8.5 Design of a Final Disposal Site

8.5.1 Examination of Technical Alternatives

The concept described below is applied to the design of a Sofulu disposal site. Although the team proposed to design new landfill (Phase 2 & 3) without liner, it was not approved by the MoE.

a. Phased Site Development and Landfill Operation

The Sofulu disposal site will be developed and operated in 3 phases as described below (refer to Figure 8-17: Design of the Sofulu Disposal Site).

Phase 1:

In this phase the current dump site will be rehabilitated. The landfill operation will be continued until the final height of the landfill (including final cover) reaches to the elevation indicated in the ultimate land use plan.

Phase 2:

The landfill operation area of the phase 2 is the uppermost section upstream of the catchment area. Since rain water fallen in this area will generate leachate by passing the current dump site, it is considered much better to fill up the area by waste than to remain as it is (like a reservoir in shape).

Phase 3:

In this phase as shown in Figure 8-17 the opposite side of the present dump site will be reclaimed by waste. The landfill operation will be completed when the height of it reaches to the ultimate use of the landfill. In addition, the surface soil can be used for covering soil for phase 2 landfill operation.

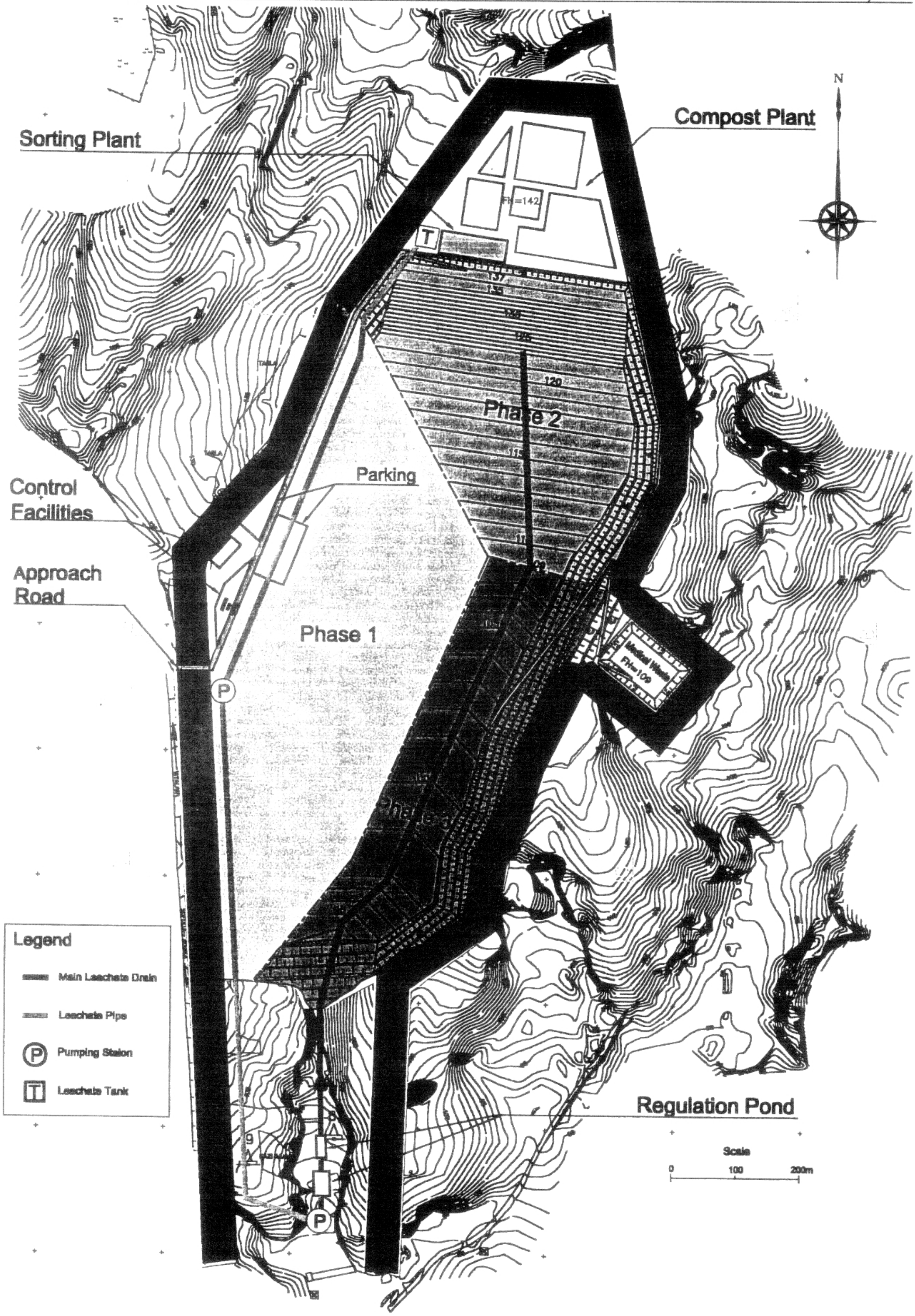


Figure 8-17: Design of the Sofulu Disposal Site

b. Appropriate Sanitary Level of the Disposal Site

Turkish Solid Waste Regulation requires that a 2 mm, high density polyethylene (HDPE) liner is laid at the slope surface of disposal site if there is impermeable layer at the bottom. Because it is impossible to remove the waste layer that are already in the disposal area the liner will not be installed during phase 1. At phase 2 and phase 3, the liner will be laid according to the SWM regulation, and leachate from the disposal site will be treated by circulation, proved to be functional during the pilot project.

- Since a 4 km long and 50 meter width greenbelt, which may have a lot of vegetation, will be constructed, it requires considerable amount of water. If diluted the leachate can be used as irrigation water for it.
- This treatment system appears to be more economic than the construction of a leachate treatment facility.

8.5.2 Preliminary design

a. Outline of the Sofulu Disposal Site

Outline of the Sofulu Disposal site is shown on Table 8-21.

