

Figure 9-24: Proposed Medical Waste Disposal Site in Cimsa

a.3 Life Span of the Medical Waste Disposal Site

The medical waste landfill site is located in the same site of the municipal solid waste(MSW) landfill. Although the life span of the medical waste landfill should naturally be determined almost same as that of MSW disposal site, the capacity of is limited which is only 5 years or less use because of shortage of available space .

At this moment, location of the next MSW disposal site is not decided yet. Therefore, Disposal site should be considered to be possible to use until 2020, the end year of target evaluation period of F/S.

According to the forecast, Cimsa medical waste disposal site will be full in 2020.

a.4 One Phase Construction of Medical Waste Landfill Site

Although Cimsa disposal site will be developed in 3 phases, medical waste disposal site is developed in one phase. The reasons are as follows :

- Medical waste disposal amount is too small comparing with the municipal waste.
- Phased medical waste landfill development will require more area than one phase development landfill.

b. Design of the Medical Waste Disposal Site

b.1 Design Standard

The Design standard to be followed is mainly the Regulation on Control of Medical Wastes except the distance to the residential area, which may not be less than 3,000 meters.

b.2 Preliminary Design of Medical Waste Final Disposal Site

b.2.1 Basic Concept of Preliminary Design

Basic concept of preliminary design of medical waste disposal site in Sofulu is summarised as shown in Table 9-35.

Table 9-35: Basic Concept of Preliminary Design of Medical Waste Final Disposal Site in Cimsa

Item	Sub-Item	During Operation
(1) Landfill planning	basic idea	- open dumping to sanitary landfill(Sofulu) - from trench method to sanitary landfill
(2) Landfill Implementation	landfill method	- cover soil immediately after dumping of medical waste - landfill division by divider(1 year / divider) - cover soil from quarry site in landfill site
	final disposal foundation	article 34 of design standard(see Table 9-39)
	Disposal site floor	article 35 of design standard(see Table 9-40)
	drainage system	article 36 of design standard(see Table 9-41)
	deposition of waste	article 37 of design standard(see Table 9-41)
	top cover	article 38 of design standard(see Table 9-41)
	gas removal	Every 50 meters(vertically and horizontally)
	vegetation of disposal site	article 39 of design standard(see Table 9-34)
(3) Leachate	system	- circulation system - gravity fall from slope surface(every 30 m)
(4)rain water	drainage system	- individual collection and direct discharge
(5)Monitoring	hauled waste	- weighing at the entrance of Sofulu site - visual observation of truck, quantity and quality of waste - visual observation after unloading of medical waste - record and report to Municipality every month
	Leachate	- quantities and qualities of leachate - Report of quantities and qualities to MoE - cancellation of circulation system after closure of the landfill site
	Discharge	- report to MoE
	underground water	- installation of monitoring well at 3 points for each sites - monitoring before starting landfill - monitoring during operation: - 10 years monitoring after closure of landfill site
	Gas removal	- during landfill and 10 years after closure of landfill site(every 50 meters vertically and horizontally)
	Security of landfill site	fence and gate at the entrance
(5)Slope	gradient	Cut part : 1:2 embankment part: 1:3
	berm width	2 meters
	vertical interval of berm	5 meters
(6) road planning	maintenance road	- 8 m width, asphalt paved,
	onsite road	- 4 m width, crushed stone paved,

b.2.2 Outline of the Medical Waste Final Disposal Site

Outline of the Medical Waste Final Disposal Site is shown as below.

Table 9-36: Outline of the Medical Waste Final Disposal Site in Cimsa

Items	Description
Land Area	Total Area : 2ha
Landfill Volume	<u>Capacity</u> 58,000m ³ <u>Disposal Period</u> 2002-2020
Road	Access road(Asphalt paved) : width4.0m,lenght280m Operation road
Leachate control facility	Leachate collection pipe 100mm:110m Main leachate drain 200mm:120m Pumping station:1 set Pump: 2set Leachate pipe 200mm:300m
Drain for runoff water	Open concrete drain :280m Pipe drain for rain fall :120m
Environmental protection facilities	Fence :500m Gas removal facility(Vertical) :30m Gas removal facility(Horizon) :110m

Purpose of the facilities and details of the planning are as follows.

b.2.3 Volume of Medical Waste Final Disposal Site

Volume of Medical Waste Final Disposal Site shall be decided based on the medical waste amount generated from year 2002 till 2020. Medical waste amount generated and final disposal amount are shown in Table 9-22.

Table 9-37: Final Disposal Amount in MGM (2002-2020)

Item	unit	formula	2,002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Waste discharge amount	ton/day	a	1.9	2.0	2.1	2.2	2.3	2.5	2.6	2.7	2.9	3.1	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.9
	ton/day	$b=ax365$	694	730	767	803	840	913	949	986	1,059	1,132	1,168	1,241	1,314	1,387	1,460	1,533	1,606	1,679	1,789
Waste + Cover soil	m ³ /year	$c=bx1.5/0.7$	1785	1,877	1,972	2,065	2,160	2,348	2,440	2,535	2,723	2,911	3,003	3,191	3,379	3,567	3,754	3,942	4,130	4,317	4,600
Total	m ³	c	1785	3,662	5,634	7,699	9,859	12,207	14,647	17,182	19,905	22,816	25,819	29,010	32,389	35,956	39,710	43,652	47,782	52,099	56,699

Required volume of the Medical Waste Final Disposal Site is shown in Table 9-38.

Table 9-38: Volume of the Medical Waste Final Disposal Site in Cimsa

Capacity (m ³)	Year of Construction	Disposal Period
58,000m ³	2001	2002-2020

b.2.4 Structure of Bottom and Top Cover of Landfill

(1) Foundation of Final Disposal Site

In accordance with the article 34 of Design Standard, structures stipulated in the design standard is summarised as shown in Table 9-39.

Table 9-39: Foundation of Final Disposal Site(Article 34) in Cimsa

Item	Soil Conditions	Remarks
Foundation layer	naturally compacted soil	minimum 3 meters thick compressibility factor more than 95%
relation with ground water table	Difference between the foundation and the highest level of underground water table	not less than 2 meters

(2) Floor of Disposal Site

In accordance with the article 35 of Design standard, floor of final disposal site shall be prepared to absolutely eliminate mixture of leachate with underground water. The composition of disposal floor is stated as shown in Table 9-40.

