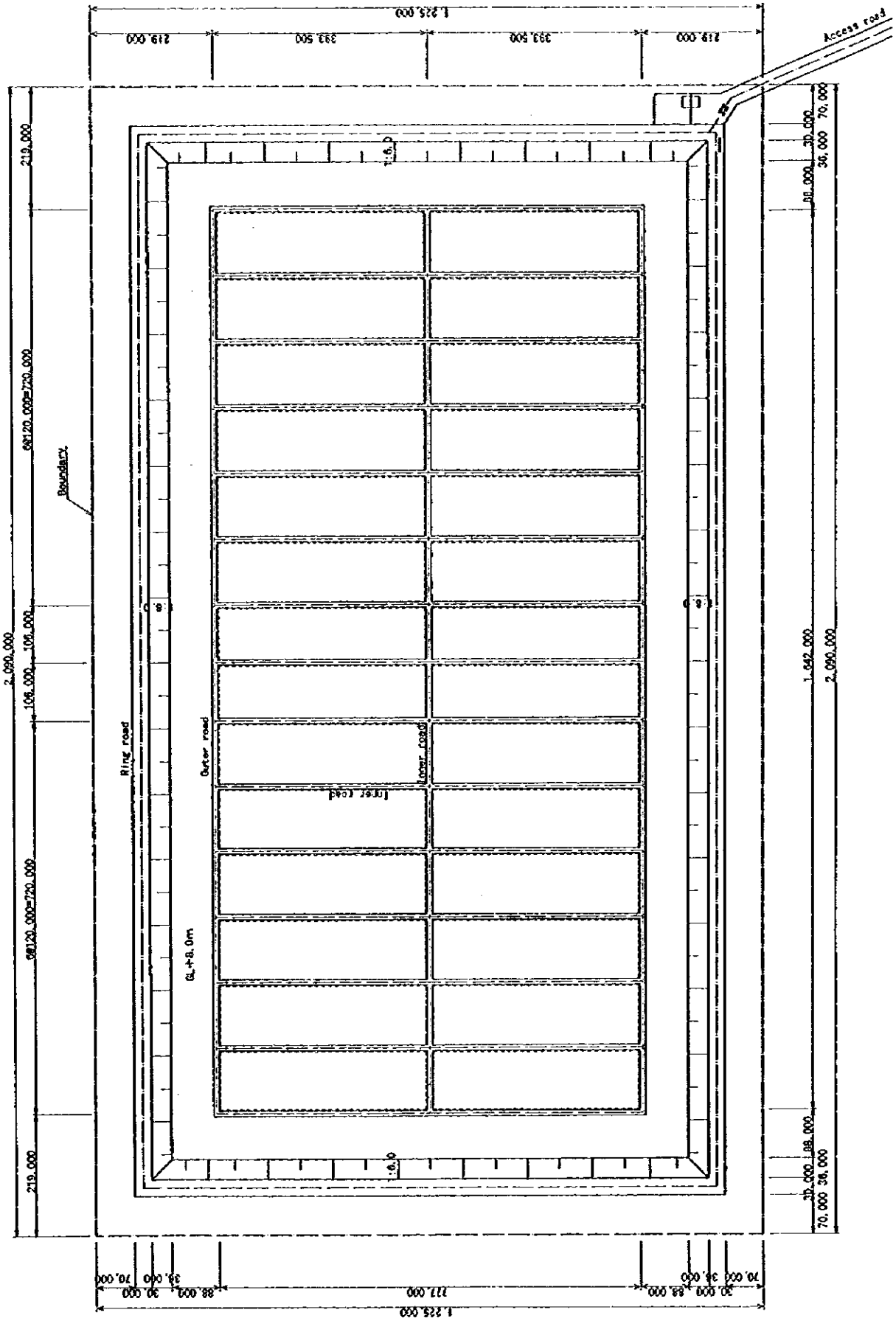


Figure H-28: Plan of Second Lift (8m elevation)

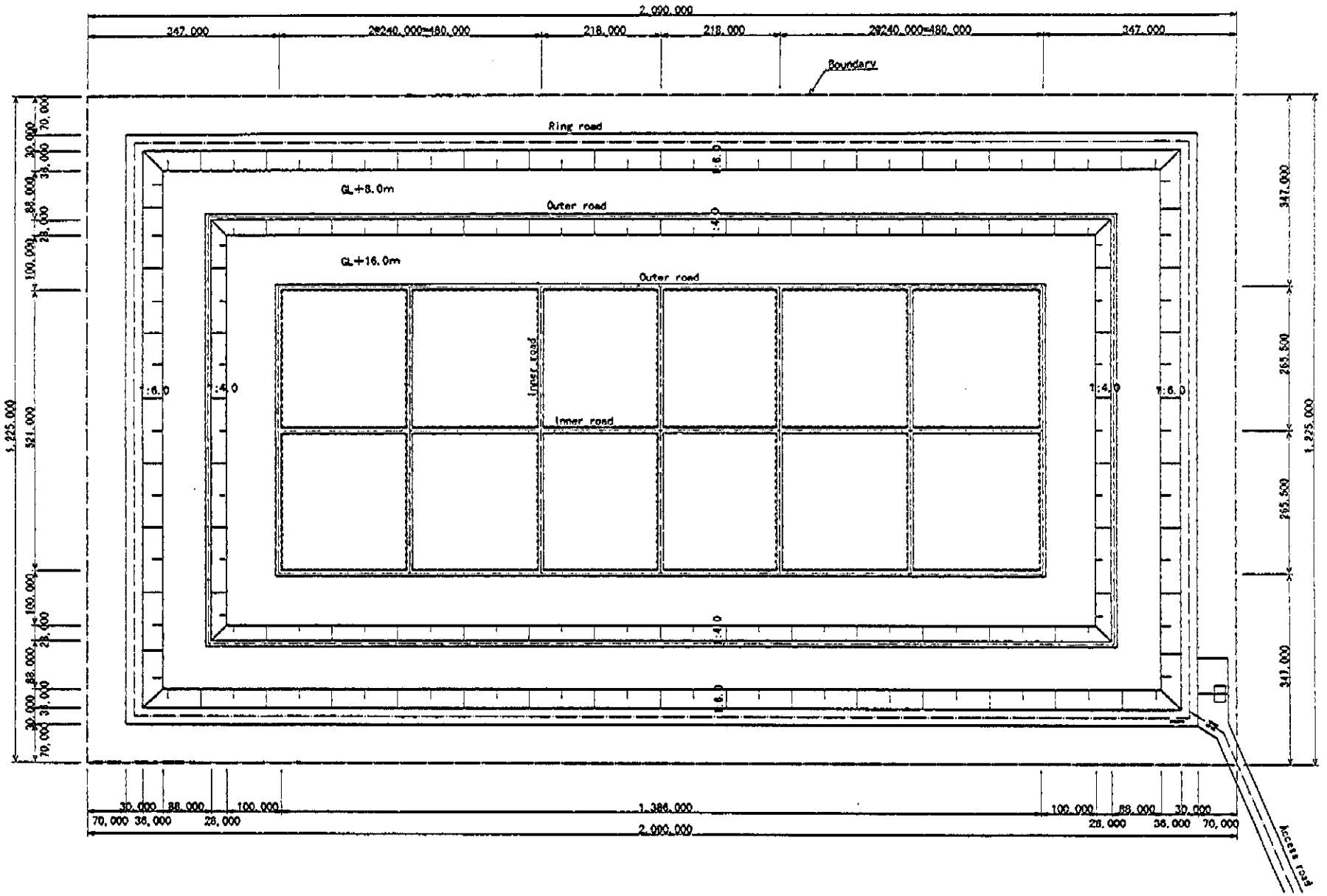


Figure H-29: Plan of Third Lift (16m elevation)

