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INTEGRATED SPATIAL PLAN
FOR
THE MAMMINASATA METROPOLITAN AREA

IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT

Pre-Feasibility Study (2)

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1. INTRODUCTION

1.1 Current Condition and Identified Issues

The volume of waste scattered along roads, rivers and canals is currently increasing in the Mamminasata metropolitan area, especially in the center of Makassar due to insufficient environmental protection. Improvement of solid waste management (SWM) is therefore a serious issue to be addressed in order to develop a harmonized and the eco-friendly Mamminasata metropolitan area. The master plan (M/P) of the solid waste management in Mamminasata area has been prepared and is presented in the Chapter on "Urban Infrastructure Development" and in the Sector Study Report (10), "Solid Waste Management Study".

(1) Waste Flow

The solid waste generated in Makassar, Gowa, Maros and Takalar is transported to each city or regency's landfill site by arm roll vehicles or tippers. Some of the waste generated in Gowa is transported to Tamangapa landfill site in Makassar. The current waste stream in Mamminasata area is summarized in Figure 1.1.

(2) Identified Issues

The major issues to be addressed in SWM in the Mamminasata area are summarized as follows.

i) Scattering Solid Waste in Public Spaces

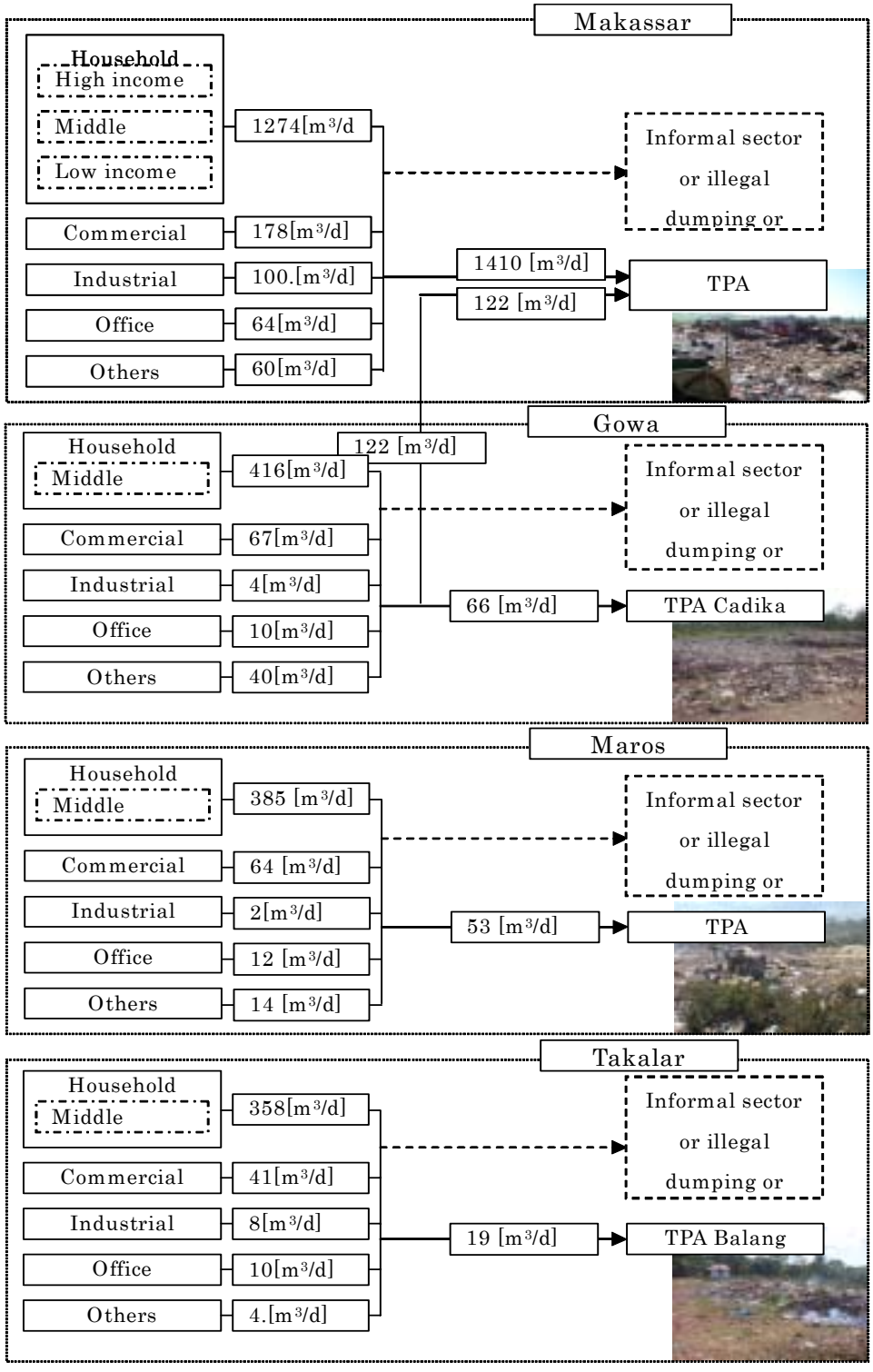
Even though street sweepers clean the main roads in The Mamminasata area there is a lot of scattering of solid waste disposed of into ditches and drains causing a number of environmental and sanitary problems. One of the reasons, especially in the area along the narrow roads, is that the local authorities cannot provide an adequate solid waste collection service.

