10.2.2 Design of a Separate Collection System

a. Examination of Technical Alternatives

Conditions to execute a separate collection system are as follows.

- The current collection amount (780t/day) is assumed to be constant during the F/S study period. If volume increases, collection vehicles shall be purchased by the city, and this is not included in this F/S.
- The collection efficiency will drop if the separate collection system is introduced. The reduction shall be assumed to be 20%, and this condition is considered for the required number of vehicles in this F/S.
- Containers (800lit.) used for the separate collection system is included in this F/S.
- 30% of the collection amount shall be collected by the container as separated waste.
- Annual collection days shall be assumed to be 300 days.
- The number of separate collection days is five times a week.

b. Preliminary design

b.1 Planned Waste Collection Amount

Planned waste collection amount for 1999 and from 2002 until 2005 are shown in Table 10-2.

Table 10-2: Waste Generation, Discharge and Collection Amount in Adana GM

	1999	2002	2003	2004	2005
Generation(ton/day)	834	1,004	1,065	1,130	1,200
Discharge(ton/day)	803	973	1,034	1,099	1,169
Collection(ton/day)	780	956	1,019	1,087	1,158
Coverage Ratio(%)	97	98	99	99	99

b.2 Productivity of Collection Vehicles

The productivity of collection vehicles ($16m^3$ compactor truck) is shown in Table 10-3.

Table 10-3: Productivity of Collection Vehicles

Number of trips per day			
working time	t1	hr	8
Daily inspection and fuelling time before working	t2	hr	0.5
Daily inspection and washing time after working	t3	hr	0.5
Loading time	t4	hr	1.5
Unloading time	t5	hr	0.2
travel distance	D	km	20

Velocity	V	km/hr	40
Number of trips per day	Tr = (t1-(t2+t3))/(D/V+t4+t5)	times	3
Amount of waste carried per day			
Volume capacity of a vehicle (2 trip)	q	m^3	16
Efficiency of lading capacity	e	-	0.8
Reserve rate of vehicle	r	-	0.1
ASG of waste	d	t/m^3	0.5
Amount of waste carried per day(ton/day/truck)	Qd=qxexTr/(1+r)xd	t/day/unit	17.5

b.3 Required Number of Collection Vehicle

The targeted collection amount and required number of collection vehicle are shown in Table 10-4.

Table 10-4: Required Number of Collection Vehicle

	formula	2002	2003	2004	2005
Collection amount (ton/day)	a	956	1,019	1,087	1,158
Increasing collection amount(ton/day)	b=ax1.2-780	367	443	524	610
	c=bx365/300	446.5	539.0	637.5	742.2
Required number of vehicle	d =c/Qd	26	31	37	43

b.4 Required Number of Containers

30% of the collection amount shall be collected by the container as a separate waste. The separate waste amount and required number of container are shown in Table 10-5.

Table 10-5: Required Number of Container in Adana

	formula	2002	2003	2004	2005
Collection amount(ton/day)	a	956	1,019	1,087	1,158
Increasing collection amount(ton/day)	b=ax30%	287	306	326	347
Increasing collection amount(m^3/day)	c=bxASG	989	1,054	1,124	1,198
required number of container	d=c/0.8x7/n	1,731	1,845	1,968	2,096

Note: ASG=0.3(ton/m^3)
n: the number of separate collection days in a week=5days

10.2.3 Design of a Sorting Plant

a. Basis for Preliminary Design

a.1 Compositions of Non-compostable Wastes

The composition of non-compostable wastes applied to the plant design, based on the JICA study team's data, is assumed as shown in the table below. Basic assumptions for the establishment of this design waste composition are as follows:

- The average of waste composition in the AGM and in the MGM is applied to the plant design.

- Organic waste (compostable wastes) comprises 30% of non-compostable waste.

Table 10-6: Composition for Non-Compostable Wastes

		Composition Average %	Moisture Average %	Average		Composition			
				Water %	Dry Solid %	Non-compostable waste %	Water %	Dry Solid %	Dry Base %
Combustibles	Kitchen Waste	53.7	77.7	41.7	12.0	**30.0**	23.3	6.7	15.1
	Paper	22.8	57.3	13.1	9.7	34.4	19.7	14.7	33.2
	Textile	2.9	50.3	1.5	1.4	4.4	2.2	2.2	5.0
	Grass and Wood	2.0	61.1	1.2	0.8	3.0	1.8	1.2	2.7
	Plastics	8.6	41.1	3.5	5.1	13.0	5.3	7.7	17.4
	Leather and Rubber	0.4	32.2	0.1	0.3	0.6	0.2	0.4	0.9
Incombustibles	Metal	1.8	19.8	0.4	1.4	2.7	0.5	2.2	5.0
	Glass	4.3	11.9	0.5	3.8	6.5	0.8	5.7	12.8
	Ceramic and Stone	1.5	30.4	0.5	1.0	2.2	0.7	1.5	3.4
	Miscellaneous	2.0	37.5	0.8	1.2	3.2	1.2	2.0	4.5
Total				63.3	36.7	100.0	55.7	44.3	100.0

a.2 Items to be Recovered

Taking these factors into account, this study revealed that it would be feasible to recycle the following materials at the proposed sorting plant, to be located in Sofulu, Adana city.

- Paper (mainly cardboard)
- Plastics (film and PET bottles)
- Glass (bottles and cullet)
- Ferrous metals
- Non-ferrous metals (mainly aluminium cans)
- Textile

a.3 Sorting Methods

The sorting plant is planned to recover ferrous metals by using a magnetic separator, and all the other materials by manual sorting on a belt conveyor. In order to raise the work efficiency of manual sorting, a plastic bag breaker will open the bags before the hand-sorting conveyor. Moreover, the possibility to pay the workers at piecework rates should be studied since it could raise workers' motivation and in turn recovery ratio. A sorting plant in Mexico City provides a good example.

b. Preliminary Design

b.1 Outline

b.1.1 Location

The sorting plant is planned to be located upstream of the Sofulu site. The area is about 95 hectares.

b.1.2 Treatment Capacity

The treatment capacity of the proposed sorting plant is designed to be 190 ton/day as the non-compostable wastes to be handled at this plant in 2005 (target year of the F/S) is projected at 54,538 ton/year.

b.1.3 Working Hours

The work schedule of the plant is as follows.

- The proposed plant operates 300 days a year
- Mondays - Saturdays 7:00 - 23:00 (16 hour/day)
- Sundays and National Holidays Closed
- Equipment operation hours 13 hour/day

b.2 Sorting Plant Design Parameters

b.2.1 Design Principles

- The treatment capacity of the sorting plant is 190 ton/day, assuming that 30 % of all MSW will be separately collected from the waste sources to the plant, and the plant operates 300 days in a year.
- The sorting plant will operate from 2002.
- The sorting plant will be constructed in the upstream section of the Sofulu site and next to the compost plant. The site will be surrounded by a buffer zone (green belt).

b.2.2 Summary of Design Parameters

The table below summarises the design parameters based on the above design assumptions.

Table 10-7: Design Parameters of Sorting Plant in Sofulu

Raw Material			
	Amount	54,538 ton/year (2005)	
	Moisture content	55.7 %	*1
	Bulk density	300 kg/m^3	*1
Plant Specification			
	Type	Manual-sorting + a magnetic separator	
	Treatment line	One line	
	Treatment Capacity	190 ton/day	
	Operation	300 day/year	
		16 hour/day by two shifts	
	Recovered Material	(1) Paper (mainly Cardboard)	
		(2) Plastics (Film and PET bottles)	
		(3) Glass (Bottles and Cullet)	
		(4) Ferrous metal	
		(5) Non-ferrous metal (mainly Aluminium cans)	
		(6) Textile	

Note: *1:Estimates from the pilot project

b.3 Plant Process Flow

The following figure shows the plant process flow.

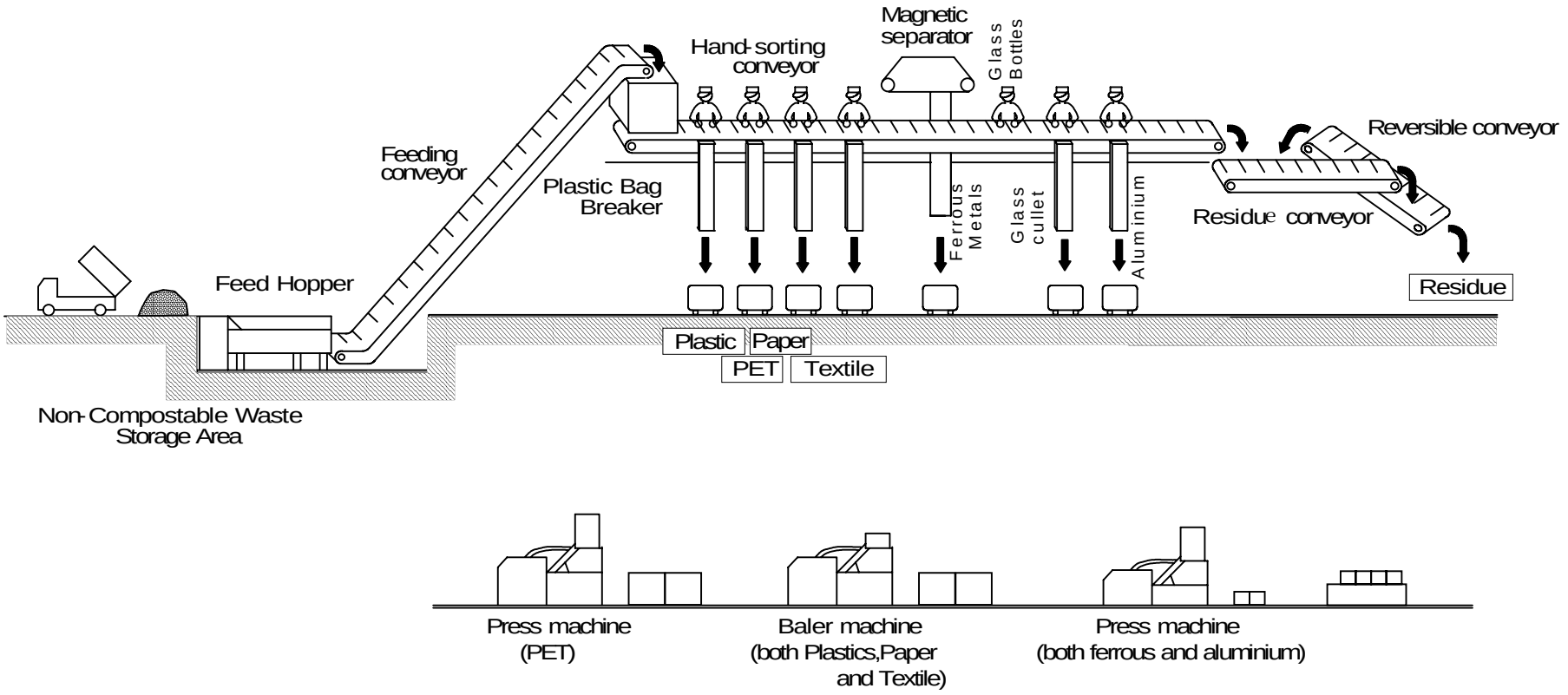


Figure 10-2: Process Flow Diagram of the Sorting Plant in Sofulu

b.4 Material Balance

The figure below shows the material balance at the proposed sorting plant.

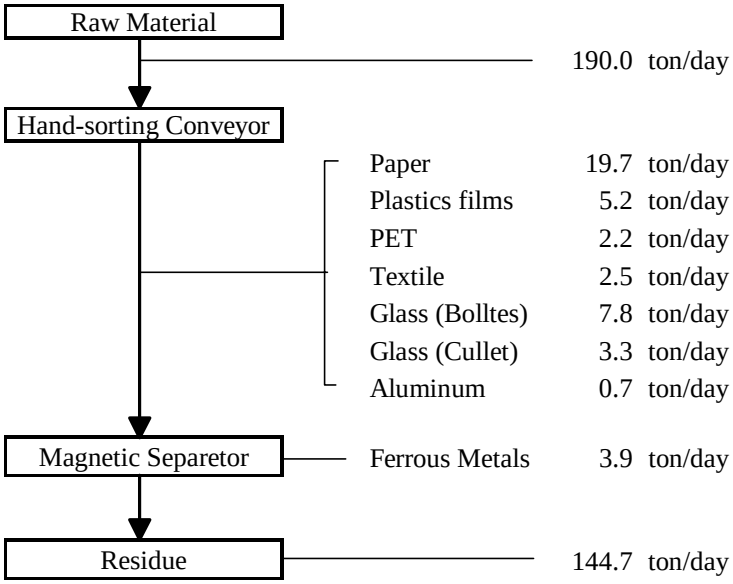


Figure 10-3: Material Balance of the Sorting Plant in Sofulu

b.5 Layout of Proposed Sorting Plant

The layout of the proposed sorting plant is presented in the figure below.

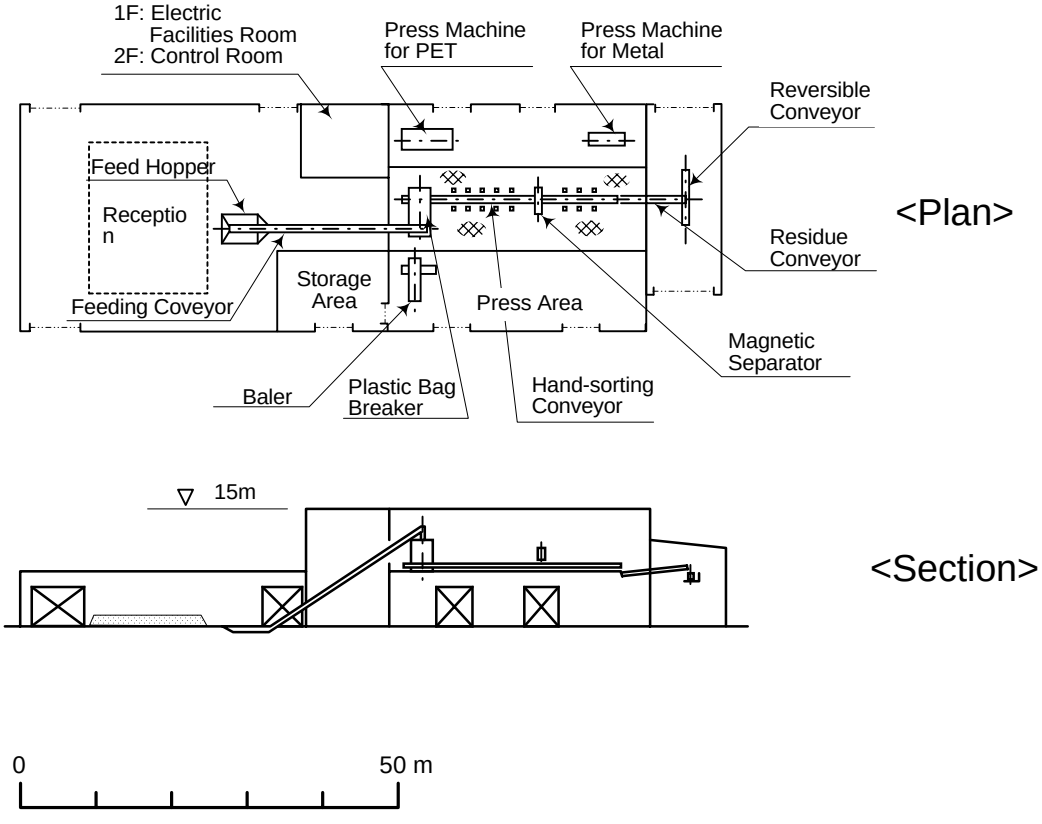


Figure 10-4: Layout of the Sorting Plant

c. Design Concept Summary of a Sorting Plant

The process flow diagram and the plant layout presented in Figure 10-2 and Figure 10-4, respectively, are designed for mechanical sorting of ferrous metal and hand sorting of the other materials. The reasons for choosing such sorting methods are as follows.

- Theoretically it is possible to design a fully mechanised sorting plant but it is expensive both in construction, and in operation and maintenance (O&M).
- In addition mechanical sorting is less efficient in terms of recovery quality than manual sorting except for ferrous metal recovery.
- Unlike mechanical sorting, manual sorting is flexible to the fluctuation of incoming wastes in terms of quantity as well as quality.
- The labour cost in the Adana GM is relatively cheap, thus labour intensity of manual sorting is not necessarily disadvantage.

10.2.4 Design of a Compost Plant

a. Examination of Technical Alternative

a.1 Composition of Compostable Waste

Composition of compostable waste applied to the plant design is assumed as shown in the table below, based on JICA study team data. The design waste composition is assumed as follows:

- The average of waste composition in the AGM and in the MGM are applied to the plant design.
- Non-compostable waste make up 10% of compostable waste.
- The average moisture content of compostable waste is 74.5%, while the moisture content of the waste separately collected by the pilot project was 68%. It is assumed to be 70% for design purposes.
- Water will be extracted from the delivered waste, under the pressure of its own weight, while they are in the reception area and the feed hopper. As a result, the moisture content will drop to about 65%. The figure was obtained from the data of the JICA study team.

Table 10-8: Composition of the Compostable Waste

		Composition Average	Moisture Average	Average		Composition			
				Water	Dry Solid	Compostable waste	Water	Dry Solid	Dry Base
		%	%	%	%	%	%	%	%
Combustibles	Kitchen Waste	53.7	77.7	41.7	12.0	**90.0**	69.9	20.1	78.8
	Paper	22.8	57.3	13.1	9.7	4.9	2.8	2.1	8.2
	Textile	2.9	50.3	1.5	1.4	0.6	0.3	0.3	1.2
	Grass and Wood	2.0	61.1	1.2	0.8	0.4	0.2	0.2	0.8
	Plastics	8.6	41.1	3.5	5.1	1.9	0.8	1.1	4.3
	Leather and Rubber	0.4	32.2	0.1	0.3	0.1	0.0	0.1	0.4
Incombustibles	Metal	1.8	19.8	0.4	1.4	0.4	0.1	0.3	1.2
	Glass	4.3	11.9	0.5	3.8	0.9	0.1	0.8	3.1
	Ceramic and Stone	1.5	30.4	0.5	1.0	0.3	0.1	0.2	0.8
	Miscellaneous	2.0	37.5	0.8	1.2	0.5	0.2	0.3	1.2
Total				63.3	36.7	100.0	74.5	25.5	100.0

a.2 Selection of Composting System

The JICA study team recommends to apply the static pile system as composting method for the new plant. The reasons are:

- Taking proximity to the residential area (about one km or less) into consideration, it is indispensable to have an odour control facility.
- For operation in rainy season it is necessary to have a roof for the composting process in order to avoid leachate generation by rain water.
- The windrow system can neither control odours nor leachate.
- The in-vessel system is expensive both in investment, and in O&M.
- The static system is relatively cheap both in investment, and in O&M. It can control both odours and leachate.

a.3 Pre-treatment Process

The proposed composting plant needs a pre-treatment process for the following reasons.

- The raw materials separated at source as compostable can still contain non-compostable materials. To prevent product quality deterioration, they should be removed. The removal method may allow material recovery from the removed materials.
- Size reduction will result in a larger surface area of waste fractions. The larger the surface area is, the more oxygen can be supplied, and aerobic decomposition is facilitated.

a.3.1 Non-compostable Material Mixed in the Raw Materials

When manual sorting is applied, the work environment will be highly unhygienic. Furthermore, the pilot project revealed that there was little incentive for the workers to sort recyclable materials. The team, therefore, did not plan to apply manual sorting to the proposed plant.

a.3.2 Size Reduction

The selective crushing separator (SCS) was applied to the design by the JICA study team, by which size reduction and the rejection of unsuitable materials can be achieved. As shown in the following figure, the SCS consists of a perforated, rotating drum screen and a rotating scraper at different speed within the drum screen.

The features of the SCS are as follows.

- Its functions include crushing and separating.
- Although the compostable wastes received by this plant has a high moisture content, the SCS will face less troubles of screen blockage which is often caused by such wastes
- It reduces the size of kitchen waste to 50mm.
- It tears plastic bags.