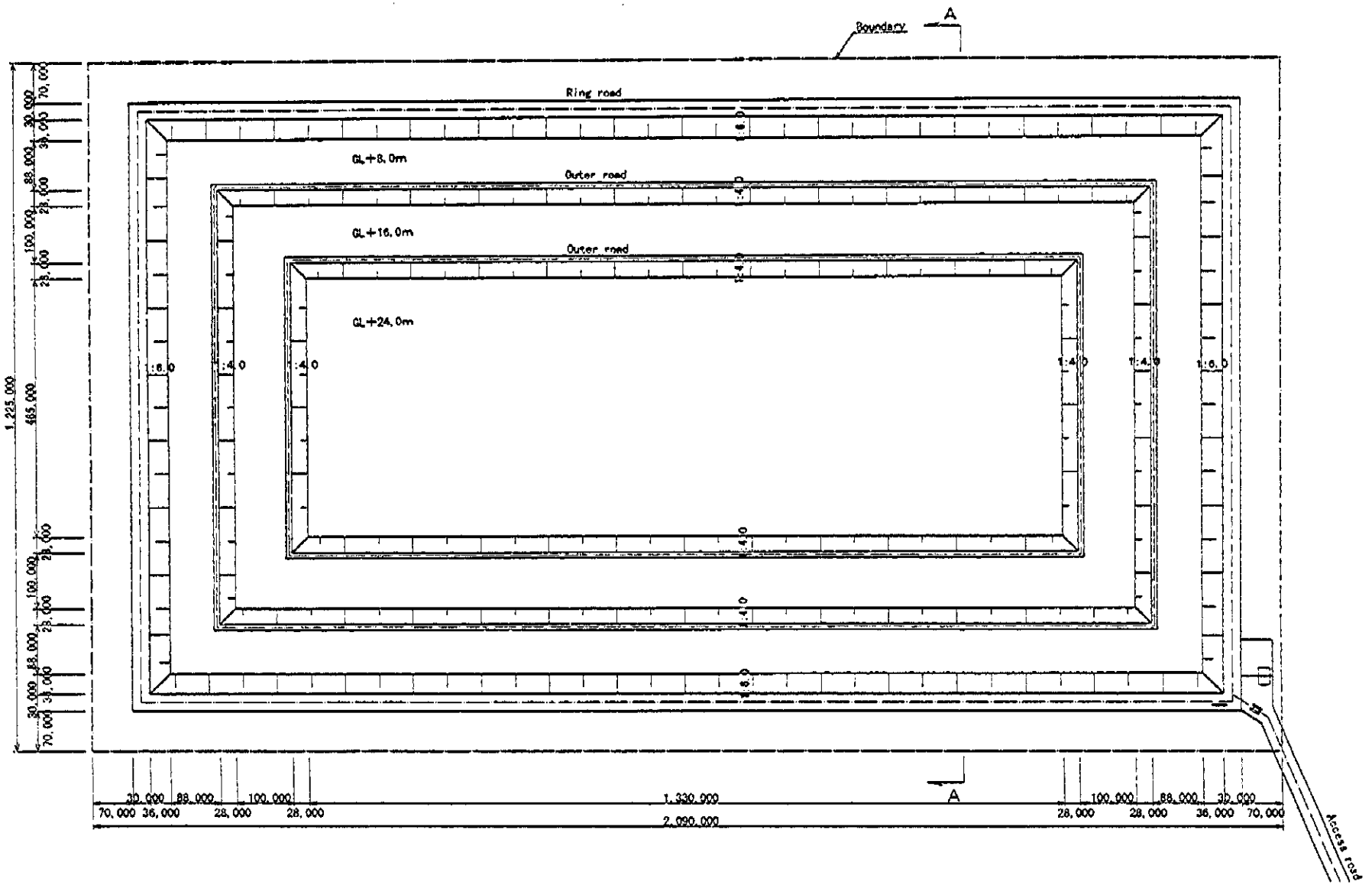


Figure H-30: Plan of Finished Landfill

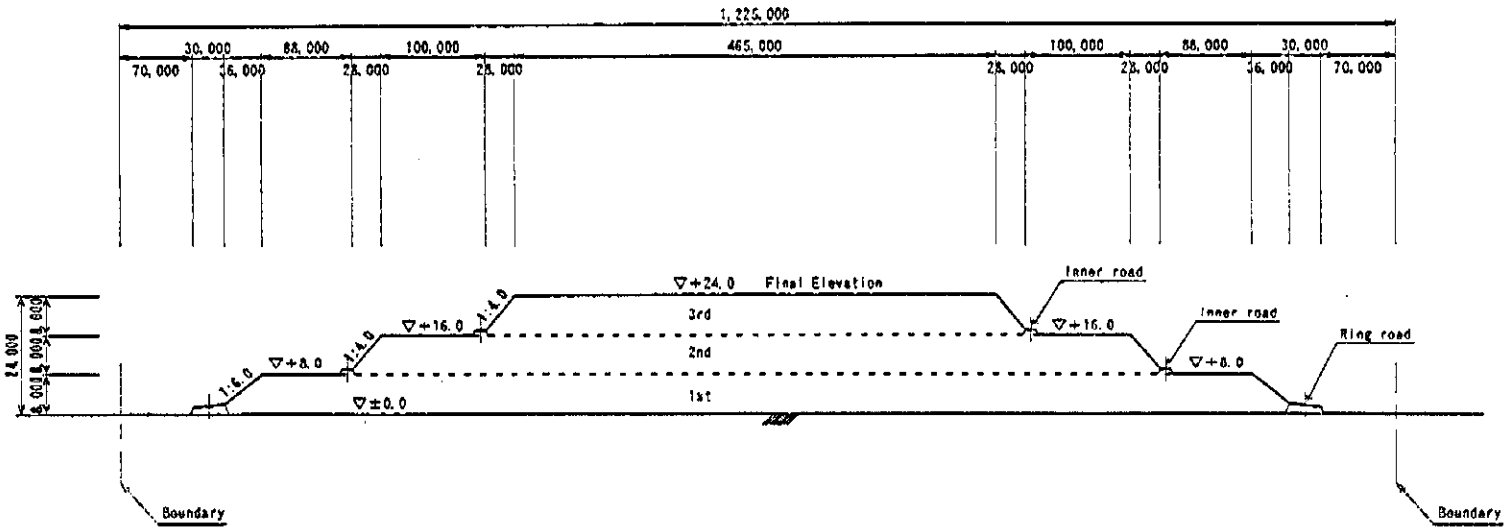
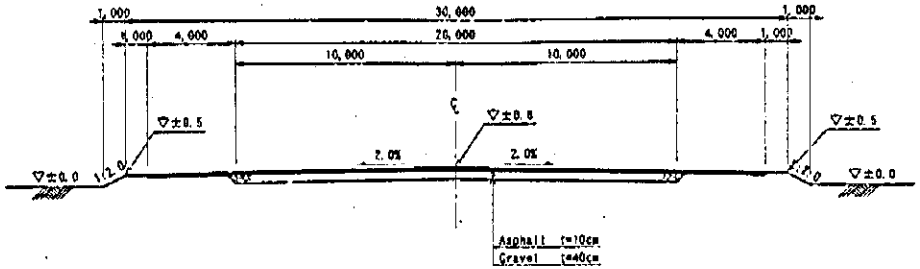
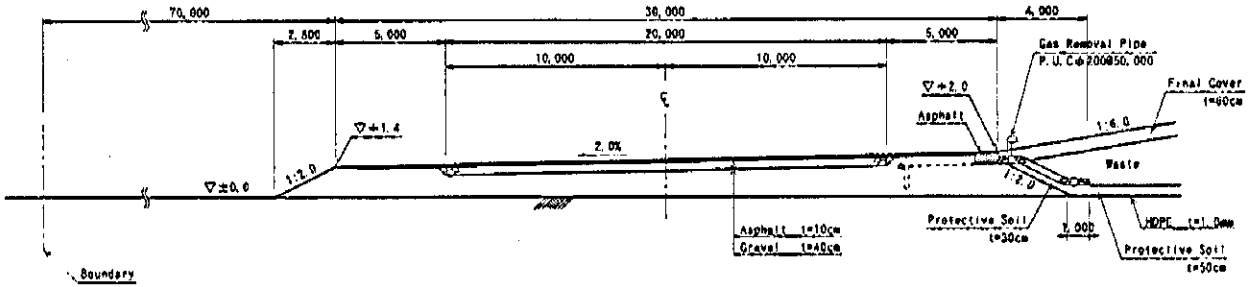


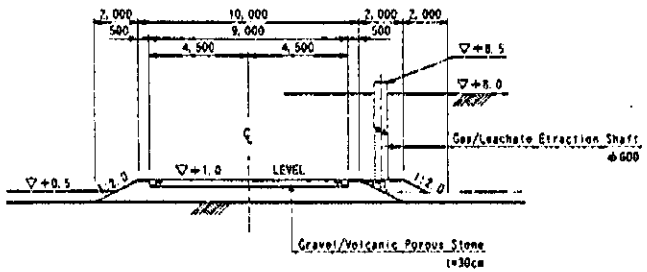
Figure H-31: Cross Section



CROSS SECTION OF ACCESS ROAD



CROSS SECTION OF RING ROAD



CROSS SECTION OF INNER ROAD

Figure H-32: Cross Section of Roads

c.11 Cost Estimates

Two cases are set for operation of the Etapa V landfill as in the case of the Etapa IV landfill. Cost estimates are also carried out in Case 1 and Case 2 respectively.

- Case 1: Investment and operation by the DGSU.
- Case 2: Investment by the DGSU and contracting out operation.

i. Case 1

Construction

Construction costs of US$ 32,101,000 until 2010 was estimated as shown in Table H-63. Table H-64 explains construction costs until closure of the landfill.

Table H-63: Construction Costs for A New Landfill Development until 2010

			Unit construction costs per ton of waste			8-16m	16-24m
					(US$/ton)	2.0682	0.6088
Year	Waste amount (1000ton)			Costs for landfill construction (US$ 1,000)			
				Design and supervision	Initial construction	Construction while operation	Total
	0-16m	8-16m	Total			0-8m 8-16m	
1999-2000			-	41			41
2000			-	204			204
2001			-	162	4,068		4,230
2002	3,609		3,609			7,464 0	7,464
2003	3,493		3,493			7,224 0	7,224
2004	3,385		3,385			7,001 0	7,001
2007	1,289	2,051	3,340			2,666 1,249	3,915
2008		3,321	3,321			0 2,022	2,022
Total	11,776	5,372	17,148	407	4,068	24,355 3,271	32,101

Table H-64: Construction Costs for A New Landfill Development until Closure

	Description	Quantity	Unit	Exchange rate, $1.00= 9.1 Pesos				
				Unit rate	Currency	Amount		
						Domestic		Foreign
						(th. Peso)	(th. US$)	(th. US$)
1	Site preparation							
1.1	site clearing	2,116,000	m^2	5	peso	10,580	1,163	
1.2	removal of salt making well	40	nos	10,000	peso	400	44	
2	Access							
2.1	access road	605	m	3,820	peso	2,311	254	
2.2	bridge	1	unit	3,220,000	peso	3,220	354	
2.3	gate	1	unit			Use of the existing gate		
2.4	lookout post	1	unit			Use of the existing gate		
3	Reception area							
3.1	weighbridge	2	unit	100,000	US$			200
3.2	tire washing pit	1	unit	20,500	peso	21	2	
3.3	site office	1	unit	750,000	peso	750	82	
3.4	garage	1	unit	450,000	peso	450	49	
3.5	water tank	1	unit	50,000	peso	50	5	
3.6	car park	2,700	m^2	190	peso	513	56	
3.7	storage yard	3,340	m^2	120	peso	401	44	

	Description	Quantity	Unit	Exchange rate, $1.00= 9.1 Pesos				
				Unit rate	Currency	Amount		
						Domestic		Foreign
						(th. Peso)	(th. US$)	(th. US$)
4	Fence	6,630	m	30	peso	199	22	
	sub-total						2,075	200
	Miscellaneous(*2)	10	%				208	20
Direct cost							2,283	220
General expenses and overhead		30	%				685	66
Total construction cost							2,968	286
Design and supervision(*1)		10	%				297	29
Sub-total cost							3,265	315
Physical contingency		10	%				327	32
IVA		15	%				490	47
Total cost (inc. conti. & tax)							4,082	394
Total cost (domestic+foreign)							4,476	
5	0-8 Elevation							
5.1	ring road	5,950	m	4,000	peso	23,800	2,615	
5.2	inner road	19,155	m	550	peso	10,535	1,158	
5.3	leachate collection (along ring road)	5,950	m	210	peso	1,250	137	
5.4	leachate collection (along inner road)	19,155	m	300	peso	5,747	632	
5.5	gas extraction (along ring road)	118	nos	200	peso	24	3	
5.6	leachate & gas extraction well	131	nos	8,000	peso	1,048	115	
5.7	bottom liner							
a	HDPE (1mm)	2,025,600	m2	1.70	US$			3,444
b	HDPE (1mm) installation	2,025,600	m2	3	peso	6,077	668	
c	protective soil (inc. installation)	1,012,800	m3	30	peso	30,384	3,339	
5.8	cover soil (0.3m)	581,175	m^3	22	peso	12,786	1,405	
5.9	pump (50mm, H=30m)							
5.10	electric work	1	unit	1,000,000	peso	1,000	110	
	sub-total						10,182	3,444
	Miscellaneous	10	%				1,018	344
Direct cost							11,200	3,788
General expenses and overhead		30	%				3,360	1,136
Total construction costs							14,560	4,924
Physical contingency		10	%				1,456	492
IVA		15	%				2,184	739
Total cost (inc. conti. & tax)							18,200	6,155
Total cost (domestic+foreign)							24,355	
(Unit cost, $/ton of waste)		11,776	th.ton				2.0682	
6	8-16 Elevation							
6.1	outer road	4,878	m	550	peso	2,683	295	
6.2	inner road	11,743	m	550	peso	6,459	710	
6.3	leachate collection (along outer road)	4,878	m	210	peso	1,024	113	
6.4	leachate collection (along inner road)	11,743	m	300	peso	3,523	387	
6.5	gas extraction (along ring road)	96	nos	200	peso	19	2	
6.6	leachate & gas extraction well	91	nos	8,000	peso	728	80	
6.7	cover soil (0.3m)	382,750	m^3	22	peso	8,421	925	
	sub-total						2,512	0
	Miscellaneous	10	%				251	0
Direct cost							2,763	0
General expenses and overhead		30	%				829	0
Total construction costs							3,592	0
Physical contingency		10	%				359	0
IVA		15	%				539	0
Total cost (inc. conti. & tax)							4,490	0
Total cost (domestic+foreign)							4,490	
(Unit cost, $/ton of waste)		7,375	th.ton				0.6088	

	Description	Quantity	Unit	Exchange rate, $1.00= 9.1 Pesos				
				Unit rate	Currency	Amount		
						Domestic		Foreign
						(th. Peso)	(th. US$)	(th. US$)
7	16-24 Elevation							
7.1	outer road	3,854	m	550	peso	2,120	233	
7.2	inner road	3,991	m	550	peso	2,195	241	
7.3	leachate collection (along outer road)	3,854	m	210	peso	809	89	
7.4	leachate collection (along inner road)	3,991	m	300	peso	1,197	132	
7.5	gas extraction (along ring road)	76	nos	200	peso	15	2	
7.6	leachate & gas extraction well	55	nos	8,000	peso	440	48	
7.7	cover soil (0.3m)	216,632	m3	22	peso	4,766	524	
	sub-total						1,269	0
	Miscellaneous	10	%				127	0
Direct cost							1,396	0
General expenses and overhead		30	%				419	0
Total construction costs							1,815	0
Physical contingency		10	%				182	0
IVA		15	%				272	0
Total cost (inc. conti. & tax)							2,269	0
Total cost (domestic+foreign)							2,269	
(Unit cost, $/ton of waste)		4,074	th.ton				0.5569	
8	Final cover (t=0.6)	968,625	m3	22	peso	21,310	2,342	
	sub-total						2,342	0
	Miscellaneous	10	%				234	0
Direct cost							2,576	0
General expenses and overhead		30	%				773	0
Total construction costs							3,349	0
Physical contingency		10	%				335	0
IVA		15	%				502	0
Total cost (inc. conti. & tax)							4,186	0
Total cost (domestic+foreign)							4,186	
(Unit cost, $/ton of waste)		-	th.ton					
Total construction cost (exc. conti.& tax)							26,284	5,210
Physical contingency		10	%				2,628	521
IVA		15	%				3,943	782
Total construction cost (inc. conti.& tax)							32,855	6,513
Total construction cost (domestic+foreign)							39,368	
Design and supervision (exc. conti.& tax)							297	29
Physical contingency		10	%				30	3
IVA		15	%				45	4
Design and supervision (inc. conti.& tax)							372	36
Design and supervision (domestic+foreign)							408	
Total cost (inc. conti. & tax)							33,227	6,549
Total cost (domestic+foreign)							39,776	
(Unit cost, $/ton of waste)		23,323	th.ton				1.7054	

Notes: (*1) 10% of design and supervision will be used for basic design, 50% for detailed design and 40% for supervision.
(*2) The cost includes a certain countermeasure for protection of fauna in the site.

Landfill Equipment

Table H-65 shows costs for procurement of the landfill equipment in Case 1. The disbursement is to be required in 2007. The equipment will also be used in Etapa IV.

Table H-65: Costs for Landfill Equipment (Case 1)

	Description	Quantity	Unit	Exchange rate, $1.00= 9.1 Pesos		
				Unit rate	Currency	Amount (US$ 1,000)
1	Bulldozer (300hp)	4	nos	400,000	US$	1,600
2	Excavator (85hp)	2	nos	110,000	US$	220
3	Sprinkler truck (15000litre)	2	nos	100,000	US$	200
	sub-total					2,020
	spare parts	10	%			202
Equipment cost (exc. conti.& tax)						2,222
Physical contingency		10	%			222
IVA		15	%			333
Equipment cost (inc. conti.& tax)						2,777
Design and supervision (exc. conti.& tax)		5	%			111
Physical contingency		10	%			11
IVA		15	%			17
Design and supervision (inc. conti.& tax)						139
Total cost (inc. tax&conti.)						2,916

Operation and Maintenance

O&M costs for landfilling require the same amount of expenditure for that in Etapa IV, i.e., US$ 707,000 /year (See Table H-43).

