3. Operational Aspect

3.1 Collection from Marginal Areas

3.1.1 Determination of "Marginal Areas"

Marginal areas mean, here, as shown in Table II-8.1-1.

(1) Collection non-served areas in the ECA
(2) Collection non-served areas in the PCA
(3) Self-disposal areas in the PCA

From the viewpoint of collection and transport service, however, self-disposal areas are excluded to speak strictly. In a broader sense, self-disposal and isolated areas should be included in the total system of the SWM.

3.1.2 Problems Connected to the Waste Collection from the Marginal Areas

(1) Partial coverage of collection service.
(2) No collection nor disposal service for the isolated areas.
(3) More than 500 clandestine open dumping sites. (This problem is caused at least partially by the partial coverage of collection service).
(4) Dual collection system problem which might have resulted in a deficient collection service.

3.1.3 The Means of Solving the Collection Problem from Marginal Areas

This problem is only able to be solved in a whole framework of the SWM; that is, the collection from the marginal areas can be achieved in connection with the improvement of collection service in general in the Study Area.

Concrete and practicable means of solving this problem are as follows;

(1) to make the best use of the existing man-power, both municipal and private,
(2) to apply efficiently the available resources, that is, collection vehicles,
(3) to admit and accept the actual collection system, i.e., the dual collection system,
(4) to readjust foregoing elements to meet requirements of the present circumstances,
(5) to increase operational efficiencies of collection; such as,
    1) increase in the rate of vehicle operation
    2) improvement of loading efficiency
    3) improvement of the number of trips
    4) increase in the utilization coefficient of municipal vehicles
(6) to implement the zone concession to the private collectors with a full responsibility of collecting all waste in the conceded service area
(7) to expand the ECA to the maximum in order to let the municipal sector carry out collection service from the marginal areas in PCA.

Therefore, the collection operation from the marginal areas has to be examined in the whole framework of SWM.

The collection from marginal areas is connected inseparably with the total collection system; it is possible to check its feasibility only when the entire collection system is duly considered. This is the reason why we referred in detail to the collection in marginal areas in I-9.1.

(1) As for the collection from marginal areas in the ECA, the paragraphs II-8.1.3-(1) and II-8.1.3-(2) explain the point in question. Realization of the proposed

collection operation in the ECA will be completed by the end of 1996 through a gradual concession process.

(2) Collection from marginal areas in the PCA: Regarding to this collection operation, the paragraph II-8.1.3-(4) outlines the main points. Exchange of operational areas between the ECA and the PCA and concession of zones to the private collectors are absolutely essential for its feasibility. The DLPM will be able to start this collection operation after 1993, for it can afford collection vehicles through granting concessions to private collectors and increasing efficiencies of its own vehicles.

(3) Solid waste management in the self-disposal areas in the PCA

In spite of making every endeavor to carry out a routine collection service, the DLP will be unable to establish a regular collection service system due to some inseparable difficulties as stated in II-8.1.3-(5)-1). In these areas, another approach is necessary instead of a regular collection service: "on site" collection and disposal system, either individual or communal. The DLP can begin the delivery of collection service in these areas after 1996 by making the best use of personnels.

3.1.4 Equipments Required for the Collection Service

(1) Previous observations

The municipal collection service will mainly cover possible collection areas, while the private sectors will be engaged in the collection service in easy collection areas in principle. However, concession processes being gradual and service areas in easy and possible areas being overlapped, some collection zones

cannot but remain as "mixed" from the operational point of view. This means the municipal bell collection service for low-income people will continue for a couple of years. In addition, the Municipality has to assume the responsibility of collecting market and sweeping wastes. These two tasks will have a considerable effect upon the number of municipal collection vehicles.

A purchase plan for vehicles was elaborated to make the collection program feasible, taking into consideration the above conditions. Table III-3.1-1 and III-3.1-2 show the vehicle purchasing plan. The determination of vehicles number has been worked out based upon the waste quantity to be collected by the Municipality and the computation basis is also given in the same table.

The second line from the top in Table III-3.1-1 denotes estimated waste amounts originating from markets and road sweeping operation; they increase steadily. The third line shows domestic waste amounts in PCA; these amounts decrease as the ECA expands. The next line designates domestic refuse amount to be collected in ECA.

Table III-3.1-1 Vehicle purchasing plan

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Market & Sweeping Waste Amount (t/n.d)	192	197	202	207	211	217	222	227	231	236	240
Domestic waste Amount (PCA) (t/w.d)	240	238	235	233	231	228	223	218	213	208	203
(ECA) (t/w.d)	108	110	109	85	67	39	29	14	0	0	0
Amount to be collected total (t/w.d)	540	545	546	525	509	484	474	459	444	444	443
Compaction vehicles actual number	31(36)	31	17+			0					
Renewal			14								
Purchase			4								
(Sub-total)	31(36)	31	35+	35+	35+	37	37	37	37	37	37
Dump trucks (convoy service)	3(4)		0								
Renewal			4								
Purchase						2					
(Sub-total)	3	3	4	4	4	6	6	6	6	6	6
Trip number (Nocturnal service included)											
Domestic waste collection	1.47	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Convoy service	8	10	10	10	10	10	10	10	10	10	10
Average load (t/truck) Domestic	4.5	5.6	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Convoy	1.9	2.2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Expected waste amount (t/w.d) Domestic	204.4	260	315	315	315	332	333	333	333	333	333
Convoy	45.6	66	100	100	100	150	150	150	150	150	150
	(250)	(326)	(415)	(415)	(483)	(483)	(483)	(483)	(483)	(483)	(483)
Waste amount supposed to be non-collected	290	219	131	110	84	---	---	---	---	---	---