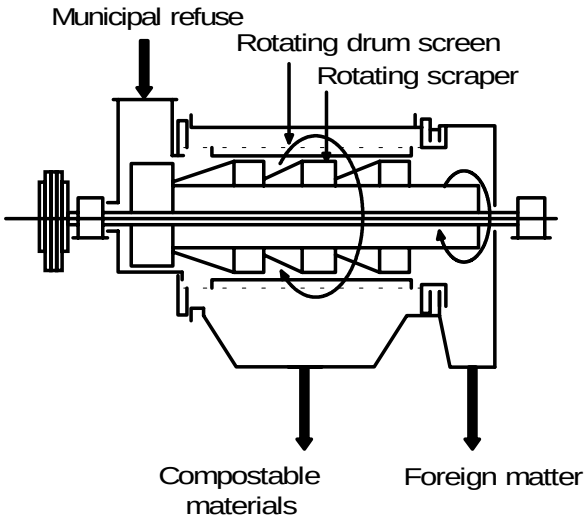


Figure 10-5: Selective Crushing Separator (SCS) in Sofulu

a.3.3 Screening Section

The proposed compost plant is planned to be equipped with the following separators.

- trommel screen (size separation for raw compost and mature compost)
- ballistic inertial separator (density separation for small glass cullet and gravel)
- magnetic separator (ferrous metals)

b. Preliminary Design

b.1 Location

The compost plant is planned to be located upstream of the Sofulu site (about 95 hectares in total).

b.2 Treatment Capacity

The treatment capacity of the proposed compost plant is designed to be 250 ton/day as the compostable wastes to be processed at this plant in 2005, target year of the F/S, is projected at 72,294 ton/year.

b.3 Working Hours

The work schedule of the plant is as follows.

- The proposed plant operates 300 days a year
- Mondays - Saturdays 7:00 - 23:00 (16 hour/day)
- Sundays and National Holidays Closed
- Equipment operation hours 13 hour/day

c. Compost plant Design Parameters

c.1 Design Principals

- The plant capacity is calculated to be 250 ton/day by assuming that 30% of MSW will be separately collected and that the plant operates 300 days in a year.
- It is planned that the compost plant starts operating in the year 2002.
- The compost plant will be constructed in the upstream section of the Sofulu site and next to the sorting plant. The site will be surrounded by a buffer zone (green belt).

c.2 Summary of Design Parameters

The table below summarises design parameters based on the design assumptions established above.

Table 10-9: Design Parameters of Compost Plant at Sofulu

Composting section				
	Type	Aerated Static Pile		
	Raw Material (Compostable Waste)	Amount	250 ton/day	
		Compostable Content	20.3 % by Dry weight	*1
		Moisture Content	70 %	
		Apparent Specific Gravity (ASG)	500 kg/m^3	*2
	Operation		300 day/year 16 hour/day	
	Treatment Capacity		250 ton/day	
	Composting Period		28 days	
	Pile Temperature		>55^oC	

Maturation (Curing) section				
	Operation		300 day/year 16 hour/day	
	Treatment Capacity	Mature compost product Moisture Content Apparent Specific Gravity (ASG)	~ 45.7 ton/day ~ 40 % 500 kg/m^3	 *2
	Maturation Period		60 day	
Final Separation section				
	Type	Trommel screen		
	Operation Time		300 day/year 16 hour/day	
	Treatment Capacity	Fine compost product Coarse compost product Moisture Content Apparent Specific Gravity (ASG)	~ 37.0 ton/day ~ 8.7 ton/day ~ 40 % 500 kg/m^3	 *2

Note: *1 : Obtained from Table 10-8 (composite of kitchen waste, grass and wood)
*2 : Estimates from the pilot project.

d. Quantity and Quality of Compost Product

Table 10-10 shows the target quality and quantity of the compost product in the preliminary design.

Table 10-10: Quantity and Quality of Compost Product

Quantity	Fine Compost	~ 37.0 ton/day ~ 11,100 ton/year
Quality	Moisture Content Apparent Specific Gravity (ASG) C/N ratio	40 % 500-700 kg/m^3 < 25

e. Flow of Compost Plant Process

The figure below shows the flow of the proposed compost plant process.

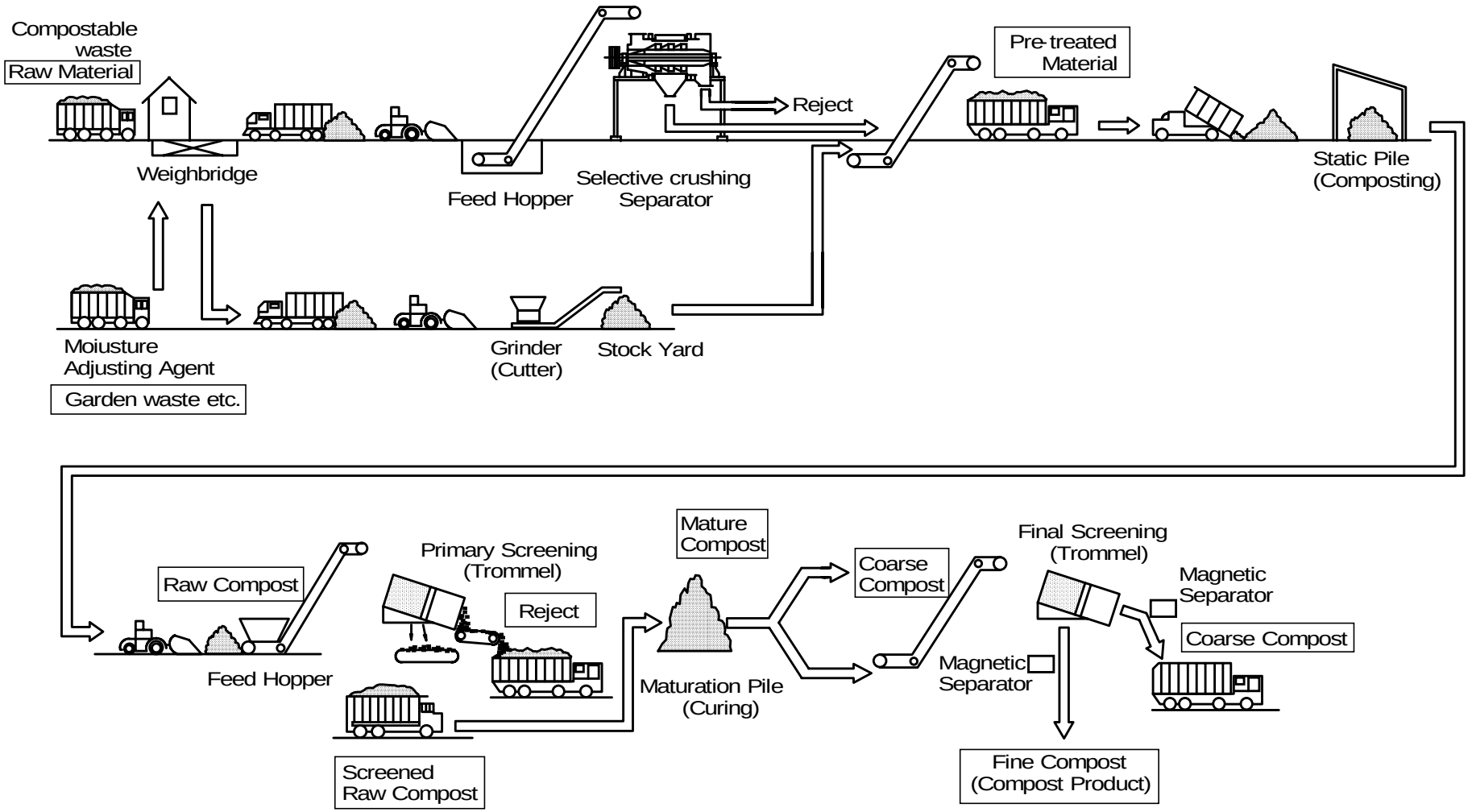


Figure 10-6: Process Flow Diagram of the Compost Plant in Sofulu

f. Material Balance

The figure below shows the material balance in the proposed plant process in the case of 70% moisture content.

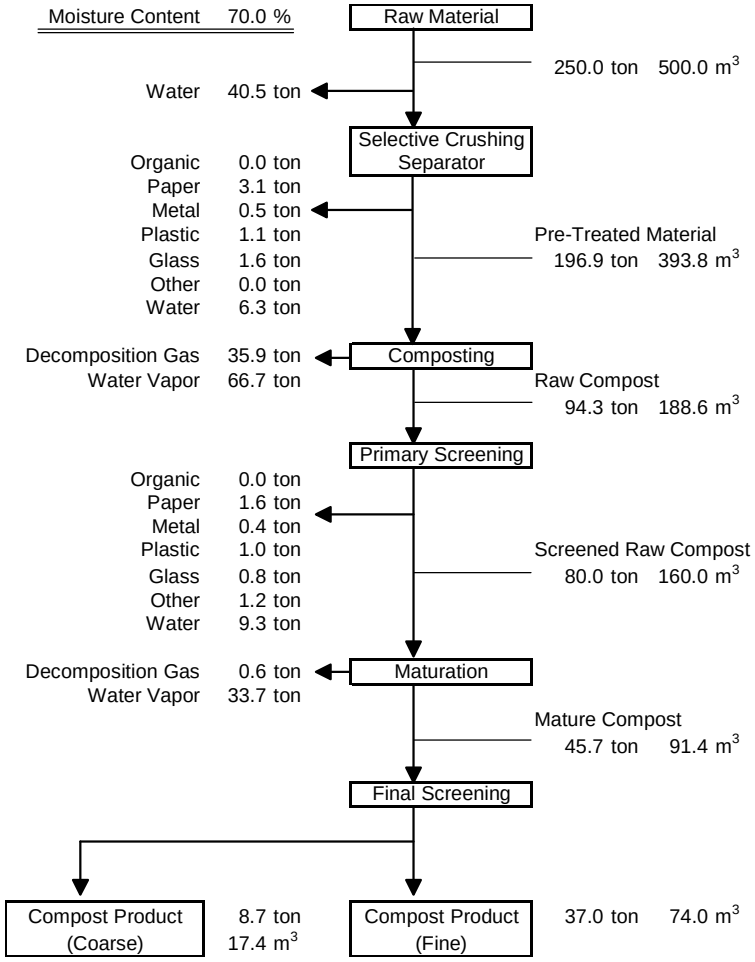


Figure 10-7: Material Balance of the Compost Plant in Sofulu

g. Layout of Proposed Compost Plant

The following figure shows the proposed layout of the compost plant.

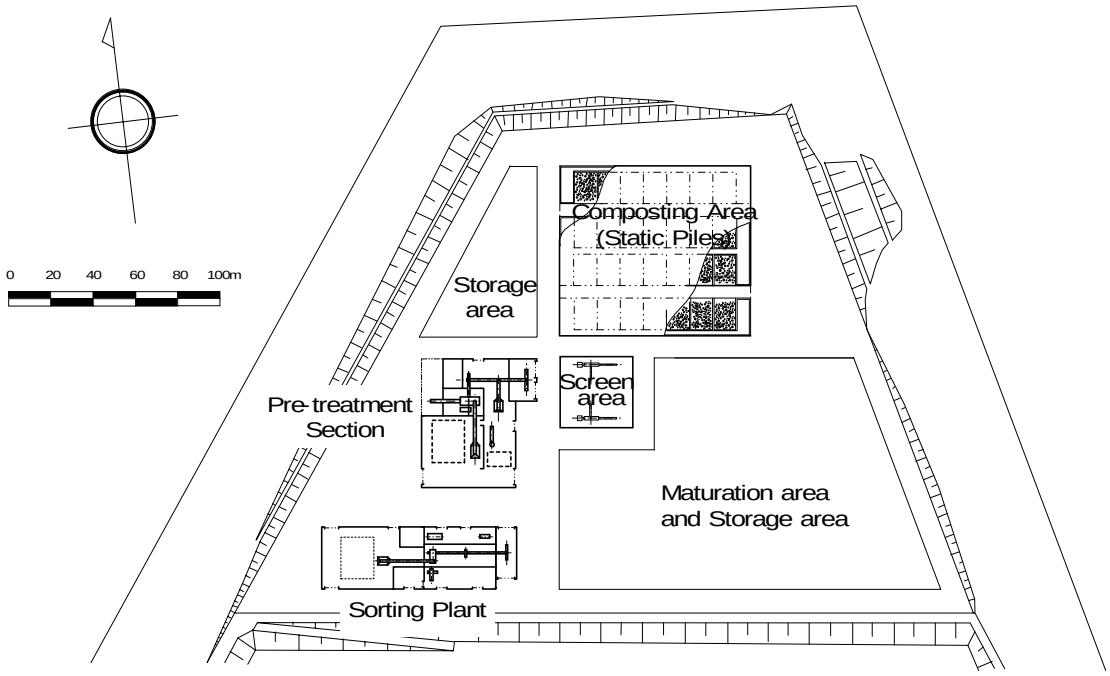


Figure 10-8: Layout of Proposed Compost Plant in Sofulu

10.2.5 Design of a Final Disposal Site

a. Examination of Technical Alternatives

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

a.1 Phased Site Development and Landfill Operation

The Sofulu disposal site will be developed and operated in 3 phases as described below (refer to Figure 10-1: Overall Sofulu Site Development Plan).

Phase 1:

In this phase the current dump site will be rehabilitated. The landfill operation will be continue 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 of the catchment area. Since rain 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 leave it as it is (shaped like a reservoir).

Phase 3:

In this phase, as shown in Figure 10-1, the opposite side of the present dump site will be reclaimed by waste filling. The landfill operation will finish when its height reaches to the ultimate use of the landfill. In addition, the surface soil can be used for soil covering for Phase 2 landfill operations.

a.2 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 Phase1. At Phase2 and Phase3, 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.

b. Preliminary Design

b.1 Outline of the Sofulu Disposal Site

Outline of the Sofulu Disposal site is shown on the table below.

Table 10-11: 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 Area :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 Temporary
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
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

Items	Description	
Environmental protection facilities	Fence	:4,570m
	Buffer zone	:4,570m
	Gas removal facility(Vertical)	:900m
	Gas removal facility(Horizon)	:2,485m
	Monitoring borehole	:3set

b.2 Final Disposal Site

b.2.1 Capacity of Final Disposal Site and Disposal Period

Final municipal solid waste disposal volume from Adana Greater Municipality is shown in table below.

Table 10-12: Final Disposal Amount in Sofulu

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	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	Σ d	430,476	891,866	1,384,942	1,913,982	2,484,045	3,103,400	3,778,288	4,508,706

b.2.2 Bottom and Slope 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 the 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 thick impermeable clay layer (K = 10^{-8} to 10^{-9} m/sec) should be kept as the liner. A 2 mm, high density polyethylene (HDPE) liner should be laid on top of it.

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

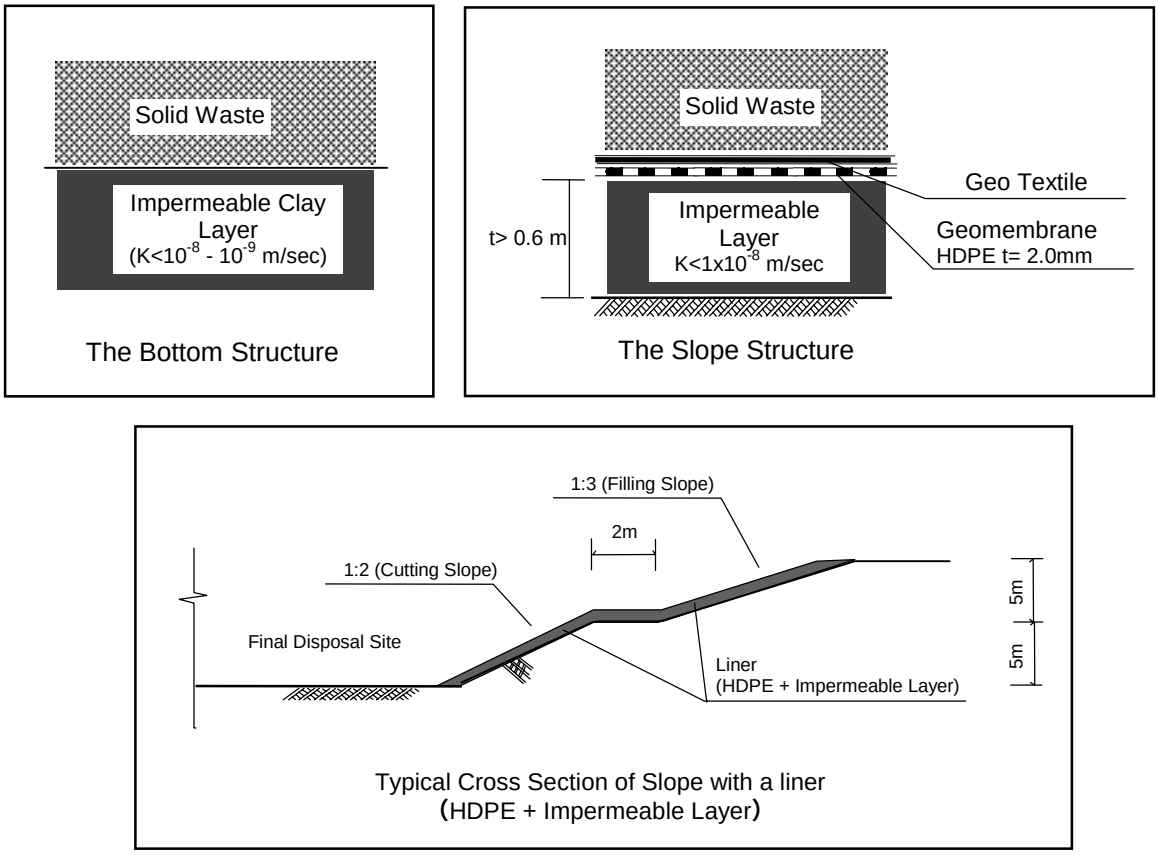


Figure 10-9: Diagrams of the Landfill's Impermeable Strata (Bottom and Slope)

c. Control Facilities and Approach Road

The layout plan of the control facilities is shown in Figure 10-10.

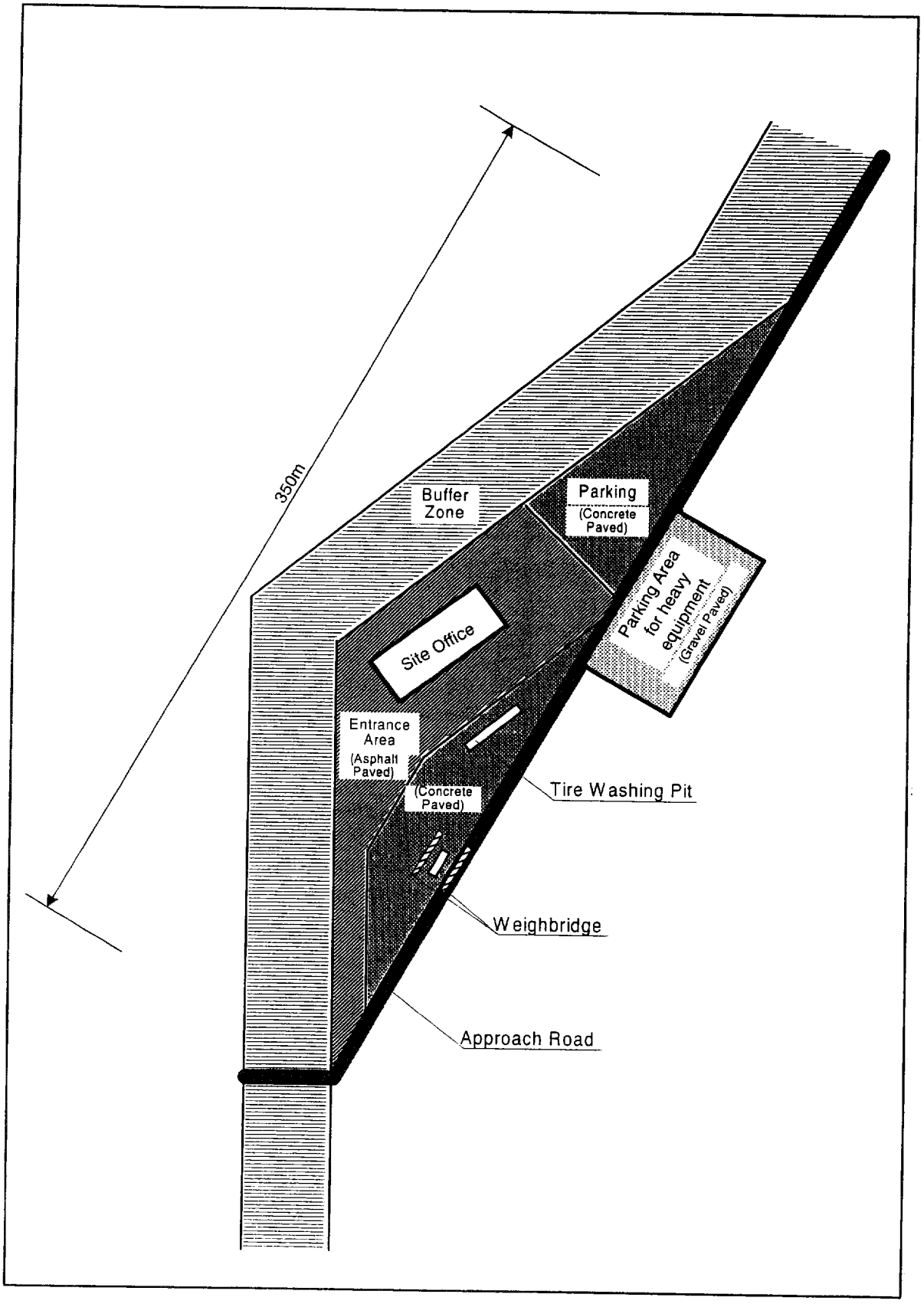


Figure 10-10: Control Facilities and Approach Road in Sofulu

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 10-13: Average Precipitation and Evaporation at Adana

unit: mm

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

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. The leachate quality for the proposed landfill site is, therefore, designed with a BOD of 2,500 mg/lit., and an SS of 500 mg/lit.

d.3 Effluent Standards

The table below shows the effluent standards for leachate generated from waste recycling plants and disposal areas.