As to leachate disposal, initial installment of pumps is to be carried out in 2004. After the initial installment, replacement of the pumps will be required every two years.

Table H-66: Initial Installment Costs for Leachate Disposal Pumps (Etapa V)

	Description	Quantity	Unit	Exchange rate, $1.00= 9.1 Pesos		
				Unit rate	Currency	Amount (US$ 1,000)
1	Pump (50mm, 3.7kw)	15	unit	5,000	US$	75
Physical contingency		10	%			8
IVA		15	%			11
Total						94

Pump's lifetime is expected to be 2 years.

Table H-67: Replacement Costs for Leachate Disposal Pumps (Etapa V)

	Description	Quantity	Unit	Exchange rate, $1.00= 9.1 Pesos		
				Unit rate	Currency	Amount (US$ 1,000)
1	Pump (50mm, 3.7kw)	15	unit	3,000	US$	45
Physical contingency		10	%			5
IVA		15	%			7
Total						57

Pump's lifetime is expected to be 2 years.

Table H-68: Operation Costs for Leachate Disposal Pumps

	Description	Quantity	Unit	Exchange rate, $1.00= 9.1 Pesos			
				Unit rate	Currency	Amount	
						(1,000 peso)	(US$ 1,000)
1	Electricity consumption	121,500	kWh	0.83	peso	101	11
IVA		15	%			15	2
Total							13

Land Rental Fee

US$ 231,000 will be disbursed annually (See Table H-69).

Table H-69: Land Rental Fee (Etapa V)

	Description	Quantity	Unit	Exchange rate, $1.00= 9.1 Pesos			
				Unit rate	Currency	Amount	
						(1,000 peso)	(US$ 1,000)
1	Land rental fee	256	ha	8,200	peso	2,099	231

ii. Case 2

Construction

Costs of construction is the same as those of Case 1, i.e., US$ 32,101,000 until 2010 (See Table H-63).

Landfill Equipment

Costs for the landfill equipment in Case 2 is the same as those in Case 2 of the Vertical Expansion Plan, i.e., US$ 901,000 /year (See Table H-47).

Operation and Maintenance

O&M costs for landfilling is the same as those in Case 2 of the Vertical Expansion Plan, i.e., US$ 598,000/year (See Table H-49). Operation costs for leachate disposal is the same amount of those for Case 1 (See Table H-66, Table H-67 and Table H-68).

Land Rental Fee

Land rental fee is the same as those of Case 1 (See Table H-69).

iii. Summary

Table H-70 and Table H-71 summarize the costs for the New Landfill Development (Etapa V). The costs estimated for Case 1 was US$ 41,205,000, while Case 2 was US$ 42,249,000.

Table H-70: Summary of Costs for A New Landfill Development (Case1)

unit: US$ 1,000

Year	B/D	D/D	Con. (Ini.)	Con(Rec)	Equip.	O&M	Land fee	Total
1999	41							41
2000		204						204
2001		162	4,068				231	4,461
2002				7,464		707	231	8,402
2003				7,224		707	231	8,162
2004				7,001		801	231	8,033
2005						13	231	244
2006						70	231	301
2007		139		3,915	2,777	720	231	7,782
2008				2,022		777	231	3,030
2009						13	231	244
2010						70	231	301
Total	41	505	4,068	27,626	2,777	3,878	2,310	41,205

B/D: Basic design for construction and equipment.
D/D: Detailed design for construction and equipment. The amount complies costs for supervision as well.
Con. (Ini): Initial investment cost for construction
Con(Rec): Recurrent cost for construction
Equip.: Landfill equipment
O&M: Operation and maintenance
Land fee: Land rental fee

Table H-71: Summary of Costs for A New Landfill Development (Case 2)

unit: US$ 1,000

Year	B/D	D/D	Con. (Ini.)	Con(Rec)	Equip.	O&M	Land fee	Total
1999	41							41
2000		204						204
2001		162	4,068				231	4,461
2002				7,464	901	598	231	9,194
2003				7,224	901	598	231	8,954
2004				7,001	901	692	231	8,825
2005						13	231	244
2006						70	231	301
2007				3,915	901	611	231	5,658
2008				2,022	901	668	231	3,822
2009						13	231	244
2010						70	231	301
Total	41	366	4,068	27,626	4,505	3,333	2,310	42,249

B/D: Basic design for construction.
D/D: Detailed design for construction. The amount complies costs for supervision as well.
Con. (Ini): Initial investment cost for construction
Con(Rec): Recurrent cost for construction
Equip.: Landfill equipment
O&M: Operation and maintenance
Land fee: Land rental fee

H.2.3 Cost of Priority Projects

Table H-72: Cost of Priority Projects, Case of Direct Operation by DGSU (Case 1)

Unit : US$ 1,000

			1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
BP Etapa IV	B/D		33	0	0	0	0	0	0	0	0	0	0	0	33
	D/D & S/V		0	298	0	0	0	0	0	0	0	0	0	0	298
	Construction		0	7,902	2,164	0	0	0	1,883	1,874	0	0	1,773	1,528	17,124
	Equipment		0	2,777	0	0	0	0	0	0	0	0	0	0	2,777
	O & M	Contract out	0	0	0	0	0	0	0	0	0	0	0	0	0
		Direct	0	0	728	111	21	111	728	818	21	111	728	818	4,195
	Land fee		0	0	425	425	425	425	425	425	425	425	425	425	4,250
	Total		**33**	**10,977**	**3,317**	**536**	**446**	**536**	**3,036**	**3,117**	**446**	**536**	**2,926**	**2,771**	**28,677**
BP Etapa V	B/D		41	0	0	0	0	0	0	0	0	0	0	0	41
	D/D & S/V		0	204	162	0	0	0	0	0	139	0	0	0	505
	Construction		0	0	4,068	7,464	7,224	7,001	0	0	3,915	2,022	0	0	31,694
	Equipment		0	0	0	0	0	0	0	0	2,777	0	0	0	2,777
	O & M	Contract out	0	0	0	0	0	0	0	0	0	0	0	0	0
		Direct	0	0	0	707	707	801	13	70	720	777	13	70	3,878
	Land fee		0	0	231	231	231	231	231	231	231	231	231	231	2,310
	Total		**41**	**204**	**4,461**	**8,402**	**8,162**	**8,033**	**244**	**301**	**7,782**	**3,030**	**244**	**301**	**41,205**
Landfill Total			***74***	***11,181***	***7,778***	***8,938***	***8,608***	***8,569***	***3,280***	***3,418***	***8,228***	***3,566***	***3,170***	***3,072***	***69,882***
Composting	B/D		50	0	0	0	0	0	0	0	0	0	0	0	50
	P/P		10	10	0	0	0	0	0	0	0	0	0	0	20
	D/D & S/V		0	164	99	33	33	0	0	0	13	2	0	0	344
	Construction		0	0	2,376	551	551	0	0	0	0	0	0	0	3,478
	Equipment		0	0	2,548	520	0	0	0	0	0	2,441	520	0	6,029
	O & M	Contract out	0	0	0	0	0	0	0	0	0	0	0	0	0
		Direct	0	0	0	662	820	820	820	820	820	820	820	820	7,222
	Land fee		0	0	33	33	33	33	33	33	33	33	33	33	330
	Total		**60**	**174**	**5,056**	**1,799**	**1,437**	**853**	**853**	**853**	**866**	**3,296**	**1,373**	**853**	**17,473**
Total			***134***	***11,355***	***12,834***	***10,737***	***10,045***	***9,422***	***4,133***	***4,271***	***9,094***	***6,862***	***4,543***	***3,925***	***87,355***
Initial Investment															
BP Etapa-IV			***33***	***10,977***											***11,010***
BP Etapa-V			***41***	***204***	***4,230***										***4,475***
Composting			***60***	***174***	***5,023***	***1,104***	***584***								***6,945***
Total			***134***	***11,355***	***9,253***	***1,104***	***584***								***22,430***

B/D : Basic design, D/D :Detailed design, S/V :Supervision, P/P : Pilot project, O&M : Operation and maintenance

Table H-73: Cost of Priority Projects, Case of Contract-Out (Case 2)

Unit : US$ 1,000

			1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
BP Etapa IV	B/D		33	0	0	0	0	0	0	0	0	0	0	0	33
	D/D & S/V		0	298	0	0	0	0	0	0	0	0	0	0	298
	Construction		0	7,902	2,164	0	0	0	1,833	1,874	0	0	1,773	1,528	17,124
	Equipment		0	0	0	0	0	0	0	0	0	0	0	0	0
	O & M	Contract out	0	0	1,499	0	0	0	1,499	1,499	0	0	1,499	1,499	7,495
		Direct	0	0	21	111	21	111	21	111	21	111	21	111	660
	Land fee		0	0	425	425	425	425	425	425	425	425	425	425	4,250
	Total		33	8,200	4,109	536	446	536	3,828	3,909	446	536	3,718	3,563	29,860
BP Etapa V	B/D		41	0	0	0	0	0	0	0	0	0	0	0	41
	D/D & S/V		0	204	162	0	0	0	0	0	0	0	0	0	366
	Construction		0	0	4,068	7,464	7,224	7,001	0	0	3,915	2,022	0	0	31,694
	Equipment		0	0	0	0	0	0	0	0	0	0	0	0	0
	O & M	Contract out	0	0	0	1,499	1,499	1,499	0	0	1,499	1,499	0	0	7,495
		Direct	0	0	0	0	0	94	13	70	13	70	13	70	343
	Land fee		0	0	231	231	231	231	231	231	231	231	231	231	2,310
	Total		41	204	4,461	9,194	8,954	8,825	244	301	5,658	3,822	244	301	42,249
Landfill Total			*74*	*8,404*	*8,570*	*9,730*	*9,400*	*9,361*	*4,072*	*4,210*	*6,104*	*4,358*	*3,962*	*3,864*	*72,109*
Composting	B/D		50	0	0	0	0	0	0	0	0	0	0	0	50
	P/P		10	10	0	0	0	0	0	0	0	0	0	0	20
	D/D & S/V		0	164	99	33	33	0	0	0	13	2	0	0	344
	Construction		0	0	2,376	551	551	0	0	0	0	0	0	0	3,478
	Equipment		0	0	1,250	177	0	0	0	0	0	1,142	177	0	2,746
	O & M	Contract out	0	0	0	1,051	1,186	1,186	1,186	1,186	1,186	1,186	1,186	1,186	10,539
		Direct	0	0	0	101	124	124	124	124	124	124	124	124	1,093
	Land fee		0	0	33	33	33	33	33	33	33	33	33	33	330
	Total		60	174	3,758	1,946	1,927	1,343	1,343	1,343	1,356	2,487	1,520	1,343	18,600
Total			*134*	*8,578*	*12,328*	*11,676*	*11,327*	*10,704*	*5,415*	*5,553*	*7,460*	*6,845*	*5,482*	*5,207*	*90,709*
Initial Investment															
BP Etapa-IV			*33*	*8,200*											*8,233*
BP Etapa-V			*41*	*204*	*4,230*										*4,475*
Composting			*60*	*174*	*3,725*	*761*	*584*								*5,304*
Total			*134*	*8,578*	*7,955*	*761*	*584*								*18,012*

B/D : Basic design, D/D :Detailed design, S/V :Supervision, P/P : Pilot project, O&M : Operation and maintenance

H.3 Institutional Plan

H.3.1 Alternatives

H.3.1.1 The Sanitary Landfill (SL)

The situation to locate the SL in the lake Texcoco area is sensitive and is subject to restrictions and audits by federal entities and by the GDF, and occasionally by authorities from the state of Mexico. The use of the land owned by the National Water Commission (CNA) was authorized under the commitment of the GDF to carry out work, monitoring and maintenance tasks in the long term. The alternation in the uses

of Etapas IV and V would be a technical decision made according to the features of the soil.

For such reason, the DGSU will have a continuous presence at the site. Therefore, it would not be very interested to give concession of the construction of infrastructure, operation and maintenance of SL to a private enterprise, and contracting out such services would be convenient.

On the other hand, these conditions suggest that the concessions are not so attractive to private enterprises as the referred contracts.

The institutional alternatives induce the analysis of three options:

- **SL.1 - Direct administration and operation** by the GDF through the DGSU.
- **SL.2 - Direct administration** by DGSU, and operation through **contracts.**
- **SL.3** - To create a **parastatal entity** to manage and operate the SL; either directly or not.

To be noticed that the investment in the sanitary landfills will be on the part of the GDF in any alternative chosen, and be carried out in Phase I. Besides, the selection of the alternative of operation of the SL will be effective as of year 2002 (Table 8-39).

H.3.1.2 The Composting Plant (CP)

The composting plant is a production unit of a scarcely attractive industry due to the difficulty to sell the product or unless the potential consumers are correctly oriented and convinced of the need for compost.

As long as it is industry, the CP is part of a waste flow, but it is also clear that it is not a simple urban cleaning activity.

There is a lack of financial and administrative autonomy for a public sector entity to manage and direct a self-sustainable industrial enterprise. Meanwhile, it should be considered that the economic self-sustainability of the compost industry depends on the purchase of the product by the GDF.