Table 9-40: Structure of Floor of Medical Waste Disposal Site(Article 35) in Cimsa

Layer from the foundation	Depth or gradient	Permeability
impervious mineral layer	min1.5 m thick	not less than 1.0×10^{-9} m/s
plastic impervious membrane (liner)	min 2.5 mm thick	
	min3 % (longitudinal floor Incline)	
	minimum 1 % (lateral floor incline)	
Drain bed (drain pipes, main collector)	minimum 0.3m thick (drain bed)	permeability factor 1.0×10^{-3} /m

b.2.3 Top Cover

After completion of the medical waste disposal, a top cover will be formed by building-up the layers shown in Figure 9-25.

In order to provide for ultimate land use of disposal site, implantation and vegetation of disposal area shall be considered. Thickness of farm soil shall be determined according to root depths of plants to be planted or grown.

Inclination of farm soil layer shall be more than 3 %, to secure rapid runoff of precipitation water.

Structure of top cover of Medical Disposal Site is shown in Table 9-41.

Table 9-41: Structure of Top Cover of Medical Disposal Site in Cimsa

Item	Depth or Gradient	Permeability
homogeneous and non-cohesive soil	not less than 0.5m thick,	
impervious mineral layer	not less than 0.5m thick	1.0×10^{-9} m/s or less
plastic membrane	minimum 2.5mm thick	
Final inclination of top cover surface	greater than 5%	
Drain layer	0.3 meter thick	
agriculture soil layer on impervious membrane	not less than 1 m	

Typical sections of foundation, floor and top cover are shown in Figure 9-25.

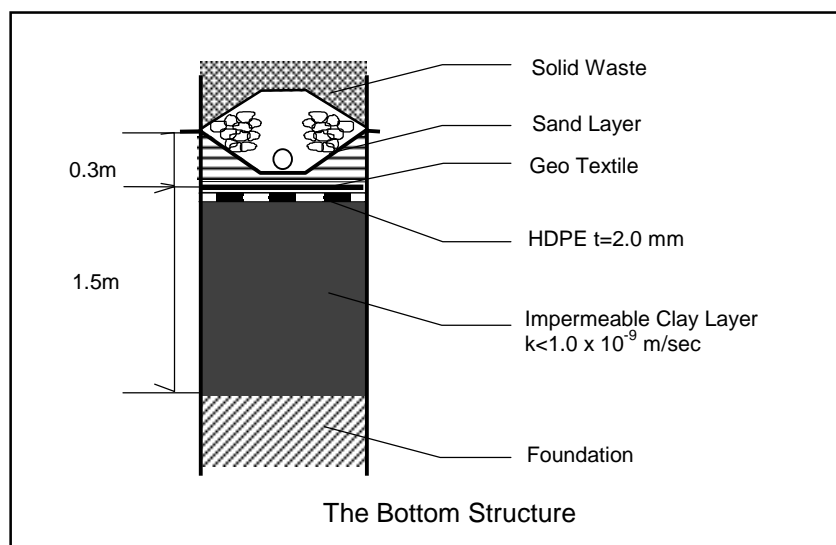
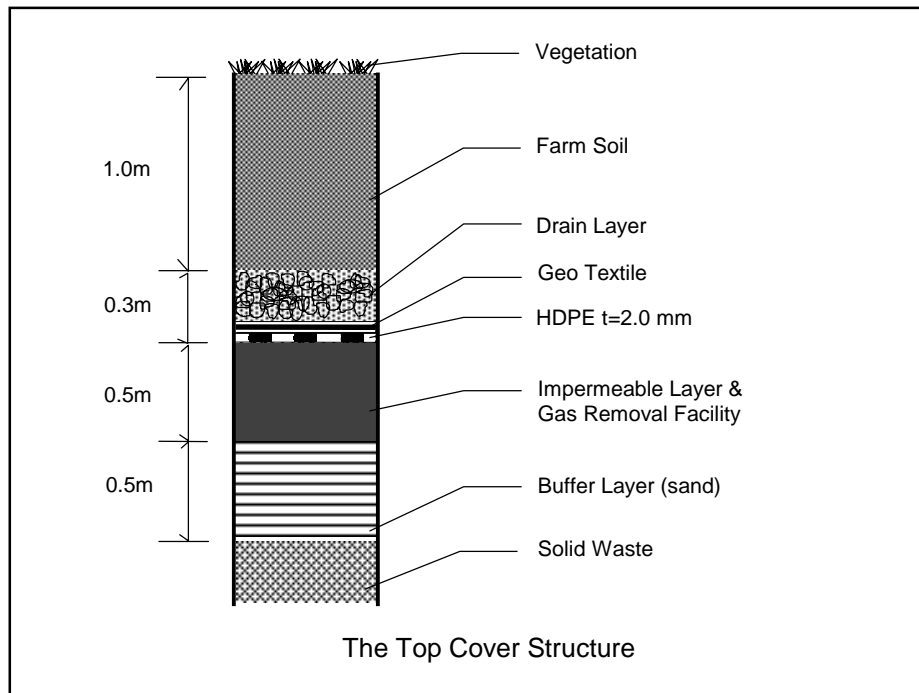
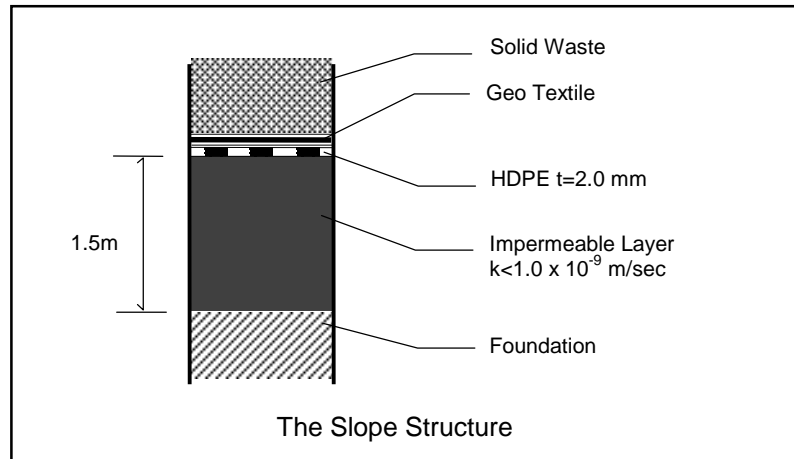


Figure 9-25: Diagrams of the Landfill's Impermeable Strata (Slope, Top Cover and Bottom)

b.2.4 Leachate Collection Facilities and Regulation Pit

(1) During Operation

A strict leachate circulation system shall be applied to the landfill. So that the rain water intrusion from outside shall be restricted and leachate generated in the site shall not be discharged outside and shall be stored/circulated in the site.