Table 8-21: Outline of the Sofulu Disposal Site

Items	Description
Land Area and Proposed Land Use	Total Area :95ha Phase1:Landfill Area :25ha Phase2:Landfill Area :13ha Phase3:Landfill Area :17ha Plant :Area :6ha Medical waste Landfill Are :3ha Buffer zone :Area :25ha Others(include regulation pond)Use :6ha
Landfill Volume	Phase / Capacity / Disposal Period Phase2 2,325,000m^3 2002-2006 Phase3 2,351,000m^3 2007-2009
Road	Approach road(Asphalt paved) :width8.0m,lenght780m Access road (Asphalt paved) :width4.0m,lenght1,885m Operation road Temporally
Control facilities and approach road	Entrance area(Asphalt paved) :9,000m^2 Site office :300m^2 Weigh bridge : 2set Tire washing pit : 1set Gate : 1set Power supply :1set water supply :1set Weighbridge and washing area(conc. paved) :2,000m^2 Parking for heavy vehicle(gravel) :5,000m^2

Items	Description	
Leachate control facility	Leachate collection pipe φ100mm	:2,485m
	Main leachate drain φ200mm	:990m
	Pumping station	:2 set
	Pump	: 4set
	Regulation pond	:1set
	Leachate pipe φ200mm	:1,680m
	Leachate Tank	:1set
Drain for runoff water	Open concrete drain	:2,665m
	Pipe drain for rain fall	:990m
Environmental protection facilities	Fence	:4,570m
	Buffer zone	:4,570m
	Gas removal facility(Vertical)	:900m
	Gas removal facility(Horizon)	:2,485m
	Monitoring borehole	:3set

Purpose and outline of the individual facilities will be explained as follows.

b. Final Disposal Site

Final disposal site shall be constructed for treating the municipal solid waste from Adana city.

b.1 Capacity of Final Disposal Site and Disposal Period

Disposal period for Sofulu Disposal Site will be planned considering both final municipal solid waste disposal volume from Adana Greater Municipality and remaining capacity of Sofulu Disposal Site. According to the above consideration, disposal period for Sofulu will be from year 2002 until year 2009. Final municipal solid waste disposal volume from Adana Greater Municipality is shown on Table 8-22 and Volume of each Phases, year of construction and disposal period are shown on Table 8-23.

Table 8-22: Final Disposal Amount in Sofulu (2002-2009)

Item	unit	formula	2002	2003	2004	2005	2006	2007	2008	2009
Final Waste Disposal Amount	ton/day	a	786	842	900	966	1,042	1,130	1,234	1,334
	ton/year	b=bx365	286,984	307,593	328,717	352,693	380,042	412,903	449,925	486,945
Waste +Cover soil	m^3/year	c=bx1.2/ 0.8	430,476	461,390	493,076	529,040	570,063	619,355	674,888	730,418
Total	m^3/year	Σd	430,476	891,866	1,384,942	1,913,982	2,484,045	3,103,400	3,778,288	4,508,706

Table 8-23: Capacity of the Phases in Sofulu

Phase No.	Capacity of Phase(m^3)	Year of Construction	Disposal Period
Phase 1	1,409,000m^3	-	1999-2001
Phase 2	2,351,000m^3	2001	2002-2006
Phase 3	2,325,000m^3	2005	2007-2009

In Phase 1 operation, municipal solid waste will be landfilled from 1999 till 2001. Earth cover will be carried out daily and final cover will be carried out once height of the landfill reaches to the elevation indicated in the ultimate land use plan.

Structure of the final disposal site is as follows.

b.2 Bottom of Final Disposal Site

According to the SWM regulation, a liner will be laid at bottom and slope of the final disposal site to prevent leachate from seeping into the ground. The structure of Bottom and slope are as follows;

- Bottom: Impermeable clay layer (K = 10^{-8} to 10^{-9} m/sec) should be kept as the liner.
- Slope: 60cm impermeable clay layer (K = 10^{-8} to 10^{-9} m/sec) should be kept as the liner. And a 2 mm, high density polyethylene (HDPE) liner should be laid on top of it.

The structure of the bottom of final disposal site is shown on the following figure.

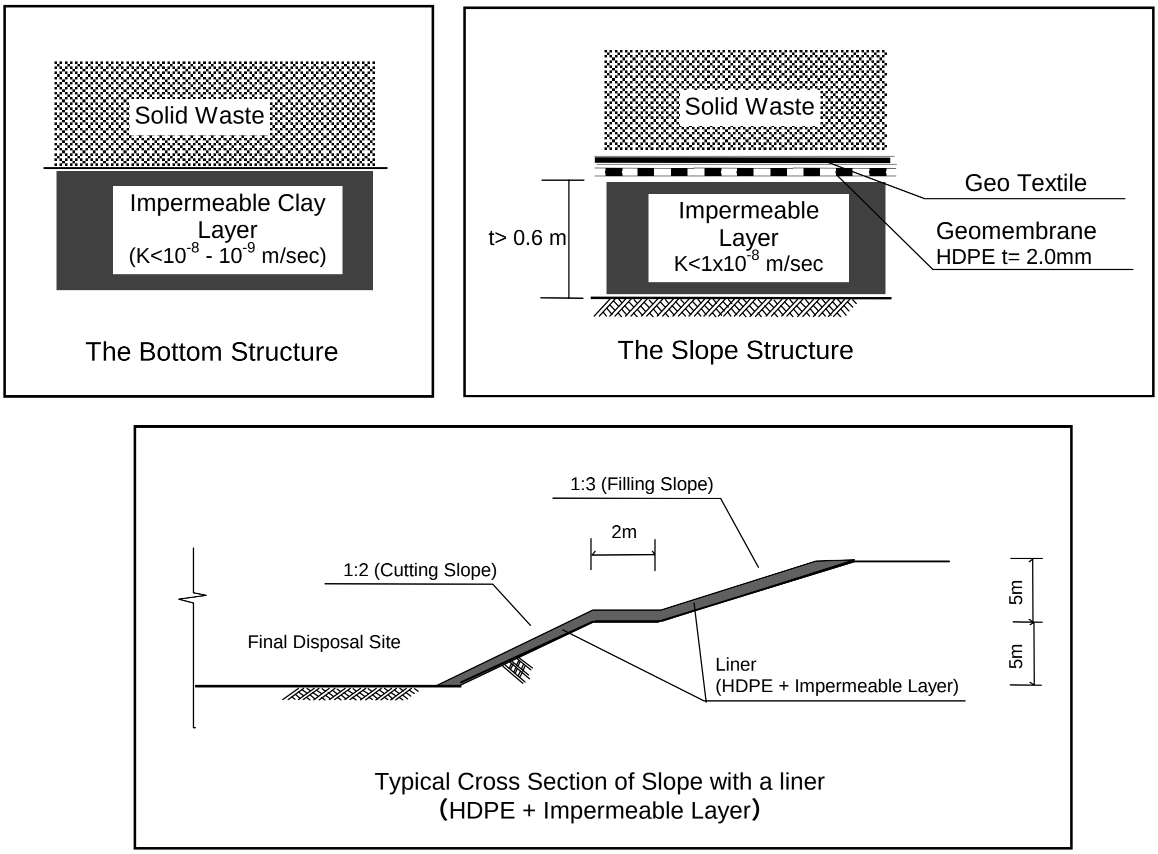


Figure 8-18: Diagrams of the Landfill's Impermeable Strata (Bottom and Slope)

b.3 Slope of Final Disposal Site

The structure of the slope of final disposal site is same as bottom of it. The slope will be 1:2 for cutting and 1:3 for filling and has 2m wide bench at every 5m height after consideration of construction of clayey liner.

b.4 Approach Road

For the refuse collection vehicles reaching the working face(waste disposal site), sorting plant and compost plant, this approach road should be constructed. Its width should be 8.0m and 780m long, paved with asphalt. Open concrete drain will be constructed along approach road in order to prevent rainfall water to flow into landfill area.

b.5 Access Road

For the refuse collection vehicles reaching the working face(current landfill operation area) , this approach road should be constructed. Its width should be 4.0m and 1,885m long, paved with asphalt. Open concrete drain will be constructed along access road in order to prevent rainfall water to flow into landfill area.

b.6 Operation Road

Operation road for the refuse collection vehicles will be constructed at the working face(current landfill operation area). This is a temporary road which will shift location according to the location of the working face.

c. Control Facilities and Approach Road

Following facilities will be planned to operate at the disposal site. Layout plan of the control facilities is shown on Figure 8-19.