The investment on the CP will be carried out by the GDF in Phase I. However, its operation and commercialization of the compost product will be analyzed and chosen from one of the following options, with its operation beginning as of year 2002 (Table II-74):

A1. Direct operation by DGSU.

A2. Operation contracted out by DGSU.

B. Parastatal.

C. Concession.

H.3.2 Evaluation of the Alternatives

It could be said in advance that the superiority of a parastatal entity is not that much in the case of the management of a SL, where there exists no commercial or industrial activity, and the high, intrinsic indirect costs are not diluted in such a small body.

Meanwhile, this superiority would become unquestionable in case that the same parastatal entity is granted the SL and the CP.

Yet the operational costs of the option SL1 are slightly more advantageous than those of the SL2 option, it is noticed that the former might bring about the syndication of the workers of Sección 1, which in turn would affect the continuity of the final disposal process with an eventual labor strike.

For the compost industry, the option **C.- concession** would be favorable for the development of the technology of production and use of compost, since the commercialization of the product would determine the survival of the enterprise.

To make this private entity more appealing, the GDF would guarantee the consumption of a certain amount of the product.

In view of a possibility that private entities do not show interest in the composting plant, the alternative **B.- parastatal** appears to be better than the **A1. - direct administration** by the GDF from the industrial aspect of this enterprise for the following reasons:

- capacity to set its own entrepreneurial policy and the prices for the private market.
- free management of the revenues generated by its economic activity.
- own property which would be allowed for financial transactions.
- administrative authority and the obligatory internal control and auditing, which leads to a correct assessment of its performance.
- its own identity and minor political interference.
- competition to fix the salaries and fringe benefits, as well as to enter collective and individual contracts that will regulate the labor relations of the entity with its workers (Art. 63 and 64 of the Organic Law).

The autonomy degree of a parastatal entity in the Federal District has improved considerably due to the Organic Law for Public Administration for the Federal District, particularly in regard to the administration of staff and salaries, which are very sensitive items that are mentioned in this Study.

Another critical item is the acquisition of goods and the contracting of services. In this regard, the same code for the direct administration is kept, but the existence of internal control and external surveillance, as well as their higher ranked than a Direction allow the parastatal entities to manage this critical topic with more autonomy.

The intrinsic cost of a parastatal administration is high, due to the fact that its autonomy requires internal and external surveillance bodies, a board of directors, accounting systems, juridical consulting and management of human, financial and material resources similar to those in a Secretariat (which dilutes its costs among several bodies). However, costs can be cut down with greater productivity of the resources applied due to its autonomy and the minor political interference. Therefore, the advantages of a parastatal entity increase proportionally with the resources involved, the commercial relations and its productive activities.

The appropriate parastatal modality would be a **decentralized body (DC)**, since the land would be owned by the GDF only and the main purpose for it would be rendering a public service instead of making profits.

Table H-74: Options for the Operation of CP and SL

	Phase 1 (1999 - 2001)	Phase 2 (2002-2004)	Phase 3 (2005-2010)	2011-
Composting Plant	Investment by DGSU 1st Priority Financing	A1. Direct operation by DGSU, or A2. Operation contracted out by DGSU. Analysis of four options: A. Status quo (DGSU), either A1 or A2., B. Parastatal and C. Concession and prepare B or C if this options is chosen.	A1, A2, B or C.	A1, A2, B or C.
Final Disposal	Investment by DGSU 1st. Priority Financing	SL1. Direct operation by DGSU, or SL2. Operation contracted out by DGSU. Analysis of three options: Status quo (DGSU), either SL1 or SL2 and SL3. Parastatal and prepare SL3 if this option is chosen.	SL1, SL2 or SL3.	SL1, SL2 or SL3.

Note: This table shows the alternatives proposed by the JICA team, which will be further analyzed by the GDF.

H.3.3 Conclusion

The GDF has financial resources to invest in both SL and CP, taking in consideration the short term to the depletion of the SL/Etapa IV. The GDF thus may choose direct administration or parastatal form - for this last option, a decentralized organism taking over the SL and the CP would be the most suitable; however, the probable span of time and political difficulties to attain the legal acts, the budgetary and administrative resources required to constitute a parastatal seem to indicate **direct administration** as the most opportune form to manage the SL and the CP.

The weak points of the direct administration would be attenuated through contracting out infrastructure works and operation and maintenance services. In the course of time, it will be possible to evolve to better alternatives, previously evaluated as anticipated in Table G-24 of the Master Plan.

H.4 Public Education Plan

H.4.1 Introduction

The Public Education Program presented in item G.2.4.2 provides for the guidelines and steps to develop this important component in the process for the implementation of the Master Plan, up to the year 2010. The said proposal outlines the objectives, components, phases, executing unit and programs for the Master Plan as a whole. Table H-75 summarizes the Public Education Program to be implemented in the 1999-2010 period.

Table H-75: Public Education Program

Phase 1 1999-2001	Phase2 2002-2004	Phase 3 2005-2010	Phase 4 2011
• Creation of the Executing body within the GDF • Preparation of the educational programs with the participation of delegations • Information to the community • Sensitization and talks • Starting the educational program for the separation at the source within the subsystem • Starting the training program for the personnel • Promotion of the environmental education in elementary schools	• Intensive education for the separation at the source of organic and recyclable material, according to the plan established • Staff training • Fostering the school education • Education for the separation at the source of recyclable materials within the delegations	• Continuation of the training program • Continuation of the program for the separation at the source (system working in the delegations) • Continuation of the maintenance stage of other educational projects • Intermediate evaluation (2005) • Intermediate readjustment of the program	• Final assessment (2011) • Readjustment of the Public Education Program

H.4.2 Education Plan for Priority Projects

Next, the educational activities to be developed are outlined to facilitate the implementation of the projects whose feasibility studies were conducted during Phase II of the Study.

a. Priority Projects

The selection of the Priority Projects that are planned to be implemented in the short term (Phase 1: from 1999 to 2001) are shown in the Master Plan. Consequently, during the second study work in Mexico, the feasibility studies of the three priority projects were conducted: Composting Plant, Etapa IV and Etapa V of Bordo Poniente sanitary landfills.

The feasibility of the composting plant relies mainly on the separation of organic material at the source. Likewise, the separation of recyclable materials at the source will bring a longer useful life span of the sanitary landfill. In this separation of materials, community participation -specially from children- will provide sustainability to the process. Besides, training of the personnel involved in the three projects will also be required.

b. Specific Education Plan for Priority Projects

Within the Public Education Program shown in the previous items, the component of the Public Education Plan that facilitates the implementation of the three priority projects is shown next. Therefore, such plan will have to encompass three main elements:

- Separation at the source.
- Personnel training.

- Promotion to the school education.

Table H-76 shows the educational plan for the priority projects during the period 1999-2010.

Table H-76: Educational program for Priority Projects

Educational components	Phase 1 1999-2001	Phase 2 2002-2004	Phase 3 2005-2010
1. Composting Plant			
1.1 Education to market traders to separate organic resources at the source.			
1.2 Education of users in the subsystem on the separation of garden wastes and organic material at the source.			
1.3 Education of users in the delegations on the separation of garden wastes and organic material at the source. (Activity subject to a greater demand of the composting plant)			
1.4 Staff training in public parks to prepare pruned tree branches and organic material to be delivered in the collection.			
1.5 Training of separate collection staff for organic material and composting plant personnel on SWM, occupational health and environmental protection.			
2. Sanitary landfills (Etapa IV and V)			
2.1 Education of users in the subsystem on the separation of recyclable wastes at the source.			
2.2 Education of users in the delegations on the separation of recyclable wastes at the source (50% of population in the year 2010).			
2.3 Training the new staff for the collection of recyclable products and the sanitary landfill personnel (IV and V) on SWM, occupational health and environmental protection.			
3. Foster the environmental and school education			

Intensive educational stage

Education maintenance stage

c. Communication

Public education and the promotion of the educational program must be a continuous process. An effective educational and promotion program must be outlined taking into consideration the community needs. A significant amount of time and energy could be saved by analyzing public education activities that have been developed in other communities and learning from their success, such as the Solid Waste Separation Program implemented and executed by the DGSU.

Those in charge of making decisions can review the educational activities and materials utilized in other programs to sensitize the public in general. The techniques used in these campaigns to promote an idea or a new behavior can be modified to express an idea for the management of solid wastes.

The DF has several channels of communication such as the following:

- Central mass media such as newspapers, radio broadcasting and TV channels.
- Direct instruments such as posters, brochures, strip cartoons, expositions, picture shows and explanatory videos.
- Talks in schools and neighborhood associations.
- Bill contests.

Another important communication channel is represented by the associations of residents of the 16 delegations, since they can take the message to the neighbors in all the districts of the city.

H.4.3 Particulars to be Considered in the Educational Process

Some general elements to develop the Public Educational Program are presented next, specially for the project of separation of wastes at the source.

a. Phases for the Education

It is divided basically into four stages of progressive and accumulative development:

- Sensitization phase.
- Information phase.
- Education phase.
- Monitoring, follow-up and assessment phase.

The common denominator of these phases is communication.

b. Target Population ("Public")

Yet all the population in the DF is the final educational objective, the proposed activities are aimed at different population groups ("public"), according to the plan schedule: These groups are the following:

- Users in the subsystem: population who is rendered the collection service in the subsystem.
- Users in the delegations: population who is rendered the collection service in the delegations.
- Market users: population of tradesmen in the Central de Abasto and markets in the DF.

- Workers: population of workers of the GDF and private entities involved in duties of public parks, separate collection, composting plants and sanitary landfill.
- School population: children that go to elementary schools in the DF.

H.5 Financing Plan

Initially in this sub-section, the analysis and the work deliverables therewith are focused entirely on the assessment of the finance needs associated with the possible institutional alternatives and funding sources, and fiscal impacts on DGSU. This brings about the sequential discussions on and possible prioritization of the implementation alternatives under the binding conditions of coherent constraints of macro-disequilibrium that Mexico currently faces and corresponding fiscal positions of the GDF.

H.5.1 Guiding Principles for Analysis of Finance Needs Assessment

In line with the institutional framework, and the comments from DGSU as well, the indicative fund needs and the associated financing plans in each of the possible combination of project components and finance sources (*Options*) are provided herewith.

a. **Configuration**

A. Analytical Dimensions

A-1. Overall Project Cost structure
A-2. Financing Requirements and Financing Plan
A-3. Cash Flow Structure

B. Variables and Variations included in Analytical Framework

B-1. Implementation Framework (Cases) and Project Components in concern

Case 1: All three components, vis-à-vis, Final Disposal Sites (FDSs, Etapa IV and Etapa V) and Compost Plant being internalized within DGSU

Case 2: FDSs and Composting Plant are constructed by DGSU and Operated on Contract-Out basis by the private sector business undertaking

With the foregoing in view:

B-2. Institutional Framework by Implementation Framework and Project Components

Alternative 1: FDSs and Compost Plant in Case 1

Alternative 2: FDSs and Compost Plant in Case 1 and Case 2, in that order

Alternative 3: FDSs and Compost Plant in Case 2 and Case 1, in that order

Alternative 4: FDSs and Compost Plant in Case 2

B-3. Financing Sources

Category 1. Own Fund (Equity) Only

Category 2. Equity-Loan Mix

Sub-C 1. World Bank-type (interest capitalized)

Sub-C 2. OECF-type (interest not capitalized)

C. Evaluation Criteria

C-1. Ability to Pay (Aggregate Project Costs)

C-2. Affordability - Annual Cash Outlays within DGSU over the period

b. Schematic Framework - Combination of Variables and Variation

In view of the foregoing, the schematic framework for the analysis in concern will be summarized as follows.

Table H-77: Institutional Framework (Cases)

		Compost Plant	
		Case 1	Case 2
Final Disposal Sites	Case 1	Alternative 1	Alternative 2
	Case 2	Alternative 3	Alternative 4

Table H-78: Funding Source

	Own Fund	External Fund: Equity-Loan mix	
		World Bank-type	OECF-type
Alternative 1	Option 1	Option 5	Option 9
Alternative 2	Option 2	Option 6	Option 10
Alternative 3	Option 3	Option 7	Option 11
Alternative 4	Option 4	Option 8	Option 12

c. Operational Presumptions

In proceeding with the analysis of finance needs as spelled out above, presumptions in project operation are reiterated somewhat in detail are set forth herewith.

c.1 Finance Needs for FDSs and Composting Plant (Case 1)

DGSU will be in a position to finance the costs of establishment, initial investment, and operation and maintenance (O/M) either in the form of cash or cash-in-kind.

c.2 Finance Needs for FDSs and Composting Plant (Case 2)

DGSU will, in lieu of operation and maintenance of management and facilities, assume the contract to cover the operation costs accrued under the management of private firms, while presumably keeping a rate of return covenant that ensures the certain rate of profit to the firm.

c.3 Expedient Borrowing of External Fund for Initial Investment

Should GDF/DGSU through the Federal Government of Mexico introduce external loan in a paucity of own fund, the borrowing will only be shed to the initial investment outlays, whereas the remaining recurrent costs are borne out by DGSU.