A regulation pit with pumps enough to store the excess leachate in winter shall be constructed in the medical waste disposal site.

(2) After closure of Disposal Site

Since the disposal site will be covered with water-proof liner after the closure of medical waste disposal site, no leachate will be received in the regulation pit. Namely, leachate circulation system will be cancelled after the closure of the disposal site.

9.7 Rehabilitation Plan of Present Landfill

9.7.1 Existing condition of Present Landfill

Dumping on the site started in 1985, when the compost plant was put into operation. However, no precautions whatsoever were taken to protect the environment. The landfill was operated as a simple dumpsite until people started to complain, main reasons being:

- Frequent fire outbreaks leading to the generation of bad smell.
- Waste was dumped on the neighbouring main road (Old Soda Road).
- Soil coverage was only carried out occasionally.

In 1992 efforts were undertaken to rehabilitate the landfill. The rehabilitation included construction works as presented in the following table, which also outlines the present condition of the construction works. The numbers in the table refer to the numbering in Table 9-42.

Table 9-42: Construction Works in 1992 and their Present Landfill Condition in MGM

	Facility constructed in 1992	Present Condition
1	Pipeline under the HDPE-liner for diversion of clean run-off water	The inlet to the pipe is covered with waste and the outlet is closed due to an earth slip. Clean run-off water is again percolating into the landfill.
2	20,000m ² bottom liner (HDPE)	The waste has far exceeded the area that was furnished with bottom liner. New bottom liners were not constructed. Area 6 was planned for future extension of the landfill. However, area 7 was used because access was easy.
3	Pipeline for leachate	The outlet is closed due to an earth slip. Leachate is accumulating on top of the HFPE-liner creating a soft ground that cannot carry trucks or bulldozers.
4	Pond with bottom liner and pump installations to collect and recirculate/evaporate leachate.	The facilities are disconnected and leachate is again discharged directly into the nearby ditch at Old Soda Road.

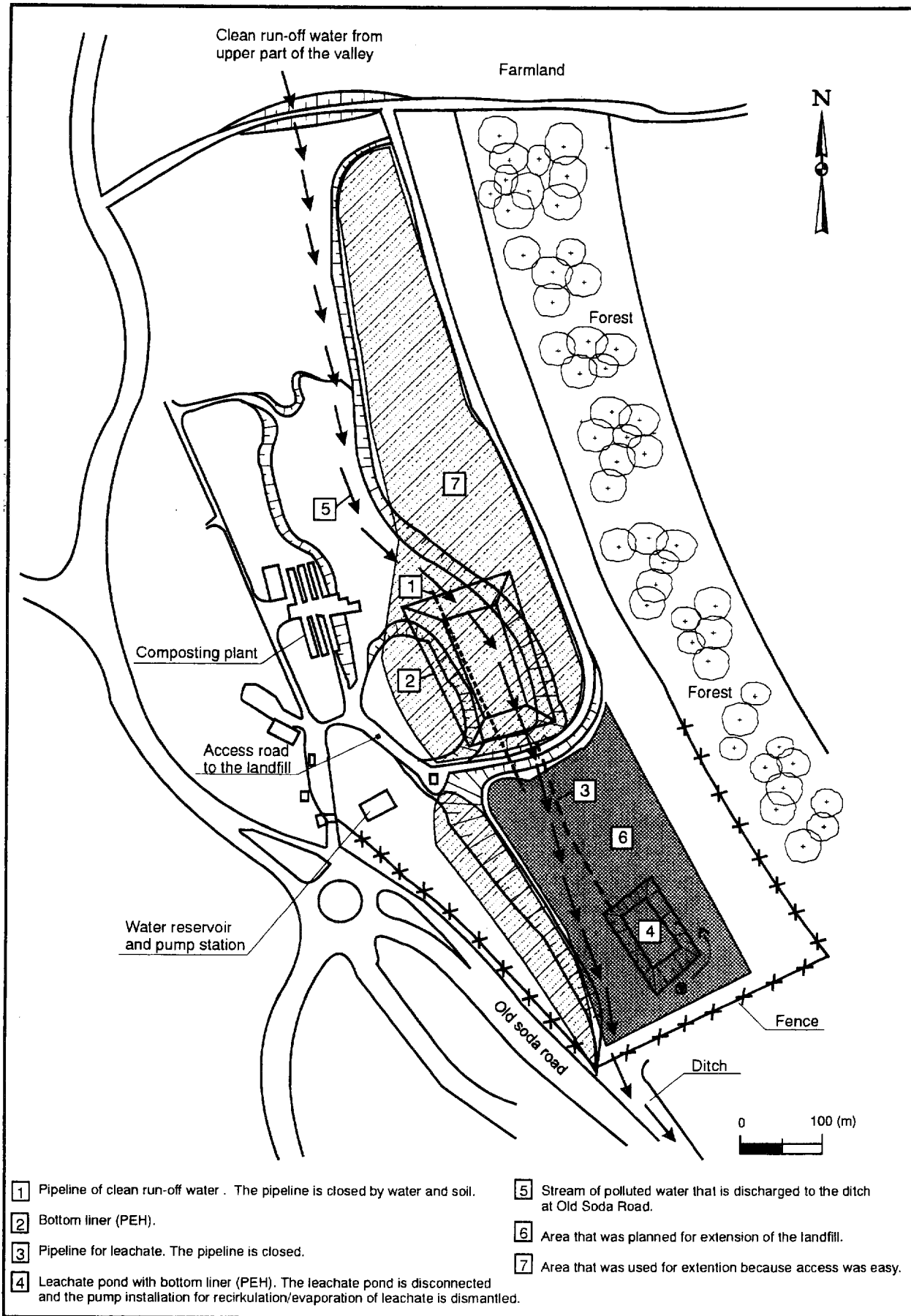


Figure 9-26: Layout of the Present Landfill of MGM

The site is located in a valley. However not at the upper part of the valley that is occupied by farmlands. Run-off water from the upper part of the valley penetrates into the landfill, creating an unnecessary large generation of leachate. As the landfill area is neighbouring farmland to the north and a forest area to the east, it will be very difficult to extend the boundary of the landfill. Thus, it is estimated that the remaining landfill volume of the site is very limited, and that the site can only be operated as a landfill for a maximum of another 2 years.