Table III-3.1-2 MUNICIPAL COMPACTION TRUCK AND CALCULATION BASIS

1	Loading capacity (Rated)	8 ton (Weight basis) 15 m^3 (Volume basis)
2	Compacted density of waste. Max. 0.45 t/m^3 (According to test compaction by the D.L.P.M. in 1987, 0.42 t/m^3. Truck scale measurement gave some results ranging from 0.47 - 0.512 t/m^3. Therefore 0.45 t/m^3 is possible.)	
3	Adopted loading rate Weight basis Volume basis	 8t x 0.75 = 6.0 ton 15 m^3 x 0.9 = 13.5 m^3 (13.5 m^3 x 0.45 t/m^3 = 6.075 ton. equivalent to that of weight basis)
4	Average load obtained with truck scale measurement from Nov., 1990 to Jan., 1991. Weight basis Volume basis	 approximately 4.5 ton Unknown
5	Verified loading efficiency 4.5/6.0 x 100 = 75% versus the adopted loading rate 4.5/8.0 x 100 = 56.25% versus the rated loading capacity	
6	Population to be covered per truck a working day (population to be covered) = $\frac{b(ton/truck)}{(G.C.WD)}$ Here, (G.G.WD.) means "generation per capitation per working day. G.C.WD in 1990 is 0.5985 " " 1995 " 0.6775 " " 2000 " 0.7483 Therefore, population to be covered per truck a working day is as follows: in 1990, 10,070 (2014) in 1995, 8,856 (1771) in 2000, 8,018 (1603) *( ) denotes household number	
7	Assignment of collection route and zone. - to designate a portion of collection zone. according to population shown in 6 above. - To assign a suitable collection route so as that efficiency may reach to the maximum level. - In case of the bell collection service, to render collection service at the appointed time and place.	

Although the ECA is to be exclusively assigned to the private collectors by the end of 1995, a transitional stage will be expected, because concession procedures will be gradual and step-by-step. During this transition period, the Municipality will assume the responsibility for collecting wastes generated by low-income or poor residents who are unable to pay regular fees. Therefore, the total refuse amount to be collected by the municipal sector comprises three types of wastes, namely street sweeping wastes, market wastes and domestic wastes.

In 1990, the DLPM possessed 36 compaction vehicles and 4 dump trucks; but operable vehicles were limited to 31 and 3, respectively. With this collection equipments, only 250 tons of waste per work day was collected, resulting in 290 tons of non-collected waste. Vehicle utilization efficiency can not be said to be high, because the average loading is only 4.5 ton per truck in spite of 8 tons of the rated capacity (56.25%). The 1.47 trip number is admissible and acceptable, for the labor law prescribes 8 working hours per day while the travelling distance is relatively longer.

(2) Calculation of vehicle number

Computation bases for compaction vehicles are as follows:

1) Average loading: 4.5 ton/truck (56.25%) in 1990
" 5.6 ton/truck (70.0%) in 1991
" 6.0 ton/truck (75%) after 1992
(Loading rate is to be improved)

2) Trip number: not to be below 1.5
(Both diurnal and nocturnal services included)

Calculation terms for convoy service;

1) Average loading: 1.9 ton/truck in 1990
" 2.2 ton/truck in 1991
" 2.5 ton/truck after 1992
(Improvement of the average load will be possible by means of a slightly deeper loading body)

2) Trip number: 1.5

Prerequisites for the calculation;

a. In 1995, when 15 zones are scheduled to be conceded to the private collectors, the forecasted waste amount to be collected should be counterbalanced with the municipal service capability.

b. In 1992, out of 31 compaction vehicles, 14 should be renewed and 4 new cars added to the existing fleet; furthermore 4 very old dump trucks should be renewed in order to meet an increasing refuse quantity.

c. In 1995, 19 new compaction vehicles and 2 additional dump trucks should be purchased.

3.1.5 Adaptability of a Container Collection System in Marginal Areas

The experiment of container collection was effected during the field study with the object of verifying an active response of the resident and sounding a possible applicability of the system to collection service in marginal areas. (Cf. Supporting Report, 4-1 Pilot Project of Containers)

With regard to residents' response or their readines to cooperate on the container collection system, the result was

beyond expectations: it was really positive. As for the applicability of this method to the collection system in marginal areas, however, it seems to be very problematic: this method cannot be applied without some important reservations.

For its materialization, it is necessary to study more in details regarding the size, the number, the distribution site, and also the specifications of collection vehicles: these are important in terms of all technical aspects. More important aspects are socio-economic ones. Without solving socio-economic problems, which may cause serious damages to the private collectors, the container collection system should not be incorporated hastily into collection planning in marginal areas in PCA where the mixed-collection will be applied. If municipally-owned containers are put in places adjacent to collection districts reserved for private collection service, there will be a strong possibility of the provoking insoluble conflicts between private and municipal sectors; because, in such a case, the container collection system may deprive private collectors of their customers. As the result of such a conflict, the entire collection system proposed in MP will collapse and the confidence of the private sectors in the municipal authorities will be definitely lost in such an extent that it will take long time to recover a close relationship with each other.