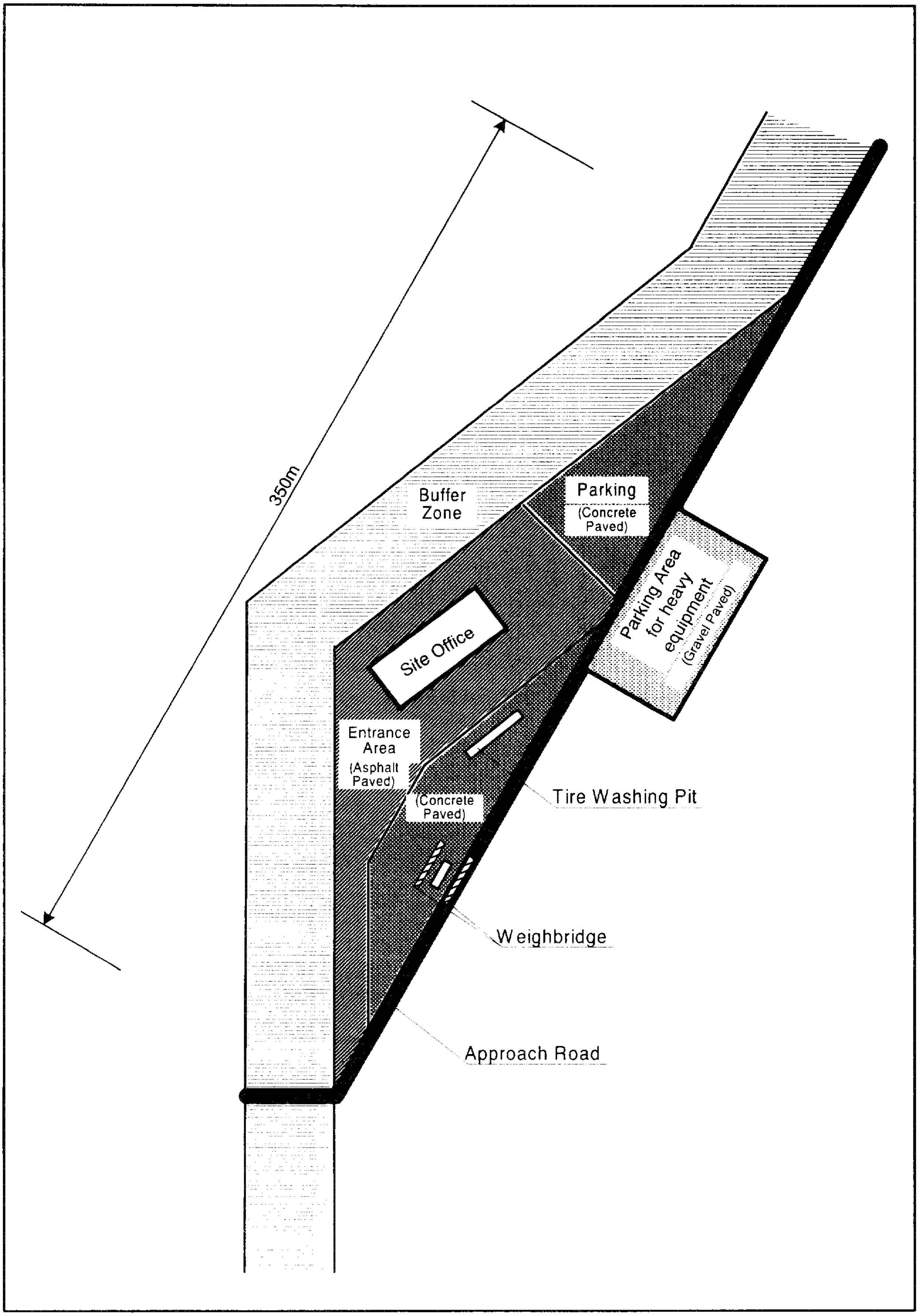


Figure 8-19: Control Facilities and Approach Road in Sofulu

c.1 Entrance Area (Asphalt paved)

Entrance area starts from approach road to the site office and has 9,000m^2 and is paved with asphalt.

c.2 Site Office

The site office (approximately 300m^2) shall have a control room and facilities for staff and management.

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

The facilities are as follows;

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

c.3 Weighbridge

A weighbridge shall be constructed on weighing cells in a concrete structure. The recorded weight of a full vehicle will be transmitted to the computer in the site office. Capacity of weighbridge shall be 60t and there shall be 2 nos. of Weighbridge installed to cover approximately 300 collection vehicles in a day at the year of 2005

c.4 Tire Washing Pit

The refuse collection vehicles should pass the tire washing pit before leaving the site to avoid carrying the dirt back into the city. The pit should be of a concrete structure.

c.5 Gate

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

c.6 Power Supply and Water Supply

Power supply should be installed at the entrance area, site office, weighbridge, compost pant, sorting plant and pumping station. Water supply should be installed at the site office, compost pant, sorting plant and tire washing pit.

c.7 Weighbridge and Washing Area

Weighbridge and washing area should be mainly for heavy equipment for the landfill operation. This area should also be available for the refuse collection vehicles to park. The area should be around 2,000m^2 and concrete paved.

c.8 Parking for Heavy Vehicle (gravel)

Parking for heavy vehicle area should be mainly for heavy equipment for the landfill operation. This area should also be available for the refuse collection vehicles to park. The area should be around 5,000m^2 and gravel paved.

d. Leachate Control Facility

d.1 Precipitation and Evaporation

The following table presents monthly values and annual values for average precipitation and evaporation in Adana. At the sanitary landfill in Adana the average annual precipitation is 670 mm/year. Evaporation from an area depends on the climatic conditions (temperature, wind and precipitation) and the type of surface.

Table 8-24: Average Precipitation and Evaporation at Adana

Adana GM	Month												
mm/month	1	2	3	4	5	6	7	8	9	10	11	12	Year
Average Precipitation	111.7	92.8	67.9	51.4	46.7	22.4	5.4	5.1	14.8	43.6	67.2	118.1	647.1
Average Evaporation	47.3	56.1	84.9	119.7	170.5	210.1	243.4	224.6	181.0	120.8	66.3	47.0	1571.7

d.2 Leachate Quality

Leachate quality varies according to type of waste disposed of at the landfill, landfill structure (aerobic, anaerobic, semi-aerobic), and climatic conditions, e.g., ambient temperature. Determining leachate quality by referring to past examples is unrealistic. The proposed final disposal site is planned to be a semi-aerobic type, but the final disposal sites in AGM are not equipped with leachate control structures (e.g., impermeable liners to block leachate from permeating the ground), and, therefore, examples from Japan and other countries were used to determine leachate quality (refer to Table 8-25). Further, as a reference, Table 8-26 shows the results of the comparison between the leachate quality, obtained by the team during the study, from the MGM's landfill and the AGM's landfill.