9.7.2 Rehabilitation Plan of Present Landfill

Rehabilitation plan will be carried out in order to improve following conditions.

- Outflow of leachate to downstream
- Fire and smoke pollution caused by spontaneous combustion in the disposal site

Following countermeasures are suggested.

a. Prevention of Outflow of Leachate to the Downstream

Leachate, which flows downstream, shall be collected in the leachate pond constructed in 1992, by leachate drain with Cobol stone. Collected leachate shall be returned to the landfill site using a pumping system, and circulation treatment shall be carried out by utilising evaporation effect. A brief outline of the leachate circulation system is as follows.

Leachate from Landfill → Main Leachate Drain → Regulation Pond
→ Pump Station → Leachate Pipe → Valve & Leachate Feeding Drum →
→ Leachate Feeding Drain → Landfill

b. Prevention of Fire and Smoke Pollution Caused by Spontaneous Combustion in the Disposal Site

The following fire extinguishing measures were included in the design as countermeasures to extinguish spontaneous fires at the site.

- Sprinkling of water
- Flattening steep slope
- Soil covering

c. Other Measures

- Gas removal facility
- Pipe line of clean run-off water to block rainwater infiltration from upper part of the valley

Overall plan of the rehabilitation of present landfill is following figure.

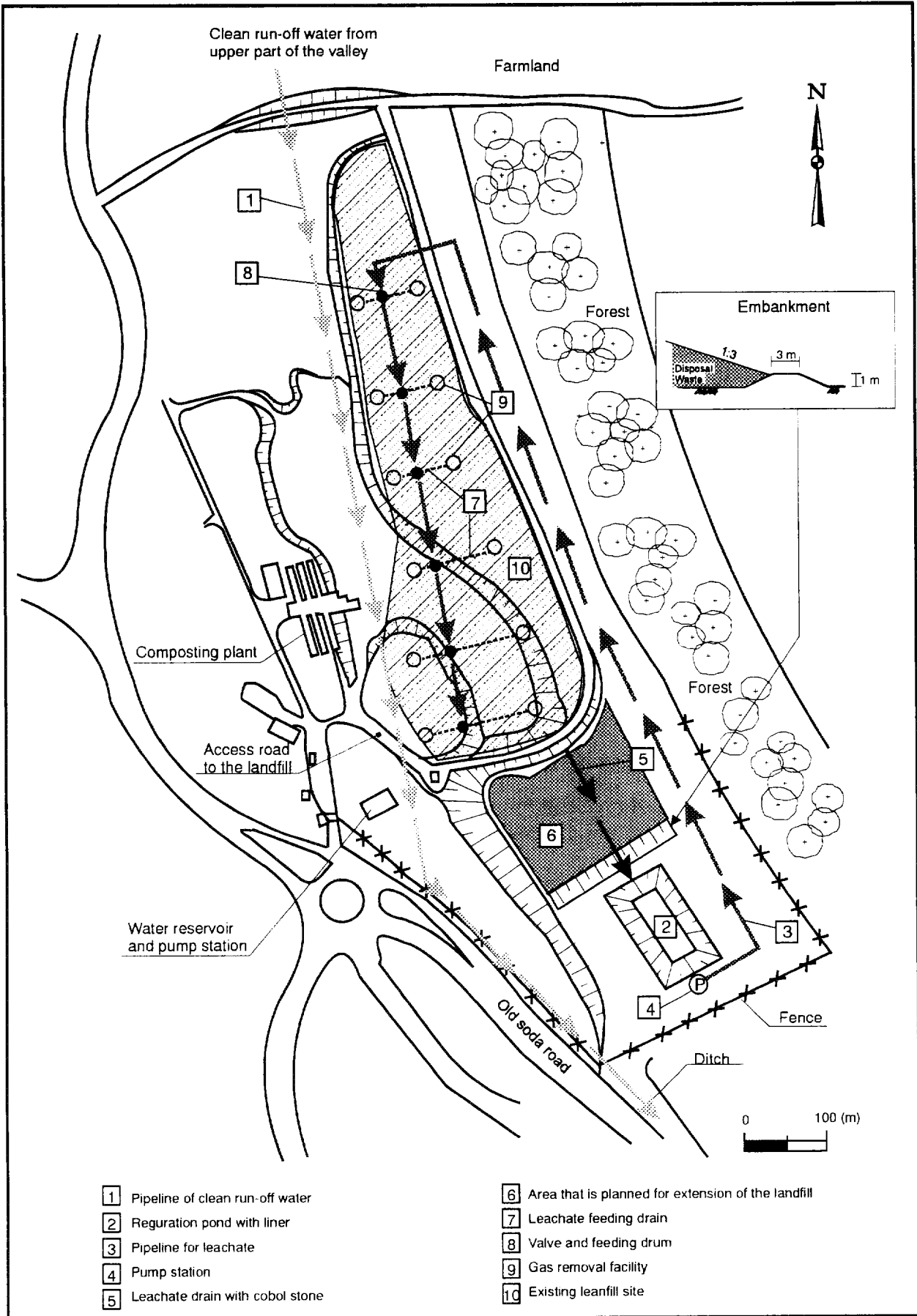


Figure 9-27: Overall Plan of the Rehabilitation of Present Landfill

9.8 Cost Estimation

9.8.1 Conditions of the Cost Estimate

The following cost estimates meet the construction and operation costs of the sanitary landfill in Cimsa constructed and operated at Turkish Solid Waste Regulation. Sanitary Landfill with primary leachate circulation system.

The estimates are based on preconditions as follows.

- The estimates do not include costs for the procurement of land.
- The estimates are based on unit prices obtained in Turkey as of May 1999.
- The estimates are based on Turkey prices as May 1999

$$\text{US\$ } 1 = 407,000 \text{ TL}$$

Unit cost is shown in Table 9-43.