When the container system is introduced in the near future, therefore, it will be very important to meet the following conditions:

(1) To put containers solely in marginal areas in PCA,

(2) To select collection sites outside at least two kilometers from the peripheries of private collection zones

(3) To make prior consultations with private collectors about the number and size of containers, location sites, and methods about how to settle disputes originating from the container system.

3.1.6 Feasibility

The plan presented is estimated to be feasible and practicable, viewed from operational, institutional aspects backed by suitable support sub-systems.

(1) Operational viewpoints

1) The plan is realistic, not theoretical.

The plan has been made based upon existing manpower and available resources, without considering the purchase of additional new vehicles or the hiring of collection workers for any of the projects. As it has been concluded, a totally new collection system would lead to a hypothetical conclusion without the utilization of the actual resources. In this sense, the plan presented can be said realistic and practicable: the fundamental principle is an application of available resources to the maximum.

2) The plan aims at the reorganization, systematization and readjustment of actual collection structure.

The actual collection system, that is, the dual collection structure, has been admitted and accepted according to the usages of the last few decades. These conventional systems need to be so readjusted as to meet requirements under the present circumstances. The plan formulated, therefore, aims to the goal of systematically

reorganizing the actual collection system, in such a manner that it would contribute both to an environmental protection in the broader sense and to a moderate alleviation of social impact. Total change of the existing collection system would be highly problematic and its realization would be unrealistic. In this sense, the plan proposed is realistic and feasible from the social point of view.

3) A feasible plan needs to be rooted in firm organizational grounds supported by a sound financial basis. The plan satisfies these two important conditions as analyzed in the other parts of the MP: economic and financial aspects have been examined sufficiently regarding not only to the municipal sector but also to the private sector.

(2) Institutional and organizational viewpoint

1) Institutional establishment proposed in II-7 will make the plan feasible and practicable.

The operational system does work and becomes effective enough only under an adequate institutional system. II-7 proposes to build up an appropriate institutional system for an effective implementation of the M.P., and for a proper SWM.

2) The proposed zone concession to the private sector is the key point to judge whether the collection plan proposed is feasible or not. Failure or success of concession schedule is instrumental to its feasibility.

This point has been duly analyzed in II-7, and the concession process has been sufficiently explained.

The collection plan, which has been reconstructed upon these prerequisites, will be therefore feasible. As concession is gradual and step-by-step, however, implementation of the proposed collection plan will also be gradual and step-by-step: this means steadiness of the total plan of the MP.

From what has been said, the plan will be practical and feasible on a reasonable basis.

3.2 Improvement of the EL Trebol Landfill Site

3.2.1 Selection of the Most Suitable Landfill Method for Improving the EL Trebol Landfill Site

Field and feasibility studies were conducted to assess three possible alternatives: (1) "truck access to bottom" method; (2) the multi-platform method; and (3) the "down-slope" method. From a technical standpoints, the down slope method has been found to offer the greatest advantages. The table below compares the characteristics of these three methods.

Table III-3.2-1 Evaluation of Three Landfill Methods of "El Trebol"

		No. 1	No. 2	No. 3
		Truck access to bottom method	Multi platform method	Down slope method
Transportation	Unloading	Basically, trucks have access to the bottom step-by-step for unloading	Always unloading at the top level ground. Bulldozers push the waste to the bottom platform-by-platform.	Always unloading at the top level ground. Push waste to bottom sliding on slope by bulldozers
	Difficulty	Aged trucks have difficulty to ascend to the bottom for unloading	No problem	No problem
	Efficiency	Not good	Good	Good
Landfilling	Need to push waste to the bottom	Not necessary	Necessary	Necessary
	Soil for covering	Direct transport by trucks	Pushed platform-by-platform using bulldozers	Push down on slope by bulldozers
	Operation	Easy	Easy	Easy
	Covering work	Easy	Not easy	Somewhat difficult
Equipment required	Soil transport	By specific truck	By bulldozers	By bulldozers
Costs	Number of personnel	A few	Many	Many
Operational conditions	Investment cost	Yes for specific trucks	For bulldozers	For bulldozers
	Time to start up	A long time	Not so long	Earliest
	Preparation work	A long time is required	About 3 months	About 4 months

Conceptual plan of the improvement El Trebol based on the down slope method is shown in the Fig. III-3.2-1 - Fig. III-3.2-5.