Biochemical Oxygen Demand (BOD_5) and Suspended Solid (SS) are used to determine leachate quality.

Table 8-25 : Comparison of Leachate Quality

Constituent	Japan (combustible waste with a semi-aerobic structure)[*1]		USA(combustible waste with an an-aerobic structure)	Denmark (combustible waste with an an-aerobic structure)
	Waste (Garbage) (a semi-aerobic Structure)	Incinerated Ash (a semi-aerobic structure)		
BOD (mg/l)	1,200	250	2,000 to 30,000 (typical 10,000)	200 to 20,000
S S (mg/l)	300	300	200 to 2,000 (typical 500)	not available

Note*1 :Source : Study on the Leachate Treatment System Development for Landfills, 1979; Japan Waste Management Association

Table 8-26 : Comparison of the Leachate Quality from the Existing Landfill Sites.

Parameters		Measurement results	
		MGM (23.05.1999)	AGM (24.05.1999)
Flow rate	L/sec	1.9	2
pH	-	7.85	7.86
TDS	ppm	6.9	6.8
COD	-	>35,000	>30,000
BOD	ppm	9,985	9,885
Total N	ppm	360.65	340.64
Total P	ppm	24.16	23
NH_4^+	ppm	346.38	335.15
Na^+	ppm	68.51	68.35
Cl^-	ppm	692.31	671.23
SO_4^-	ppm	121.5	128.3
Hg^{+2}	ppm	1.54	1.4
Cd^{+2}	ppm	<0.04	<0.035
Pb	ppm	-	0.06
As	-	-	<0.05
Total Coliform	cob/mL	7,250	7,100
E.Coli	cob/mL	500	360

As indicated in Table 8-26, leachate quality is considerably better in semi-aerobic landfill structures than in anaerobic landfills.

- This proposed Sofulu landfill site adopted the semi-aerobic structure for the disposal site in order to maintain a lower load to the leachate treatment facilities and to immediately stabilise the disposed waste in the landfill. Accordingly, the leachate quality for the proposed landfill site is designed with a BOD of BOD 2,500 mg/l, and SS 500 mg/l, based the Japanese values for leachate quality (BOD – 1,200mg/l; SS – 300mg/l) and, even though they are anaerobic structures, the leachate quality of the present landfills.

d.3 Effluent Standards

Table 8-27shows the effluent standards for leachate generated from waste recycling plants and disposal areas.

Table 8-27: Effluent Standards

Parameters	unit	Composite Sample 2-hours	Composite Sample 24-hours
BOD_5	mg/l	100	50
COD	mg/l	160	100
SS	mg/l	200	100
Oil & Grease	mg/l	20	10
PO_4-P	mg/l	2	1
Total Cr	mg/l	2	1
Cr^{+6}	mg/l	0.5	0.5
Pb	mg/l	2	1
CN^-	mg/l	1	0.5
Cd	mg/l	0.1	
Fe	mg/l	10	
F^-	mg/l	15	
Cu	mg/l	3	
Zn	mg/l	5	
Fish Bioassay	-	10	
pH	-	6 - 9	6 - 9

Source: Water pollution control regulation,
Office Gazette No. 19919 on 4.9.1988

d.4 Leachate Treatment Method

This chapter describes the following methods of treating the leachate.

- Recirculation of leachate and evaporation of leachate
- Treatment in a leachate treatment plant constructed at the landfill.

d.4.1 Regulation Pond (Buffer reservoir)

The described treatment methods all require a regulation pond (buffer reservoir) that facilitates the storage of leachate during winter, when the generation of leachate is high and the lower temperatures reduce the biological activity of microbes.

To keep peak loads on the leachate treatment plant to a minimum, and hence the required investment, the regulation pond is designed considering the following issues:

- The varying quantity of leachate generated during the year.
- The varying treatment capacity of the leachate treatment plant caused by the lower microbial activity during winter.

d.4.2 Recirculation and Evaporation of Leachate

The method involves:

- Storage of leachate in the regulation pond during winter.
- Recirculation of leachate through old waste to clean some of the leachate.
- Evaporation of leachate by sprinkling/irrigation during summer.

d.4.3 Reticulation of Leachate

The Recirculation of leachate is based on the concept of old waste working as a biological filter that can purify leachate generated from new waste. The principles for Recirculation of leachate are presented in the following figure.

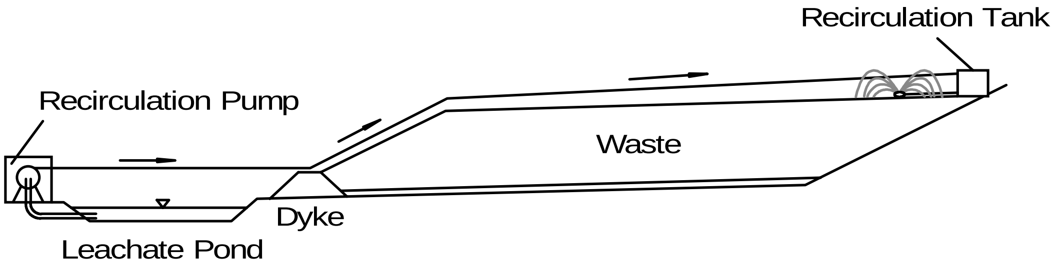


Figure 8-20: Recirculation of Leachate in Sofulu

d.4.4 Evaporation of Leachate

During summer a reduction of the leachate quantity may be achieved by evaporating leachate that is sprinkled on top of old landfill section. The old landfill section is preferably furnished with final coverage and vegetation in order for the evaporation to become as efficient as possible.

d.4.5 Treatment of Leachate in a Plant at the Landfill

For the treatment of leachate, the biological contact aeration process, the rotating biological compactor process, and the waste stabilisation ponds are used. In Japan the first two cases are more common, because of the lack of land and the strict effluent standards. However, the two processes rely heavily on machinery, require the use of chemicals, which complicates operation, making them highly capital intensive. Therefore, if a large area can be secured it would be effective to use the waste stabilisation ponds , the more economical and easily operated method.

d.4.6 Selection of the Leachate Treatment Method

If a large plot of land, like the proposed landfill site, can be secured, it is technologically and economically desirable to use Recirculation or evaporation methods, where leachate does not leave the disposal site. This proposed landfill site consists of phase 1 under landfilling and phase2 and phase3 going to be developed surrounding east of phase 1. Therefore proposed landfill site has the old waste section that can be utilised for Recirculation and evaporation of leachate. Considering this site conditions, Recirculation and evaporation method shall be adopted for leachate treatment at proposed landfill site. Based on this method, leachate treatment process such as waste stabilisation pond, where leachate will be decomposed biologically, is not required. Phase 1 of old waste section will be utilised for Recirculation at beginning stage, and Phase 2 of old waste section also will be utilised when the section is available for Recirculation and evaporation.

d.5 Proposed Leachate Treatment (Recirculation and Evaporation)

The flow of the proposed leachate treatment process is shown in Figure 8-21. And plan of leachate treatment facility is shown in Figure 8-22.