ii) Scattering Solid Waste in Temporary Disposal Sites (TPSs)

Solid waste is scattered outside of containers, which is located in TPSs or in TPSs. There have been times when some TPSs operated without hauled containers though there have been containers in use at other times. There are no containers in use when armroll vehicles transport the collected waste to a landfill site. Then, some people tend to dispose of solid waste where the container should be located, because there is no container available. As a result, scattering waste appears here and there.

iii) Over Capacity and Unsanitary Operation at Landfill Sites

There is a lack of capacity remaining at the existing landfill sites in The Mamminasata area, especially in Makassar. Though estimated remaining years is approximately three to four years. Furthermore, due to no sufficient embankment, a part of the received solid waste is disposed of in the area where waste has not been protected by embankment. The daily cover soil required to prevent scattering of waste, to mitigate odors and minimize vermin is not being applied at the landfill sites. Leachate infiltrates through the solid waste layer to the groundwater due to there being no liner system at the sites. This causes environmental problems for the surrounding areas. Improvement of leachate collection and treatment, and implementation of daily cover soil, are needed to secure the capacity of the landfill site.



Source: JICA Study Team

Figure 1.1 Waste Flow in the Mamminasata area[1]

[1] Others includes street waste and medical waste

1.2 Countermeasure on Significant Issue

In the Master Plan study, the identified major issues were (i) scattering of solid waste in surrounding areas such as public spaces and TPSs, and (ii) the lack of remaining capacity at existing landfill sites in The Mamminasata area, especially Tamangapa landfill site for Makassar and Gowa. Of these, with respect to having a secure waste stream in the near future, the lack of remaining capacity at existing landfill sites is the most critical issue. This is especially so at Tamangapa landfill site, the current landfill site in Makassar city, which has only three to four years remaining capacity. Gowa also utilizes Tamangapa landfill site due to lack of the capacity and the landfill equipment in the landfill site in Gowa. On the other hand, the landfill sites in Maros and Takalar have potential capacity for more than a few years and also have the area for possible extension in the future. The existing condition of the landfill sites in The Mamminasata area is summarized as follows.

Table 1.1 Condition of Current Landfill Sites

		Makassar	Gowa	Maros	Takalar
Location		Tamangapa Kec. Manggala	Cadica Kec. Plangga	Bontoramba Desa Bonto Matene Kec. Mandai	Balang Kec. Polombangkeng Selatan
Beginning year		1993	1997	1997	About 1985 -
Expected remaining life-time		3 to 4 years[2]	5 to 6 years	5 to 10 years	5 to 10 years
Area		14.3 ha	2.0 ha	2.8 ha	2.8 ha
Operation	Soil covering	Covering soil but not consistently	No soil covering	No soil covering	Covering soil but not consistently
Equipment	Bulldozer	4	1	0	(0)[3]
	Wheel loader	0	0	2	(0)
	Excavator	1	0	1	(0)
Facility	Office	1	1	1	1
	Leachate pond	1 (not operated properly)	0	0	0
	Gas vent system	1	0	0	0
Activity by waste pickers	Number of waste pickers	178	10	20	8

Source: Cleansing departments in Makassar, Gowa, Maros and Takalar

[2] Remaining year of landfill sites is estimated with the assumption of implementation of sufficient daily cover soil

[3] It means that the equipment is sometimes rent when needed

The fact that the existing Tamangapa site has only three to four years of remaining useful life for landfill will cause significant problems for the solid waste management systems in Makassar and Gowa. It usually takes more than three to four years to construct new landfill sites. Only three to four years of remaining life will cause significant problems if no appropriate countermeasures for waste disposal taken during three to four years to come. Though the extension of existing landfill site may be one of the options, the Tamangapa landfill site is limited in available land for extension because the housing estate is developed in the surrounding area. The Cadica landfill site in Gowa is not sufficient for available areas to extend the landfill site. The location of landfill sites in Maros and Takalar will not be suitable for Makassar and Gowa. Therefore, new landfill site after the Tamangapa landfill site should be prepared in the location with consideration of collection areas of Makassar city and Gowa regency, including other regencies in the future.