Table 10-14: Effluent Standards in Sofulu

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

Sources: Water pollution control regulation,
Offical Gazette No. 19919 on 4.9.1988

d.4 Selection of the Leachate Treatment Method

This proposed landfill site consists of Phase 1, currently used for landfilling, and Phase 2 and Phase 3, to be developed to the east of Phase 1. Therefore the proposed landfill site has the old waste section that can be used for recirculation and evaporation of leachate. Considering these site conditions, recirculation and evaporation method shall be adopted for leachate treatment at the proposed landfill site.

d.5 Proposed Leachate Treatment (Recirculation and Evaporation)

The flow of the proposed leachate treatment process is shown in below.

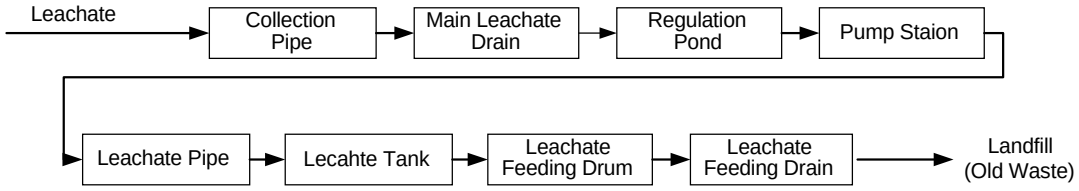


Figure 10-11: Proposed Leachate Treatment Process in Sofulu

d.6 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.

$Qj=1/1000 \times Ij \times (C_1A_1+C_2A_2)$ （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.7 Design Leachate Generation Amount

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

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

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

d.8 Determining the Recirculation Pump Capacity

The calculation of the recirculation pump's capacity is based on the following formula.

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

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 the table below. The shadow indicates the ideal capacity.

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

Table 10-15: Results of the Calculation of Recirculation Pump and the Regulation Pond 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.9 Planning for Regulation Pond

Size of the regulation pond shall be 25m wide x 40m long x 2m deep with a 1,100m^3 storage capacity that has a safety factor of more than 1.2.

e. Environmental Protection Facilities

Environmental protection facilities are established in order to protect environmental conditions around landfill site. They include a fence, a buffer zone, a gas removal facility, a leachate treatment facility, a landfill liner, and a monitoring borehole.

f. Personnel and Heavy Vehicle Plan

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

Table 10-16: Personnel and Heavy Vehicle Plan

Personnel and heavy vehicle	Number	
Personnel		
Site Manager	1 person	(2002-2005)
Waste controller	1 person	(2002-2005)
Operator	5 person	(2002-2005)
Driver	3 person	(2002-2005)
Worker	2 person	(2002-2005)
Security guard	2 person	(2002-2005)
Total	14 person	(2002-2005)

Personnel and heavy vehicle	Number
heavy vehicle	
Bulldozer(230HP)	3Units (2002-2005)
Excavator(99HP)	1Unit (2002-2005)
Dump truck(8m^3)	3Units (2002-2005)
Water truck	1Unit (2002-2005)
Total	8units (2002-2005)

10.2.6 Design of a Medical Waste Disposal Site

a. Fundamental Issues

a.1 Target Wastes

Target waste to be disposed of at the medical waste disposal site is defined as shown in the table below, according to the regulation on control of medical wastes.

Table 10-17: Target Wastes to be Disposed at Medical Waste Disposal Site in Sofulu

Type	Target	Definition
Infected	**yes**	All types of human tissues and organs, urine containers, blood or placenta contaminated waste bacteria cultures, infectious diseases ward and emergency ward wastes, bacteria and virus retaining air filters, faeces and faeces-contaminated articles corpses of biological research animals and wastes of quarantined patients of likely to be contaminated by disease agents (collection after sterilisation)
Pathogenic	**yes**	Waste bearing pathogenic factors (collection after sterilisation)
Pathological	**yes**	Organs, parts of body, animal corpses, blood and other body fluid, that may carry pathogenic organisms.
Radioactive waste	**no**	Disposal in accordance with statue (2690.9.7.1982)
Safe chemicals	**no**	Irrecoverable waste chemicals (through municipal collection) liquid waste (by water pollution control regulation)
Dangerous chemicals	**no**	(1) Recoverable dangerous waste and expired medicines(individual collection with care to eliminate undesirable reactions. (2) Mercury (separate collection) (3) Shock-sensitive substances and materials reacting or highly reactive with water (separately destroy with attention to noxious effects)
Waste of domestic nature	**no**	Uninfected kitchen waste garden waste, office package materials bottles and like

a.2 Location of the Medical Waste Disposal Site

As shown in Figure 10-12, a medical waste disposal site will be constructed at the eastern centre of the proposed Sofulu disposal site.

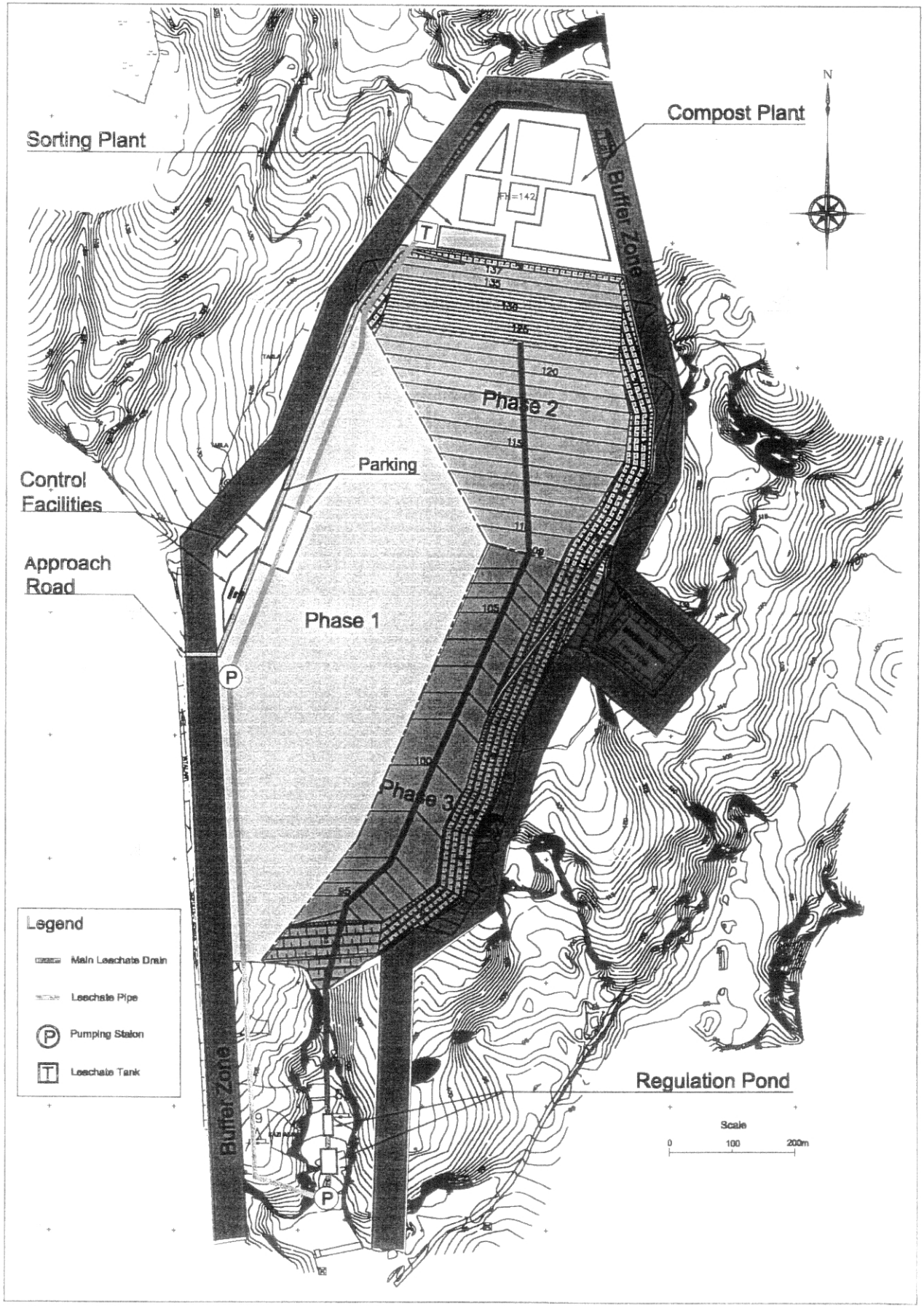


Figure 10-12: Proposed Medical Waste Disposal Site in Sofulu

Figure 10-12: Proposed Medical Waste Disposal Site in Sofulu

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 must be more than 3,000 meters.

b.2 Preliminary Design of the Medical Waste Final Disposal Site

b.2.1 Basic Concept of the Preliminary Design

Basic concept of preliminary design of medical waste disposal site in Sofulu is summarised as shown in the table below.

Table 10-18: Basic Concept of a Medical Waste Final Disposal Site in Sofulu

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
	Disposal site floor	article 35 of design standard
	drainage system	article 36 of design standard
	deposition of waste	article 37 of design standard
	top cover	article 38 of design standard
	gas removal	Every 50 meters(vertically and horizontally)
	vegetation of disposal site	article 39 of design standard
(3) Leachate Treatment	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 in the table below.

Table 10-19: Outline of the Medical Waste Final Disposal Site in Sofulu

Items	Description
Land Area	Total Area :3ha
Landfill Volume	Capacity: 48,000m^3 Disposal Period: 2002-2009
Road	Inspection Road : width4.0m, length 235m
Leachate control facility	Leachate collection pipe φ100mm:445m Main leachate drain φ200mm:120m Pumping station:1 set Pump: 2set Leachate pipe φ200mm:200m Leachate Pit:1set
Drain for runoff water	Open concrete drain :235m Pipe drain for rain fall :120m
Environmental protection facilities	Fence :400m Gas removal facility(Vertical) :27m Gas removal facility(Horizon) :445m

b.2.3 Volume of the Medical Waste Final Disposal Site

Medical waste amount generated and final disposal amount are shown in the table below.

Table 10-20: Final Disposal Amount in Sofulu

Item	unit	formula	2,002	2003	2004	2005	2006	2007	2008	2009
Waste discharge amount	ton/day	a	5.2	5.5	5.8	6.2	6.5	6.8	7.2	7.6
	ton/year	b=ax365	1,898	2,008	2,117	2,263	2,373	2,482	2,628	2,774
Waste + Cover soil	m^3/year	c=bx1.5/0.7	4,881	5,163	5,444	5,819	6,102	6,382	6,758	7,133
Total	m^3	Σc	4,881	10,044	15,488	21,307	27,409	33,791	40,549	47,682

b.2.4 Leachate Collection Facilities and Regulation Pit

i. During Operation

A strict leachate circulation system shall be applied to the landfill to prevent rain water intrusion, the leachate will be circulated and stored in the site to prevent if from leaving the site.

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

ii. Post-Closure of the 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.

Therefore, the leachate circulation system will be closed in one year after the closure of the disposal site.

b.2.5 The Landfill's Impermeable Strata

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

In order to provide for ultimate land use of disposal site plants will be grown. The thickness of farm soil shall be determined according to root depths of plants to be planted or grown.

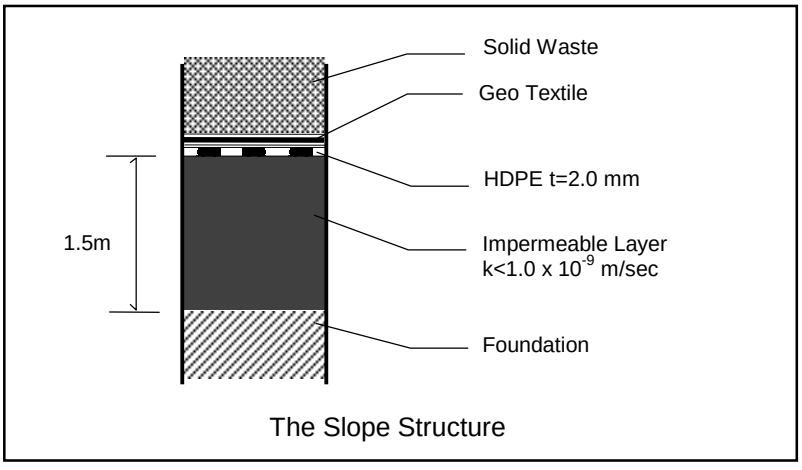
The inclination of farm soil layer shall be more than 3 %, so that the top soil does not erode during excessive rain.

Structure of the top cover of the medical disposal site is shown in Table 10-21.

Table 10-21: Structure of Top Cover of Medical Disposal Site in Sofulu

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	$1.0x10^{-9}$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	

The landfill's impermeable strata of slope, top cover and bottom are shown in following figures.



The Slope Structure

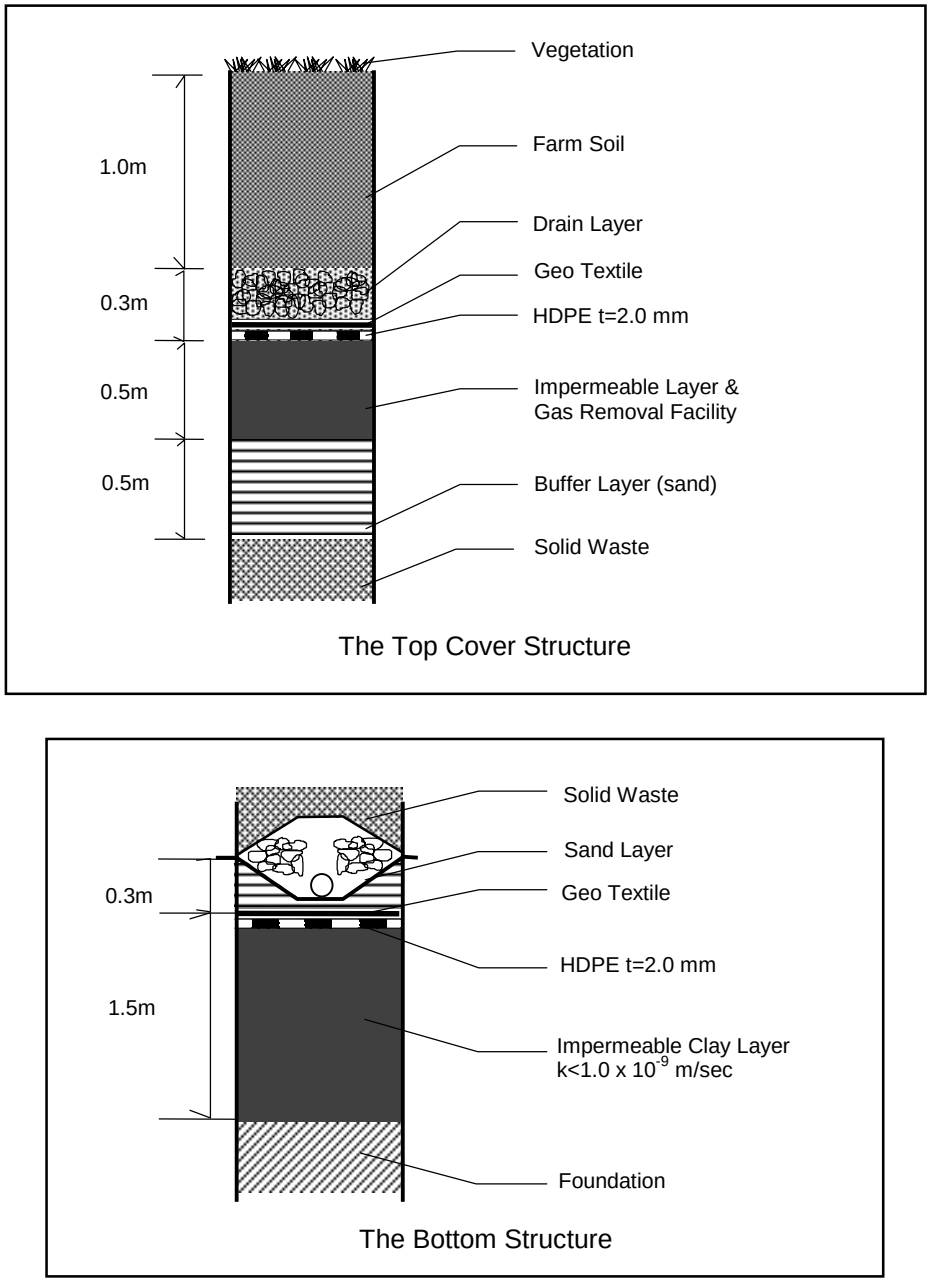


Figure 10-13: Diagrams of the Landfill's Impermeable Strata (Slope, Top Cover and Bottom)

10.3 Operation Plan

10.3.1 Sorting Plant

a. Fundamental Issues

The operation plan will cover the work flow from waste reception to recyclable materials storage.

a.1 Working Hours

The following are the sorting plant's operating hours.

- Mondays - Saturdays: 7:00 - 23:00 (16 hour/day)
- Sundays and National Holidays: Closed.
- Equipment operation hours 13 hours/day

a.2 Types of Solid Wastes

The sorting plant will receive the following types of wastes.

- Non-compostable MSW separated at source such as households and commercial enterprises.

a.3 Main Design Parameters

The table below summarises the design parameters based on the above design assumptions.

Table 10-22: Design Parameters of the Sorting Plant in Sofulu

Raw Material			
	Amount	54,538 ton/year (2005)	
	Moisture content	55.7 %	*1
	Bulk density	300 kg/m^3	*1
Plant Specification			
	Type	Manual-sorting + a magnetic separator	
	Treatment line	One line	
	Treatment Capacity	190 ton/day	
	Operation	300 day/year 16 hour/day by two shifts	
	Recovered Material	(1) Paper (mainly Cardboard) (2) Plastics (Film and PET bottles) (3) Glass (Bottles and Cullet) (4) Ferrous metal (5) Non-ferrous metal (mainly Aluminium cans) (6) Textile	

Note: *1 : Estimates from the pilot project

a.4 Process Flow of the Plant

The process flow of the proposed sorting plant is presented in Figure 10-2.

a.5 Layout of Proposed Sorting Plant

The layout of the proposed sorting plant is presented in Figure 10-4.

b. Staff and Job Description

Operation and maintenance (O&M) will be contracted out to the private sector, while the AGM will instruct and supervise the plant and bear responsibility to prevent any adverse impacts on the environment.