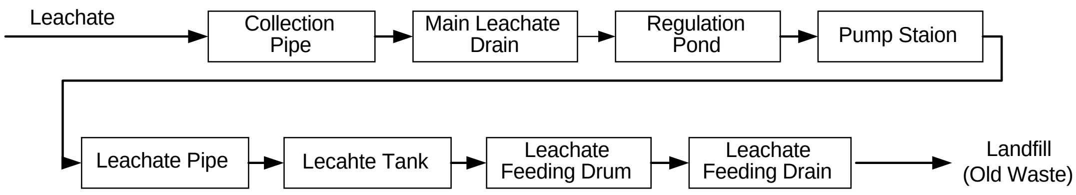


Figure 8-21: Proposed Leachate Treatment Process in Sofulu

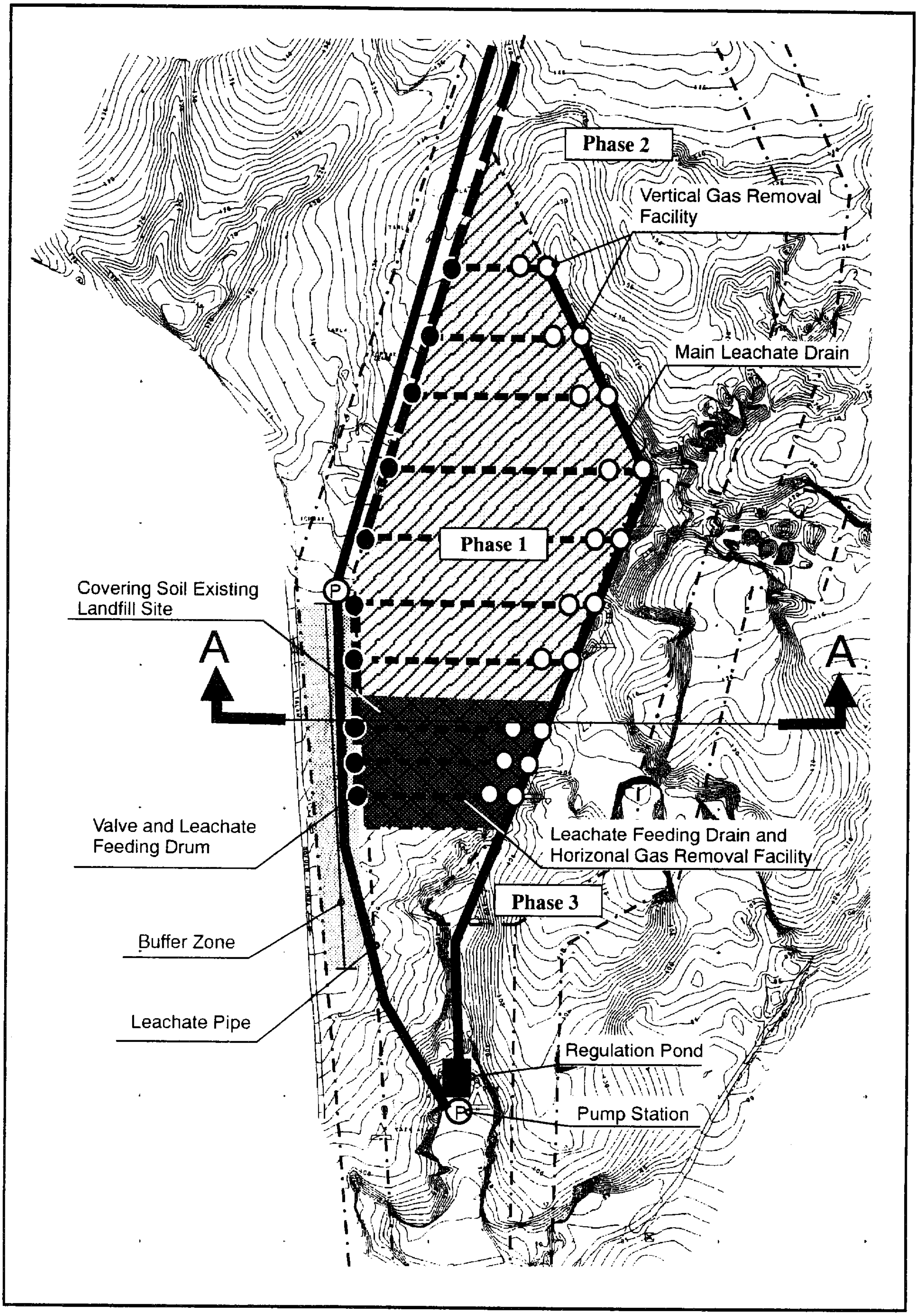


Figure 8-22: Plan of Leachate Treatment Facility in Sofulu

d.6 Engineering Calculation

d.6.1 Selection of a Treatment Method During the Landfill Operations

The proposed landfill is planned to be operated as follows.

Table 8-28: Forecast for the Size and Type of Surface Cover of the Landfill Sections in Sofulu

Year		Type of Surface Cover	Landfill Section			Total
			Phase 1 ha	Phase 2 ha	Phase 3 ha	ha
		Open	25	---	---	
2001	Dec	Final	0	---	---	25
2002	Jan	Open	0	13	---	13
2006	Aug	Final	25	0	---	25
2006	Sep	Open	0	0	17	17
2009	Dec	Final	25	13	0	38
2010	Jan	Open	0	0	0	0
		Final	25	13	17	55

- Phase 1: Leachate from the landfill site is generated from water trapped in the MSW layers and rainwater. For the rainwater from the Phase 2 landfill section, under construction, a rainwater drainage system – separate from the leachate drainage – will expel the rain from the disposal site.
- Phase 2: Landfill operations from Phase 1 would have been complete, and a final cover applied. During this period leachate will be generated from the completed area (with the final cover) and the landfill areas in operation in Phase 2. Because landfill sections for Phase 3 will be under construction in 2004, there will be no leachate from this section.
- Phase 3: Leachate will be generated from the two completed sections with a final cover (from Phases 1 & 2) and the landfill section in use during Phase 3.

In accordance with the disposal plan, the following is a basic method adopted for the proposed leachate treatment.