DRAIN PIPE
DIAMETER=45cm
LENGTH=290m
GATE
FENCE LENGTH=85m
TENTATIVE LEACHATE POND
PRESERVATIVE AREA FOR GENERIC SOIL
FENCE LENGTH 80m
ACCESS ROAD WIDTH=15m
UNLOADING AREA FOR PRIVATE COLLECTOR 25m×50m
SLOPE FOR HEAVY DUTY MACHINE I=20%
EXCAVATION=30m LANE FOR SHOTING SOLID WASTE
LANE FOR RETURNING HEAVY MACHINE
SLOPE FOR HEAVY DUTY MACHINES
LANE FOR SHOTING COVERING SOIL
EXISTING AREA OF DUMPING OPERATION
PARKING LOT 20m×50m
TRUCK SCALE
WORK SHOP 50m²
GATE
ASPHALT PAVEMENT WIDTH=15m LENGTH=20m
Drainage Ditch 40cm×40cm LENGTH=580m
FENCE LENGTH=115m
COVERING SOIL STORAGE AREA
SHED FOR OPERATOR 30m²
FUEL OIL YARD 15m²
UNLOADING AREA FOR MUNICIPALITY COLLECTOR 25m×20m
1
2
3
4
5
6
7
8
9

TREBOL LANDFILL SITE
ICHNOGRAPHICAL
PLANNIG VIEW

TENTATIVE LEACHATE POND

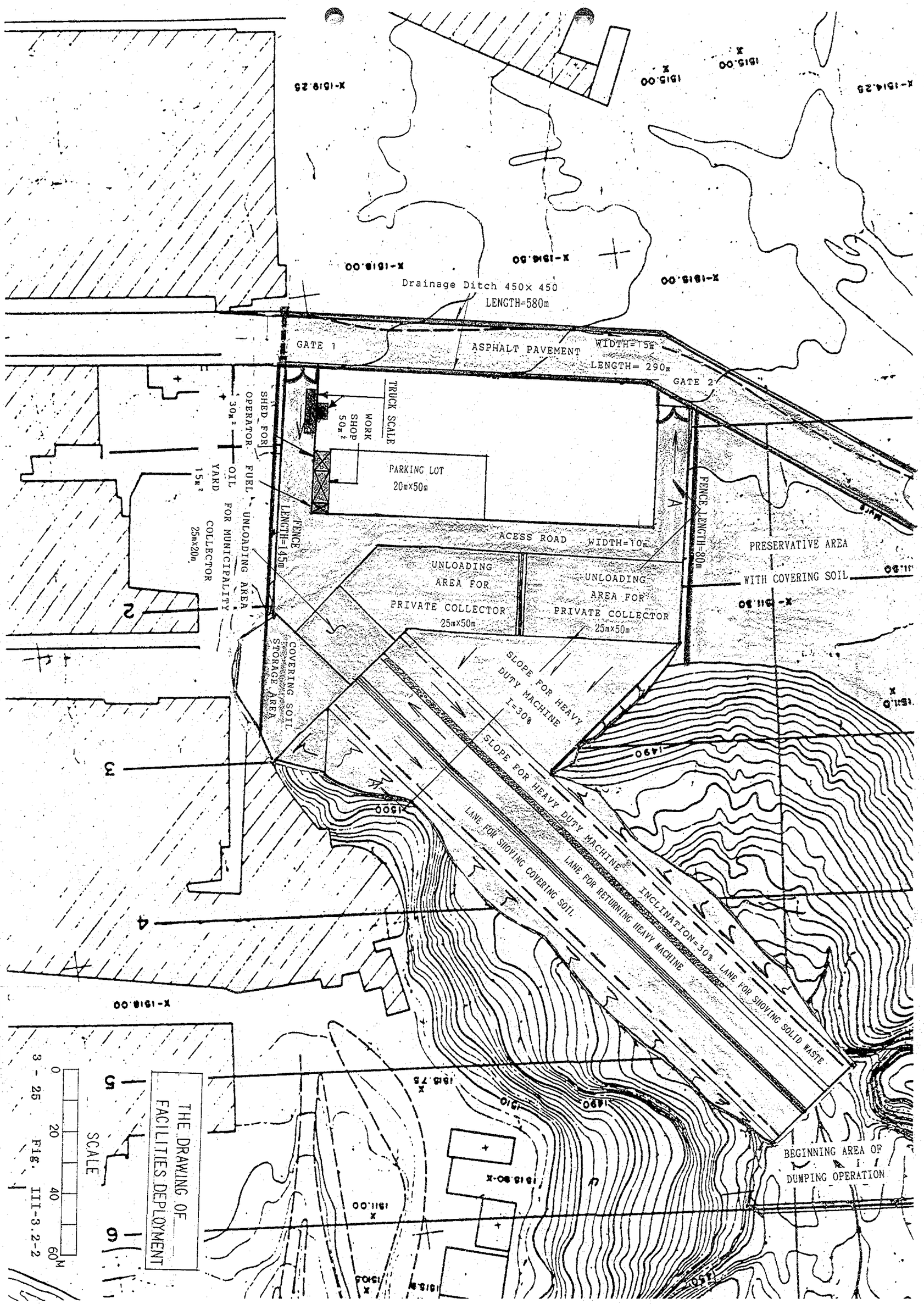
FENCE LENGTH=85m

WIRE MAT DAM
LENGTH=10m HIGHT=7.0m

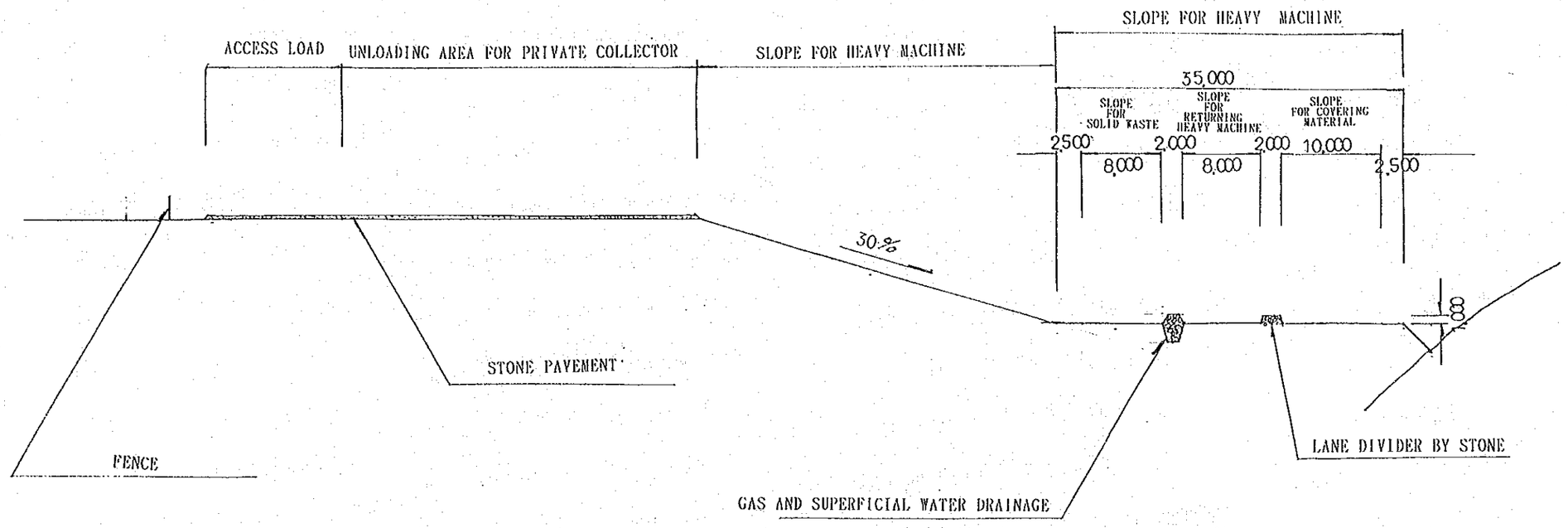
CONCRETE DAM
LENGTH=10m HIGHT=4.0m

Scale
0 50 100

Fig. III-3.2-1

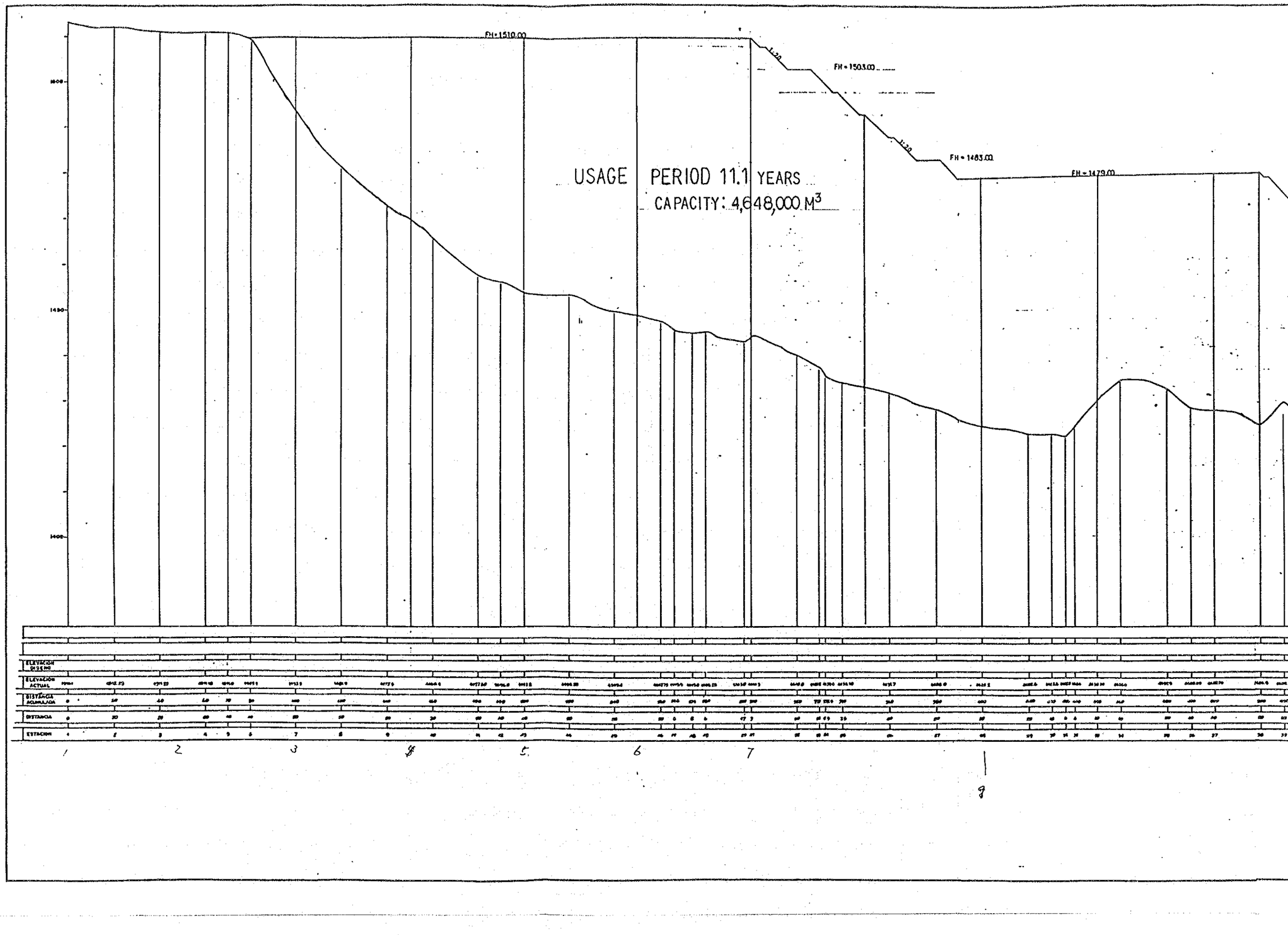

Drainage Ditch 450× 450
LENGTH=580m
GATE 1
ASPHALT PAVEMENT
WIDTH=15m
LENGTH= 290m
GATE 2
TRUCK SCALE
WORK SHOP 50m²
SHED FOR OPERATOR
30m²
OIL YARD 15m²
FUEL UNLOADING AREA FOR MUNICIPALITY COLLECTOR 25m×20m
PARKING LOT 20m×50m
FENCE LENGTH=145m
ACESS ROAD WIDTH=10m
FENCE LENGTH=80m
PRESERVATIVE AREA WITH COVERING SOIL
UNLOADING AREA FOR PRIVATE COLLECTOR 25m×50m
UNLOADING AREA FOR PRIVATE COLLECTOR 25m×50m
COVERING SOIL STORAGE AREA
SLOPE FOR HEAVY DUTY MACHINE I=30%
SLOPE FOR HEAVY DUTY MACHINE INCLINATION=30%
LANE FOR SHOVING COVERING SOIL
LANE FOR RETURNING HEAVY MACHINE
LANE FOR SHOVING SOLID WASTE
BEGINNING AREA OF DUMPING OPERATION
THE DRAWING OF FACILITIES DEPLOYMENT
SCALE
0 20 40 60M
3 - 25 Fig. III-3.2-2

A — A SECTION



S : 1/500

Fig. III-3.2-3


FH = 1510.00
1:3.0
FH = 1503.00
1:3.0
FH = 1483.00
FH = 1479.00
USAGE PERIOD 11.1 YEARS
CAPACITY: 4,648,000 M3
1600
1500
1400
ELEVACION DISEÑO
ELEVACION ACTUAL
DISTANCIA ACUMULADA
DISTANCIA
ESTACION
1
2
3
4
5
6
7
8