Table 9-43: : Unit Cost in Cimsa

Description	Unit	Unit cost (US\$)
Personnel		
manager	man. Month	980.0
engineer	man. month	810.0
site manager	man. month	740.0
driver, operator, mechanic	man. month	430.0
secretary, clerk	man. month	210.0
collection worker, labourer, watchmen	man. month	270.0
Earthwork		
machine excavation, 200 m transport, and stockpiling of soil	m ³	1.5
machine excavation, 500 m transport, and stockpiling of soil	m ³	1.9
machine excavation, 1,000 m transport, and stockpiling of soil	m ³	2.4
construction of embankment, machine filling and compacting of soil	m ³	2.9
s/t geomenbran with geotextile t=2mm	m ²	16.0
Installation of geomenbran with geotextile t=2mm	m ²	2.1
s/t compacted clay layer	m ³	4.3
s/t vegetation soil	m ³	6.1
Drainage		
provide 100 mm PVC-drainage pipe (earthwork is not included)	m	0.8
provide 150 mm PVC-drainage pipe (earthwork is not included)	m	1.7
provide 200 mm PVC-drainage pipe (earthwork is not included)	m	2.5
Perforated pvc pipe dai.=80mm	m	1.2
Perforated pvc pipe dai.=100mm	m	1.7
Perforated pvc pipe dai.=125mm	m	2.4
Perforated pvc pipe dai.=160mm	m	3.6
Perforated pvc pipe dai.=200mm	m	7.3
Concrete pipe dai.=300mm	m	3.0
Concrete pipe dai.=400mm	m	5.0
Concrete pipe dai.=500mm	m	7.0
Concrete work		
s/t/p reinforced concrete paving (200mm) on prepared gravel base (300mm) and sub grade	m ²	12.0
s/t/p premixed concrete 180 kg/cm ²	m ³	38.0
s/t/p premixed concrete 240 kg/cm ²	m ³	40.0
Road work		
s/t/p concrete road pavement (t = 0.15m)	m ²	20.0
s/t/p hot-mix asphalt road pavement (t = 0.1m)	m ²	10.0
s/t/p gravel road (t=0.3m) and subgrade preparation	m ²	4.9
Miscellaneous		
s/t/p turf	set (m ²)	42.0
s/t/p plant trees 2 to 5 m in height	tree	49.0
Gate 8m wide	set	890.0
s/t/p fence (timber pole H=2.5m, barbed wire)	m	7.4
s/t/p steel pipe(Dai.=100mm)	m	40.0

Description	Unit	Unit cost (US\$)
Basic materials		
diesel oil	lit.	0.5
gasoline	lit.	1.0
crushed rock	m ³	14.0
sand	m ³	15.0
reinforcing bar	ton	332.0
Building Works		
Garage from a steel structure with steel cladding including foundation and floor	m ²	131.0
Office building R/C including all works	m ²	270.0
Sorting Plant & Compost Plant	m ²	123.0
Heavy vehicles and equipment (brand-new)		
s/t Bulldozer (19-20 ton)	Nos.	253,000
s/t Bulldozer (24-25 ton)	Nos.	322,000
s/t Excavator (21 ton) (Bucket capacity 1.m ³)	Nos.	126,000
s/t Crawler loader(Bucket capacity 1.8 m ³)	Nos.	164,000
s/t Crawler loader (Bucket capacity 2.5 m ³)	Nos.	182,000
s/t Dump truck (capacity 34 ton)	Nos.	57,000
s/t Dump truck (capacity 26 ton 12~18 m ³)	Nos.	37,000
s/t Compactor vehicle (16m ³) (16 ton)	Nos.	64,000
s/t Compactor vehicle (14m ³)	Nos.	60,000
s/t Compactor vehicle (12m ³) (12 ton)	Nos.	58,000
Water Tanker (9,000lit.)	Nos.	50,000

Note : s: supply of material, t: transport, p: placement

9.8.2 Investment

a. Final Disposal Site

Investment for Final disposal site consists of Construction works and Vehicle & Equipment.

a.1 Construction Works

The following cost estimate is based on the preliminary design of the proposed Cimsa sanitary landfill carried out during the F/S. Total cost of construction works and design and supervision will be calculated based on the following formula.

Construction Works

Total Cost of Construction Works	:A	
Miscellaneous(10%)	:B	=Ax10%
Direct Cost	:C	=A+B
General expenses/overhead(30%)	:D	=Cx30%
Total Cost	:E	=C+D
Physical contingency(10%)	:F	=Ex10%
VAT(15%)	:G	=Ex15%
Total Investment Cost	:H	=E+F+G

Design and Supervision

Total Cost of Construction Works	:A	
Total Cost of Design and Supervision	:I	=Ax7%
(Design 5%+Supervision2%)		

$$\begin{aligned} \text{Physical contingency(10\%)} & :J = I \times 10\% \\ \text{VAT(15\%)} & :K = I \times 15\% \\ \text{Total Investment Cost} & :L = I + J + K \end{aligned}$$

Table 9-44: Investment Cost of Construction of Municipal Solid Waste Landfill Site (Phase1,Phase2) & Administration Area

Description	Quantity	Unit	Unit Cost(US\$)	Amount(US\$)
Control Facilities				
site cleaning	142,000	m ²	0.2	28,400
entrance area, asphalt pavement	1,000	m ²	10	10,000
site office	300	m ²	270	81,000
weigh bridge	2	set	100,000	200,000
tire washing pit	1	set	5,000	5,000
gate	1	set	890	890
power supply	1	set	20,000	20,000
water supply system	1	set	20,000	20,000
parking, washing area, reinforced conc.pav	1,000	m ²	20	20,000
Approach road (w=8.0m)	170	m	80	25,500
Fence	2,040	m	7.4	15,096
planting of buffer zone	300	tree	49	14,700
Phase 1 & Phase 2 Municipal Solid Waste landfill site & Plant				
Access road (w=4m)	105	m	40	4,200
leachate collection	1,750	m	7.0	12,250
main leachate drain	480	m	18	8,640
Gas removal facility(Vertical)	620	m	43	26,660
Gas removal facility(Horizon)	1,750	mm	6.0	10,500
excavation of soil	598,600	m ³	1.9	1,137,340
construct embankment	66,500	m ³	2.9	192,850
construct basement & side slope using imported clay	9,710	m ²	53	514,630
soil(HDPEt=2mm)	340	m	8	2,720
open concrete drain	480	m	6	2,880
Pipe drain for rain fall	1	set	546,000	546,000
Leachate treatment facility	3	set	500	1,500
Monitoring borehole				
Total				2,900,756
Miscellaneous(10%)				290,076
Direct cost				3,190,832
General expenses/overhead(30%)				957,250
Total cost				4,148,082
Physical contingency(10%)				414,808
VAT(15%)				622,212
Total investment cost				5,185,102

Table 9-45: Investment Cost of Construction of Municipal Solid Waste Landfill Site (Phase3)