- Phase 1 will be utilised until proposed landfill site is completed. Leachate generated from phase 1 will be collected at leachate drain which was constructed during pilot project by JICA study team. It is possible to be treated by Recirculation and evaporation during summer season because of less rainfall. But it is difficult to be treated by the same method during winter season because of heavy rainfall. After landfilling has been commenced at proposed landfill site, leachate generated will be treated by Recirculation and evaporation method through newly constructed regulation pond.
- In the phase 2, leachate Recirculation in the completed section, i.e., old waste section of landfill section from Phase 1 and phase 2, will be introduced.
- In the phase 3, leachate Recirculation in old waste section of phase 1, phase 2 and phase 3 will be introduced.

d.6.2 Capacity of the Leachate Recirculation Facility

To determine the scale of the leachate Recirculation facility, the daily leachate generation figures are required to calculate the design leachate amount. There are two ways to calculate design leachate amount: 1) based on rational formula, 2)based on empirical data. For the design of the proposed leachate Recirculation facility, the rational formula was used. The following is the mathematical formula used to calculate design leachate amount.

$$Qj = 1/1000 \times Ij \times (C_1A_1 + C_2A_2) \qquad \text{(Formula1)}$$

Qj：Design leachate generation amount (m^3/day) for day (j) in a given year.
Ij ：Rainfall amount (mm/day)for day (j) in a given year.
C1：Leachate generation coefficient from area of current landfill operation
C2：Leachate generation coefficient from landfilled area
A1：Area of current landfill operation(m^2)
A2：Landfilled area (m^2)

d.6.3 Leachate Generation Coefficient

AGM did not have the daily meteorological data that is required to calculate the leachate generation coefficient, for this reason the figure used was the coefficient used in Japanese, that would give a degree of safety at an average annual precipitation of 1,600 mm.

C1=0.5

C2=0.3

In future there is a need to calculate an accurate generation coefficient, based on the observed leachate generation amount from the pilot project.

d.6.4 Design Leachate Generation Amount

The daily leachate treatment amount generated from the proposed Sofulu landfill site of AGM was calculated under the following conditions.

- All the rainwater outside the landfill site is expelled, and none enters the disposal section.
- Daily precipitation (I) is taken as 3.81 mm/day, based on December’s monthly precipitation which is the highest throughout the year. Average daily precipitation calculated based on monthly average precipitation in Table 8-24 is shown in Table 8-29 .

Table 8-29: Average Daily Precipitation

mm/day	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average Precipitation	3.60	3.31	2.19	1.71	1.51	0.75	0.17	0.16	0.49	1.41	2.24	3.81	1.77

- The operation plan includes the separation of the landfill sections with small dikes during Phase 2 and Phase 3. Assuming that the leachate amount would increase during the latter part of Phase 3, the total area of the landfill section (17ha) will be divided in to two sections: one completed section with an inter-mediate cover (8.5 ha) and one section under use. Phase 1(25 ha) and phase 2(13 ha) shall be considered as completed section with an inter-mediate cover or a final cover. Therefore total area with leachate generation coefficient of 0.3 will be 46.5 ha.
- The daily leachate Recirculation amount is calculated.

The daily leachate treatment amount is calculated by the following formula.

$$Q=1/1000 \text{ x}3.81 \text{ x } (0.5\text{x}85,000+0.3\text{x}465,000)=693.4\text{m}^3/\text{day}$$

Where: I = 3.81 mm/day
C1=0.5
C2=0.3
A1=85,000 m^2
A2=465,000 m^2

Based on this result the proposed leachate treatment facility's design leachate generation amount is 700m^3/day.

d.6.5 Determining the Recirculation Pump Capacity

The calculation of the Recirculation pump's capacity is based on the following conditions.

- In order to determine the appropriate size of the regulation pond & the pump capacity, the amount of leachate to be generated from the disposal area and the regulation pond capacity (Aj) were used in the calculation. The variables were altered to calculate the most appropriate size and capacity.
- In this case, fifty percent of the leachate that is circulated to the disposal site by the pump will evaporate, and the rest is assumed to return to the regulation pond from the disposal site as part of the design leachate generation amount.
- The amount of leachate that will flow into the regulation pond, ΣQj, is calculated as follows:

$$\Sigma Qj = Qj + (C_1 \text{x} R_{j-1})$$

Where Qj：Design leachate amount (m^3/d)on day (j) in a given year
C1：Generation coefficient for the disposal area. (0.5)
Rj：Amount of leachate circulated (m^3/d) to the disposal area by the pump on day (j) in a given year.

The results of the calculations are shown in Table 8-30. The shadow indicates the ideal capacity.

From the results, capacity of the Recirculation pump and the regulation pond are determined as 1370 m^3/day and 750 m^3 respectively.

Table 8-30: Results of the Calculation in Sofulu

Capacity of Recirculation Pump (m^3/day)	Capacity of Regulation Pond (m^3)
1,300	2,500
1,350	1,040
1,360	895
1,370	750
1,380	605
1,390	461

d.6.6 Planning for Regulation Pond

Leachate collected from Main Leachate Drain will flow to regulation pond and be back to the landfill area by pumping up.

Capacity of regulation pond should satisfy following condition.

- Capacity of regulation pond ＞＝750（m^3）

Size of the regulation pond shall be 25m width x 40m length x 2m effective depth with 1,100m^3 storage capacity which has a factor of safety more than 1.2.

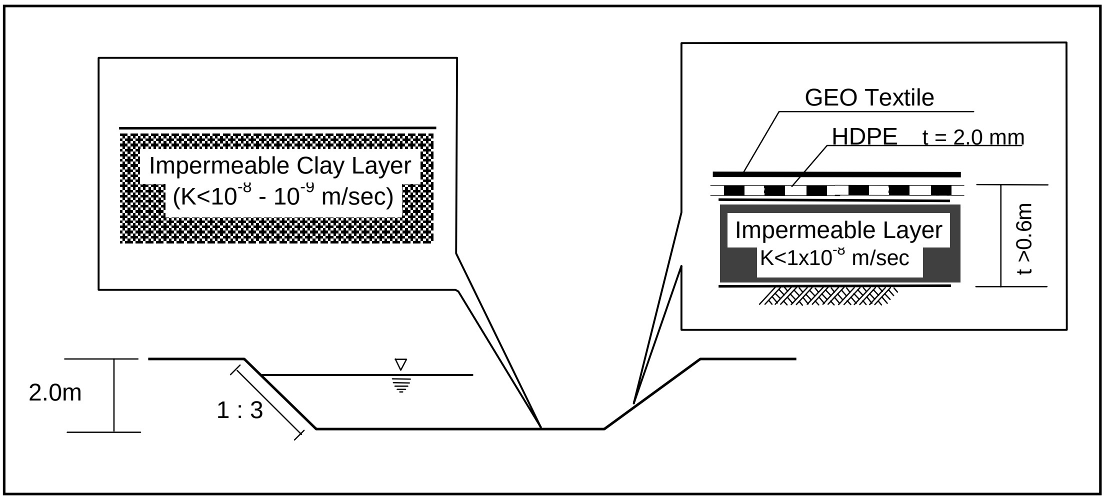


Figure 8-23: Regulation Pond in Sofulu

d.6.7 Planning for Pump & Pumping Station

Difference of elevation between regulation pond and Recirculation pit which will locate near Sorting & Compost Plant has around 50m and it will require a big capacity pump to pump up directly. Therefore another intermediate pump station will be installed at middle point and 2 pumps shall be used for pumping up leachate.