Table 10-23 is the staff allocation schedule of the plant. The number of operators and sorters are derived from the volume of materials to be processed and plant operation capacity.

b.1 Administration

Administrative work will be executed by a director, who oversees the operation and management of the sorting plant, and supporting staff including an accountant and secretary.

b.2 Operation

Plant operation is overseen by a sub-manager of the plant involving five sections. Each is headed by one supervisor for one shift.

b.2.1 Waste Reception Section

Waste is received in this section and fed to the plant. Waste unsuitable for the sorting process such as bulky waste should be manually rejected by the workers. A wheel-loader is used to feed waste to a hopper. These works are managed by the waste reception supervisor.

b.2.2 Facility Operation Section

The workers of this section, headed by the sub-manager, operates the facility such as the feed hoppers and the hand-sorting conveyors. The entire operation will be done in a central control room. This section shall also take responsibility of the electrical control system.

This section is in a key position coordinating the preceding waste reception section and the following hand-sorting section. The capability to assess the situation of the plant as a whole is required.

b.2.3 Manual Sorting Section

This is the section where recyclable materials are sorted out from the waste on a conveyor belt. The manual sorting supervisor looks after waste composition and sorting works, and adjusts the speed of the conveyor. The line workers are allocated on both sides of the conveyor and manually pick up a specific item assigned to each worker in advance.

b.2.4 Product Section

The product section conditions recyclable materials separated by the manual sorting section and store it if needed. The supervisor of this section gives instruction on product handling and storage to the product separation workers, press machine operators, baling machine operator, and folk lift driver.

b.2.5 Transport Section

This section manages the transport of waste residue from the plant to the final disposal site. The truck drivers supervise waste residue loading onto the trucks, transport it, and maintain the vehicles.

Table 10-23: Staffing Schedule in Sofulu

Position		Shift		Total
		1	2	
ADMINISTRATION				
	Sub-manager	1	---	1
	Accountant	1	---	1
	Secretary	1	---	1
	sub-total	3	---	3
OPERATION				
	Pre-treated section			
	Supervisor	1	1	2
	Facility operate section			
	Machine operator	2	2	4
	Reception section			
	Loader operator	1	1	2
	Labourer	1	1	2
	Manual-sorting section			
	Hand-sorting supervisor	1	1	2
	Hand-sorting labourer	12	12	24
	Product section			
	Supervisor	1	1	2
	Labourer	7	7	14
	Press machine operator	2	2	4
	Baler machine operator	1	1	2
	Fork lift driver	1	1	2
	Transport section			
	Truck driver	1	1	2
	Labourer	1	1	2
	sub-total	32	32	64
Total		35	32	67

10.3.2 Compost Plant

a. Fundamental Issues

It covers the process from waste reception to final product storage.

a.1 Working Hours

This compost plant is open the following hours.

- Mondays - Saturdays 7:00 - 23:00 (16 hour/day)
- Sundays and National Holidays Closed
- Equipment operation hours 13 hour/day

a.2 Types of Solid Wastes

The compost plant will receive the following types of wastes.

- Compostable MSW separated at sources such as households, commercial enterprises, etc.
- Garden wastes (as moisture adjusting agent)

a.3 Main Design Parameters

The table below summarises the design parameters taking the above design assumptions into account.

Table 10-24: Design Parameters of the Compost Plant

Composting section				
	Type	Aerated Static Pile		
	Raw Material (Compostable Waste)	Amount	250 ton/day	
		Compostable Content	20.3 % by dry weight	*1
		Moisture Content	70 %	
		Apparent Specific Gravity (ASG)	500 kg/m^3	*2
	Operation		300 day/year 16 hour/day	
	Treatment Capacity		250 ton/day	
	Composting Period		28 days	
	Pile Temperature		>55^{o}C	
Maturation (Curing) section				
	Operation		300 day/year 16 hour/day	
	Treatment Capacity	Mature compost product	~ 45.7 ton/day	
		Moisture Content	~ 40 %	
		Apparent Specific Gravity (ASG)	500 kg/m^3	*2
	Maturation Period		60 day	
Final Separation section				
	Type	Trommel screen		
	Operation Time		300 day/year 16 hour/day	
	Treatment Capacity	Fine compost product	~ 37.0 ton/day	
		Coarse compost product	~ 8.7 ton/day	
		Moisture Content	~ 40 %	
		Apparent Specific Gravity (ASG)	500 kg/m^3	*2

Note: *1 : Obtained from "Composition of the Compostable Waste" (composite of kitchen waste, grass and wood)
*2 : Estimates from the pilot project.

a.4 Process Flow of the Plant

Figure 10-6 shows the process flow of the compost plant.

a.5 Layout of Proposed Compost Plant

The layout of the proposed compost plant is presented in Figure 10-8.

b. Staff and Job Descriptions

Table 10-25 is the staff allocation schedule for the proposed compost plant. The number of operators and manual workers is derived from the volume of materials to be processed and plant operation capacity.

b.1 Administration

Administrative work will be executed by a director, who supervises the operation and management of the plant, an accountant, who will be also in charge of product sales promotion, and a secretary.

b.2 Operation

Operation is managed by a sub-manager of the plant and involves two parts: pre-treatment section and composting section. Both consist of sections, each of which is headed by one supervisor for one shift. The job description of the sections is as follows.

b.2.1 Pre-treatment

i. Waste Reception Section

Compostable wastes is received by this section and transferred to the pre-treatment equipment. The section has workers who reject wastes unsuitable for the equipment and a wheel loader operator who feeds the other wastes to a feed hopper. These works are controlled by the reception supervisor.

ii. Facility Operation Section

The facility operators, under the supervision of the sub-director, operate pre-treatment equipment such as the feed hopper, feed conveyor, and selective crushing separator (SCS). All of these will be managed in a central control room. This section is also responsible for the electricity control works.

This section is in a key position coordinating the preceding waste reception section and the following transport section. The capability to assess the entire pre-treatment section is required.

iii. Selective Crushing Separation Section

The supervisor of this section controls the performance of the SCS by observing the waste input and the waste output. When the moisture content of the fed wastes is found to be high, he/she directs the operator and workers to add moisture adjusting agent. He/she also directs the transport of the materials pre-treated by the SCS.

iv. Transport Section

After the screening of the SCS, the pre-treated materials and the rejects are transported to the next proper section. The supervisor manages material transport by giving instructions to the truck drivers on when and to where the materials will be transported.

b.2.2 Composting

i. Static Pile Section

The supervisor of this section directs the loader operators to pile pre-treated materials onto an appropriate place. He or she is responsible for the maintenance of the aerobic environment in the piles by adjusting the air blowing rate. Further, he or she gives instructions to the workers about turning and water supply to the piles.

ii. Screening Section

There are two stages of screening: primary screening for raw compost and final screening for mature compost. The primary screening line and the final screening line is operated alternately by the same operators and workers. They also operate the packaging machine of the final compost product.

iii. Maturation Section

The screened raw compost from the screening section is matured in this section. Although it is usual to mature the materials to ensure stabilisation, market demand for the screened raw compost without maturation may rise. In such occasion, the plant director and sub-director have to give necessary instructions to the workers of this section.

Table 10-25: Staff Allocation Schedule in Adana

Position			Shift		total
			1	2	
ADMINISTRATION					
	Sub-manager		1	---	1
	Accountant		1	---	1
	Secretary		1	---	1
		sub-total	3	---	3
OPERATION					
	Pre-treated section				
		Supervisor	1	1	2
		Facility operate section			
		Machine operator	2	2	4
		Reception section			
		Loader operator	1	1	2
		Labourer	1	1	2
		Transport section			
		Labourer	2	2	4
		Truck driver	1	1	2
		sub-total	8	8	16
	Composting section				
		Supervisor	1	1	2
		Static pile section			
		Loader operator	1	1	2
		Labourer	2	2	4
		Transport section			
		Loader operator	---	---	---
		Labourer	---	---	---
		Truck driver	1	1	2
		Separate section			
		Operator	1	1	2
		Loader operator	1	1	2
		Labourer	2	2	4
		Curing section			
		Loader operator	1	1	2
		Labourer	2	2	4
		sub-total	12	12	24
		Total	23	20	43

10.3.3 Final Disposal Site

a. Fundamental Issues

This operation plan shall be applied for the proposed disposal site in AGM.

a.1 Working Hours

This proposed disposal site is open the following hours.

- Mondays - Fridays: 7:00 - 23:00 (16 hour/day)
- Saturdays, Sundays and National Holidays: Closed
- Equipment operation hours 7 hours/day

a.2 Types of Solid Wastes

The disposal site will receive the following types of wastes.

- Mixed municipal solid waste such as households and commercial enterprises
- Rejected waste from the Sorting plant and the Compost plant
- Other wastes (Industrial Waste, Waste of Adjacent Municipalities)

a.3 Preliminary Design

The outline of the preliminary design for proposed disposal site is shown in the table below.

Table 10-26: Outline of the Sofulu Disposal Site

Items	Description
Land Area and Proposed Land Use	Total Area :95ha Phase1:Landfill Area :25ha Phase2:Landfill Area :17ha Phase3:Landfill Area :13ha Plant :Area :6ha Medical waste Landfill Area :3ha Buffer zone :Area :25ha Others(include regulation pond)Use :6ha
Landfill Volume	Phase2: Capacity 2,351,000m^3, Disposal Period 2002-2006 Phase3: Capacity 2,325,000m^3, Disposal Period 2007-2009

a.4 Personnel and Heavy Vehicle Plan

The following personnel and heavy vehicle are required to operate at the landfill site.

Table 10-27: Personnel and Heavy Vehicle Plan in Sofulu

Personnel and heavy vehicle	Number
Personnel	
Site Manager	1 person (2002-2005)
Waste controller	1 person (2002-2005)
Operator	5 person (2002-2005)
Driver	3 person (2002-2005)
Worker	2 person (2002-2005)
Security guard	2 person (2002-2005)
Total	14 person (2002-2005)
heavy vehicle	
Bulldozer(230HP)	3Unit (2002-2005)
Excavator(99HP)	1Unit (2002-2005)
Dump truck(8m^3)	3Unit (2002-2005)
Water truck	1Unit (2002-2005)
Total	8unit (2002-2005)

b. Operation Plan

b.1 Weighbridge

The final disposal site, sorting plant and composting plant, which are to be sited in the same land plot, will share two weighbridges.

The weighbridge will be used to measure the following.

- Mixed wastes directly delivered to the landfill.
- Medical wastes directly delivered to the landfill.
- Non-compostable wastes fed to the sorting plant.
- Recyclable materials and residue segregated at the sorting plant.
- Compost and residue from the compost plant.

b.2 Operation at Landfill Area

b.2.1 Landfill Method

With the cell method, soil is spread daily to cover the solid wastes. Through this method a highly compacted landfill can be obtained, and this prevents scattering of solid waste, generation of offensive odour, and the breeding of disease vectors and noxious insects. Therefore, the cell method should be applied.

b.2.2 Cover Soil

Cover soil will be placed, and the thickness of each layer is as follows.

- daily covering soil: 20 cm
- final covering soil: 100 cm (depending on the ultimate use)

The ratio of cover soil to the disposal volume of waste will be 20 %, excluding final covering soil.

b.3 Landfill Procedure

The area and volume of Phase 2 landfill area shall be 17 ha and 2,351,000m^3 respectively. The municipal solid waste can be filled for 5 years at this area. The area and volume of Phase 3 landfill site shall be 13 ha and 2,325,000m^3 respectively. municipal solid waste can be filled for the period of 3 years at this phase.

In Phase 2 and Phase 3, the landfill area shall be divided into lots by a dike; the area of each lot shall cover one year's operation. Landfill operations shall be executed from downstream upwards in order to connect the leachate collection pipe easier. Rainfall drainage pipes shall be provided from the upstream lot, adjacent to the landfill area, in order to separate the rainwater and the leachate. This rainfall drainage pipe shall be extended according to the progress of landfill operations.

c. Conditions of Landfill Site at Final Cover Stage

Conditions of landfill site at final cover stage are as follows.

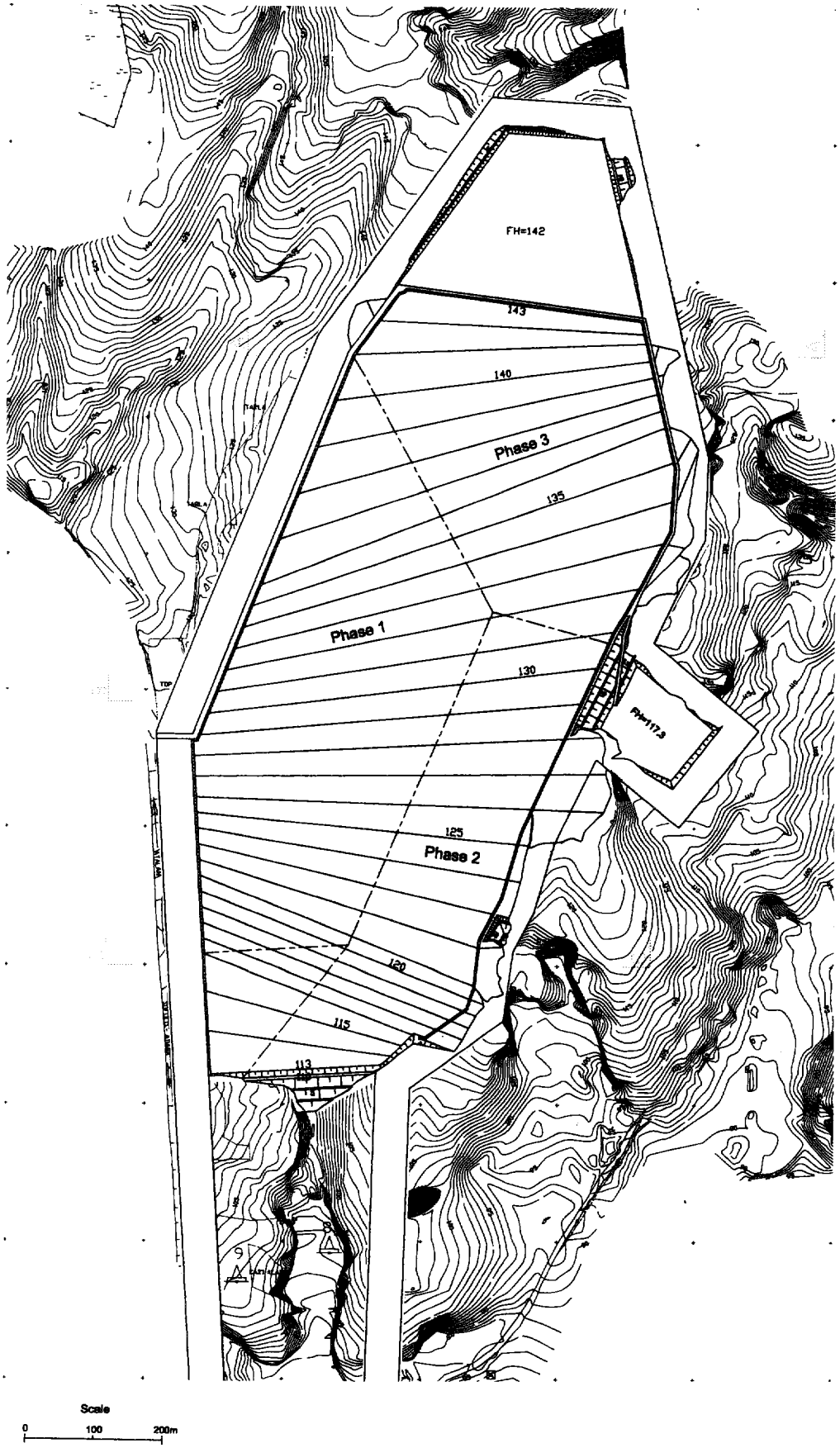


Figure 10-14: The condition of Proposed Landfill Site at Final Cover Stage

10.3.4 Medical Waste Disposal Site

a. Fundamental Issues

a.1 Working Hours

This proposed disposal site is open the following hours.

- Mondays - Fridays: 7:00 - 14:00 (7 hour/day)
- Saturdays, Sundays and National Holidays: Closed.
- Equipment operation hours 7:00 - 16:00

a.2 Types of Solid Wastes

The disposal site will receive the following types of wastes.

- Medical waste
- Infected waste
- Pathogenic waste
- Pathological waste

a.3 Preliminary Design

The outline of the preliminary design for the proposed medical disposal site is shown in the table below.

Table 10-28: Outline of the Medical Disposal Site in Sofulu

Items	Description	
Land Area	Total Area	: 3ha
Landfill Volume	Capacity	: 48,000m^3
	Disposal Period	: 2002-2009

b. Operation Plan

b.1 Weighbridge

The final disposal site, sorting plant and composting plant, sited in the same land plot, will share two weighbridges.

The weighbridge will be used to weigh the following.

- Mixed wastes directly delivered to the landfill.
- Medical wastes directly delivered to the landfill.
- Non-compostable wastes fed to the sorting plant.
- Recyclable materials and residue segregated at the sorting plant.
- Compost and residue from the compost plant.

b.2 Operation at Landfill area

b.2.1 Landfill Implementation

Landfill implementation of the medical landfill is shown in the table below.

Table 10-29: Landfill Implementation of the Medical Landfill in Sofulu

Item	Sub-Item	During Operation
Landfill Implementation	landfill method	-cover soil immediately after dumping of medical waste - landfill division by divider(1 year / divider) - cover soil from quarry in landfill site
	final disposal foundation	article 34 of design standards
	Disposal site floor	article 35 of design standards
	drainage system	article 36 of design standards
	deposition of waste	article 37 of design standards
	top cover	article 38 of design standards
	gas removal	Every 50 meters(vertically and horizontally)
	vegetation of disposal site	article 39 of design standards
Leachate	system	-recirculation system -gravity reliant (from slope surface)
Rain water	drainage system	-individual collection and direct discharge

b.2.2 Landfill Procedure

The area and the volume of the medical waste landfill site are 3 ha and 48,000m^3 respectively. Medical waste can be filled for 8 years at this area.

Medical waste landfill area shall be divided into lots by a dike; the area of each lot shall be covered for a year's operation. Landfill operation shall be executed from downstream upwards in order to prevent leachate amount to increase due to rainfall water flowing from upstream. Therefore temporary drainage shall be constructed at the upstream lot, adjacent to the landfill area, in order to separate the rainwater and leachate. This temporary drainage shall be abolished and changed to the leachate drainage system according to the progress of landfill operations.

10.4 Cost Estimation

10.4.1 Separate Collection System

The following cost estimate is based on the preliminary design of the proposed separate collection system carried out during the F/S.

Table 10-30: Procurement Schedule of Container for Separate Collection for Sofulu (2002-2005)

		2000	2001	2002	2003	2004	2005
Container (800 Lit.)	nos.	800	931	114	123	128	123
	US$ 1,000	28	33	4	4	4	4
Compactor (16m^3)	nos.	-	26	5	6	6	6
	US$ 1,000	-	1,664	320	384	384	324

Table 10-31: Operation & Maintenance Cost of Collection Vehicle for Sofulu (2002-2005)

	2002	2003	2004	2005
Number of Collection Vehicles (nos.)	26	31	37	43
O & M Cost (US$ 1,000)	1,066	1,271	1,517	1,763

10.4.2 Sorting Plant

Investment cost and schedule for the sorting plant are shown in the following tables. 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 is in the cost estimate of the landfill site.

Table 10-32: Investment Cost of the Sorting Plant for Sofulu (2001)

Item		Cost (US$)
Sorting plant construction		369,400
Equipment		1,697,000
Sub-total		2,066,400
Miscellaneous	10%	206,600
Direct cost		2,273,000
General expenses/overhead	30%	681,000
Total construction cost		2,954,000
Physical contingency	10%	296,000
VAT	15%	443,000
Total cost		3,693,000

Table 10-33: Investment Schedule of the Sorting Plant for Sofulu (2000-2005)

unit : US$ 1,000

	2000	2001	2002	2003	2004	2005	Total
D/D	199	---	---	---	---	---	199
Civil	---	661	---	---	---	---	661
Machine	---	2,597	---	---	---	---	2,597
V&E	---	435	---	---	---	---	435
O&M	---	---	446	446	446	446	1,784
Total	199	3,693	446	446	446	446	5,676

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

10.4.3 Compost Plant

Investment cost and schedule for the compost plant are shown in the following tables. 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 is in the cost estimate of the landfill site.