H.5.2 Financing Plan – Finance Needs Assessment, Sources of Fund, and Associated Cash Flows

The numerical assumptions set for the finance needs estimation include: (i) project life, (ii) cost recovery, (iii) foreign exchange quotation, (iv) cost estimation (base cost), (v) physical contingency factor, (vi) price escalation factor, (vii) financial terms, (viii) O/M costs, (ix) interest during construction (IDC), and (x) Equity-Loan Mix. Parameters used for the specific estimation are postulated and summarized in Data M. The work outcomes in accounting term are summarized below. Funds from all principal sources are presumably identified as line items in each of the project components in the financing plan, while being set out in terms of foreign currencies for and grouped in the tables herewith.

a. Funding Requirements by Project Component and Funding Source

In the context of the technical cost estimates as reflected in the preceding section, the financial costs of initial investment exclusive of interest during construction (IDC) are estimated at P. 274.8 million (US$ 30.2 million), P. 267.5 million (US$ 29.4 million), P. 286.7 million (US$ 31.5 million), and P. 279.4 million (US$ 30.7 million) as per 1998 price for the Alternatives 1, 2, 3, and 4, respectively. In addition, the aggregate financial costs inclusive of the costs of operation and maintenance worked out respective of P. 767.1 million (US$ 84.3 million), P. 776.2 million (US$ 85.3 million), P. 786.2 million (US$ 86.4 million), and P. 795.3 million (US$ 87.4 million), in that order above. Should the occasion arises, accumulated financial costs of the expedient borrowing of P. 273.0 million (US$ 30.0 million) for initial investment are estimated at respective of P. 1,116.6 million (US$ 122.7 million), P. 1,109.3 million (US$ 121.9 million), P. 1,084.7 million (US$ 119.2 million), and P. 1,084.7 million (US$ 119.2 million) for each of the Alternatives in ascending order from 1 through 4, while assuming the loan conditions of international lending institution[7]. Alternatively, the aggregate financial burden liable to the government of the Federal District (GDF) turned out to be P. 1,547.0 million (US$ 170 million) for each of the Alternatives considered when the fund comes from bi-lateral lending institution.

In a bid to take a glance at a number of figures alike, a summary table providing the above work deliverables, vis-à-vis, the aggregate project costs by project and cost components, and debt service accrued is given below as Table H-79.

[7] Difference is made due to the variation in disbursement schedule during loan period. Note that, when borrowing is made from international lending institutions, interests accrued during loan period are capitalized, thus making different "principals" and associated amortization in the end of loan period and during repayment period.

Table H-79: Financial Costs by Combination of Component and Funding Source

	Initial Investment	Recurrent Costs	Total 1/	Amortization	
				World Bank-type	OECF-type
Alternative 1					
Etapa IV	13.3	15.0	28.3		
Etapa V	5.9	28.7	34.6		
Sub-total	19.3	43.7	62.9		
Compost Plant	10.9	10.5	21.4		
Total	30.2	54.1	84.3	122.7	170.0
Alternative 2					
Etapa IV	13.3	15.0	28.3		
Etapa V	5.9	28.7	34.6		
Sub-total	19.3	43.7	62.9		
Compost Plant	10.1	10.5	22.4		
Total	29.4	55.9	85.3	121.9	170.0
Alternative 3					
Etapa IV	9.9	14.0	23.9		
Etapa V	10.6	30.4	41.4		
Sub-total	20.6	44.4	65.0		
Compost Plant	10.9	10.5	21.4		
Total	31.5	54.9	86.4	119.2	170.0
Alternative 4					
Etapa IV	9.9	14.0	23.9		
Etapa V	10.6	30.4	41.1		
Sub-total	20.6	44.4	65.0		
Compost Plant	10.1	12.3	22.4		
Total	30.7	56.7	87.4	119.2	170.0

1/ exclusive of interest during construction (IDC)

b. Funding Needs within DGSU by Option– "Income Statement" Analysis

Further, an approach attempted to harness the quantitative analysis of the direct fiscal impact on DGSU is adopted, while taking the expedient borrowing from external finance source in view. In this case, the fund replenished and used for procurement will be categorized in "source of funds", thereby leading to no account of "use of funds" within DGSU. With this, the analysis will be geared sequentially to the estimation of project costs excluding loan proceeds.

In line with the method of cost estimation adopted thus far, the fund requirements directly harness the fiscal position of DGSU worked out P. 767.1 million (US$ 84.3 million), P. 776.2 million (US$ 85.3 million), P. 786.2 million (US$ 86.4 million), P. 795.3 million (US$ 87.4 million), P. 1,611.6 million (US$ 177.1 million), P. 1,612.5 million (US$ 177.2 million), P. 1,598.5 (US$ 175.6 million), P. 1,607.1 million (US$ 176.6 million), P. 2,043.9 million (224.6 million), P. 2,052.9 million (US$ 225.6 million), P. 2,062.9 million (US$ 226.7 million), and P. 2,067.5 (US$ 227.2 million) for the options (Options) 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12, respectively. It would be reminded that each of the options, vis-à-vis, Options 1, 2, 3, 4. Options, 5, 6, 7, 8, and Options 9, 10, 11, 12, are associated with the funding categories of own

fund, international lending institution-type, and bi-lateral lending institution-type, For easy reference, a summary table providing the above work deliverables is given below as Table H-80.

Table H-80: Finance Needs within DGSU by Option

Institutional Framework	Own Fund	External Fund	
	(US$ million)	World Bank-type (US$ million)	OECF-type (US$ million)
All Components internalized (Alternative 1)	Option 1 – 84.3	Option 5 – 177.1	Option 9 – 224.6
FDSs-Internalized, CP-Externalized (Alternative 2)	Option2 – 85.3	Option 6 – 177.2	Option 10 – 225.6
FDSs-Externalized, CP-Internalized (Alternative 3)	Option 3 – 86.4	Option 7 – 175.6	Option 11 – 226.7
All Components Externalized (Alternative 4)	Option 4 – 87.4	Option 8 – 176.6	Option 12 – 227.2
Average	85.9	176.6	226.0

As attached, a summary of "income statements" numerically elucidating the overall cash flow structure in a time slice of the project period and loan repayment period by Option is provided in Table H-81.

Table H-81: Summary "Income Statements" by Option

	Alternative 1:LF1CP1									Alternative 2: FL1CP2								
Options	OF	EF-WB				EF-OECF				OF	EF-WB				EF-OECF			
	1	5				9				2	6				10			
year	Investm ent Outlay	Amortiz ation	Disburs ement	Net Outlay	Investm ent Outlay	Amortiz ation	Disburs ement	Net Outlay	Investm ent Outlay	Amortiz ation	Disburs ement	Net Outlay	Investm ent Outlay	Amortiz ation	Disburs ement	Net Outlay				
1999	0.2	0.2		0.3	-0.03	0.2	0.03	0.3	0.00	0.2	0.2		0.3	-0.04	0.2	0.03	0.3	-0.01
2000	13.7	13.7		14.3	-0.62	13.7	1.5	14.3	0.47	13.7	13.7		14.9	-1.22	13.7	1.5	14.9	0.32
2001	16.0	16.0		12.9	3.18	16.0	4.2	12.9	7.02	13.9	13.9		11.0	2.84	13.9	4.1	11.0	6.99
2002	9.8	9.8		1.7	8.10	9.8	5.7	1.7	13.80	10.3	10.3		2.1	8.14	10.3	5.5	2.1	13.60
2003	9.0	9.0		0.8	8.12	9.0	5.9	0.8	14.07	9.9	9.9		1.7	8.24	9.9	5.8	1.7	14.08
2004	7.8	7.8	12.3		19.76	7.8	5.9		13.87	8.3	8.3	12.2		20.51	8.3	6.0		14.33
2005	3.4	3.4	12.3		15.29	3.4	5.9		9.41	3.9	3.9	12.2		16.05	3.9	6.0		9.86
2006	3.5	3.5	12.3		15.41	3.5	5.9		9.52	4.0	4.0	12.2		16.16	4.0	6.0		9.98
2007	7.6	7.6	12.3		19.43	7.6	5.9		13.60	8.1	8.1	12.2		20.24	8.1	6.0		14.06
2008	6.3	6.3	12.3		18.20	6.3	5.9		12.31	5.5	5.5	12.2		17.65	5.5	6.0		11.47
2009	3.8	3.8	12.3		15.73	3.8	6.2		10.01	4.0	4.0	12.2		16.14	4.0	6.2		10.12
2010	3.2	3.2	12.3		15.13	3.2	6.2		9.41	3.7	3.7	12.2		15.83	3.7	6.2		9.86
2011-2014			36.8		21.90		24.6		24.79			36.6		36.56		24.7		24.66
2015-2029							86.2		86.36							86.3		86.30
Total	84.3	84.3	122.7	30.0	177.10	84.3	170.0	30.0	224.6	85.3	85.3	121.9	30.0	177.2	85.3	170.1	30.0	225.6

	Alternative 3: LF2CP1									Alternative 4:LF2CP2								
Options	OF	EF-WB				EF-OECF				OF	EF-WB				EF-OECF			
	3	7				11				4	8				12			
year	Investm ent Outlay	Amortiz ation	Disburs ement	Net Outlay	Investm ent Outlay	Amortiz ation	Disburs ement	Net Outlay	Investm ent Outlay	Amortiz ation	Disburs ement	Net Outlay	Investm ent Outlay	Amortiz ation	Disburs ement	Net Outlay				
1999	0.2	0.2		0.0	0.20	0.2	0.02	0.0	0.22	0.2	0.2		0.3	-0.03	0.2	0.03	0.3	0.00
2000	10.6	10.6		10.6	0.03	10.6	1.1	10.6	1.13	10.5	10.5		10.9	-0.39	10.5	1.1	10.9	0.76
2001	18.7	18.7		16.9	1.80	18.7	3.8	16.9	5.65	16.5	16.5		15.2	1.37	16.5	3.8	15.2	5.12
2002	10.3	10.3		1.6	8.69	10.3	5.7	1.6	14.39	10.8	10.8		2.1	8.76	10.8	5.5	2.1	14.23
2003	9.6	9.6		0.9	8.74	9.6	5.9	0.9	14.69	10.5	10.5		1.6	8.94	10.5	5.8	1.6	14.78
2004	8.4	8.4	11.9		20.32	8.4	6.0		14.43	8.9	8.9	11.9		20.81	8.9	6.0		14.89
2005	3.8	3.8	11.9		15.73	3.8	6.0		9.85	4.3	4.3	11.9		16.22	4.3	6.0		10.30
2006	3.4	3.4	11.9		15.28	3.4	6.0		9.39	3.8	3.8	11.9		15.77	3.8	6.0		9.85
2007	5.9	5.9	11.9		17.78	5.9	6.0		11.90	6.4	6.4	11.9		18.27	6.4	6.0		12.35
2008	6.8	6.8	11.9		18.75	6.8	6.0		12.87	6.0	6.0	11.9		17.95	6.0	6.0		12.03
2009	4.7	4.7	11.9		16.59	4.7	6.2		10.87	4.8	4.8	11.9		16.74	4.8	6.2		11.02
2010	4.0	4.0	11.9		15.92	4.0	6.2		10.20	4.5	4.5	11.9		16.41	4.5	6.2		10.69
2011-2014			35.8		21.90		24.8		24.79			35.8		21.90		24.8		24.79
2015-2029							86.4		86.36							86.4		86.36
Total	86.4	86.4	119.2	30.0	175.60	86.4	170.2	30.0	226.7	87.4	87.4	119.2	30.0	176.6	87.4	170.1	30.0	227.2

c. Indicative Repayment Schedule

Provided that GDF would intake the external fund for capital investment of US$ 30.0 million prior to the commencement of the project, this small part of analysis provides herewith an indicative amortization plan. In association with the assumptive parameters as given in Data M, the study reveals that the annual amortization that DGSU is liable will reach respective of P. 111.9 million (US$ 12.3), P. 110.0 million (US$ 12.2), P. 108.3 million (US$ 11.9 million), and P. 108.3 million (US$ 11.9) for each of the Alternatives, when the World Bank-type borrowing is assumed. Alternatively, DGSU is liable to debt services corresponding to the OECF-type lending with P. 56.4 million (US$ 6.2 million) per annum. It would be noted that the amount of annual debt service varies where disbursement schedules and associated interest during construction are different among Alternatives thus by making the alternation of accumulated principals in the end of loan period. Indicative loan repayment schedules for the expedient loan of US$ 30.0 million with the prospective interest rate at 20 percent per annum is attached as Table H-82. Year average interest rates on outstanding deposits is given in Data M.