Capacity of pump shall satisfy following requirements considering water head and head loss.

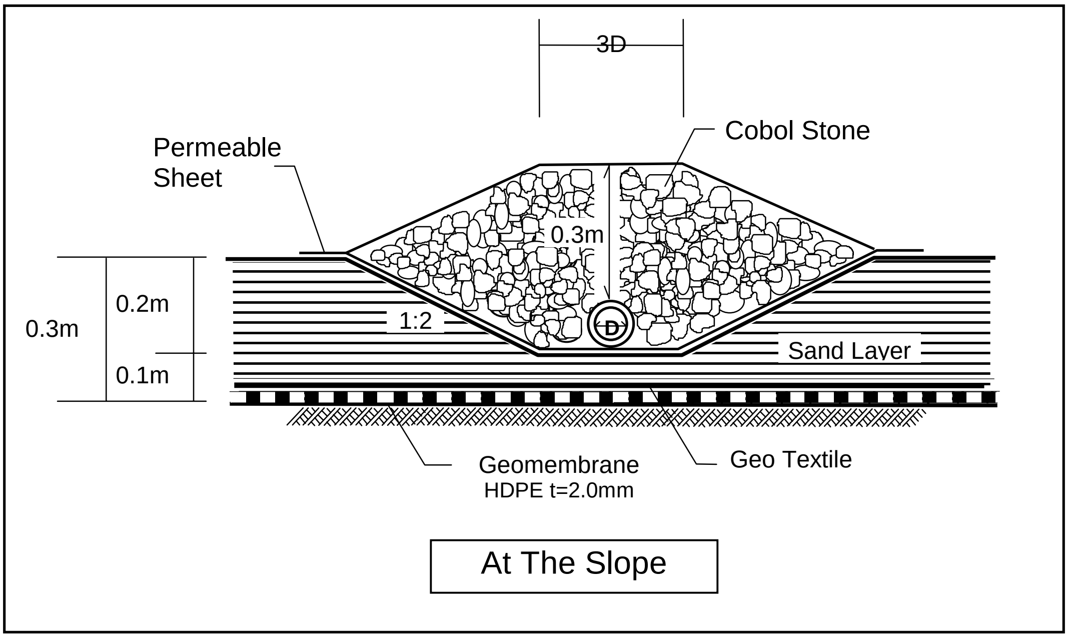
- Capacity of pump ＞＝1,370(m^3/day)x1.2（safety factor）=1,644(m^3/day)
- Total head（actual head＋head loss）/2＝(50+10)/2＝30m

Based on the requirements above, pump with capacity of 30m head pressure and 138(m^3/h) discharge volume should be selected. 2 pumps including 1 standby pump shall be installed at each pump station and 12hours operation is considered.

$$138\ (m^3/h) \times 12(hour) = 1{,}656(m^3/day) > 1{,}644(m^3/day)$$

d.7 Leachate Collection Pipe

Leachate generated from landfill will be collected by the leachate collection pipe and flow into leachate main drain. Structure of the leachate collection pipe shall be φ 100mm PVC perforated pipe with gravel surround and section is shown in Figure 8-24.



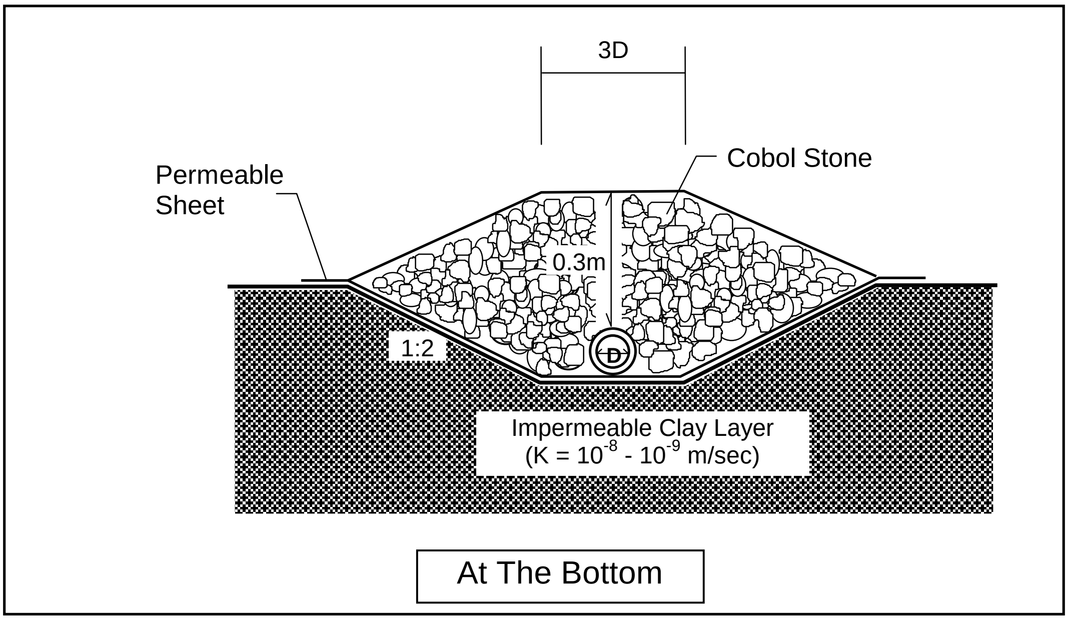


Figure 8-24: Typical Section of Leachate Collection Pipe & Main Leachate Drain

d.8 Main Leachate Drain

Leachate collected from leachate collection pipe will flow into leachate main drain. Structure of the leachate main drain shall be φ200mm PVC perforated pipe with gravel surround and section is shown in Figure 8-24.

d.9 Leachate pipe

Leachate collected to the regulation pond will be pumped up to leachate tank through leachate pipe. Structure of the leachate pipe is PVC pipe on top of sand bed and shown in Figure 8-25.