Table 10-34: Investment Cost of the Compost Plant for Sofulu (2001)

Item		Cost (US$)
Compost plant construction		675,200
Equipment		3,115,000
Sub-total		3,790,200
Miscellaneous	10%	379,800
Direct cost		4,170,000
General expenses/overhead	30%	1,252,000
Total construction cost		5,422,000
Physical contingency	10%	543,000
VAT	15%	813,000
Total cost		6,778,000

Table 10-35: Investment Schedule of the Compost Plant for Sofulu (2000-2005)

unit : US$ 1,000

	2000	2001	2002	2003	2004	2005	Total
D/D	365	---	---	---	---	---	365
Civil	---	1,208	---	---	---	---	1,208
Machine	---	4,570	---	---	---	---	4,570
V&E	---	1,000	---	---	---	---	1,000
O&M	---	---	549	549	549	549	2,196
Total	365	6,778	549	549	549	549	9,339

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

10.4.4 Final Disposal Site

a. Control Facility and Phase 2

Investment costs of construction and vehicle & equipment for the control facility in Phase 2 are shown in the following tables.

Table 10-36: Investment Cost of Construction of MSW Landfill Site (Phase2) & Administration Area in Sofulu

Item		Cost (US$)
Control facilities		720,658
Phase 2 MSW landfill site		5,315,405
Sub-total		6,036,063
Miscellaneous	10%	603,606
Direct cost		6,639,669
General expenses/overhead	30%	1,991,901
Total construction cost		8,631,570
Physical contingency	10%	863,157
VAT	15%	1,294,736
Total cost		10,789,463

Table 10-37: Investment Cost for Vehicle & Equipment of MSW Landfill Site in Sofulu

Item		Cost (US$ 1,000)
Vehicle & Equipment		1,253
Spare parts	10%	125
Physical contingency	10%	125
VAT	15%	188
Total cost		1,691

b. Phase 3

Investment costs for the Phase 3 are shown in the table below.

Table 10-38: Investment Cost of Construction of MSW Landfill Site (Phase3) in Sofulu

Item		Cost (US$)
Phase 3 MSW landfill site		7,651,473
Miscellaneous	10%	765,147
Direct cost		8,416,620
General expenses/overhead	30%	2,524,986
Total construction cost		10,941,606
Physical contingency	10%	1,094,161
VAT	15%	1,641,241
Total cost		13,667,008

c. Investment Schedule

Investment schedule for the MSW landfill site are shown in the table below.

Table 10-39: Investment Schedule of MSW Landfill Site in Sofulu

unit : US$ 1,000

	2000	2001	2002	2003	2004	2005	Total
D/D	1,007				101		1,198
Civil		10,790				13,767	24,466
V&E		1,691					1,691
O&M			331	331	331	331	1,324
Total	1,007	12,481	331	331	522	14,007	28,679

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

10.4.5 Medical Waste Disposal Site

Investment cost of construction and vehicle & equipment for the medical waste disposal site are shown in the following tables.

Table 10-40: Investment Cost of Construction of the Medical Solid Waste Landfill in Sofulu

Item		Cost (US$)
Medical Waste Landfill Site		543,946
Miscellaneous	10%	54,395
Direct cost		598,341
General expenses/overhead	30%	179,502
Total construction cost		777,843
Physical contingency	10%	77,784
VAT	15%	116,676
Total cost		972,303

Table 10-41: Investment Cost for Vehicle & Equipment of the Medical Waste Landfill Site in Sofulu

Item		Cost (1,000US$)
Vehicle & Equipment		253
Spear parts	10%	25
Physical contingency	10%	25
VAT	15%	38
Total cost		341

The investment schedule for the medical waste disposal site is shown in the table below.

Table 10-42: Investment Schedule for Medical Solid Waste Landfill Site in Sofulu

unit : US$ 1,000

	2000	2001	2002	2003	2004	2005	Total
D/D	48						48
Civil		972					972
V&E		341					341
O&M			23	23	23	23	92
Total	48	1,313	23	23	23	23	1,453

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

10.5 Institutional Development Plan

10.5.1 Administration and Organisation

a. General

The Ministry of Environment objects in general that while solid waste collection activities are more or less successfully carried out by the district municipalities, unfortunately the greater municipalities have failed to a large extent in accomplishing their duties related to recycling and sanitary landfilling. The Adana Greater

Municipality should be now in the position to get rid of such an image in the views of the Ministry of Environment and realise an exemplary planning action with respective operations. These attempts must be models for ministerial extension services and provide an impetus for similar attempts in other greater municipalities.

Each municipality or any other municipally authorised agency dealing with dumping, landfilling and final waste disposal have to fulfil certain administrative obligations and regularly inform the Ministry of Environment about their previous and on-going activities in this regard. This obligation serves for the purpose that; the Ministry of Environment firstly gets acquainted with the current landfill practices in municipal areas, and secondly, be informed about prospective activities which need to be evaluated, oriented and formally controlled.

Likewise, the Adana Greater Municipality should also inform the Ministry of Environment on its plans regarding the further use of the Sofulu site for sanitary landfill purposes for a certain period as well as its rehabilitation works to be taken up. This administrative duty is also valid for the identification of location for the new sanitary landfill site, at which sorting and compost plants will also take place. It has to be substantially justified that, those decisions are made in accordance with a series of criteria as set forth by respective regulations of the Ministry of Environment.

The Adana Greater Municipality should be aware that necessary formal procedures must be fulfilled by respective municipalities in Turkey to allocate the disposal sites in urban development and land use plans, and precisely indicate whether they are currently used or closed. As legally envisaged, these areas are prohibited to become settlements, and this issue has to be adequately pursued throughout the decision, and enforcement process running under the initiative of the municipal councils and municipal parliaments. The prohibition duration is 30 years for present landfill sites and 40 years for closed landfill sites. It is also a compulsory administrative duty of the Adana Greater Municipality to obey these judicial provisions, which are in close connection with prospective activities in solid waste management.

In compliance with prospective activities, administrative liabilities must be identified and organisational schemes must be developed for:

- Further operation of the present landfill in Sofulu under sanitary conditions and its concurrent rehabilitation,
- Operation of a new sanitary landfill site,
- Operation of a new sorting plant and
- Operation of a new compost plant.

b. Further Operation and Rehabilitation of Sofulu

It falls under the responsibility of the Adana Greater Municipality to look after the fulfilment of managerial and operational requirements as well as technical provisions and specifications, as set forth in respective regulations and instructions of the Ministry of Environment, related to sanitary landfill management. While layering the new wastes by taking necessary measures and meeting requirements of a sanitary waste disposal practice, the Adana Greater Municipality should also provide the

appropriate network for gas exhaustion and leachate collection along with adequate discharge and outlet systems prior to laying a surface cover for closure.

According to regulations, the final disposal sites have to be surrounded by a fence. Entries to and departures from the site have to be supervised and controlled. A guard hut should be constructed along with an operation room and a weighbridge. All these requirements are regretfully not met in Sofulu, and therefore, more importance need to be attached in order to ensure a serious and proper management and service.

Private and municipal agencies, or corporate entities, that are responsible for the operation of final disposal site should legally employ a technician, who has to be in charge of the control of wastes entering into the site as well as of landfilling operations within the site. The operator of the disposal site is obliged to prepare an operation plan in compliance with Solid Waste Sanitary Landfill Operations Procedures as developed by the Ministry of Environment. Within the framework of this operation plan, certain monitoring activities must be carried out; primarily, leachate and gas emissions, and the results of periodical measuring must be forwarded to the Ministry of Environment, if required. These measuring and monitoring obligations are valid for 10 years upon the termination of the sanitary landfill operations and closure of the site.

There are also some subsidiary legal obligations pertaining to two main concerns. One of them is the training of personnel on environmental risks and the other one is the applications of requirements for cleanliness in working place. The training of personnel on environmental protection practices is not only necessary for himself, but also for the welfare of his human and natural environment. They should be sufficiently informed about the risks of their occupational engagement and be trained about protection measures on the job. Sanitation and disinfection of work garments, equipment, and vehicles constitute a significant duty to be taken up. Trucks and excavators operating in the landfill site must be cleaned before leaving the site. The municipal administration is in this regard legally instructed to look after the prompt loyalty to training and sanitation requirements by the contractor or other assigned agency. This principle naturally also applies for the landfill operations of the Adana Greater Municipality.

c. Rehabilitation and Sanitary Landfilling at Sofulu Site

In the management and operation of a sanitary landfill site, the minimum level of staffing varies, depending on the quantity of waste received as well as the method applied in landfilling operations. For those landfill sites with a capacity over 250 ton per day, where waste is placed and compacted by machines, a reasonable staffing should include the following personnel:

Personnel	Number	
Personnel		
Site Manager	1 person	(2002-2005)
Waste controller	1 person	(2002-2005)
Operator	5 person	(2002-2005)
Driver	3 person	(2002-2005)
Worker	2 person	(2002-2005)
Security guard	2 person	(2002-2005)
Total	14 person	(2002-2005)

In identification of the definitive personnel size, mainly three criteria have to be referred:

i. waste volume handled,
ii. number of work shifts a day
iii. mechanisation level.

Thereafter the personnel size needed for sanitary landfilling operations on Sofulu site or on the prospective sanitary final disposal site of Adana can be finalised.

A separate personnel list must also be prepared for the rehabilitation activities to be carried at the Sofulu site. Since sanitary landfill and rehabilitation operations will be concurrently undertaken at the Sofulu site for a certain period of time, both activities can be managed together. A support staff composed of traffic marshals, vehicle operators for waste and earthmoving, and manual labourers (with a size that is identified in the light of waste and earth volume handled; number of work shifts a day, and mechanisation level) would be sufficient.

The daily operations at the landfill site fall generally into three groups of activities: waste reception; waste deposition; and site maintenance and control.

Waste reception comprises operations as:

- checking vehicles and loads at the site entrance.
- segregating wastes and loads.
- temporary storage for on-site roads.
- registry and record keeping.
- on-site traffic control and direction to the working face.

Waste deposition encompasses on-site operations, which are:

- waste placement in the working face.
- compaction.
- excavating cover material.
- spreading cover material.
- construction of on-site haul roads.
- construction of dikes and earthworks.

Site maintenance and control embraces mainly supervision and monitoring activities, such as:

- litter and dust control.

- maintenance of buildings, fences and plants.
- surface water control.
- leachate control.
- gas and odour control.
- vermin and bird control.
- environmental monitoring.

All these operations have to be carried out within the framework of the Operation Plan as required by the Ministry of Environment in compliance with Solid Wastes Sanitary Landfill Operations Procedures.

d. Sorting and Compost Plants in Adana

There are two options for the management of the operations of sorting and compost plants; either separately or jointly. If these two plants are located at the same site, it would naturally be rational and economic to jointly manage their operations. The following staffing has been represented in the table below, where one can distinguish between separate personnel and joint personnel of the compost and sorting plants.

Table 10-43: Staffing of Compost and Sorting Plants in Adana

Personnel	Compost Plant	Sorting Plant
Sub-manager	1	1
Accountant	1	1
Secretary	1	1
Supervisor	4	6
Machine operator	6	10
Loader operator	8	2
Labourer	18	42
Driver	4	4
Total	43	67

10.5.2 Legislation and Enforcement

The first legal regulation related to solid waste management has been made by the General Public Health Act of 1930 and this duty has been given to the municipalities. According to the Greater Municipalities Act of 1984, the greater municipalities are obliged to identify the locations, where solid wastes and industrial wastes have to be collected, sorted, recycled, and disposed within the overall waste management system. The greater municipalities have been further obliged to set up the necessary sites and plants as well as to operate them, whilst the district municipalities are associated solely with waste collection activities. The greater municipalities, and likewise the Adana Greater Municipality, are free either to set up and operate recycling plants and final disposal sites by themselves or let them be set up and operated by a certain company on contractual basis.

The municipalities or any other municipally authorised organisations, that are in charge of establishing and operating landfills are legislatively obliged to submit their recent reports to the Ministry of Environment about the status of their SWM activities and current state of dumpsites, landfills, or closed disposal sites. This subject was

made compulsory and binding for the municipalities through the Regulation on Solid Waste Landfill Sites prepared by the Department for the Management of Wastes and Chemicals of the Ministry of Environment and issued in May 1993.

Accordingly the Adana Greater Municipality is bound, like rest of the municipalities, to meet the requirements and forward the necessary documents to the Ministry of Environment in this concern. The regulation also states that the municipalities have to identify the locations of current dumpsites, disposal sites, and landfills in their urban development and land use plans and to prohibit any settlement on these areas for 30 years. Special attention and care have to be devoted by the Adana Greater Municipality to this issue.

For the closure of dumpsites, landfills, and final disposal sites, the regulation envisages no final surface coverage to be undertaken without establishing necessary systems required for gas exhaust and outlet. In case of omitting any responsibility or obligation stated in the regulation, the Adana Greater Municipality will be subjected to penalties as indicated under the provisions of Article 46.

According to the Regulation on Solid Waste Landfill Sites again, the Adana Greater Municipality is obliged to indicate the location of the closed dumpsites, landfills and final disposal sites on urban development and landuse plans, and to permit no construction or settlement on these sites for a time period of 40 years following closure.

The Adana Greater Municipality is also legally obliged to train personnel engaged in sorting, recycling, composting and disposal practices. They must provide not only vocational training, but also consciousness building on basic environmental protection and public health principles is also legally envisaged.

In the identification of eligible locations to be used for sanitary landfill sites, sorting and compost plants and in making final decision on Sofulu site as well, a series of criteria set forth by the regulation have been met, e.g., distance to settlement areas; water resources; underground water movements; geological, geo-technical and hydrogeological structure; traffic and transportation distance; aesthetics; and landfill capacity.

However, there are also some legal liabilities to be accomplished by the sanitary landfill operator during final disposal activities. The sanitary landfill has to be operated in accordance with Solid Waste Sanitary Landfill Operations Procedures as envisaged by the Ministry of Environment. Following the completion of landfill operations and closure of the sanitary disposal site, the monitoring activities must be obeyed for 10 years.

The Amendment on the Regulation for Solid Waste Control issued on September 15th, 1998 declares that the Ministry of Environment is in favour of utilisation of recyclables and assigns the governorates and municipalities to promote and to encourage actions and implementations in this respect. With the aid of incentives, these agencies are also supposed to foster use of recycled materials wherever possible.

The regulation stresses that medical wastes, chemicals, radio-active wastes, and hazardous wastes must be separately disposed. The governorates and municipalities are responsible for the separate disposal of hazardous and medical wastes pursuant to

the Regulation for the Control of Hazardous Wastes issued on September 27th, 1995 and Regulation for the Control of Medical Wastes issued on May 20th, 1993, respectively.

Commercial and industrial enterprises producing, importing and selling products in PET, PVC, PE, PS, PP, aluminium, tin, glass, and other products made of recyclable containers are subject to material recovery and must collect a certain portion of their empty containers back.

Based on quota and deposits practices is managed by a commission, that fixes yearly target rates for each enterprise, individually. If the target rates are not achieved by the enterprise, the quota conditions for the following year get harder.

According to the Regulation for Solid Waste Control, the mayors within the municipal boundaries, and the governors in the rest of the adjacent municipalities within the provincial boundaries, are obliged to take necessary measures for separate collection or sorting of recyclables in order to ensure a more environmentally sound waste disposal and a more economic utilisation of collected inorganic and organic but recyclable household, commercial, institutional, market and park wastes.

10.5.3 Financial System

a. Problems in the Present Cleansing Tax System

The cleansing tax system was introduced in 1994 with the aim to establish a financial base for the cleansing services. The system does not function, however, due to the following problems.

- Revisions in the cleansing tax tariff are not in accordance with the increase in cleansing service expenses.
- The cleansing tax tariff does not reflect waste discharge characteristics and the taxpayers' ability to pay.
- The number of buildings to be taxed are not fully identified.
- Since the cleansing tax is only standardised by province, the tax amount does not take into account the disparity in municipal cleansing service expenses.
- Since the cleansing tax is imposed by building use, incentives to promote waste volume reduction and separate collection are difficult to establish.

b. Improvement Measures

The introduction of a cleansing tax system by waste amount is one way to solve the aforementioned problems. This would refer to the setting up and collection of a cleansing tax tariff in accordance with the discharge amount. This is not to say, however, that this system is without any problems. The table below compares the advantages and disadvantages of a cleansing tax system by waste amount and a cleansing tax system by building use.

Table 10-44: Advantages and Disadvantages of Cleansing Tax System by Waste Amount and by Building Use

	Advantages	Disadvantages
Cleansing Tax System by Waste Amount	• Willingness to pay the SWM expenses is clearly determined. • The SWM collection fee may be established by service level. • Imposing taxes by waste amount would enable activities that would encourage waste minimisation.	• Waste discharge amount is difficult to measure. • Establishing a tariff that reflects waste discharge characteristics and the peoples ability to pay is difficult. • Cost involved in fee collection can easily rise. • Easily induces illegal dumping.
Cleansing Tax System by Building Use	• Facilitates establishing of fees. • Cost involved in fee collection becomes cheaper	• Establishing a waste collection fee by service level is difficult. • Incentives to promote separate collection and waste minimisation are difficult to promote if collection is by building.

As in other taxes, the collection of the cleansing tax is compulsory, hence it is generally said that 70 to 80% of the amount is collected. Joining the cleansing tax with the real estate tax is also expected to further increase the rate.

In contrast, it is difficult to make collection compulsory under a direct collection system. If direct collection is carried out in accordance with the waste amount, a weighing system should be established.

From the results of the above studies, this study recommends the restructuring of the cleansing tax system.

c. Actualisation of the Implementation Plan

The factor to be considered first and foremost in the implementation of a financial system is the full utilisation of the advantages of the cleansing tax system introduced. This would mainly refer to the following:

- Establishing an adequate tax tariff
- Raising the collection rate to over 90%

In addition, to promote separate discharge and waste minimisation, specific waste bags should be introduced and a separate fee for bulky discharges should be established to gain public co-operation.

The following points regarding the financial system should be improved to actualise the implementation plan.

- Improvement of cleansing tax collection rate
- Reconsideration of cleansing tax tariff

c.1 Improvement of Cleansing Tax Collection Rate

Aiming for a 90% cleansing tax collection rate would significantly require not only the establishment of a solid financial base, but also the implementation of the beneficiary pays principle. Almost all of the residents discharge their own waste, while nearly all households receive the waste collection, treatment, and disposal services. At present the number of buildings subject to the cleansing tax is not systematically identified. To discourage cleansing tax evasion, cleansing tax should be billed jointly with the real estate tax.

c.2 Reconsideration of Cleansing Tax Tariff

The cleansing tax is reviewed yearly but still is not enough for the ever increasing cleansing service costs. The waste discharge characteristics cannot be reflected in the tax due to the standardisation of the tax tariff. It is, therefore, important to study the discharge conditions in households and offices to adopt a suitable tax rate. Cross subsidy should also be considered for households.

c.3 Elucidation of Cleansing Service Expenditures

The accounting of various SWM cleansing services are currently not carried out separately. A separate accounting should be carried out in order to clarify how much is being spent on every service.

10.5.4 Privatisation and Contracting System

In fulfilling its legally obligatory services related to recycling and sanitary landfill management, the Adana Greater Municipality, like rest of the municipalities, has the right either to undertake these activities by itself, or commission a private entity to undertake them on its behalf. If commissioning an entity is found appropriate and beneficial, this is naturally possible through a privatisation action based on certain contractual provisions.

It is for sure that the Adana Greater Municipality has gained considerable experience in general aspects of privatisation carried out in diverse service sectors. Relying on this experience the following can be contracted out to the public sector.

- Sanitary landfill operations in the Sofulu site.
- Rehabilitation operations in the Sofulu site.
- Sanitary landfill operations at the prospective site.
- Sorting operations at the prospective sanitary landfill site.
- Composting operations at the prospective sanitary landfill site.

There are however a series of legal obligations that deserve due attention in contracting. These legal obligations which have to be of binding character for the contractor are:

- Security obligations - physical instalments for the safety of site.
- Monitoring and reporting obligations - environmental quality assessments and measuring.