Phase3 Municipal Solid Waste landfill site				
Description	Quantity	Unit	Unit Cost(US\$)	Amount(US\$)
Access road (w=4m)	385	m	40	15,400
leachate collection	505	m	7.0	3,535
main leachate drain	170	m	18	3,060
Gas removal facility(Vertical)	160	m	43	6,880
Gas removal facility(Horizon)	505	m	6.0	3,030
excavation of soil	275,400	m ³	1.9	523,260
construct basement & side slope using imported clay	8,510	m ²	53	451,030
soil(HDPEt=2mm)	385	m ²	8	3,080
Open concrete drain	170	m	6	1,020
Pipe drain for rain fall				
Total				1,010,295
Miscellaneous(10%)				101,030
Direct cost				1,111,325
General expenses/overhead(30%)				333,398
Total cost				1,444,723
Physical contingency(10%)				144,472
VAT(15%)				216,708
Total investment cost				1,805,903

Table 9-46: Investment Cost of Construction of Medical Solid Waste Landfill Site

Medical Waste landfill site				
Description	Quantity	Unit	Unit Cost(US\$)	Amount(US\$)
Approach road (w=4m)	280	m	40	11,200
leachate collection	110	m	7.0	770
main leachate drain	120	m	18	2,160
pumping station	1	m	5,000	5,000
pump	2	set	15,000	30,000
leachate pipe	300	set	14	4,200
Gas removal facility(Vertical)	30	m	43	1,290
Gas removal facility(Horizon)	110	m	6.0	660
excavation of soil	78,600	m	1.9	149,340
construct basement without using imported clay soil(HDPE t=2mm)	4,700	m ²	24	112,800
construct basement & side slope using imported clay	12,950	m ²	53	686,350
soil(HDPEt=2mm)	280	m	8	2,240
open concrete drain	120	m	6	720
Pipe drain for rain fall				
Total				1,045,300
Miscellaneous(10%)				104,530
Direct cost				1,149,830
General expenses/overhead(30%)				344,949
Total cost				1,494,779
Physical contingency(10%)				149,478
VAT(15%)				224,217
Total investment cost				1,868,474

Investment schedule for Municipal Solid Waste Landfill and Medical Solid Waste Landfill are shown in Table 9-47 and Table 9-48 respectively.

Table 9-47: Investment Schedule for Municipal Solid Waste Landfill Site in Cimsa (2002-2005)

unit: US\$ 1,000

	2000	2001	2002	2003	2004	2005
Civil works	-	5,185	-	-	1,805	7,548
Design and supervision	317	-	-	25	105	-
Total	317	5,185	-	25	1,910	7,548

Table 9-48: : Investment Schedule for Medical Solid Waste Landfill Site in Cimsa (2002-2005)

unit: US\$ 1,000

	2000	2001	2002	2003	2004	2005
Civil works	-	1,869	-	-	-	-
Design and supervision	91	-	-	-	-	-
Total	91	1,869	-	-	-	-

a.2 Vehicle & Equipment

The municipal solid waste landfill vehicle and equipment procurement schedule, determined in previous sections, is summarised in Table 9-49. From this table, following investment schedule is made.

Total cost for Vehicle & Equipment will be calculated based on the following formula.

Vehicle & Equipment

Total Cost of Equipment	:A	
Spare parts(10%)	:B	=Ax10%
Physical contingency(10%)	:C	=Ax10%
VAT(15%)	:D	=Ax15%
Total Investment Cost	:E	=B+C+D

Table 9-49: Procurement Schedule for Vehicle & Equipment of Municipal Solid Waste Landfill Site in Cimsa (2002-2005)

	2002	2003	2004	2005
Bulldozer(180HP)	2	-	-	-
Excavator(168HP)	1	-	-	-
Dump truck(8m ³)	3	-	-	-
Water tanker	1	-	-	-

Table 9-50: Investment Schedule for Vehicle & Equipment of Municipal Solid Waste Landfill Site in Cimsa (2002-2005)

unit: US\$ 1,000

	2001	2002	2003	2004
Bulldozer (180HP)	644	-	-	-
Excavator (168HP)	126	-	-	-
Dump truck (8m ³)	111	-	-	-
Water tanker	50	-	-	-
Sub Total	931	-	-	-
Spare parts (10%)	93	-	-	-
Physical contingency (10%)	93	-	-	-
VAT (15%)	140	-	-	-
Total	1,257	-	-	-

The medical solid waste landfill vehicle and equipment procurement schedule, determined in previous sections, is summarised in Table 9-51. From this table, following investment schedule is made.

Table 9-51: Procurement Schedule for Vehicle & Equipment of Medical Solid Waste Landfill Site in Cimsa (2002-2005)

	2002	2003	2004	2005
Bulldozer(180HP)	1	-	-	-

Table 9-52: Investment Schedule for Vehicle & Equipment of Medical Solid Waste Landfill Site in Cimsa (2000-2005)

unit: US\$ 1,000

	2001	2002	2003	2004
Bulldozer(180HP)	253	-	-	-
Sub Total	253	-	-	-
Spare parts(10%)	25	-	-	-
Physical contingency(10%)	25	-	-	-
VAT(15%)	38	-	-	-
Total	341	-	-	-

b. Sorting Plant

Investment cost estimate is presented in Table 9-53. The cost has two components: facility construction and operation equipment. It should be noted that the cost for land preparation is not included here but in the cost estimate of the landfill site.