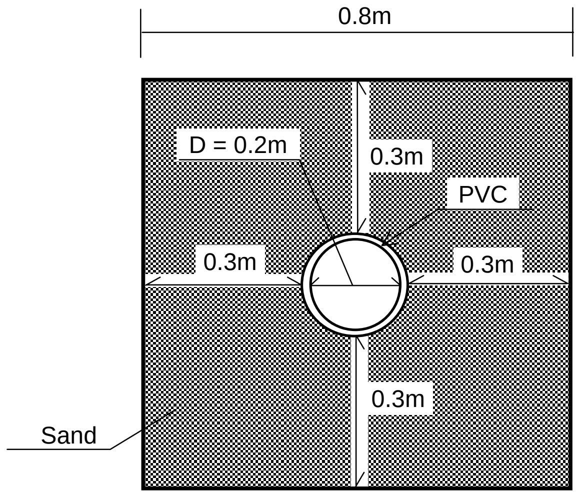


Figure 8-25: Typical Section of Leachate Pipe in Sofulu

d.10 Leachate Tank

Leachate in tank pumped up from regulation pond through leachate pipe will be divided into two. One is discharged into Leachate Feeding Drum for recirculating and the other is used for water source for planting. As used for planting, leachate shall be diluted with potable water.

d.11 Leachate Feeding Drum & Leachate Feeding Drain

Leachate will flow into Leachate Feeding Drum and Leachate Feeding Drain. Then it will penetrate into Land fill for recirculating treatment. Leachate Feeding Drum and Leachate Feeding Drain will be connected to the existing facilities which was constructed under Pilot project.

e. Drain for Runoff Water

Drain for runoff water shall be provided for running off the rainfall water to outside landfill area.

e.1 Open Concrete Drain

Open concrete drain shall be provided along the inspection road for discharging rainfall water outside the landfill area and will have 300mm x 300mm section and 2,665m long.

e.2 Pipe Drain for Rainfall

Pipe drain for rainfall will be provided for discharging rainfall water in the landfill area. φ400mm concrete pipe will be used and total length will be around 990m.

f. Environmental Protection Facilities

Environmental protection facilities shall be provided for protecting surrounding environmental conditions from Landfill and preventing invader from outside the area.

f.1 Fence

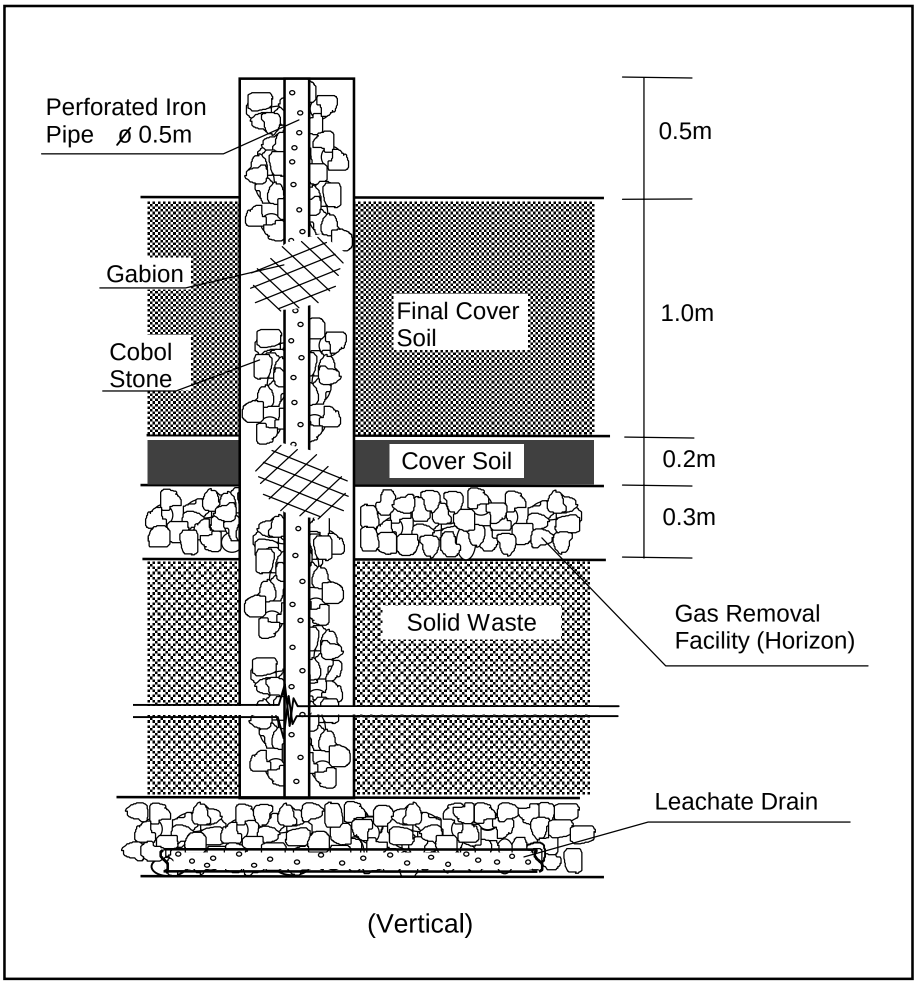
The fence will restrict the access of the scavengers and animals to the site. The fence installed around the site will be of mesh type and will have a height of 2m and a length of about 4,600m. Scattering of waste from the landfill site will be prevented by mobile fences near the active cells and by tall trees planted as buffer zone. Therefore, waste scattering beyond the buffer zone will be minimal. In addition to those measures, the fence around the project site will function as final barrier for flowing waste.

f.2 Buffer Zone

The planting of fast growing trees at the circumference of the landfill site, 50 meter wide, will also work to prevent the scattering of litter such as plastic bags and furthermore will function as a vegetation screen(visual shield) that will improve the aesthetic landscape view and avoid possible impact by offensive odour and noise.

f.3 Gas Removal Facility

To remove the landfill gases carefully from the landfill site, vertical chimneys will be installed with perforated iron pipes and Gabion, every 50m. Horizontal gas removal facilities made of gravel will be installed before final earth cover is laid. At its bottom, these will be connected to the leachate collection pipe and leachate pipe, in order to achieve better ventilation of the gases. Structures of the gas removal facilities are shown in Figure 8-26.



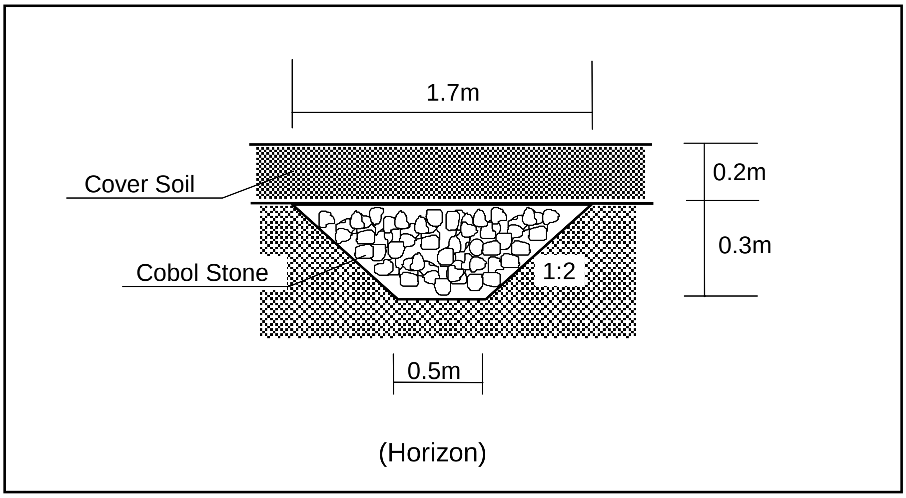


Figure 8-26: Gas Removal Facility in Sofulu