- Training obligations - environmental protection and public health measures.
- Hygienic obligations – personnel, equipment and vehicle sanitation.
- Follow up obligations – monitoring for aftercare measures.

Special care has to be taken to above mentioned issues within the contractual framework for judicial reasons without neglecting the following issues for professional reasons:

- Managerial and operational obligations – tasks and performances,
- Personnel obligations - qualification and size of managerial and operational staff,
- Financial obligations – investment, personnel, operation and maintenance costs and payments,
- Scheduled obligations – timely achievements.

The contracting conditions could be made mutually favourable and beneficial, if the municipality and the contractor agree on a gentleman's protocol for the renewal of their contract, which is legally restricted to 1 year.

10.5.5 Monitoring and Information Management System

A legal enforcement executed by the Ministry of Environment through the Regulation on Solid Waste Landfill Sites requires each municipality or municipally authorised organisation to forward to the ministry relevant information on previous and recent status of waste discharge activities as well as current situation of dumpsites, landfills, and closed disposal sites. The Adana Greater Municipality must also obey this action. The aim of the Ministry of Environment through this legislative instrument is, at the first glance, to assess leachate and gas emissions endangering natural and human resources in close surrounding, and to set up a perpetual monitoring of activities and measures taken in this regard.

The Ministry of Environment emphasises that, the greater municipalities should provide such an information channel to put the ministry in a better position to assess the current and potential environmental risks, whereby the locational conditions and disposed waste amount are taken into consideration. This commitment is further important for the ministry to identify necessary measures in currently used and/or previously used but recently closed landfill sites based on analyses related to waste volume, waste composition, locational specifications, geological and hydrogeological structures, etc. The Ministry of Environment asks the municipalities for information exchange and calls for coordination in these issues.

In the light of above explanations, it is obvious that, the operating agency of the sanitary landfill site of Adana has to enter into certain legal commitments with the Ministry of Environment within the framework of an operation plan. This prepared plan must be confirmed by the ministry in respect to its compliance with the Solid Waste Sanitary Landfill Site Operations Procedures. Not only operation regulations and instructions are indicated in this plan, but also a series of monitoring activities. These monitoring requirements, which are basically confined to leachate and gas

emissions, must be periodically fulfilled, and the results reported to the Ministry of Environment. Therefore a precise list and description of monitoring tasks must be developed, in which specifications related to measuring activities are amply identified along with reporting procedures to be pursued upon evaluations. These obligations necessitate an adequate information system to be structured upon a periodical checklist for an effective monitoring.

The Adana Greater Municipality must prepare an operation plan for those sections of the Sofulu site, in which sanitary landfill practices will start. In addition to this plan, another specific document has to be prepared for those sections of the Sofulu site, in which rehabilitation activities will be carried out concurrently. For the prospective sanitary landfill site of Adana, a detailed plan has to be prepared for ministerial confirmation, as well. All these operation plans will naturally be associated with monitoring obligations on procedural basis.

Another important subject is the monitoring and control of settlement actions nearby the landfills. The regulation envisages that currently used waste disposal sites, as indicated in the land use plans, must not be permitted for any settlement purpose for a time period of 30 years. A similar action is also envisaged for closed dumpsites, which prohibits any settlement over this area for a time period of 40 years following the closure. Those closed dumpsites have to be regularly inspected and monitored by undertaking periodical samples related to gas generation, leachate, and underground and surface water contamination. Closed sanitary waste disposal sites on the other hand, which is presently a very rare case in Turkey, must be monitored 10 years long following the closure, as mentioned in the regulation.

The consequence to be drawn from these provisions is that, over the Sofulu site no settlement action will be permitted for 40 years upon its closure. This site will additionally be kept under monitoring throughout this period. Following the termination of sanitary landfill operations in prospective landfill site in Adana, this site will also be monitored 10 years long.

According to the Regulation on the Solid Waste Landfill Sites 1993 again, it is not sufficient to secure the bottom impermeability of waste storage and outlet for methane gas. Wastes must be adequately laid over and they should therefore be weighed and controlled before being admitted to the site. No domestic or wild animals should be allowed into the fenced sanitary landfill site. The leachate and gas emissions must be regularly assessed and monitored.

Regarding the closure of old dumpsites, it is neither sufficient to cover the surface of stored wastes and establish a functioning gas collection and outlet system. The closed dumpsites must be inspected and controlled continuously. Especially in those closed dumpsites near the residential areas, methane gas must particularly be measured . On regular monitoring basis; the plant cover over the waste storage, access and entrance roads as well as the gate, surface water drainage, leachate collection systems and gas outlets must be maintained and repaired, if required.

10.5.6 Human Resources Development

In the Regulation on Solid Waste Disposal Sites issued in May 1993, the Ministry of Environment sets forth, that all solid waste management activities of the

municipalities should be carried out in association with training. All engaged personnel have to be conscious about and be trained on the "environmental protection from cradle to grave" principle.

In compliance with above stated principle, the municipal and private personnel engaged in solid waste management must be mentally well prepared for environmental protection and fulfil the requirements adequately throughout implementations and operations. The Ministry of Environment is in the expectation, as articulated in the regulation, that those individuals working on waste collecting, sorting and storing phases of solid waste management process are obliged to be informed about the risks generated by wastes and must take necessary measures in this regard. Similarly, the manpower working in rehabilitation of old dumpsites must be priorly well trained about the dangers caused by the methane gas. They have to be equipped properly and must know how to take necessary measures, appropriately.

According to the regulation, the personnel working in operational and field services have to wear gloves, protective glasses, boots and special garments. Work garments, equipment, and vehicles ought to be disinfected and cleaned on a periodical basis.

Cleanliness is another prime issue that needs to be emphasised by every occasion. The garments worn by the personnel, instruments, and vehicles used during operations must be cleaned and disinfected. The personnel must get used to cleanliness and learn it from his near social and labour environment.

These provisions require the Adana Greater Municipality to give more efforts on training of personnel on general environmental protection issues, environmental relevance and risks as well as protection regulations and implementations to be pursued throughout their tasks related to solid waste collection, transportation and disposal as well as after care engagements subsequent to closures.

10.5.7 Public Education and Cooperation

a. Promoting Education, Public Awareness, and Training

a.1 Initiative for Source Separation

Experimental pilot projects should be carried out as environmental education and co-operation projects, with the following objectives:

- To raise public awareness on SWM issues and change people's attitudes toward waste minimisation, recovery, and recycling.
- To introduce public co-operation and participation as a means of promoting a separate waste collection system in the whole city. Awareness of the limitation of natural resources, and of the magnitude of the impacts of human activities on the environment; learning about composting and recycling as a way to help reduce the amount of waste being produced.
- To formulate and conduct public education programs on SWM issues through meetings and workshops.

In making the pilot project for public education, it is necessary to select the more appropriate area and materials to get joint participation of the whole area population.

In order to achieve the objectives of campaign project the following campaign materials are recommended:

Table 10-45: Education Materials for Adana GM

Material	Advantages	Disadvantages
Printed flyers	Repetition effect Re-usability	Little impression
Charts and posters	High portability	Limitation of information Not for the masses
Overhead projector (OHP)	Can be used in lecture theatres	High cost (projector) Heavy and low mobility
Slides	Good for a large number of people Relatively low cost	High cost (projector & development)
Sound filmstrips	Good for a large number of people Story-like explanation	High cost (projector & dark curtain & film making)
Use of real examples	Instant explanation with local materials (easy access and high familiarity)	Seasonal and location constraints
Radio & television	High impact with repetition effect	High cost
Video film	High impact Quick replay	Needed electric facilities High cost (VCR & parts)

a.2 Education on Sustainable Development

To improve the present SWM problems with the promotion of the independent and positive involvement of the general public for reducing environmental load, it is essential to spur changes in the socio-economic and cultural system.

In order to promote such voluntarily involvement by the general public, it is required to promote public education, and environmental-related learning from the viewpoint of lifelong learning, at greater municipal level, at home, school, and the workplace, so that the various sectors can obtain basic knowledge of relation between human beings and the environment, and so that they can deepen their understanding of the environment and take voluntary action for environmental conservation.

Taking into account the above, Adana GM must attach importance to the implementation of the following activities.

- Adana GM must develop the information base, which is conductive to the environmental education of the general public, and must promote the provision of information through various kinds of media. It should also foster human resources for the promotion of separate collection activities and should develop facilities for environmental learning, etc. Also, in order to improve work for public education by local authorities, Adana GM must promote programs, which has to do with environmental education, in towns and cities.

f.1.3 Promoting Training

To effectively promote measures for separate collection experiment, it is necessary to improve and strengthen systems to carry out these measures by continuously fostering human resources to fulfil the role of such promotion in a well-planned manner.

f.2 Environmentally Sound SWM

It is necessary to reduce as much as possible the final amount of waste to be treated in order to minimise waste, by limiting the generation of wastes, promoting the use of recycled resources, and properly disposing of wastes as well as reducing the amount of wastes.

As the issue of waste represents a big problem, which must be solved in order to construct an socio-economic system with reduced environmental load, in addition to limiting the generation of wastes, it will be necessary to reduce waste amounts by promoting the reuse, reduce and recycling of resources.

f.3 Education Program Guideline

Environmental education is given by a number of institutions, organisations and agencies. However, no separate collection system has been globally introduced at the city level and the public is hardly aware of the SWM problems. In order to deepen understanding of the SMW problems and contribute for minimisation and recycling, an education program for the priority projects is guideline consisting of the following elements:

1) The present public education system in Adana GM will offer the basis for the education program proposed. No drastic reforms or changes may be applied for the system, since these require extra governmental expenditure and, at the same time, create unwelcome disorder within the system.

2) Harmonious co-ordination is required among “formal education programs” and “community-base education programs”. This stabilise the ties between government and private sectors, and encourage sustainable SWM improvement in Adana GM.

3) The program should take stepwise deployment onto short, middle and long range targets: the short term program aims to establish a fundamental basement and plays the role of a “booster” for the middle and long term programs off; the middle and long term programs will be an engine of sustainable separate collection improvement.

4) Each roles of relate entities and actors should be clarified both in the co-operative program planning and implementation. The program will provide each entity occasions to practice co-operative actions. This may lead a moderate institutional reform in the field of co-operative SMW improvement.

f.4 Key Approach for Sustainable Development

This approach is consisted of three stages, that is, short range, middle range and long range programs.

Short Range Program: targeting the year 2005

This program identified as a booster for taking off the pilot project. It aims to enhance people’s conscious on separate collection system; introduce co-operative scheme on SWM improvement; renovate former useful programs for SWM and community participation, and offer basic knowledge on separate collection.

Middle Range Program: targeting the year 2010

This second stage booster will enforce and expand the basic ideas and strategy in the former stage bridging toward the next program. Review on the short program will be expected to indicate useful lesson in the next stage.

Long Range Program: targeting the year 2020

The final program wills pursuit to review and estimate impacts of the first and second programs, and establish a harmonious sound SWM system with long span sustainability in total.

f.5 Recommendation to Promote Separate Collection System at the Selected Priority Project Area

Most of householders may have interest to participate in the separate waste collection experiment. Some residents, however, will not be able to take part in waste separation activities for a variety of reasons. But most of the people understand that objectives of waste separation contribute for the better environment and the future of its city.

The followings are simple issues to be considered to promote the experiment:

1) To discuss the idea with the building representatives and doorkeepers. They are familiar with the buildings, its residents and how waste is collected.

2) To find out how garbage is handled now. To verify if each householder required bringing the garbage to a collective waste bin installed at a designated area or floor. If there are containers outside the buildings to store the garbage, etc.

3) To determine what composting and recycling opportunities are available in the area?

4) Design a separate collection and recycling systems that fits into each situation and area. For example, if each householder places their garbage into a waste bin or container, then set up a separate waste bin and container for organic wastes and recyclable materials, providing instructions on what should and should not go into it.

5) To prepare information (e.g., leaflets, pamphlets, etc.) for householders on how the program is to work and why it is important to participate.

6) To launch the program using the building representatives, doorkeepers or internal newsletter to broadcast the program.

7) Monitor the program to make sure everyone knows how to participate properly and receives information on how well they are doing to encourage their continuous co-operation.

8) Adjust the program to take any changes into account.

10.6 Project Evaluation

10.6.1 Technical Evaluation

Technical systems of the priority projects comprise:

1. Introduction of a separate collection system
2. Construction of a sorting plant
3. Construction of a compost plant
4. Construction of Sofulu MSW disposal site
5. Construction of Sofulu medical waste disposal site

The technical evaluation assesses the feasibility of these priority projects, with reference to the present technical capabilities of the target area.

a. Separate Collection System

The introduction of the separate collection system is expected to be difficult as mixed collection is currently practised in the target areas. To overcome this difficulty, separate collection is going to be introduced gradually, first in areas where the system can be easily implemented. In the F/S, areas like GSHC - pilot project area in Mersin - are prioritised and the aim is to disseminate the practice to 30% of the population by 2005.

Based on the pilot project in Mersin, it is concluded that properly explaining the objectives, the methods, and the degree of public co-operation required to the residents would ensure the feasibility of introducing the separate collection system. The pilot project verified the feasibility as non-compostable waste in compostable waste is only less than 10%. By modifying the contents to suit the conditions in Adana GM, the education book produced to promote the pilot project is also an indispensable tool in gaining very effective public participation.

Conclusively, by making full use of the experiences gained from the pilot project in Mersin, the gradual introduction of the separate collection system is very feasible.

b. Sorting and Compost Plant

Adana GM does not have a compost plant and is naturally therefore inexperienced with the aspects, e.g., technology, involved in the construction of one. Mersin, on the other hand, is one of the municipalities in Turkey with some experience in the construction and operation of plants – none of the plants, however, are successfully operated. The sorting facilities that are constructed in some cities are very simple in structure and totally different from what this study proposes. In the planning, design, construction, and operation of the sorting and compost plant, therefore, a fully experienced consultant and plant manufacturer from advanced nations should be contracted on condition that they enter a joint venture with local firms. This would facilitate the transfer of the relevant techniques and know-how to local firms.

With the exclusion of the plastic bag breaker for the sorting plant and the selective crushing separator (SCS) for the compost plant, all relevant equipment can be procured locally, and would therefore eliminate any worries in the acquisition of spare parts and in maintenance. The plastic bag breaker and the SCS will be imported, but since the structure of both equipment is not complex, no problems are foreseen to arise especially with the transfer of techniques required for the operation and maintenance of these equipment using the aforementioned methods. In terms of acquisition of spare parts and maintenance, the setting up of a local agency could overcome any problem.

c. MSW and Medical Waste Disposal Site

The local construction firms are deemed fully capable of developing the MSW and medical waste disposal sites. The disposal sites in Turkey, however, do not fully carry out sanitary landfilling as stipulated by the SWM and Medical Waste Control Regulations of MoE. A consultant from an advanced country that is fully experienced in the planning, design, construction and operation of a sanitary landfill will be contracted and made to work hand in hand with a local firm, also in consideration of technology transfer.

No problems are forecast to arise in the procurement of the equipment necessary for the operation of the MSW and medical waste disposal sites, as all that is necessary are available locally.

10.6.2 Social Evaluation

The priority project would incur various social impacts, however, only the intangible social impacts were evaluated.

Negative Impacts:

- Loss of livelihood for scavengers.
- Rise in cleansing tax rates.

Positive Impacts:

- Improvements in sanitary and public health conditions of the Sofulu dumpsite surrounding area
- Promote investment and tourism.
- Increase in land value.

a. Measures to Mitigate Negative Impacts

a.1 Loss of Livelihood for Scavengers

The priority project proposes to prohibit the entry of unauthorised persons into the disposal site in 2002 for an effective sanitary landfill operation. If this is enforced, this will deprive the scavengers, who work in the dump site, of their livelihood. As for the mitigation measures, Adana GM may request the operator of the sorting plant to hire scavengers as sorting workers.

a.2 Rise in Cleansing Tax Rates

The priority project proposes to raise the present cleansing tax rate and increase the revenue of SWM services to implement the proposed projects. Although this would increase the financial burden of the citizens, the following considerations are taken into account to minimise the negative impacts.

a) To introduce a cross-subsidy mechanism (i.e., the affluent pays for the less well off).

b) To keep the proposed rate below the amount that people are willing to pay (WTP).

c) To keep the proposed rate below 1.0% of the resident's income.

The table below compares these amounts.

Table 10-46: Ratio of Cleansing Tax to Income for Adana GM

	2002	2003	2004	2005
Average annual household income (US$/year)*	8,750	8,880	9,010	9,150
Cleansing tax per household (US$/year)	8.3	15.0	15.1	30.2
Ratio of cleansing tax (%) to income	0.09	0.17	0.17	0.33

Note: * Calculated assuming that the increase is in proportion to the per capita GRDP.

The priority project proposes a cleansing tax rate higher than the amount residents are willing to pay (US$ 8.3/year) assuming that they can afford to pay more as the WTP is far below 1 % of the average income.

b. Positive Impacts

b.1 Improvements in Sanitary and Public Health Conditions of the Sofulu Dumpsite Surrounding Area

The implementation of the project will bring various benefits. The open dumping operation adversely affects Sofulu dumpsite and its surrounding area. Consequently, neighbours frequently complain about these unfavourable conditions, and therefore strongly oppose the use of the site. These negative impacts will considerably be prevented by the implementation of sanitary landfill operations. The implementation of the project, therefore, will improve the sanitary and public health conditions of the Sofulu dumpsite surrounding area, and ease resident opposition to the operation of the disposal site. In particular fire outbreaks, that affect not only the surroundings, but also the city centre, will be eliminated completely.

b.2 Promotion of Investment and Tourism

In addition to the above-mentioned health effects, separate collection, promotion of government related recycling by constructing sorting and compost plants, and the proper disposal of wastes will provide Adana GM with a favourable environment would eventually promote investment and tourism. Since Adana GM is the centre of economic and social activities in the Cukurova region, the improvement of its environment will enhance its image and eventually contribute to attracting more investors and tourists to the area.

b.3 Increase in Land Value

A well managed waste disposal operation will improve the living environment, which in turn will increase the value of the land in the area. A study on the relationship between the living environment and land value suggests that, other factors held constant, housing values rise at an average rate of 6.2 % a mile within a two-mile radius of the landfill, presumably because the environmental and aesthetic problems associated with living near a landfill diminish as distance increases[1]. Thus, the implementation of projects, sanitary landfill operation, etc., increases the land value around the present Sofulu disposal site.

[1] Beede, D.N. and Bloom, D.E. 1995, The Economics of Municipal Solid Waste, The World Bank

10.6.3 Environmental Evaluation

The table below summarises the impacts that are predicted to occur with the implementation of the priority project.

Table 10-47: Summary of the Priority Project Environmental Evaluation for Adana GM

Project	Positive Impacts	Negative Impacts
Separate Collection	• Removal of offensive odour • Improvement in aesthetic conditions • Contributes to the prevention of global warming • Creation of job opportunities	• Increase in traffic ⇒ Air pollution ⇒ Global warming ⇒ Traffic accidents ⇒ Traffic congestion ⇒ Consumption of fossil fuel
Sorting and Compost Plants	• Creation of job opportunities • Soil improvement of farm land • Contributes to global environmental conservation ⇒ Energy saving ⇒ Prevention of air pollution ⇒ Consumption of fossil fuel	• Operation of plants ⇒ Air pollution ⇒ Noise ⇒ Vibration ⇒ Consumption of fossil fuel
Improvement of MSW and Medical Waste Disposal Site	• Improvement of sanitary and public health conditions • Reduction of landfill gas ⇒ Less air pollution ⇒ Contributes to the prevention of global warming • Treatment of leachate ⇒ Control water pollution • Improvement in aesthetic conditions • Increase in land prices • Reduction of public nuisance • Creation of job opportunities	• Increase in equipment ⇒ Air pollution ⇒ Noise ⇒ Vibration ⇒ Consumption of fossil fuel

The introduction of separate collection will generate various significant positive impacts on the target area. These impacts will outnumber the negative impacts that will result from an increase in the use of waste collection vehicles.

Construction and operation of sorting and compost plants will have various significant positive impacts on the target area. This benefit will outnumber the negative impacts that will result from the operation of the plants.