TREBOL LANDFILL SITE

LONGITUDINAL VIEW

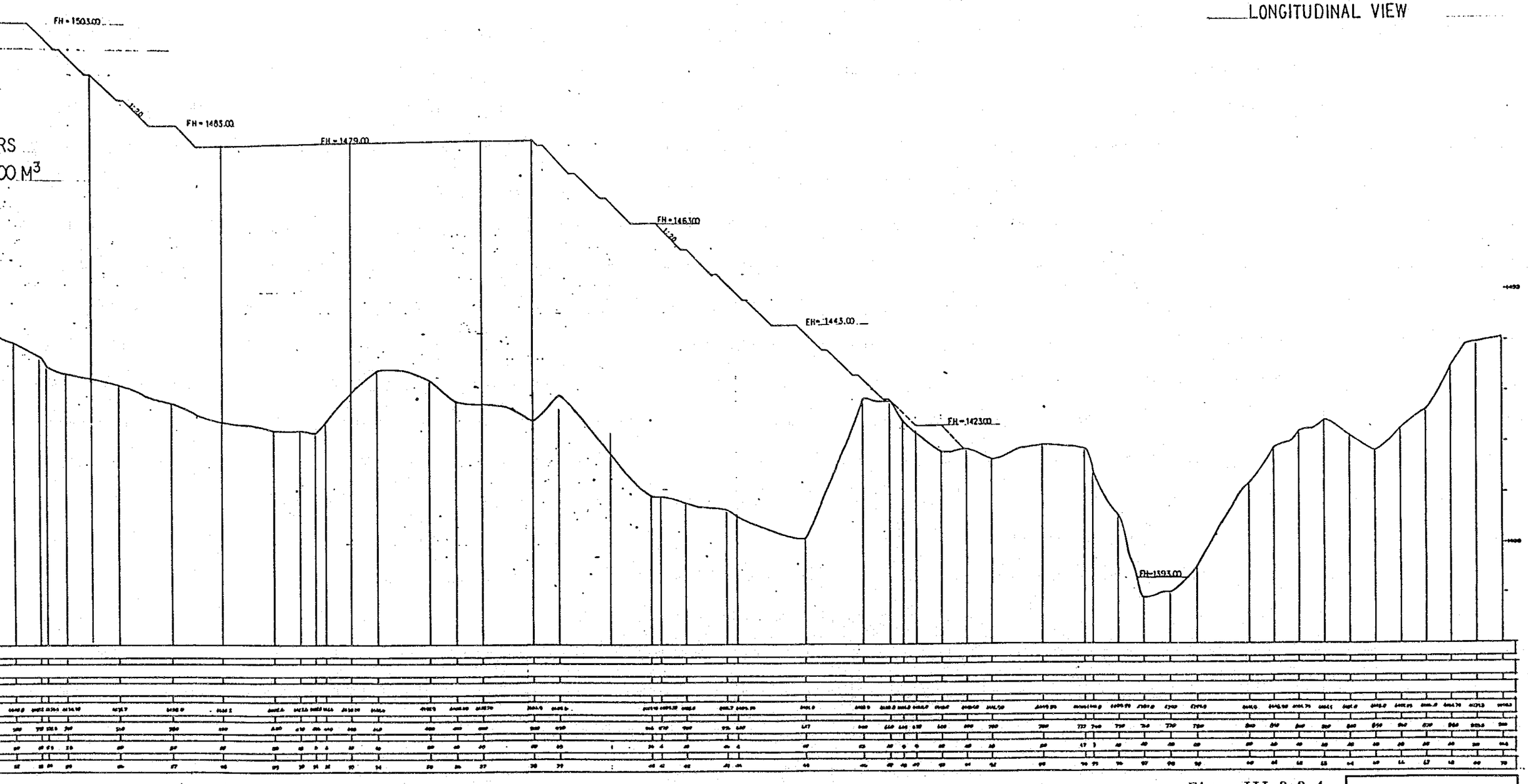


Fig. III-3.2-4

MANEJO DE DESECHOS SOLIDOS EN GUATEMALA		
EL TREBOL		
PERFIL LONGITUDINAL ESCALA HORIZONTAL 1:000 ESCALA VERTICAL 1:000		
ELABORADO POR TELECTRO S.A	DIR. GENERAL ING. J. MONTENEGRO	JICA
FECHA SEPTIEMBRE 1998		

Completed Plane View of Trebol Landfill Site

Fig. III-3.2-5

MANEJO DE DESECHOS SOLIDOS
EN GUATEMALA
EL TREBOL
PLANO TOPOGRAFICO
ESCALA 1:1000

ELABORADO POR: DIRECCION:	JICA
ELECTRO S.A. Ing. Jorge Montenegro R.	
FECHA: SEPTIEMBRE 1990	

3.2.2 Improvement of the EL Trebol Landfill Site

(1) The most basic concept and basis for Trebol landfill improvement are as follows:

The slope with about 35 m width will be constructed with the waste.

Basically the waste and covering materials will be transported sliding on each specified lane which is constructed on the slope divided into three lanes, between them 2 m width partition zone consisting of cobble stones are provided for gas ventilation and leachate draining.

- BOD of leachate = 12,000 mg/l BOD
- Quantity of leachate = 500 tons/day (measured)

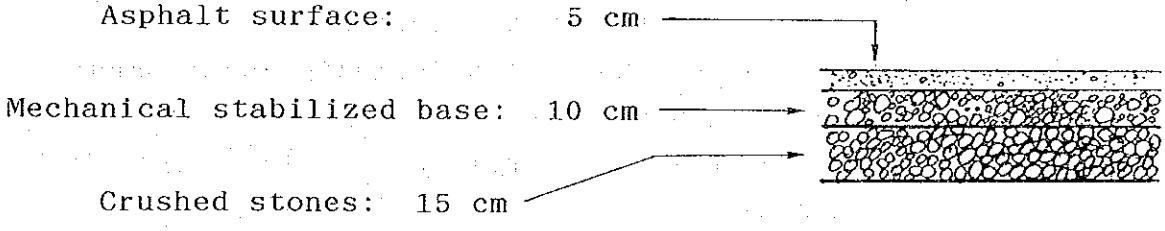
(2) Improvement planning

1) Improving access roads including internal roads

a. Main access road

The main existing road along the existing fence will be paved as follows:

- Width of the road: 15 m
- Length of the road: 290 m
- Structure and material; shown in the figure



b. Ground preparation

Existing top level ground where the collection vehicles unload the waste, and scavengers operate, is necessary to be improved with hard soil.

- Ground area: about 3400 m²

2) Drainage of rain water

The rain water on the top level ground and places nearby has to be collected and led to the outside of landfill site in order to minimize the quantity of leachate.

- Maximum rainfall rate: 120.5 mm/hr.
- Area subject to collection: 33,400 m²
- Design of drainage system: Open Ditch

Size of ditch	450 mm x 450 mm
Material of ditch	Concrete
Length of total ditch	about 580 m

3) Administration facility

To implement the controlled landfilling method, the following facilities are necessary to be provided from the administrative view points:

a. Fence

Existing concrete made fence has to be partially reconstructed including some more extension to enclose the site completely, along with 3 gates to control the public from entering.

- Size of fence: 10 cm thickness x 2.3 m height
- Material: Reinforced concrete
- Length of fence: about 310 m (extension)
- Size of gate: 2.3 m (H) x 6 m (W)
- Material of gate: Mild steel made

b. Workshop

A workshop is constructed for maintenance of bulldozers and shovel loaders, etc.