Table H-82: Indicative Repayment Schedule for Alternatives

Alernative 1
Option 5 : Multi-Lateral Agency

Principle $		30.0 US$ million							
	Disb't	0.261	14.348	12.851	1.670	0.848	30.0		
	Share	0.9%	47.8%	42.9%	5.6%	2.8%	1.0		
	Interest	20.0%		CETES	15.0%	Margin	5.0%	World Bank	7.5%
	Repayment	15							
	Grace	5							
	Yrs Period	10							
	Level Payt	-12.3							
	CommitC								
	IDC (int 1998-2002)			21.5					

	Balance Beging	Disbursement	IDC	Outstanding	Interest Payment	Principal Repayment	Commitment Charge	End Balance	Amortization	Accumulated Payment
1999	0.00	0.26	0.03					0.29		0.0
2000	0.29	14.35	1.49					16.13		0.0
2001	16.13	12.86	4.51					33.50		0.0
2002	33.50	1.67	6.87					42.04		0.0
2003	42.04	0.85	8.58					51.46		0.0
2004				122.7	10.3	2.0	0		12.3	12.3
2005				110.5	9.9	2.4	0		12.3	24.5
2006				98.2	9.4	2.9	0		12.3	36.8
2007				85.9	8.8	3.4	0		12.3	49.1
2008				73.6	8.2	4.1	0		12.3	61.4
2009				61.4	7.3	4.9	0		12.3	73.6
2010				49.1	6.4	5.9	0		12.3	85.9
2011				36.8	5.2	7.1	0		12.3	98.2
2012				24.5	3.8	8.5	0		12.3	110.5
2013				12.3	2.0	10.2	0		12.3	122.7
2014				0.0						
Total		30.0	21.5		71.3	51.5			122.7	122.7

Option 9 : Bi-Lateral Agency

Principle $		30.0 US$ million					
	Disb't	0.26	14.35	12.86	1.67	0.85	30.0
	Share	0.9%	47.8%	42.9%	5.6%	2.8%	1.0
	Interest	20.0%					
	Repayment	30					
	Grace	10					
	Yrs Period	20					
	Level Payt	-6.2					
	CommitC						
	IDC (int 1998-2002)			0.0			

	Balance Biginig	Disbursement	IDC	Outstanding	Interest Payment	Principal Repayment	Commitment Charge	End Balance	Amortization	Accumulated Payment
1999	0.0	0.3	0.0		0.026			0.3	0.026	0.0
2000	0.3	14.3	0.0		1.487			14.6	1.487	1.5
2001	14.6	12.9	0.0		4.208			27.5	4.208	5.7
2002	27.5	1.7	0.0		5.661			29.1	5.661	11.4
2003	29.1	0.8	0.0		5.913			30.0	5.913	17.3
2004	30.0				5.913			30.0	5.913	23.2
2005	30.0				5.913			30.0	5.913	29.1
2006	30.0				5.913			30.0	5.913	35.0
2007	30.0				5.913			30.0	5.913	40.9
2008	30.0				5.913			30.0	5.913	46.9
2009				123.2	5.997	0.161	0	6.2	6.158	53.0
2010				117.0	5.965	0.193	0	6.2	6.158	59.2
2011				110.8	5.927	0.231	0	6.2	6.158	65.3
2012				104.7	5.880	0.278	0	6.2	6.158	71.5
2013				98.5	5.825	0.333	0	6.2	6.158	77.6
2014				92.4	5.758	0.400	0	6.2	6.158	83.8
2015				86.2	5.678	0.480	0	6.2	6.158	90.0
2016				80.1	5.582	0.576	0	6.2	6.158	96.1
2017				73.9	5.467	0.691	0	6.2	6.158	102.3
2018				67.7	5.329	0.829	0	6.2	6.158	108.4
2019				61.6	5.163	0.995	0	6.2	6.158	114.6
2020				55.4	4.965	1.193	0	6.2	6.158	120.8
2021				49.3	4.726	1.432	0	6.2	6.158	126.9
2022				43.1	4.439	1.719	0	6.2	6.158	133.1
2023				36.9	4.096	2.062	0	6.2	6.158	139.2
2024				30.8	3.683	2.475	0	6.2	6.158	145.4
2025				24.6	3.183	2.970	0	6.2	6.158	151.5
2026				18.5	2.594	3.564	0	6.2	6.158	157.7
2027				12.3	1.882	4.276	0	6.2	6.158	163.9
2028				6.2	1.026	5.132	0	6.2	6.158	170.0
2029				0.0						
Total		30.0	0.0		131.3	30.0			170.0	170.0

Alternative 2
Option 6 : Multi-Lateral Agency

Principle $		30.0	US$ million						
	Disb't	0.258	14.932	11.050	2.118	1.656	30.0		
	Share	0.9%	49.8%	36.8%	7.1%	5.5%	1.0		
	Interest	20.0%		CETES	15.0%	Margin	5.0%	World Bank	7.5%
	Repayment	15							
	Grace	5							
	Yrs/Period	10							
	Level Payt	-12.2							
	CommitC								
	IDC (int 1998-2002)			21.1					

	Balance Beginig	Disbursement	IDC	Outstanding	Interest Payment	Principal Repayment	Commitment Charge	End Balance	Amortization	Accumulated Payment
1999	0.00	0.26	0.03					0.28		0.0
2000	0.28	14.93	1.55					16.77		0.0
2001	16.77	11.05	4.46					32.27		0.0
2002	32.27	2.12	6.67					41.06		0.0
2003	41.06	1.66	8.38					51.09		0.0
2004				121.9	10.2	2.0	0		12.2	12.2
2005				109.7	9.8	2.4	0		12.2	24.4
2006				97.5	9.4	2.8	0		12.2	36.6
2007				85.3	8.8	3.4	0		12.2	48.7
2008				73.1	8.1	4.1	0		12.2	60.9
2009				60.9	7.3	4.9	0		12.2	73.1
2010				48.7	6.3	5.9	0		12.2	85.3
2011				36.6	5.1	7.1	0		12.2	97.5
2012				24.4	3.7	8.5	0		12.2	109.7
2013				12.2	2.0	10.2	0		12.2	121.9
2014				0.0						
Total		30.0	21.1		70.8	51.1			121.9	121.9

Option 10 : Bi-Lateral Agency

Principle $		30.0	US$ million				
	Disb't	0.26	14.93	11.05	2.12	1.66	30.0
	Share	0.9%	49.8%	36.8%	7.1%	5.5%	1.0
	Interest	20.0%					
	Repayment	30					
	Grace	10					
	Yrs/Period	20					
	Level Payt	-6.16					
	CommitC						
	IDC (int 1998-2002)			0.0			

	Balance Beginig	Disbursement	IDC	Outstanding	Interest Payment	Principal Repayment	Commitment Charge	End Balance	Amortization	Accumulated Payment
1999	0.0	0.3	0.0		0.026			0.3	0.026	0.0
2000	0.3	14.9	0.0		1.545			15.2	1.545	1.6
2001	15.2	11.0	0.0		4.144			26.2	4.144	5.7
2002	26.2	2.1	0.0		5.460			28.4	5.460	11.2
2003	28.4	1.7	0.0		5.838			30.0	5.838	17.0
2004	30.0				6.003			30.0	6.003	23.0
2005	30.0				6.003			30.0	6.003	29.0
2006	30.0				6.003			30.0	6.003	35.0
2007	30.0				6.003			30.0	6.003	41.0
2008	30.0				6.003			30.0	6.003	47.0
2009				123.3	6.003	0.161	0	6.2	6.164	53.2
2010				117.1	5.971	0.193	0	6.2	6.164	59.4
2011				111.0	5.933	0.232	0	6.2	6.164	65.5
2012				104.8	5.886	0.278	0	6.2	6.164	71.7
2013				98.6	5.831	0.333	0	6.2	6.164	77.9
2014				92.5	5.764	0.400	0	6.2	6.164	84.0
2015				86.3	5.684	0.480	0	6.2	6.164	90.2
2016				80.1	5.588	0.576	0	6.2	6.164	96.3
2017				74.0	5.473	0.691	0	6.2	6.164	102.5
2018				67.8	5.334	0.830	0	6.2	6.164	108.7
2019				61.6	5.169	0.996	0	6.2	6.614	114.8
2020				55.5	4.969	1.195	0	6.2	6.164	121.0
2021				49.3	4.731	1.434	0	6.2	6.164	127.2
2022				43.1	4.448	1.720	0	6.2	6.164	133.3
2023				37.0	4.100	2.064	0	6.2	6.164	139.5
2024				30.8	3.687	2.477	0	6.2	6.164	145.7
2025				24.7	3.191	2.973	0	6.2	6.164	151.8
2026				18.5	2.597	3.567	0	6.2	6.164	158.0
2027				12.3	1.883	4.281	0	6.2	6.164	164.1
2028				6.2	1.027	5.137	0	6.2	6.164	170.0
2029				0.0						
Total		30.0	0.0		131.6	30.0			170.0	170.0

Aoternative 3
Option 7 : Multi-Lateral Anency

Principle $		30.0 US$ million							
	Disb't	0.007	10.551	16.907	1.640	0.864	30.0		
	Share	0.7%	35.2%	56.4%	5.5%	2.9%	1.0		
	Interest	0.20		*CETES*	15.0% Margin		5.0%	World Bank	7.5%
	Repayment	15							
	Grace	5							
	Yrs/Period	10							
	Level Payt	-11.9							
	CommitC								
	IDC (int 1998-2002)			12.0					

	Balance Beginig	Disbursement	IDC	Outstanding	Interest Payment	Principal Repayment	Commitment Charge	End Balance	Amortization	Accumulated Payment
1999	0.00	0.01	0.001					0.01		0.0
2000	0.01	10.55	1.06					11.62		0.0
2001	11.62	16.91	4.01					32.54		0.0
2002	32.54	1.64	6.67					40.85		0.0
2003	40.85	0.86	0.29					42.00		0.0
2004				119.2	10.0	1.9	0		11.9	11.9
2005				107.3	9.6	2.3	0		11.9	23.8
2006				95.3	9.1	2.8	0		11.9	35.8
2007				83.4	8.6	3.3	0		11.9	47.7
2008				71.5	7.9	4.0	0		11.9	59.6
2009				59.6	7.1	4.8	0		11.9	71.5
2010				47.7	6.2	5.7	0		11.9	83.4
2011				35.8	5.0	6.9	0		11.9	95.3
2012				23.8	3.6	8.3	0		11.9	107.3
2013				11.9	2.0	9.9	0		11.9	119.2
2014				0.0						
Total		30.0	12.0		69.2	50.0			119.2	119.2

Option 11 : Bi-Lateral Agency

Principle $	30.0 US$ million						
Disb't	0.22	10.55	16.91	1.64	0.86	30.2	
Share	0.7%	35.2%	56.4%	5.5%	2.9%	1.0	
Interest	20.0%						
Repayment	30.0						
Grace	10.0						
Yrs/Period	20.0						
Level Payt	-6.2						
CommitC							
IDC (int 1998-2002)			0.0				

	Balance Beginig	Disbursement	IDC	Outstanding	Interest Payment	Principal Repayment	Commitment Charge	End Balance	Amortization	Accumulated Payment
1999	0.0	0.2	0.0		0.022			0.2	0.022	0.0
2000	0.2	10.6	0.0		1.098			10.8	1.098	1.1
2001	10.8	16.9	0.0		3.844			27.7	3.844	5.0
2002	27.7	1.6	0.0		5.699			29.3	5.699	10.7
2003	29.3	0.9	0.0		5.949			30.2	5.949	16.6
2004	30.2				6.036			30.2	6.036	22.6
2005	30.2				6.036			30.2	6.036	28.7
2006	30.2				6.036			30.2	6.036	34.7
2007	30.2				6.036			30.2	6.036	40.8
2008	30.2				6.036			30.2	6.036	46.8
2009				123.9	6.036	0.162	0	6.2	6.197	53.0
2010				117.7	6.003	0.194	0	6.2	6.197	59.2
2011				111.6	5.964	0.233	0	6.2	6.197	65.4
2012				105.4	5.918	0.279	0	6.2	6.197	71.6
2013				99.2	5.862	0.335	0	6.2	6.197	77.8
2014				93.0	5.795	0.402	0	6.2	6.197	84.0
2015				86.8	5.715	0.483	0	6.2	6.197	90.2
2016				80.6	5.618	0.579	0	6.2	6.197	96.4
2017				74.4	5.502	0.695	0	6.2	6.197	102.6
2018				68.2	5.363	0.834	0	6.2	6.197	108.8
2019				62.0	5.196	1.001	0	6.2	6.197	115.0
2020				55.8	4.996	1.201	0	6.2	6.197	121.2
2021				49.6	4.756	1.441	0	6.2	6.197	127.4
2022				43.4	4.468	1.730	0	6.2	6.197	133.6
2023				37.2	4.122	2.075	0	6.2	6.197	139.7
2024				31.0	3.707	2.491	0	6.2	6.197	145.9
2025				24.8	3.209	2.989	0	6.2	6.197	152.1
2026				18.6	2.611	3.586	0	6.2	6.197	158.3
2027				12.4	1.894	4.304	0	6.2	6.197	164.5
2028				6.2	1.033	5.164	0	6.2	6.197	170.0
2029				0.0						
Total		30.2	0.0		131.8	30.2			170.0	170.0

Alternative 4
Option 8 : Multi-Lateral Anency

Principle $		30.0 US$ million							
	Disb't	0.264	10.916	15.172	2.062	1.586	30.0		
	Share	0.9%	36.4%	50.6%	6.9%	5.3%	1.0		
	Interest	20%		*CETES*	15.0% Margin		5.0%	World Bank	7.5%
	Repayment	15							
	Grace	5							
	Yrs/Period	10							
	Level Payt	-11.9							
	CommitC								
	IDC (int 1998-2002)			19.9					