The improvement of the final disposal site will significantly mitigate the existing negative impacts, and outnumber the negative impacts that will result from an increase in the use of heavy landfill equipment.

10.6.4 Financial Evaluation

a. Financial Evaluation Method

Financial evaluation is carried out to determine whether the cleansing service management and financial plan can be realised within the financial capacity of the agency in charge. Since the cleansing services involve several agencies, the evaluation of the financial state of each agency would be difficult. Here, an overall financial evaluation of the cleansing service in the target area, that consists of Adana

GM, Seyhan DM, and Yuregir DM, is carried out in accordance with the conditions shown in the table below.

Table 10-48: Conditions for Financial Evaluation for Adana GM

Agency in charge of cleansing services	Contracting out of waste collection and public area cleansing services to private companies is promoted. However, planning and monitoring should be carried out by the DM. Contracting out of the cleansing of main roads and the operation of the sorting plant, compost plant, and disposal site to private companies is promoted. However, planning and monitoring should be carried out by the GM.
Evaluation Period	Financial evaluation is carried out by calculating the FIRR and preparing the cash flow based on revenues and expenditures from 2000 to 2016 (17 year period).
Revenue	Revenues refer to those gained from: • cleansing tax • budget allocation from general finances of the DMs and the GM • sale of recoverables and compost • tipping fee for direct haulage and medical waste Alternative studies are carried out on the cleansing tax and budget allocation from general finances. The revenue in 2005 will be adopted for the period from 2006 to 2016.
Investment Cost	The following investment costs until 2005 is considered: • introduction of a separate collection system • construction of a sorting plant • construction of a compost plant • development of an MSW disposal site • construction of a medical waste disposal site For collection vehicles and heavy machinery, the life span is set at 7 years, with due consideration of the required renewal cost from 2006 to 2016. For the MSW disposal site, the investment for site renewal used for 2005 is adopted for 2009 and 2013, and the residual cost in 2016 is calculated as the negative investment cost for 2017. Also, for collection vehicles and heavy machinery with a life span exceeding 2015, the residual cost in 2016 is calculated as the negative investment cost for 2017. Alternative studies is carried out for the allocation of the investment cost.
Operation Cost	The estimated cost is adopted until 2005. The expenditures adopted for 2006 to 2016 are as in 2005.
Cut-off Rate	The interest in foreign funds for main projects is currently 4 to 5%. The standard cut-off rate (8%) used by the European Development Bank and World Bank is applied.
Price Increase	The prices for 1998 is adopted in the financial evaluation; price increase is not considered.

b. Case Studies

The following case studies are implemented to determine financial sources for the investment, maintenance, and management costs.

b.1 Cleansing Tax

The problem with the current cleansing tax system is its inability to cope with the increasing SWM costs. This is mainly because of the absence of sufficient feedback due to a lack of clear understanding of the buildings taxed and the SWM expenses. The following three case studies are implemented with regard to the cleansing tax system.

Case Study	Cleansing Tax Rate	Collection Rate	No. of Taxpayers*
CT.1	Maintaining the 1998 tax rate	90% in 2002	cleansing tax for households will increase in proportion to the population; cleansing tax for offices will increase in proportion to the GRDP.
CT.2	The fee in 2005 will be raised by 3.6 times the 1998 tax rate, and the total amount to be collected will be 7.2 times the present amount. (This will cover 50% of the cleansing service expenses including depreciation costs.)	90% in 2002	cleansing tax for households will increase in proportion to the population; cleansing tax for offices will increase in proportion to the GRDP.
CT.3	The fee in 2002 will be raised 3.6 times the 1998 tax rate, and the total amount to be collected will be 7.2 times the present amount. (This will cover 50% of the cleansing service expenses including depreciation costs.)	90% in 2002	cleansing tax for households will be in proportion to the population. Cleansing tax for office will be in proportion to GRDP.

Note: *: number of buildings taxed.

b.2 Allocation from General Financial Source

Although Adana GM receives cleansing tax payments from the DMs, 5% of its finances (municipal budget) is allocated to the cleansing services. The DMs allocate 20% of their revenues, excluding those acquired from the cleansing tax, to the cleansing services. Below are the three case studies implemented with regard to the allocation of budget for SWM.

Case	GM	DM	General Financial Source Growth Rate in Real Terms (Estimate)
MB.1	2.5%	10%	1.3 times the 1998 figure by 2005
MB.2	5%	20%	1.3 times the 1998 figure by 2005
MB.3	7.5%	30%	1.3 times the 1998 figure by 2005

b.3 Investment Fund Allocation

In Turkey, investment funds are either derived from foreign loans or central government subsidies. Municipalities repay foreign loans with interest. For the investment required for SWM, the following two case studies are implemented for 2000 and 2001.

Case Study	OECF Loans*[1]	Government Subsidy
FI-1	75%	25%
FI-2	50%	50%

Note: *[1]: loans are repayable in 25 years, with a 7 year grace period and an interest rate of 2.2%

c. Expenditure Plan

c.1 Overall SWM Costs

The overall SWM cost needed for the implementation of the priority project (target year: 2005) is summarised in the following table.

Table 10-49: Cost Summary of Priority Projects for Adana GM

unit: US$1,000

Items		2000	2001	2002	2003	2004	2005	Total
Investment	Separate Collection	0	1,349	257	193	321	257	2,377
	Sorting Plant	142	2,629	0	0	0	0	2,771
	Compost Plant	263	4,877	0	0	0	0	5,140
	Final Disposal Site	317	6,442	0	25	1,891	6,189*6	14,864
	Medical WDS	91	2,210	0	0	0	0	2,301
	Sub-total	813	17,507	257	218	2,212	6,446	27,453
O & M Costs	Separate Collection	0	0	924	1,100	1,232	1,452	4,708
	Sorting Plant	0	0	378	378	378	378	1,512
	Compost Plant	467*2	467*2	440	440	440	440	2,694
	Final Disposal Site	1,650*3	1,763*3	375	375	375	341	4,879
	Medical WDS	0	0	34	34	34	34	136
	Administration*1	402	423	524	538	549	577	3,013
	Sub-total	2,519	2,653	2,675	2,865	3,008	3,222	16,942
Existing System	Collection & Haulage*4	4,029	4,291	3,468	3,468	3,468	3,468	22,192
	Public Area Cleansing*5	1,888	1,947	2,008	2,072	2,138	2,206	12,259
	Sub-total	5,917	6,238	5,476	5,540	5,606	5,674	34,451
Overall SWM expenses		9,249	26,398	8,408	8,623	10,826	15,342	78,846
Overall SWM costs		8,436	8,891	11,011	11,288	11,522	12,121	63,269

Note: *1: 5% of the overall SWM expenses (inclusive of depreciation cost)
*2: Calculated based on US$32/ton (US$19/ton of the current O&M cost of the compost plant + US$13/ton of depreciation cost)
*3: Calculated based on US$10/ton
*4: Calculated based on US$25/ton
*5: Calculated based on US$221/ton
*6: Modified the investment cost according to the disposal volume after 2006 assumed to be equivalent to the volume of 2005 for the financial evaluation.

The overall SWM cost for 2005, calculated by converting the priority project investment cost into the depreciation cost, is US$12.1 million – double the overall expenses (US$10.7 million) at present.

c.2 Investment Plan

In the financial evaluation, the renewal cost from 2006 to 2016 and the residual value by the end of 2016 are calculated as negative investment costs for 2017. The table below summarises the investment costs for each priority project.

Table 10-50: Investment Costs for Financial Evaluation for Adana GM

unit: US$ 1,000

		2000-2001	2002-2005	2006-2016	Salvaged Value
Investment	Collection & Haulage	1,697	1,488	5,206	-2,111
	Sorting Plant	3,892	0	870	-373
	Compost Plant	7,143	0	2,000	-857
	Final Disposal Site	13,488	11,310	25,690	-6,878
	Medical Disposal Site	1,361	0	1,654	-414
	Total	27,581	12,798	35,420	-10,633

c.2 Cost, Waste Volume, and Collection and Treatment Unit Cost

Using these investment amount as a basis, the following life spans are assumed to calculate the depreciation costs.

- Civil Work 30 years
- Facilities 15 years
- Vehicles and heavy machinery 7 years
- Containers 7 years

The following table summarises the annual expenses inclusive of the depreciation cost and operation cost.

Table 10-51: Annual SWM Costs for Financial Evaluation for Adana GM

unit: US$1,000/year

	2002	2003	2004	2005	2002-2005 average
Collection & Haulage	9,241 (218)	9.488 (260)	9,784 (310)	10,080 (360)	9,648 (287)
Public Area Sweeping	4,017 (0)	4,160 (0)	4,303 (0)	4,449 (0)	4,232 (0)
Sorting Plant	732 (286)	732 (286)	732 (286)	732 (286)	732 (286)
Compost Plant	1,088 (539)	1,088 (539)	1,088 (539)	1,088 (539)	1,088 (539)
Final Disposal Site	3,321 (2,990)	3,321 (2,990)	3,321 (2,990)	3,321 (2,990)	3,321 (2,990)
Medical Disposal Site	195 (172)	195 (172)	195 (172)	195 (172)	195 (172)
Administration*	930	949	971	993	961
Total SWM Works	19,524 (4,205)	19,933 (4,247)	20,394 (4,297)	20,858 (4,347)	20,177 (4,273)

Note: *5% of every SWM cost (total); Figures in the ( ) are depreciation costs.

On the other hand, the collection, treatment, and disposal amount are as shown in the table below.

Table 10-52: Waste Amount for Financial Evaluation for Adana GM

unit: ton/year

	2002	2003	2004	2005	2002-2005 average
Collection & Haulage	327,394	349,641	373,340	398,856	362,308
Public Area Cleansing	21,598	22,364	23,137	23,918	22,754
Sorting Plant	39,785	44,641	48,766	54,538	46,933
Compost Plant	64,912	66,961	70,176	72,294	68,586
Final Disposal Site	286,984	307,593	328,717	352,693	318,997
Medical Disposal Site	1,898	2,008	2,117	2,263	2,072
Total SWM Works*	348,992	372,005	396,477	422,774	385,062

Note: *: collection amount + public area cleansing amount

Based on the above results, the collection, treatment, and disposal unit costs are as shown in table below.

Table 10-53: Unit Costs for Financial Evaluation for Adana GM

unit: US$/ton

	2002	2003	2004	2005	2002-2005 average	Reference Present*
Collection & Haulage	28.2	27.1	26.2	25.3	26.6	24.8
Public Area Cleansing	186.0	186.0	186.0	186.0	186.0	185.6
Sorting Plant	18.4	16.4	15.0	13.4	15.6	0
Compost Plant	16.8	16.2	15.5	15.0	15.9	0
Final Disposal Site	11.6	10.8	10.1	9.4	10.4	0.8
Medical Disposal Site	102.7	97.1	92.1	86.2	94.1	0.8
Total SWM Works*	55.9	53.6	51.4	49.3	52.4	39.2

Note: * average of the unit costs in 1997 and 1998.

c. Revenue Plan

c.1 Cleansing Tax Revenues

Tax collection in district municipalities for household and commercial wastes currently vary considerably. There are discrepancies between the amount collected and the POS results. Here the potential for tax collection is calculated based on the willingness to pay shown by the residents and enterprises in the POS: 197,180 TL or US $8.3/household/year and 466,784 TL or US$19.7/enterprise/year. Because accurate statistics regarding enterprises are not available, the rate used by Yuregir DM for the number of buildings taxed (households: 65,300, enterprises: 9,600) are used.

The study assumes the number of households to increase with the population and the number of enterprises with GRDP. The below shows the cleansing tax collection potential and the revenue plans.

Table 10-54: Revenue Plan (Cleansing Tax) for Adana GM

			1998	2002	2003	2004	2005
Household	Population		1,151,038	1,335,987	1,383,347	1,431,174	1,479,477
	No. of households*		230,208	267,197	276,669	286,235	295,895
	Potential (US$1,000)		1,911	2,218	2,296	2,376	2,456
	Collection rate (%)		-	90.0	90.0	90.0	90.0
	Revenue Plan (US$1,000)	Case CT.1	-	1,996	2,066	2,138	2,210
		Case CT.2		1,996	2,066	2,138	7,956
		Case CT.3		7,186	7,438	7,697	7,956
Commercial	GRDP (billion TL**)		1,034,350	1,269,250	1,332,730	1,399,370	1,469,310
	No. of enterprises		33,844	41,530	43,607	45,787	48,076
	Potential (US$1,000)		-	818	859	902	947
	Collection rate (%)		-	90.0	90.0	90.0	90.0
	Revenue Plan (US$1,000)	Case CT.1	-	736	773	812	852
		Case CT.2		736	773	812	3,067
		Case CT.3		2,650	2,783	2,923	3,067
Total	Case CT.1		1,366**	2,732	2,839	2,950	3,062
	Case CT.2			2,732	2,839	2,950	11,023
	Case CT.3			9,836	10,221	10,620	11,023

Note: * The number of family members per household is assumed to average 5 persons.
** Actual collected amount in 1998 was TL 388,509 million (US$1.00 = TL 284,480)

c.2 Revenues from Sale of Recoverables and Compost

In comparison with the sale of recoverables by scavengers, the introduction of the sorting plant and the compost plant is seen to encourage competitive pricing, as a sizeable amount of recoverables and compost product would be generated.

As shown in the table below, when combined, the sales of recoverables from Sofulu disposal site generated by the scavengers in 1997 and the unit sales price of the middlemen in 1998 produced a unit cost of TL 27.4 million/ton (US$96/ton).

Table 10-55: Amount and Price of Recycled Materials for Adana GM

	Amount	Price	Expected Revenue	
	ton/month (A)	1000 TL/kg or million TL/ton (B)	million TL/month (C=A x B)	US$/month*
Metal	94	18	1,692	5,948
Aluminium	17	200	3,400	11,952
Glass	269	12.5	3,363	11,822
Plastic	125	50	6,250	21,970
PET	54	50	2,700	9,491
Paper	473	23	10,879	38,242
Bone	-	29	-	-
Total	1,032	(27.4)	28,284	99,425

Note: US$1.00 = TL 284,480 is adopted.

Looking at the results of the compost market survey in 1999, the following compost market prices can be expected: TL 5.9 million/ton (US$14.5/ton) for fine compost and TL 2.8 million/ton (US$6.9/ton) for coarse compost. The proposed plant is expected to produce 80% fine compost and is estimated during the financial evaluation to gain a revenue shown in the following table.

Table 10-56: Revenue Plan (Sale of Recoverables and Compost) for Adana GM (2002 -2005)

unit: US$1,000

		2002	2003	2004	2005
Amount (ton/year)	Recycling Material	10,197	11,384	12,406	13,812
	Compost	11,684	12053	12632	13013
Recycling Materials		979	1,093	1,191	1,326
Fine Compost		136	140	147	151
Course Compost		16	17	17	18
Total		1,131	1,250	1,355	1,495

c.3 Revenue from Tipping Fees

The unit cost of US$10.4/ton will be collected from those directly hauling MSW into the disposal site. A tipping fee of US$94/ton will be collected from those directly hauling medical waste into the medical waste disposal site. The following revenues were assumed for the financial evaluation (Table 10-55).

Table 10-57: Revenue Plan (Tipping Fee) for Adana GM (2002-2005)

unit: US$1,000

		2002	2003	2004	2005
Amount (ton/year)	Direct haulage	9,855	10,585	11,315	12,410
	Medical waste	1,898	2,008	2,117	2,263
Direct haulage		102	110	118	129
Medical waste		178	189	199	213
Total		280	299	317	342

c.4 Budget Allocation

Table below shows the municipal budget (excluding cleansing tax) in 2002 to 2005 and the amount allocated from the cleansing service budget specified in every case study.

Table 10-58: Revenue Plan (Budget Allocation) for Adana GM (2002-2005)

		Unit	2002	2003	2004	2005
GM Budget		billion TL*	20,520	21,446	22,417	23,434
		US$1,000*	72,131	75,388	78,801	82,376
DMs Budget		billion TL*	13,401	13,784	14,180	14,590
		US$1,000*	47,106	48,452	49,846	51,288
Budget allocation for SWM	MB.1	US$1,000	6,514	6,730	6,955	7,188
	MB.2	US$1,000	13,028	13,460	13,909	14,376
	MB.3	US$1,000	19,542	20,190	20,864	21,564

Notes: * 1998 Turkish Lira rate was used.
** US$ 1 = 284,480 TL

d. FIRR and Account Balance

d.1 Study on Financial Plan

The FIRR is calculated by assuming a total of 9 cases, 3 each for the cleansing tax and the budget allocation from other sources. The results are as shown in Table 10-57.

Table 10-59: FIRR by Case for Adana GM

Case	Changes in Cleansing Tax	Allocation from Municipal Tax	FIRR	Benefit/Cost Ratio under a Cut-off Rate of 8%
1-A	CT.1	MB.1	N/A	0.4493
1-B		MB.2	N/A	0.7179
1-C		MB.3	6%	
2-A	CT.2	MB.1	N/A	0.6614
2-B		MB.2	4%	
2-C		MB.3	16%	
3-A	CT.3	MB.1	N/A	0.7459
3-B		MB.2	8%	
3-C		MB.3	21%	

The case 2-C (3.6 times increase in cleansing tax in 2005 and 1.5 times budget allocation from municipal revenues in 2002), 3-B (3.6 times increase in cleansing tax in 2005 and maintain present budget allocation rate from municipal revenues) and 3-C (3.6 times increase in cleansing tax and 1.5 times budget allocation from municipal revenues in 2002) will generate an FIRR exceeding the cut-off rate.

Although still under the cut-off rate, 1-C (maintaining the 1998 tax cleansing rate and 1.5 times increase in budget allocation from municipal revenues in 2002) shows the highest FIRR of the case studies, at 6%.

d.2 Study on Investment Fund Allocation

For the 2 case studies with a positive FIRR that is also lower than the cut-off rate, the investment funds for 2000 ~ 2001 were determined by calculating the FIRR of FI-1 (25% of the investment by government subsidy) and FI-2 (50% of investment by government subsidy).

- Case 1-C (CT.1 - MB.3)

  Implement a 1.5 times increase in the SWM budget allocated from the municipal tax revenue without increasing the cleansing tax.

- Case 2-B (CT.2 - MB.2)

  Raise the cleansing tax in 2005 but maintain the present SWM budget.

- Case 3-B (CT.3 - MB.3)

  Raise the cleansing tax in 2002 but maintain the present SWM budget (rate allocated from municipal revenues).

The results are as shown in table below.

Table 10-60: FIRR by Investment Funding for Adana GM

Case	Combination	FIRR
Case1-C-I	CT.1 - MB.3 - FI.1	8%
Case1-C-II	CT.1 - MB.3 - FI.2	10%
Case2-B-I	CT-2 - MB-2 - FI.1	5%
Case 2-B-II	CT-2 - MB-2 - FI.2	7%

The scenario proposed in Case 1-C is clearly seen to have an FIRR higher than the cut-off rate if more than 25% of the investment is subsidised by the government.

e. Sensitivity Analysis

In view of the financial state of the Turkish government, subsidising half of the investment required by Adana for the 2000 - 2001 period is considered difficult even if the amount required is only US$ 14 million. Here, sensitivity analysis is carried out on the rise and fall of revenue and expenditure for Case 1-C (maintaining the 1998 cleansing tax rate and increase the budget allocated from municipal tax revenue to 1.5 times the present rate). The results of the analysis are as shown in the following table.

Table 10-61: Sensitivity Analysis for Case 1-C for Adana GM

unit: %

	Expenditure					
Revenue		- 10%	- 5%	0%	+ 5%	+ 10%
	- 10%	6	3	0	-4	N/A
	- 5%	10	6	3	0	-4
	0 %	12	9	6	3	0
	+ 5%	15	12	9	6	4
	+ 10%	18	15	12	9	6

The results confirm that in order to surpass the opportunity costs, a 5% increase in the revenues or a 5% decrease in the expenditures should be incurred.

f. Financial Evaluation

The results of the aforementioned studies gave a clearer understanding of the following issues.