Maintenance tools and equipment which are provided have to be used.

- Size of workshop 50 m^2
- Materials = Steel columns with slate roof

c. Oil tank yard

The oil tank yard will be constructed beside the internal road.

- Size of yard 15 m^2

d. Parking lot

The parking lot will be constructed for city government owned vehicles and others.

- Size of parking lot = 1000 m^2

e. Operator's shed

The shed will be constructed for operators resting and other purposes.

- Size of shed = 30 m^2
- Material = Steel and slate roof

4) Dam construction

This will consist of concrete and wire-mat dams to form a leachate reserving pond.

On the pond, a pump house and its foundation will be constructed.

- Structure of concrete dam: Gravity dam
- Size of dam: Height: 4.0 m x Length: 10 m x
  Width at top: 0.5 m
  Width at bottom: 3.7 m
- Structure of wire-mat dam: Wire-mat constructed dam
- Size of dam: Height: 7.0 m x Length: 10 m x
  Width at top: 1.0 m
  Width at bottom: 14 m
- Materials of wire-mat dam: Wire-net and cobble stones

5) Leachate pond

- Volume of pond: about 1000 m^3
- Number of concrete foundation: 1
- Number of pump house: 1
- Size of pump house: 12 m^2
- Material of pump house: Steel construction with slate roof

(3) Equipment planning

To implement the controlled landfill site the following equipments have to be provided:

1) Bulldozers

Waste and cover soil have to be pushed down on the slope by bulldozers from the top level ground to the gully bottom.

- Number of bulldozers: 4 (four)
- Type of bulldozers: High sprocket type for soft ground
- Capacity: 230 HP

Note: In addition to 4 bulldozers stated above, another existing old bulldozers should be incorporated for operation

2) Shovel loaders

These loaders will be mostly used for excavation and transportation of the natural soil for covering of waste.

- Number: 2 (two)
- Type: Wheel loader type
- Capacity: 55 HP, 0.6 m^3

3) Submerged pumps

The pump will be used for leachate circulation from the pond.

- Number: 2
- Type: Submerged type
- Capacity: 30 m^3/hr x 5.5 kW

4) Aerator

The aerator will be used for leachate aeration in the tentatively made small pond.

- Number: 1
- Type: Portable type
- Capacity: 3.7 kW

5) Truck scale

This scale will be used for weighing of solid waste transported to the site, and the data will be automatically processed by a computer.

- Number: 1
- Type: Multi load-cell type with computer data processor
- Capacity: 30 tons

3.2.3 Cost Estimation and Its Basis

(1) Construction cost

1) Ground preparation Q46,000

2) Access road

- Pavement construction

Asphalt pavement
4350 m² x 55 Q/m² = Q239,250
Stone pavement
5300 m² x 10 Q/m² = Q53,000
1590 m² x 800 Q/m² = Q127,200 (Stone)
Sub total Q419,000

3) Drainage system

1 Ditch (450 mm x 450 mm) 580 m x 300 Q/m = Q175,400
2 Drainage pipe, diameter: 45 cm x Length: 290 m x 200 Q/m = Q58,000

Sub total Q233,400

4) Administration facility

- Fence H = 2.3 m	310 m x 70 Q/m =	Q21,700
- Gate	3 gates x 2000 =	Q6,000
- Work shop	50 m² =	Q50,800
- Oil tank yard	15 m² =	Q30,000
- Parking lot	1000 m²	Q50,000
- Operator's shed	30 m²	Q62,700
Sub total		Q221,000

5) Dam construction

- Concrete dam H: 4.0 m, L: 10 m	Q50,000
- Wire-mat dam Wire Mat H: 7.0, L: 10 m	Q340,000
Sub total	Q399,000
- Pump's foundation	Q14,770
- Electricity supply	Q90,000

(2) Equipment cost

1) Bulldozer	4 x Q1,337,000 =	Q5,348,000
2) Shovel loader	2 x 197,900 =	Q395,800
3) Submerged pump (including pump house)		Q210,000
4) Aerator	2 x 5,000 =	Q10,000
5) Truck scale (including house and foundation)		Q400,000

(3) Operational cost

1) Fuel

for Bulldozers

5.8 gallon/bulldozer x 7 x 9 hrs = 365 gallons/day

for Shovel loaders

1.6 gallon/loader x 2 x 6 hrs = 19 gallons/day

total consumption 365 + 19 = 384 gallons/day

384 x 313 days = 120,190 gallons/year

fuel cost Q6.3/gallon = Q758,340/year

2) Maintenance

Unit maintenance cost for bulldozer = Q42/hr

Unit maintenance cost for loader = Q3/hr

Maintenance cost for bulldozer

42 x 7 x 9 hrs = Q2646/day

Maintenance cost for loader

3 x 2 x 6 = Q36/day

Total cost (2646 + 36) x 313 = Q839,466/year

3) Covering soil

28,264 m^3/year x Q23/m^3 = Q651,000 (in 1992)

4) Electricity: Q72,590/year

5) Personnel cost

Five bulldozer operators (one stand-by)

x Q600/man x 12 months

Note: Other personnel for landfill operation