	Balance Beginig	Disbursement	IDC	Outstanding	Interest Payment	Principal Repayment	Commitment Charge	End Balance	Amortization	Accumulated Payment
1999	0.00	0.26	0.026					0.29		0.0
2000	0.29	10.92	1.15					12.36		0.0
2001	12.36	15.17	3.99					31.52		0.0
2002	31.52	2.06	6.51					40.09		0.0
2003	40.09	1.59	8.18					49.85		0.0
2004				118.9	10.0	1.9	0		11.9	11.9
2005				107.0	9.6	2.3	0		11.9	23.8
2006				95.1	9.1	2.8	0		11.9	35.8
2007				83.2	8.6	3.3	0		11.9	47.7
2008				71.2	7.9	4.0	0		11.9	59.6
2009				59.3	7.1	4.8	0		11.9	71.5
2010				47.4	6.2	5.7	0		11.9	83.4
2011				35.5	5.0	6.9	0		11.9	95.3
2012				23.6	3.6	8.3	0		11.9	107.3
2013				11.9	2.0	9.9	0		11.9	119.2
2014				0.0						
Total		30.0	19.9		69.2	50.0			119.2	119.2

Option 12 : Bi-Lateral Agency

Principle $		30.0 US$ million					
	Disb't	0.26	10.92	15.17	2.06	1.59	30.0
	Share	0.9%	36.4%	50.6%	6.9%	5.3%	1.0
	Interest	20.0%					
	Repayment	30.0					
	Grace	10.0					
	Yrs/Period	20.0					
	Level Payt	-6.2					
	CommitC						
	IDC (int 1998-2002)			0.0			

	Balance Beginig	Disbursement	IDC	Outstanding	Interest Payment	Principal Repayment	Commitment Charge	End Balance	Amortization	Accumulated Payment
1999	0.0	0.3	0.0		0.026			0.3	0.026	0.0
2000	0.3	10.9	0.0		1.144			11.2	1.144	1.2
2001	11.2	15.2	0.0		3.753			26.4	3.753	4.9
2002	26.4	2.1	0.0		5.477			28.4	5.477	10.4
2003	28.4	1.6	0.0		5.841			30.0	5.841	16.2
2004	30.0				6.000			30.0	6.000	22.2
2005	30.0				6.000			30.0	6.000	28.2
2006	30.0				6.000			30.0	6.000	34.2
2007	30.0				6.000			30.0	6.000	40.2
2008	30.0				6.000			30.0	6.000	46.2
2009				123.2	6.036	0.162	0	6.2	6.197	52.4
2010				117.0	6.003	0.194	0	6.2	6.197	58.6
2011				110.8	5.964	0.233	0	6.2	6.197	64.8
2012				104.6	5.918	0.279	0	6.2	6.197	71.0
2013				98.4	5.862	0.335	0	6.2	6.197	77.2
2014				92.2	5.795	0.402	0	6.2	6.197	83.4
2015				86.0	5.715	0.483	0	6.2	6.197	89.6
2016				79.8	5.618	0.579	0	6.2	6.197	95.8
2017				73.6	5.502	0.695	0	6.2	6.197	102.0
2018				67.4	5.363	0.834	0	6.2	6.197	108.2
2019				61.2	5.196	1.001	0	6.2	6.197	114.4
2020				55.0	4.996	1.201	0	6.2	6.197	120.6
2021				48.8	4.756	1.441	0	6.2	6.197	126.8
2022				42.6	4.468	1.730	0	6.2	6.197	133.0
2023				36.5	4.122	2.075	0	6.2	6.197	139.2
2024				30.3	3.707	2.491	0	6.2	6.197	145.4
2025				24.1	3.209	2.989	0	6.2	6.197	151.6
2026				17.9	2.611	3.586	0	6.2	6.197	157.8
2027				11.7	1.894	4.304	0	6.2	6.197	164.0
2028				6.2	1.033	5.164	0	6.2	6.197	170.0
2029				0.0						
Total		30.0	0.0		131.3	30.2			170.0	170.0

H.5.3 "Totem Pole" Evaluation - Preferential Order amongst Implementation Order

Affordability as well as ability to pay attached to GDF/DGSU are quantifiably investigated on a set of assumptions and provided herewith in a bid to offer a reference for taking further step in the long and arduous processing within the concerned administrative machine (s).

a. Ability to Pay: Aggregate Project Costs

a.1 Funding Sources

From what the analysis numerically exhibited in the accounting analysis of funding needs in II.7.5.2, it will be deduced that fiscal impact over the years of project duration is least when the project is financed by internal fund within GDF, followed by the cases of World Bank (WB)-type lending and Overseas Economic Cooperation Fund, Japan (OECF)-type lending. Cost ratios of the borrowing options reach 1.92 and 2.63 on average basis respectively, given the cost by own fund being set at unit (*i.e.*, 1.0). This is simply because the two sources of external borrowing carry amortization besides project cost, where the overall cost by OECF-type lending outnumbers that by WB-type due to the longer repayment period. The funds required in average during the project period are figured out at US$ 85.9 million, US$ 176.6 million, and US$ 226.0 million for respective of own fund, WB-type lending, and OECF-type lending (refer to Table II-80). Consequently, this outcome places self-financing at the top of "Totem Pole" of preference, followed by WB-type and OECF-type loans in descending order. Once for all, the alternative cases will be lined up in descending order of Option 1, Option 2, Option 3, Option 4 (thus far Own Fund cohort), Option 5, Option 6, Option 7, Option 8 (so far WB-type funded), Option 9, Option 10, Option 11, and Option 12 (thus far OECF-type funded).

a.2 Institutional Framework

Amongst the institutional alternatives under the own finance, the case of all the three components being internalized (Alternative 1) is observed most favorable, followed by the choices of final disposal sites (BP E-IV and V) under DGSU (Alternative 2), compost plant under DGSU (Alternative 3), and BP E-V and compost plant being all externalized (Alternative 4), in descending order. This line of preference evidently imparts a numerical proof of fiscal burden that DGSU would be liable to the prospective "contract out" treaty with the private firm(s) involved. It would be noted, notwithstanding, that it would be misleading if the analysis on preference order are confined to the categories of external borrowing simply because they do attach bias to the order with a large weights of debt service.

b. Affordability of DGSU – Annual Fund Needs within DGSU

In tandem with the total cost of project that has to be committed once for all prior to the project implementation, at issue in the alignment and placement of alternatives in the order of preference is the investment outlays that invariably draw a substantial part of public expenses allowed to GDF/DGSU every year. In search of the alternatives that are to be "friendly" to the fiscal position of DF government and DGSU, the accounting cash flows associated with each of the options have been investigated by categorically dividing the outlays into three parts in chronological

order, notably, initial investment, operation and maintenance inclusive of intermittent investments for replacement, and amortization, with the ceilings of cash-outlay presumably benchmarked at US$ 10.0 million, US$ 13.0 million, and US$ 7.0 million per annum, in that order.

In so doing, annual finance needs within DGSU, that is the investment expenses exclusive of initial investments being covered by the loan, has been taken into consideration. Within this analytical framework, combined with the grades of 1 through 5 assigned in accordance with the annual cash-outlays estimated, the order in "Totem Pole of Preference" turned out to be almost in line with what had been seen in the analysis of the Ability to Pay except that amongst the WB-type and OECF-type lending. Grouped in cascading preference blankets, the Option 1 showed off its robustness in numerical line-ups, followed by the Options 4, 11, and 12 in the second tier, Options 3, 9, and 10 in the third tier, Options 8, 7, and 2 in the fourth, and eventually Options 5 and 6 in the end. It should be noted, however, that the outcome as demonstrated thus far is only indicative and might be subject to alteration depending on the variables and parameters adopted in evaluation.

A Totem Pole of preferential order with each of the options in the queue by size of aggregate fund needs is depicted as Figure H-33.

Excellent

Good

Fair

Poor

Terrible

Preferential Order

Totempole-Evaluation (Annual Finance Needs)

I	*Option 1*				
II	*Option 4*	*Option 11*	*Option 12*		
III	*Option 3*	*Option 9*	*Option 10*		
IV	*Option 8*	*Option 7*	*Option 2*		
V	*Option 5*	*Option 6*			

Preferential Order

Totempole-Evaluation (Aggregate Costs and Annual Finance Needs)

I	*Option 1*	*Option 4*			
II	*Option 2*	*Option 3*	*Option 12*		
III	*Option 5*	*Option 6*	*Option 7*	*Option 8*	*Option 9*
IV	*Option 10*	*Option 11*	*Option 12*		

	Evaluation Criteria				
		Annual Expenses			
Option	Project Cost	Initial 5years x<=US$10mil	Operation x<=US$13mil	Amortization x<=US$7mil	Consolidated Points
Option 1	1	2.5	5.0	4.8	2.8
Option 2	2	3.0	5.0	4.6	3.0
Option 3	3	3.5	5.0	4.8	3.3
Option 4	4	4.0	5.0	4.8	3.5
Option 5	5	4.3	2.0	2.6	2.8
Option 6	6	4.6	2.0	2.6	2.9
Option 7	7	4.8	2.0	3.0	3.0
Option 8	8	5.0	2.0	3.0	3.1
Option 9	9	4.0	4.0	3.5	3.2
Option 10	10	4.0	4.0	3.5	3.2
Option 11	11	4.2	4.0	3.5	3.3
Option 12	12	4.2	4.0	3.5	3.3

Figure H-33: Totempole Evaluation - Preferential Order Amongst Options

c. Soundness of Public Finance in DGSU

Should the borrowing from external source be considered by GDF/DGSU, it would be appropriate to quantitatively measure the fiscal impact of amortization in DGSU. Debt Service Ratio (DSR), which is commonly used as a proxy index to represent soundness of public finance, with the whole revenue and own revenue as denominators worked out respective of 6.7 percent and 12.2 percent with P. 2,609.4 million (US$ 286.7 million equivalent with the quotation at P. 9.1/US$ in September 1998) of debt service authorized by Congress for the year 1998[8]. While considering the expedient loan of about US$ 30.0 million, an incremental portion of debt service as borne by DF government corresponds to 0.3 percent at maximum and 0.05 percent at minimum reaching respective of 12.5 percent and 12.25 percent on *Ceteris Paribus* condition[9], well below the generally accepted critical line of DSR 25 percent.

Budget allocation to DGSU for the year 1999 is allegedly P. 992.1 million with a little as 3.2 percent of increase in nominal term. Keeping this in view, the share of amortization associated with the presumptive loan amount of P. 273.0 million (US$ 30.0 million) out of the annual budget would range mostly between around 4 percent to 20 percent or 25 percent at maximum for the categories of own fund and WB-type lending, whereas mostly 5 percent to 15 percent at maximum for OECF-type lending.

d. Policy Implication

With due recognition of the rung of financial hardship that GDF/DGSU would have to endure annually in the forthcoming time-slice of 12-year-period of project implementation, it would be commendable that the project would be financed by own fund, IF and ONLY IF (i) the government in 1999 could decisively commit to the budget allocation of around US$ 30 million for initial investment during 1999 to 2003, and (ii) DGSU could deliberately carry the annual fiscal burden and recurrent costs accrued that accounts for around 10-17 percent of the total DGSU budget annually after the year 2004[10]. Should the occasion arise when DGSU has to consider funding sources embracing external borrowing, it would be recommended that DGSU borrow funds in line with the OECF-type loan conditions where no-capitalized interest to principal and longer repayment period are assumed. This type ensures the lower principal surmounted in the wake of full disbursement of loans, and smaller amortization in the following repayment years.

Nonetheless, it would be noteworthy that the World Bank-type loan be considered where DGSU is not liable to amortization during the initial construction period. While high obligation of debt service during the repayment period is assumed in this case, financial burden during the initial investment period is much lesser than the other two funding sources. This is a kind of trade-off issue between the amortization plans of "continuously so" and "First easy go and later very tough"[11].

---

[8] Source: HACIENDA, *Informes sobre la Situacion Economica, las Finanzas Publica y Deuda Publica, Acciones y Resultados del Primer Trimestre de 1998*, May 1998

[9] *DSR* herewith is being defined as debt service over own revenue of DF in 1998.

[10] In the case of all the sub-components being internalized.

[11] In favor of the World Bank type lending, inflation and possible increase in budget allocation to DGSU in conjunction with economic recovery and sound management of macroeconomic policy in Mexico would lessen the financial burden in the years to come.

In the meantime, the mission was advised that the approved line of credit accorded to DGSU for the year 1999 was around P. 356 million (equivalent to US$ 39.1 million as per P.9.1 per dollar).

Lastly, and not more than a reference for the comprehensive understanding on the ordering of preference, the evaluation outcomes are lined up in the Totem Pole by project cost and annual cash-outlays with the specific weights of 0.1 and 0.9 attached respectively. Option 1 came ahead of others with the followings in descending order, that is, Option 4, Option 3, Option 2, Option 6, Option 7, Option 8, Option 9, Option 5 in the second tier, and Option 10, Option 11, and eventually Option 12 came in the end.