Table 9-53: Investment Cost of the Sorting Plant in Cimsa

Item	Details	unit	Unit Cost US\$	Quantify	Cost US\$
Sorting plant construction					
Facility construction	max.height=15m	m ²	123	2,400	295,200
Facility floor pavement	Concrete t=0.1m	m ²	10	2,200	22,000
Road pavement	for common item	m ²	---	---	---
Structure Total					317,200
Equipment					
Weighbridge	for common item	unit	---	---	---
Waste reception section					
Feeding conveyor with hopper	W=300, Side angle 35%	unit	80,000	1	80,000
Hand-sorting section					
Plastic bag breaker	Conveyor Type	unit	150,000	1	150,000
Hand-sorting conveyor	W=450, Flat belt type	unit	92,000	1	92,000
Magnetic separator	Permanent magnet	unit	8,000	1	8,000
Residue conveyor	W=300, Belt type	unit	9,000	1	9,000
Reversible conveyor	W=300, Belt type	unit	11,000	1	11,000
Product section					
Press machine for metals	Oil pressure type	unit	75,000	1	75,000
Baler machine	Oil pressure type	unit	110,000	1	110,000
Press machine for PET	Oil pressure type	unit	80,000	1	80,000
Recover box	---	unit	26,000	1	26,000
Other section					
Electric facilities	---	unit	119,000	1	119,000
Drainage facilities	---	unit	60,000	1	60,000
Ventilation facilities	---	unit	75,000	1	75,000
Machine floors, etc.	---	unit	48,000	1	48,000
Heavy vehicles					
Wheel loader for reception	1.5 m ³ refuse bucket	unit	83,000	1	83,000
Dump truck	3 ton , 6m ³	unit	37,000	2	74,000
Fork lift	capacity 1 ton	unit	54,000	1	54,000
Equipment Total			---	---	1,154,000
Sub-total					1,471,200
Miscellaneous	10%				146,800
Direct cost					1,618,000
General expenses/overhead	30%				486,000
Total construction cost					2,104,000
Physical contingency	10%				210,000
VAT	15%				315,000
Total Cost					2,629,000

Table 9-54 shows costs for the sorting project from 2000 to 2005 annually.

Table 9-54: Investment Schedule of Sorting Plant in Cimsa (2000-2005)

unit : US\$ 1,000

	2000	2001	2002	2003	2004	2005	Total
D/D	142	---	---	---	---	---	142
Civil	---	567	---	---	---	---	567
Machine	---	1,685	---	---	---	---	1,685
V&E	---	377	---	---	---	---	377
O&M	---	---	378	378	378	378	1,512
Total	142	2,629	378	378	378	378	4,283

Note: D/D : Detailed design, Civil : Civil works, Machine :Machinery
V&E : Vehicles and Equipment, O&M : Operation and maintenance

c. Compost Plant

Investment cost estimate is presented in Table 9-55. The cost has two components: facility construction and operation equipment. It should be noted that the cost for land preparation is not included here but in the cost estimate of the landfill site.

Table 9-55: Investment Cost of the Compost Plant in Cimsa

Item	Details	unit	Unit Cost US\$	Quantity	Cost US\$
Compost plant construction					
Pre-treatment section construction	max.height=11m	m ²	123	2,100	258,300
Pre-treatment floor pavement	Concrete t=0.1m	m ²	10	1,900	19,000
Static pile section construction	max.height=7m	m ³	22	3,800	83,600
Static pile section pavement	Concrete t=0.1m	m ²	10	3,400	34,000
Maturation area section pavement	Concrete t=0.1m	m ²	10	4,300	43,000
Screen section pavement	Concrete t=0.1m	m ²	10	900	9,000
Road pavement	Hot-mix asphalt t=0.1m	m ²	10	4,000	40,000
Structure Total					486,900
Equipment					
Weighbridge	for common item	unit	---	---	---
Pre-treatment section					
Waste reception section					
Feeding conveyor with hopper	W=300, Side angle 35%	unit	80,000	1	80,000
Pre-treatment facilities					
Selective crushing separator	dia.=2.2m	unit	822,000	1	822,000
Pre-treated conveyor	W=300,belt type	unit	18,000	1	18,000
Residue conveyor	W=300,belt type	unit	9,000	1	9,000
Moisture adjusting agent section					
Grinder	Wood	unit	31,000	1	31,000
Feeding conveyor with hopper	W=300, belt type	unit	9,000	1	9,000
Other section					
Ventilation facilities	---	unit	28,000	1	28,000
Machine floors, etc.	---	unit	35,000	1	35,000
Composting section					
Ventilation facilities	---	unit	39,000	1	39,000
Maturation section					
Biological deodorising facilities	---	unit	129,000	1	129,000
Screen section					
Primary screen section					
Trommel	with hopper and conveyor	unit	86,000	1	86,000
Magnetic separator	Permanent magnet	unit	4,000	1	4,000
Inertial separator	Ballistic type	unit	5,000	1	5,000
Final Primary screen section					
Trommel	with hopper and conveyor	unit	103,000	1	103,000
Magnetic separator	Permanent magnet	unit	4,000	1	4,000
Inertial separator	Ballistic type	unit	5,000	1	5,000
Bagged machine	Plastic bag 20kg	unit	12,000	1	12,000
Other section					
Electric facilities	---	unit	250,000	1	250,000
Drainage facilities	---	unit	86,000	1	86,000
Heavy vehicles					
Wheel loader					
Wheel loader for reception	1.2 m ³ refuse bucket	unit	75,000	1	75,000
Wheel loader for static pile	1.2 m ³ refuse bucket	unit	75,000	1	75,000
Wheel loader for raw compost	1.2 m ³ refuse bucket	unit	75,000	1	75,000
Wheel loader for screen section	1.2 m ³ refuse bucket	unit	75,000	1	75,000
Dump truck					
Dump truck for pre-treated material	3 ton , 6m ³	unit	37,000	2	74,000
Dump truck for raw compost	3 ton , 6m ³	unit	37,000	2	74,000
Dump truck for screened compost	3 ton , 6m ³	unit	37,000	1	37,000
Equipment Total			---	---	2,240,000
Sub-total					2,726,900
Miscellaneous	10%				274,100
Direct cost					3,001,000
General expenses/overhead	30%				900,000
Total construction cost					3,901,000
Physical contingency	10%				390,000
VAT	15%				586,000

Total Cost				4,877,000
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Table 9-56 shows costs for the composting project from 2000 to 2005 annually.

Table 9-56: Investment Schedule of Compost Plant in Cimsa

unit : US\$ 1,000

	2000	2001	2002	2003	2004	2005	Total
D/D	263	---	---	---	---	---	263
Civil	---	872	---	---	---	---	872
Machine	---	3,138	---	---	---	---	3,138
V&E	---	867	---	---	---	---	867
O&M	---	---	440	440	440	440	1,760
Total	263	4,877	440	440	440	440	6,900

Note: D/D : Detailed design, Civil : Civil works, Machine :Machinery
V&E : Vehicles and Equipment, O&M : Operation and maintenance

d. Collection System

Investment cost for Collection System has two components. One is for Container for Separate and the other is for Collection Vehicle.

d.1 Container for Separate Collection

The container for separate collection procurement schedule, determined in previous sections, is summarised in Table 9-57. From this table, the following investment schedule is made

Table 9-57: Procurement Schedule of Container for Separate Collection in Cimsa

	2000	2001	2002	2003	2004	2005
Container(800lit.)	470	486	63	62	72	67

Table 9-58: Investment Schedule for of Container for Separate Collection in Cimsa

unit: US\$ 1,000

	2000	2001	2002	2003	2004
Container(800lit.)	5	5	1	1	1

d.2 Collection Vehicle

The collection vehicle, determined in previous sections, is summarised in Table 9-59.