- Case CT.1

  This case scenario, which intends to maintain the present rate in cleansing tax rate, is considered financially feasible if the rate of the SWM budget (MB.3) to be allocated is 1.5 times the present rate and more than 25% of the investment fund for 2000 - 2001 is subsidised by the government (FI.1 and FI.2)

- Case CT.2

  This case scenario, which intends to more than triple (3.6) the 1998 cleansing tax rate in 2005, is considered financially feasible if the rate of the SWM budget (MB.3) to be allocated is 1.5 times the present rate.

- Case CT.3

  This scenario which intends to more than triple (3.6) the 1998 cleansing tax rate in 2002, is considered feasible if the SWM budget maintains present budget allocation rate (MB.2) or to be allocated is 1.5 times the present rate (MB.3).

Based on the above results, the following table showing the financially feasible SWM cases was prepared.

Table 10-62: Financially Feasible Cases for Adana GM

	Cleansing Tax* (CT)	Budget Allocation (MB)	Investment Funding (FI)	Cost Reduction
R1	more than triple (3.6) the present rate in 2002. (CT.3)	1.5 times the budget allocation rate from the municipal tax. (MB.3)	no government subsidy	none
R2	more than triple (3.6) the present rate in 2005. (CT.2)	1.5 times the budget allocation rate from the municipal tax. (MB.3)	no government subsidy	none
R3	more than triple (3.6) the present rate in 2002. (CT.3)	maintain present budget allocation rate from municipal tax. (MB.2)	no government subsidy	none

	Cleansing Tax* (CT)	Budget Allocation (MB)	Investment Funding (FI)	Cost Reduction
R4	maintaining the 1998 tax rate (CT.1)	1.5 times the budget allocation rate from the municipal tax. (MB.3)	government subsidy for more than 25% of investment required in 2000 - 2001 (FI.1 and FI.2)	none
R5	maintaining the 1998 tax rate (CT.1)	1.5 times the budget allocation rate from the municipal tax. (MB.3)	no government subsidy	-5%

Note: all cases target a collection rate of 90% in 2002.

This study recommends R1, which is the attainment of a 90% cleansing tax collection rate by 2002, along with ensuring the collection of a cleansing tax amount that would provide 50% of the needed funds for the cleansing services, including the depreciation cost. Accordingly, there is a need to either implement more than 5% reduction in the expenses by contracting out the services and properly managing the administration cost, or secure government subsidy for more than 25% of the required investment cost.

g. Implementation Plan Study

g.1 Issues on the Implementation Plan

The most significant issue in the formulation of the implementation plan is who will shoulder the increase in the SWM costs and how. Although the cleansing tax will be ultimately used to cover 100% of the cost, a phased development is required.

The results of the financial evaluation of the priority project recommends raising the collection rate of the cleansing tax to 90% by 2002 and the collection of an amount that would provide 50% of the amount required to cover the SWM costs (including depreciation cost). In reality, however, this is not easy to attain. As seen in most countries, a price increase of 3.6 times in real terms easily generates social unrest. Further, the proposed government subsidy for 50% of the investment in 2000-2001 is considered difficult in view of the current financial state of the nation. Accordingly, the following phases are considered in the study on the implementation plan.

Phase 1:

Realise the collection of 90% of the cleansing tax by 2001; secure a foreign loan with low interest. (Secure government subsidy for the domestic expenses to be incurred.)

Phase 2:

Raise the cleansing tax 1.8 times in real terms in 2003; raise 1.1 times the allocation rate from the municipal budget for cleansing services.

Phase 3:

Further raise (double in real terms) the cleansing tax in 2005, aiming to provide 50% of the SWM cost (inclusive of depreciation cost).

g.2 FIRR Calculation and Study on Residents' Share of the Cost

g.2.1 FIRR Calculation

After increasing the collection rate by 2001, the cleansing tax will be raised gradually, 1.8 times in real terms in 2003 and twice in real terms in 2005. With this as a premise, a combination of case studies based on the financial evaluation results were carried out on the rate to be allocated from municipal tax revenues and the government subsidy (in percentage). The case studies are as shown below (4 x 3 = 12 cases).

Table 10-63: Case Studies for the Implementation Plan for Adana GM

Financial Resource	Case	Allocation Rate
Municipal tax revenues (MB)	MB.a	1.05 times
	MB.b	1.1 times
	MB.c	1.15 times
	MB.c	1.2 times
Government subsidy (F.1)	FI.a	20%
	FI.b	25%
	FI.c	30%

The results of the calculation are as shown in the following table.

Table 10-64: FIRR by Implementation Plan Case Studies for Adana GM

Government Subsidy Rate Rate of allocation from Municipal Tax Revenues	FI.a (20%)	FI.b (25%)	FI.c (30%)
MB.a (1.05 times)	7.0%	7.4%	7.7%
MB.b (1.1 times)	8.3%	8.7%	9.0%
MB.c (1.15 times)	9.5%	9.9%	10.3%
MB.d (1.2 times)	10.7%	11.1%	11.4%

As shown in the table, raising the rate allocated from municipal tax revenues to 1.1 times would ensure the feasibility of the project even if only a 20% subsidy can be obtained from the government.

g.2.2 Residents' Share

Although nothing is clearly known about the average household income from 1994 onwards, this is assumed at US$8,280 in 1998 (1.3 times the 1994 figure) in consideration of the growth in Turkey's economy. The following table shows how increasing the cleansing tax in real terms in 2003 and 2005 would affect the residents.

Table 10-65: Changes in Residents' Share for Adana GM

	2002	2003	2004	2005
Average annual household income (US$/year)*[1]	8,750	8,880	9,010	9,150
Cleansing tax per household (US$/year)	8.3*[2]	15.0	15.1	302.2
Ratio of cleansing tax (%) to income	0.09	0.17	0.17	0.33

Note: *1: Calculated assuming that the increase is in proportion to the per capita GRDP.
*2: Willingness to pay from POS

As far as the ratio of the cleansing tax to the annual income is concerned, the two gradual steps proposed for price increase will not have a significant impact.

g.3 Balance in Revenue and Expenditure

Of the case studies, the cash flow of the recommended case, MB.b - FI.a (1.15 increase in the allocation rate from the municipal tax; 20 % government subsidy), was prepared as shown in the table below.

Although this case would incur a financial deficit until 2002, covering the overall cleansing service expenses (inclusive of depreciation cost) would be possible. Consequently, a reserve of US$ 9 million can be gained by the end of 2005 making it possible to cover the renewal costs after 2006.

g.4 Actualisation of the Implementation Plan

The phased appreciation of the cleansing tax clearly confirms the feasibility of the implementation plan. However, the following points regarding the financial system should be improved to actualise the plan.

- Improvement of cleansing tax collection rate
- Reconsideration of cleansing tax fee (rate)

g.4.1 Improvement of Cleansing Tax Collection Rate

Aiming for a 90% cleansing tax collection rate would significantly require not only the establishment of a solid financial base, but also the implementation of the beneficiary pays principle. Most of the residents discharge their own waste, while most of the households receive the waste collection, treatment, and disposal services. At present the number of buildings subject to the cleansing tax is not systematically identified. To discourage cleansing tax evasion, cleansing tax should be billed jointly with the real estate tax.

g.4.2 Reconsideration of Cleansing Tax Fee

The cleansing tax is reviewed yearly but still is not enough for the ever increasing cleansing service costs. The waste discharge characteristics cannot be reflected in the tax due to the standardisation of the tax amount. It is, therefore, important to study the discharge conditions in households and offices to adopt a suitable tax amount. Cross subsidy should also be considered for households.

Table 10-66: Cash Flow of the Recommended Case (MB.b - FI.a)

unit: US$ 1,000

Cash Flow

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
a.	Cash-in																		
a.1	Finance																		
	Grant	324	5,192																5,516
	Loan	3,080	23,120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26,200
	Long Term Loan	1,295	20,770	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22,065
	Short Term Loan	1,785	2,350	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4,135
	Finance Total	3,404	28,312	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31,716
a.2	Revenue																		
	Cleansing Tax	2,049	2,390	2,732	5,112	5,310	11,023	11,023	11,023	11,023	11,023	11,023	11,023	11,023	11,023	11,023	11,023	11,023	149,869
	Budget Allocation	12,213	12,612	13,028	14,806	15,300	15,814	15,814	15,814	15,814	15,814	15,814	15,814	15,814	15,814	15,814	15,814	15,814	257,722
	Recycling materials	126	63	979	1,093	1,191	1,326	1,326	1,326	1,326	1,326	1,326	1,326	1,326	1,326	1,326	1,326	1,326	19,364
	Compost	0	0	152	157	164	169	169	169	169	169	169	169	169	169	169	169	169	2,501
	Direct haulage	0	0	102	110	118	129	129	129	129	129	129	129	129	129	129	129	129	1,878
	Medical waste	0	0	178	189	199	213	213	213	213	213	213	213	213	213	213	213	213	3,122
	Revenue Total	14,388	15,065	17,171	21,467	22,282	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	434,456
	Cash-in Total	17,792	43,377	17,171	21,467	22,282	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	466,172
b.	Cash-out																		
b.1	Investment	1,619	25,962	324	388	544	11,542	0	0	5,164	12,450	388	388	388	11,154	0	5,164	324	75,799
b.2	Expenditure																		
	O&M Cost	16,173	17,235	15,319	15,686	16,097	16,511	16,511	16,511	16,511	16,500	16,500	16,500	16,500	16,500	16,500	16,500	16,500	278,554
	Interest	0	180	714	514	514	514	514	514	487	460	433	406	379	352	325	298	271	6,875
	Expenditure Tota	16,173	17,415	16,033	16,200	16,611	17,025	17,025	17,025	16,998	16,960	16,933	16,906	16,879	16,852	16,825	16,798	16,771	285,429
b.3	Repayment	0	0	0	0	0	0	0	1,226	1,226	1,226	1,226	1,226	1,226	1,226	1,226	1,226	1,226	12,260
	Cash-out Total	17,792	43,377	16,357	16,588	17,155	28,567	17,025	18,251	23,388	30,636	18,547	18,520	18,493	29,232	18,051	23,188	18,321	373,488
c.	Reserved Fund (a.-b.)	0	0	814	5,693	10,820	10,927	22,575	32,998	38,283	36,321	46,448	56,601	66,782	66,223	76,846	82,332	92,684	92,684

Table 10-67:Profit and Loss Statement

unit: US$ 1,000

Profit and Loss Statement

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Total
a.	Revenue	14,388	15,065	17,171	21,467	22,282	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	28,674	434,456
b.	Cost																		
b.1	Expenditure	16,173	17,415	16,033	16,200	16,611	17,025	17,025	17,025	16,998	16,960	16,933	16,906	16,879	16,852	16,825	16,798	16,771	285,429
b.2	Depreciation	0	0	4,205	4,247	4,297	4,347	4,347	4,347	4,347	4,130	4,124	4,124	4,124	4,124	4,124	4,124	4,124	63,135
	Cost Total (b.1+b.2)	16,173	17,415	20,238	20,447	20,908	21,372	21,372	21,372	21,345	21,090	21,057	21,030	21,003	20,976	20,949	20,922	20,895	348,564
c.	Profit and Loss (a.-b.)	-1,785	-2,350	-3,067	1,020	1,374	7,302	7,302	7,302	7,329	7,584	7,617	7,644	7,671	7,698	7,725	7,752	7,779	85,892

10.6.5 Economic Evaluation

a. Economic Evaluation Method

The economic evaluation is carried out to determine the necessity of the project in view of present national economic conditions. Because environmental benefits are difficult to quantify, the economic evaluation is mostly limited to cost minimisation methods and qualitative evaluation. With resource-recovery and disposal site cost reduction as the benefits that can be expected from the introduction of an intermediate treatment facility, a comparison is carried out between costs and benefits of a project that involves (*with-project*) and does not involve (*without-project*) the introduction of such facility.

In this study, the proposed project characteristics are as follows:

- Promote resource recovery and reduction of disposal amount through the construction of a sorting plant and compost plant.
- Introduce separate collection to improve compost quality.

Taking the above into consideration, the evaluation of the project is carried out as follows.

Table 10-68: Economic Evaluation Method for Adana GM

	Collection & Public Area Cleansing	Intermediate Treatment	Final Disposal
Evaluation Method	Qualitative Evaluation	Quantitative Evaluation (Cost-benefit Analysis) Qualitative Evaluation	Qualitative Evaluation
Evaluation Period		17 years (2000-2016)	

The benefits and costs for quantitative evaluation are as shown in the table below.

Table 10-69: Benefits & Costs for Adana GM

	Intermediate Treatment
Benefits (B)	• Resource recovery (recoverables and compost) • Reduced disposal cost • Reduced haulage cost • Effective land use
Costs (C)	The following were converted into economic cost: • Investment cost for and O&M cost of separate collection • Investment cost for and O&M cost of sorting plant • Investment cost for and O&M cost of compost plant
Evaluation Standard	EIRR > 8%

The benefits and O&M costs in 2005 will be used for 2006 - 2016. As in the financial evaluation, the investment required for renewal is considered for investment cost. In addition, the salvage value in 2016 is calculated as the negative cost in 2017.

b. Benefits

b.1 Resource Recovery

The benefits from resource recovery are calculated using the sales price of recyclables and compost. The price is the unit price used in the financial analysis.

Table 10-70: Benefits from Recoverables and Compost for Adana GM

unit: US$1,000

Item		Unit Price (US$/ton)	2002	2003	2004	2005
Recycling materials		96.0*	979	1,093	1,191	1,326
Compost	Fine	14.5*	136	140	147	151
	Coarse	6.9*	16	17	17	18

Note: * In view of global environmental preservation, this value is considered to be underestimated due to the connection between recycling and energy-saving measures.

b.2 Reduced Disposal Cost

The benefit from a reduced disposal cost was calculated at US$13.5/ton, the unit price for disposal in Sofulu disposal site in 2002-2005.

Table 10-71: Benefits from Reduced Disposal Cost

Item	Unit	2002	2003	2004	2005
Waste Reduction	ton/year	36,015	36,962	38,380	38,614
Benefit (US$ 1,000)	US$ 13.5/ton	486	499	518	521

b.3 Reduced Haulage Cost

Sofulu disposal site is 10 km from the city of Adana. A site to replace Sofulu could not be found within a 20km radius from the city. If resource recovery will not successfully reduce the disposal amount, collection efficiency drops as this waste amount should be disposed of at a site located more than 10km further than Sofulu.

- Hauling waste to a disposal site 10km further results in a haulage efficiency of 23.3 ton/day/truck. In contrast, a disposal site located 20km away would result in a haulage efficiency of only 17.5 ton/day/truck, consequently generating a 33% increase in haulage expenses.

  23.3 ton ÷ 17.5 ton = 1.33

- A decline in efficiency results in the following increase in collection and haulage costs:

  US$30/ton x 0.33 = US$10/ton

The benefits from reduced haulage costs resulting from a reduction in disposal amount are as shown in the table below.

Table 10-72: Benefits from Reduced Haulage Costs for Adana GM (2002-2005)

Item	Unit	2002	2003	2004	2005
Waste Reduction	ton/year	36,015	36,962	38,380	38,614
Transportation Cost Reduction	US$1,000	360	370	384	386

b.4 Effective Land Use

The reduction in disposal amount would lead to the need for a smaller disposal site.

- For the landfill area and capacity targeted for the Sofulu disposal site, reductions in the disposal site space required means the acquisition of 96m^2 for every 1,000 ton of waste.
- If the reduction in disposal amount after 2006 is considered equivalent to 2005, the reduction in the disposal amount within a 15 year period (2002-2016) will total 574,730 ton.
- Consequently, 5.5ha of the site can be used for other purposes.

  574,730 ton x 96m^2/1,000 ton/10,000m^2 = 5.5ha
- Wheat production in Turkey averages 2,000kg/ha and is sold by farmers for US$180/ton. Consequently, the extra space (from the 5.5ha) will be converted into a wheat field that is expected to generate a sales of US$360/ha per annum.
- The extra space (from the 5.5 ha) is expected to generate a yearly wheat sales of US$1,986.

  5.5ha x US$360 = US$1,986

Table 10-73: Land Use Benefits for Adana GM (2002-2005)

Item	Unit	2002	2003	2004	2005
Land Use	ha	8.2	8.2	8.2	8.2
Land use	US$1,000	2	2	2	2

c. Cost

The following rates are used for conversion of market prices into economic prices, with due consideration of the value added tax rate (15%), income tax rate (personal: 20%; corporate: 25%), income of farmers (72% of the urban working households).

Table 10-74: Conversion Rates for Economic Evaluation for Adana GM

Items			Conversion rate	Remarks
Investment	Vehicles, heavy equipment		0.825	VAT15%, income tax 2.5%
	Plant		0.818	Combination of personnel cost and materials
	Civil work		0.608	Combination of personnel cost and materials
O&M cost	Personnel	Skilled	0.800	Income tax 20%
		Unskilled	0.580	Skilled cost x 72%
	Service		0.741	Combination of personnel cost and materials
	Fuel		0.768	VAT15%, Fuel consumption tax 7.2%, Income tax 1%
	Other materials		0.840	VAT15%, Income tax 1%

The investment costs converted into economic prices are summarised in the following table.

Table 10-75: Investment Costs for Economic Evaluation for Adana GM

unit: US$1,000

		1999-2001	2002-2005	2006-2016	Salvaged Value
Investment	Collection & Haulage*	420	368	1,288	-522
	Sorting Plant	3,044	0	718	-308
	Compost Plant	5,590	0	1,650	-707
	Total	9,054	368	3,656	-1,537

Note: * The introduction of containers and the standardisation of collection vehicles would increase collection service efficiency. Not considering improvements in collection efficiency, 30% of the cost involved in the introduction of the separate collection system is considered.

The O&M costs by year converted into economic prices are as shown in the following table.

Table 10-76: O&M Costs for Economic Evaluation for Adana GM

unit: US$1,000

	2002	2003	2004	2005
Collection & Haulage*	230	274	327	380
Sorting Plant	310	310	310	310
Compost Plant	414	414	414	414
Total	954	998	1,051	1,104

Note: * The introduction of containers and the standardisation of collection vehicles would increase collection service efficiency. Not considering improvements in collection efficiency, 30% of the cost involved in the introduction of the separate collection system is considered.

b. EIRR Calculation Results

Based on the above benefits and costs the EIRR is calculated at 6 %.

The benefits from resource recovery are considered to include various improvements in global environmental issues, e.g., reduction of CO_2 levels in the atmosphere.

Therefore, various issues will need to be addressed if the benefits are evaluated in terms of market price.

If the benefits are evaluated as 1.2 times, the EIRR would be calculated as 10 %, which over the cut-off rate 8 %.

c. Qualitative Evaluation

c.1 Intermediate Treatment

Only a few of the benefits were subjected to quantitative evaluation. The established evaluation standards, however, cannot be met with only the benefits quantitatively measured.

As awareness of the importance of global environmental preservation intensifies world-wide, the effects of resource recovery through the construction of a sorting plant and a compost plant would widely surpass the benefits quantitatively measured.

The following are also some of the effects that is considered to result from resource recovery:

- Soil conditioning by compost utilisation
- Generation of jobs from the operation of the sorting plant
- Improvements in resource recovery activities
- CO_2 reduction due to energy conservation

In view of these impacts, therefore, the need to implement the proposed priority project is fully justified.

c.2 Collection and Public Area Cleansing

The need to promptly remove the waste from the urban area is fully acknowledged and is the premise for the operation of the cleansing service and cleansing tax collection system. Some of the positive impacts this action is foreseen to bring about are as follows:

- Secure urban public health and sanitation (control the generation of vermin and rodents; prevent the occurrence of contagious diseases)
- Prevent canal clogging and traffic congestion
- Secure pleasant environment (prevent the generation of offensive odour; improve landscape)
- Encourage smooth conduct of economic activities and develop the tourism industry

c.3 Final Disposal

The adequate final disposal of hauled waste prevents the occurrence of adverse environmental impacts.

The improvement of the present Sofulu disposal site is foreseen to have the following impacts:

- Improvement in public health and environment around the disposal site
- Prevention of leachate runoff to outer areas by adopting the circulation process
- Reduction in haulage cost

To counter-act any risk that may result from the handling or unexpected contact with contagious materials, the development of a medical waste disposal site is of extreme importance. This undertaking will not meet any opposition as this would actually contribute to eliminating the fears and worries of the surrounding residents.

Based on the above qualitative evaluation, the priority project is deemed feasible.