H.6 Environmental Impact Assessment (EIA)

H.6.1 Scope of EIA Work

a. Background

Solid waste can be a health and environmental hazard. It attracts vermin; it produces offensive odor; it degrades city beauty; and it is a source of contaminants to pollute soil, groundwater and any other natural assets. Thus, solid waste management projects should be those to protect human health and the environment. Nevertheless, because of highly undesirable nature of solid waste, its mismanagement, once happened, might lead to unexpected negative impacts on social and natural environment, hence the necessity of environmental impact assessment (EIA) at the design stage.

As stated in Section A.5, Mexico has a legislative base for the realization of EIA for projects with potential environmental impact. The principal structure is given by the LGEEPA, which are in turn supplemented by several regulations on specific issues including EIA. While these are enforced at the federal level by the SEMARNAP, there are bylaws on general environmental matter and regulations on EIA which are issued by local governments (at state, municipality and DF levels) due to the progress of decentralization.

According to the LGEEPA, waste management projects for municipal waste is under the jurisdiction of state governments, and so is the EIA procedure for those projects[12]. The EIA for the proposed F/S projects were, however, considered to follow the EIA guidelines of general modality issued by the SEMARNAP for the following reasons.

- The proposed land is geographically within the State of Mexico but the land is owned and controlled by the CNA. Therefore, the EIA process would have to involve both organizations and the EIA reports should have to be satisfactory for both the SEMARNAP's EIA guideline and the EIA regulation of the State of Mexico.
- In spite of the above, the EIA regulations of the local states, including the State of Mexico, largely follow the SEMARNAP's EIA guideline and there is little disparity. In other words, EIA which is carried out based on the SEMARNAP's guideline should meet the EIA regulation of the State of Mexico.
- The Federation is responsible of protecting environment in the federal area.

b. Screening and Scope of the Work

Section G.7 described the screening process where it was concluded that the EIA studies for the Etapa V project and the composting plant were to be undertaken by the team. For those two, scoping was attempted whose summary is as presented in Table H-83 (see Tables in Section G.7 of this report for detail).

[12] The EIA regulation of the State of Mexico defines projects subject to the EIA procedure of the state, which include installation and operation of a treatment plant and a final disposal site for municipal solid waste.

Table H-83: Summary of Scoping

Evaluation Factors	BP V	Composting Plant
Social Environment		
Resettlement		
Economic Activities		
Transport		
Public Facilities		
Division of Community		
Historical Heritage/Cultural Properties		
Water Rights/Access Rights		
Public Health	B	B
Waste (from the project)		
Accidents/Risks	B	B
Natural Environment		
Topography and Geology		
Soil Erosion		
Groundwater	B	B
Hydrological Conditions		
Coastal Zone		
Fauna and Flora	C	
Meteorology		
Landscape/ Aesthetics	B	
Pollution		
Air Pollution	B	B
Water Pollution	B	B
Soil Contamination	B	B
Noise and Vibration		B
Land Subsidence		
Offensive Odor	B	B

In the table above, B refers to factors on which the project might have impacts if not well engineered or operated and C represents a lack of site information to determine whether adverse impacts are expected. Some factors with B also suffer a scarcity of base information.

For the EIA of the Etapa V project and composting plant project, Table H-83 presents a scope of the EIA study: which factors should be paid careful attention (factors of white cells with letters B or C) and which are necessarily not (factors of shaded cells). It should be noted, however, that the scoping was attempted in the IEE process with limited resources at the initial stage of the study.

H.6.1.1 Present Environmental Setting

The information on present environmental situation in the project sites was collected and examined during the second study work in Mexico. It is attempted below to point out key issues of current environmental state of the area, which would be especially important to examine possible environmental impact.

I Physical Aspects

a. Climate

Section A.1.3 of Annex A describes the climate of Mexico City. In considering waste management projects in ex-Lake Texcoco area, the following should be kept in mind.

- Annual rainfall is about 600 mm/year, while annual evaporation is 1,800 mm/year.
- Rainfall is concentrated in the rainy season, i.e. June, July, August and September. These months may have more than 150 mm/month of precipitation. On the other hand, the dry season may have rainfall no more than 5 mm/month.

b. Geomorphology and Geology

According to the previous study by Moro company (1992)[13], geology of the area of the ex-Lake Texcoco and its surrounding area consists of such geological units as alluvial deposits, lacustrine deposits, lime-sand toba, volcanic brecha, and andesite lava, but within the ex-Lake Texcoco area, lacustrine deposit predominates, reflecting the history of its formation.

This lacustrine deposit is a plain comprising a number of sequential clay strata with some occurrence of volcanic sand, lime and glass. The total depth of this formation is assumed to be about 180m.

c. Soils

The soil studies were conducted by the JICA team. Although soil studies in the composting plant site was not carried out, oral communication with the counterpart and visual observation concluded that the soil type is fairly similar to that in Etapa IV, the closest landfill site.

Accordingly, it is understood that the soil type of the area is largely clay which is extended down to 50 m depth. This clay formation shows significantly high water content. Therefore it is considered that the stratum is soft and compressible.

d. Hydrology

d.1 Rivers and Canals

Several rivers flow into the ex-Lake Texcoco area. Although they are called rivers (Ríos), as a matter of fact, it should be more appropriate to call them canals. Their prime role is to serve as open sewerage receiving wastewater from residential areas of the DF and some of the municipalities of the State of Mexico. For this reason, they are found to be a nuisance for residents who are exposed to their unfavorable odor.

Those canals are, from northeast, the Río San Juan Teotihuacán, Río Papalotla, Río Xalapango and Río Coxcacoaco; from east, the Río Texcoco, Río Chanpingo, Río San Bernardino, Río Santa Mónica and Río Coatepec; and from south, the Río San Francisco, Río Churubusco and Río de la Compañía. In terms of the flow volume, Río Churubusco and Río de la Compañía are the main water ingress into the area, with

[13] Estudios y Proyectos Moro, S.A. de C.V., *Estudio Geologico-Geohidrologico de Detalle en la Zona de Brodo Poniente, Estado de Mexico*, August 1992

flow volume of 10.0 and 4.2 m^3/sec on average[14], while the total flow volume of the others is merely 0.4 m^3/sec and it could be nearly zero in the dry season.

Water flown by those canals partly goes to several artificial lakes namely Lago Churubusco, Lago de Regulación Horaria, Lago Xolapango and Lago Nabor Carrillo, and water treatment facilities. The rest of water and some water from those water reservoir flow via canal network within and on the periphery of the ex-Lake Texcoco area. In the canal network, *Brazo Izquierdo Río Churubusco* and a drain called *Dren Texcoco Norte* will be of particular concern since the former flows the northwest limit of the composting plant site and the latter flows the south limit of Etapa V.

In general, water in the area finally find its way at canals *Canal de Desagüe* or *Canal de las Sales* both of which flow from south to north on the west edge of the ex-Lake Texcoco area. They join another large canal *Gran Canal* in the north of the Solar Evaporator (*Caracol*), and the Gran Canal runs towards a lake Lago Zumpango and further north.

d.2 Water Bodies

As stated above, there are four major water bodies in the area; Lake Churubusco, Regulation Lake, Lake Xolapango and Lake Nabor Carrillo. All of those are the major accomplishment of the early 80s by the Texcoco Project to control the surface hydrology of the area. Total capacity of them is approximately 50 million m^3, of which Lake Nabor Carrillo has the capacity of 36 million m^3.

Apart from the hydrologic purpose, they are also important in serving as a host of migratory birds during winter.

d.3 Underground[15]

Interestingly, the surface clay stratum is peculiar to the ex-Lake Texcoco area. Once stepping out from the area, it becomes thin and eventually disappears. Within the area, the stratum has a depth of more than 50m according the JICA Team's field survey, and 40 to 90m according to Moro company (1992). Regarded as an aquitard, this stratum is mostly saturated with water, and the groundwater table is found at only 1.2m to 0.03m depth from the ground surface. It could be much shallower in rainy season.

The water (referred to be "shallow groundwater") in this geological clay formation is so saline that salt making was actively operated in the area. Alkalinity is also high. Rudolph, *et al.* (1989)[16] reported 80,500 ppm and Moro company (1992) reported 90,000 ppm. Because of the high salt content in this shallow groundwater, it is not used for human consumption.

Below this stratum is another aquifer which extends not only the ex-Lake Texcoco area but also wide part of the Mexico Valley. It is mostly made of sandy material with occasional occurrence of lime or clay horizontal layers. This is the aquifer from which water has been exploited for years to serve for public and industrial use particularly

[14] Data from Texcoco Project
[15] Data obtained from JICA team's field survey, Moro (1992) and ABC (1993)
[16] Rudolph, Herrera, Yates (1989), *Groundwater flow and solute transport in the industrial well fields of the Texcoco saline aquifer system near Mexico City,* Geofiscica International, vol.28-2 (adopted from ABC (1993))

extensively in the south of Mexico City, although there is now restriction to extract this groundwater due to the land subsidence caused by over exploitation.

The depth from the ground surface to this deeper aquifer is about 80m, and the thickness is thought to be 100 to 400m.

II. Biological Aspects

a. Flora and Fauna

a.1 Flora

Vegetation of the ex-Lake Texcoco area is poor because of the saline soil. Most part of the area is merely covered with pasture *Distichlis spicata* which is resistant to salinity. Land with lower salinity may allow other species to grow, but overall, species richness is substantially low. Trees or shrubs are rare.

a.2 Fauna

To the contrary, the area provides habitats to diverse species of animals. Among those, a wide range of birds can be found.

A Mexican official norm NOM-059-ECOL-1994 establishes a list of species which are categorized as rare (R), threatened (Th), endangered of extinction (Ex), or to be specially protected (Pr). Out of species found in the project site during the field investigation, the following ones fall into one of these categories.

In the Etapa V landfill site:

Reptiles: *Guerrhonotus liocephalus* (R), *Salvadora bairdii* (R), *Thamnophis eques* (Th), *Thamnophis scaliger* (Th), *Pituophis deppei* (Th)

Fowl: *Buteo jamaicensis* (Pr)

In the composting plant site and its surrounding:

Fowl: *Anas acuta* (Pr), *Anas discors* (Pr), and *Buteo jamaicencis* (Pr) (all are directly observed)

Reptiles: *Thamnophis Scaliger* (Th), *Pituophis deppei* (Th) and *Guerrhonotus liocephalus* (R) (all are only found in bibliography)

Mammal: *Peromiscus maniculatus* (Th) (only found in bibliography)

b. Ecosystem and Landscape

The land formation history of the ex-Lake Texcoco area suggests that the land was formerly under the lake and experienced a drastic change to become what it is. As a result, the ecosystem of the area was largely distorted.

As already stated, one of its most outstanding feature is exceptionally high salt content in the soil, and consequently in the groundwater. The salty soil does not allowed vegetation development in the area and area has been a source of dust storm which may have been deteriorating the air quality of the DF to a certain extent. Accordingly, the CNA has been taking care of the area and making efforts to restore the ecology.

The other characteristics of the area is that extensive hydraulic works take place. As previously stated, a number of canals flow into the area, and water is partly stored in the reservoirs and finally directed to further north. The control of water movement is managed exclusively by CNA. The major environmental interests are that most of water is in fact wastewater discharged from the metropolis and that the presence of large quantity of water, especially Lake Nabor Carrillo, receives migratory birds from north America during winter.

Under such conditions, the following is generally concluded.

- The ecology of the area has been deteriorated by human manipulation for centuries.
- Its severe environment with salinity has excluded most of wildlife, but because of its peculiarity, it also possesses unique species (see previous section).
- Because of the presence of the canals, water environment in the area may be giving a health hazard, but interestingly also serves for the avian ecology.

In regard to the tourism, the area is not and will not be supposed to be a tourist place. It is controlled by CNA and the general public dose not have a free access to get into the area. Furthermore, there is no historical heritage or archaeological asset in and around the area.

The area is fairly flat and arid, not giving an aesthetic landscape.

III. Socioeconomic Aspects

The ex-Lake Texcoco area is within the Mexico Valley Metropolitan area and lies next to Ecatepec and over the borders of other several municipalities in the state of Mexico, namely Nezahualcoyotl, Texcoco, Atenco and Chimalhuacan. Being adjacent to the DF where massive scale of productive activities concentrate, those municipalities have experienced rapid population growth.

As shown in Table H-84, almost all households enjoy electricity supply. Except Chimalhuacan, the provision rate of public sewerage of the other four is higher than the average of the State of Mexico. Ecatepec, Nexahualcoyotl and Texcoco have higher provision rate of piped water in house.

Table H-84: Public Service Provision Rate (1995)

(unit: % of households)

	Public Sewerage	Piped water in house	Electricity
State of Mexico	*84.9*	*49.1*	*97.6*
Atenco	86.3	37.0	99.1
Chimalhuacan	82.8	11.5	98.7
Ecatepec	93.5	57.6	99.4
Nezahualcoyotl	99.2	57.6	99.7
Texcoco	88.3	59.7	98.9

Source: INEGI