From this table, the following investment schedule is made

Table 9-59: Procurement Schedule of Collection Vehicle in Cimsa

	2001	2002	2003	2004	2005
Compactor (16m ³)	21	4	3	5	4

Table 9-60: Investment Schedule for of Collection Vehicle in Cimsa

unit: US\$ 1,000

	2001	2002	2003	2004	2005
Compactor(16m ³)	1,344	256	192	320	256

9.8.3 Operation and Maintenance Costs

Operation & Maintenance Cost will be required for Final Disposal Site, Sorting Plant, Compost Plant and Collection System

a. Final Disposal Site

Operation cost will be required for Municipal Solid Waste, Final Disposal Site and Medical Solid Waste Final Disposal Site. Operation and maintenance cost will be composed of Civil Work, Equipment and Manpower. The contents are explained as follows.

- The operation cost for civil works, such as temporary dike construction and repairing for site building, shall be added 1 % of Direct Cost on top of it.
- The operation cost for Equipment, such as Fuel and oil, shall be added 10% of basic price on top of it.
- The operation cost for personnel shall be considered only for Municipal Solid Waste Landfill, since they will work for both.

a.1 Municipal Solid Waste Final Disposal Site

Operation & Maintenance Quantities and Cost for Municipal Solid Waste Final Disposal Site are shown in Table 9-61 and Table 9-62 respectively.

Table 9-61: Operation & Maintenance Quantities of Municipal Solid Waste Final Disposal Site in Cimsa

Item	2002	2003	2004	2005
Municipal Solid Waste Landfill (US\$ 1,000)	52	52	52	18
Leachate treatment facility (US\$ 1,000)	94	94	94	94
Vehicles & Equipment (US\$ 1,000)	164	164	164	164
Personnel				
Site Manager	1	1	1	1
Waste controller	1	1	1	1
Operator	5	5	5	5
Driver	2	2	2	2
Worker	2	2	2	2
Security guard	2	2	2	2
Total	13	13	13	13

Table 9-62: Operation & Maintenance Cost of Medical Solid Waste Final Disposal Site in Cimsa

unit: US\$ 1,000

Item	2002	2003	2004	2005
Municipal Solid Waste Landfill	146	146	146	112
Vehicles & Equipment	164	164	164	164
Personnel				
Site Manager	12	12	12	12
Waste controller	5	5	5	5
Operator	26	26	26	26
Driver	10	10	10	10
Worker	6	6	6	6
Security guard	6	6	6	6
Total	375	375	375	341

a.2 Medical Solid Waste Final Disposal Site

Personnel for Medical Solid Waste Final Disposal Site shall not be required. Operation & Maintenance Cost for Medical Solid Waste Final Disposal Site are shown in Table 9-64.

Table 9-63: Operation & Maintenance Cost of Medical Solid Waste Final Disposal Site in Cimsa (2002-2005)

unit: US\$ 1,000

Item	2002	2003	2004	2005
Medical Solid Waste Landfill	19	19	19	19
Vehicles & Equipment	15	15	15	15
Total	34	34	34	34

b. Sorting Plant

Operation & Maintenance Cost for Sorting Plant is shown in Table 9-64.

Table 9-64: Operation & Maintenance Cost of Sorting Plant in Cimsa

unit: US\$ 1,000

	2002	2003	2004	2005
O & M Cost	404	404	404	404

c. Compost Plant

Operation & Maintenance Cost for Compost Plant is shown in Table 9-65

Table 9-65: Operation & Maintenance Cost of Compost Plant in Cimsa

unit: US\$ 1,000

	2002	2003	2004	2005
O & M Cost	513	513	513	513

d. Collection System

The Operation & Maintenance Cost for 16m³ Compactor Truck shall be considered under Collection System. Annual Operation & Maintenance Cost for one collection vehicle is shown in Table 9-66.

Table 9-66: Annual Operation & Maintenance Cost for One Collection Vehicle

Item	formula	Unit	
Working time	a	(hr)	8
Collection days per year	b	days	350
Fuel consumption per hour	c		0.039
Flywheel Power	d	HP	319
Diesel Consumption rate per hour	e=cxd	lit./hr/unit	12,441
Diesel Consumption rate per day	f=axe	lit./day/unit	100
Diesel consumption cost per day	g=bxg	US\$/year/unit	17,500
Lubrication Oil (10% of Diesel consumption)	h=gx10%	US\$/year/unit	1,750
Spare parts (10% of unit cost of compactor truck)	i	US\$/day/unit	6,400
Repair (10% of unit cost of compactor truck)	j	US\$/year/unit	6,400
Driver 1person	k	US\$/year	5,160
Worker1car=2person	l	US\$/year	6,480
O&M total		US\$/year/unit	44,000

Operation & Maintenance cost for collection system is shown in Table 9-67.

Table 9-67 Operation & Maintenance Cost of Collection Vehicle in Cimsa

Item	2002	2003	2004	2005
Number of Collection Vehicles	21	25	28	33
O & M cost (US\$ 1,000)	924	1,100	1,232	1,452

e. Summary of Cost Estimation

MERSIN			2000	2001	2002	2003	2004	2005
Separate Collection System	Container	Invest		5	1	1	1	1
	Compactor	Invest		1,344	256	192	320	256
		O&M for Compactor			924	1,100	1,232	1,452
Plant	Sorting Plant	Design & Supervision	142					
		Invest. for civil work		567				
		Invest. for machine		1,685				
		Invest. for V&E		377				
		O&M			378	378	378	378
	Compost Plant	Design & Supervision	263					
		Invest. for civil work		872				
		Invest. for machine		3,138				
Invest. for V&E			867					
	O&M			440	440	440	440	
Final Disposal	Municipal Waste	Design & Supervision	317			25	105	
		Invest. for civil work		5,185			1,805	7,548
		Invest. for V&E		1,257				
		O&M			375	375	375	341
	Medical Waste	Design & Supervision	91					
		Invest. for civil work		1,869				
Invest. for V&E			341					
	O&M			34	34	34	34	