1.3 Target Area and Site Selection

The concept of the Mamminasata spatial plan illustrates several principle concepts for the creation of the future Metropolitan, such as “To create a dynamic and harmonized Metropolitan area along with the preservation of the environment and the enhancement of amenities throughout the Mamminasata area” or in the catch phrase such as “Clean, Creative and Coordinated Metropolitan Mamminasata”. For the selection of the location for a new landfill site, after these concepts, inter regional cooperation with a close working relationship for public service is indespensable. Therefore, an inter-regional landfill site in the Mamminasata metropolitan area is required and agreed for realization under the inter-regional cooperation in Mamminasata.

Four alternative sites for the new landfill for Makassar and Gowa were studied comparatively in compliance with the National Standard Indonesia SNI 03 -3241 (1994) “Procedure for Selection of Landfill Site Location” and with the surrounding land use plan of Gowa and Makassar government and the recommendation of both government. The assessment result for alternative sites is summarized in following table.

Table 1.1 Condition of Current Landfill Sites

Location	Tammangapa	Bajeng	Samata	Pattallassang
Transportation Distance from collection area in Makassar	A (Approximately 15 km away from center of Makassar)	C (Approximately 40 km away from center of Makassar)	B (Approximately 20 km away from center of Makassar)	C (Approximately 40 km away from center of Makassar)
Location restrictions (Airport)	A (Far away from airport)	A (Far away from airport)	A (Far away from airport)	A (Far away from airport)
Location restrictions (Flood plain)	B (Not so near from flooding area)	B (Not so near from flooding area)	B (Not so near from flooding area)	A (Not so near from flooding area and upper field)
Location restrictions (Faults)	NA	NA	NA	NA
Land capacity (Capacity)	C (Not so much capacity)	B (approximately 8ha)	A (approximately 150ha)	A (approximately 50ha)
Site Access	A (there is access road now)	B (there is access road now though the road condition is not so good)	B (There is no access road near the proposed site.)	C (There is no access road near the proposed site and long transportation distance from collection areas)
Soil conditions	A (paddy clay: permeability 5 x 10-5 to 8 x 10-6cm/sec for depth 1.5m to 2m, loose sand layer, black soft clay layer ,etc)[4]	B	A (paddy clay: permeability 5 x 10-5 to 8 x 10-6cm/sec for depth 1.5m to 2m, loose sand layer, black soft clay layer ,etc)	B
Topography	A	A	B	A
Hydrology	B	C	B	A
Technical feasibility	B	B	A	B
Natural environment	B	B	B	A
Social environment	C (Opposition from local residents)	C (Though opposition from local residents, explanatory meeting for public is periodically prepared)	D (Opposition from local residents)	B (Not so many residents in near the landfill site and little negative response currently)
Ranking	2	4	3	1

Note: A to D mean favorable to less favorable. N.A. means not available.

[4] The information is based on JICA Study "Master Plan and Feasibility Study on Wastewater and Solid Waste Management for the City of Ujung Pandang in the Public of Indonesia" (1996)

The site selection was made taking into account the location distance (not far from Makassar and the central part of the Mamminasata area), land availability (according to the regional government, Gowa Regency) and environmental considerations. The site was finally agreed with Gowa government and relevant stakeholders in Mamminasata.

The selected site is Panaikang village in Pattallassang district in Gowa Regency which is 20 to 30km from the centre of Makassar, which is part of a newly planned industrial estate in Gowa.

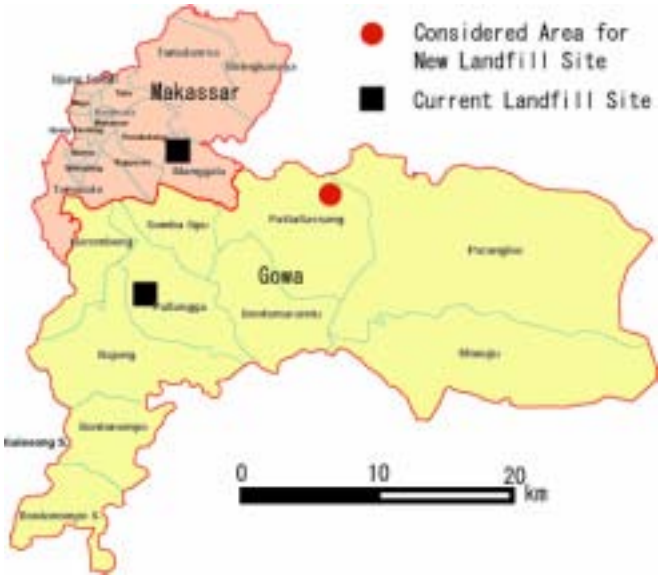


Figure 2.4 Location of New Landfill Site

The available area for a landfill site, including all the facilities, is approximately 210ha, including an industrial estate, according to Gowa at this moment. The planned sanitary landfill site can contribute to the promotion for the introduction of industries which generate non-hazardous waste, especially recycling industries which can utilize separated waste from such as plastic, paper, cans, and bottles the sanitary landfill site in the future.

1.4 Objectives of the Project

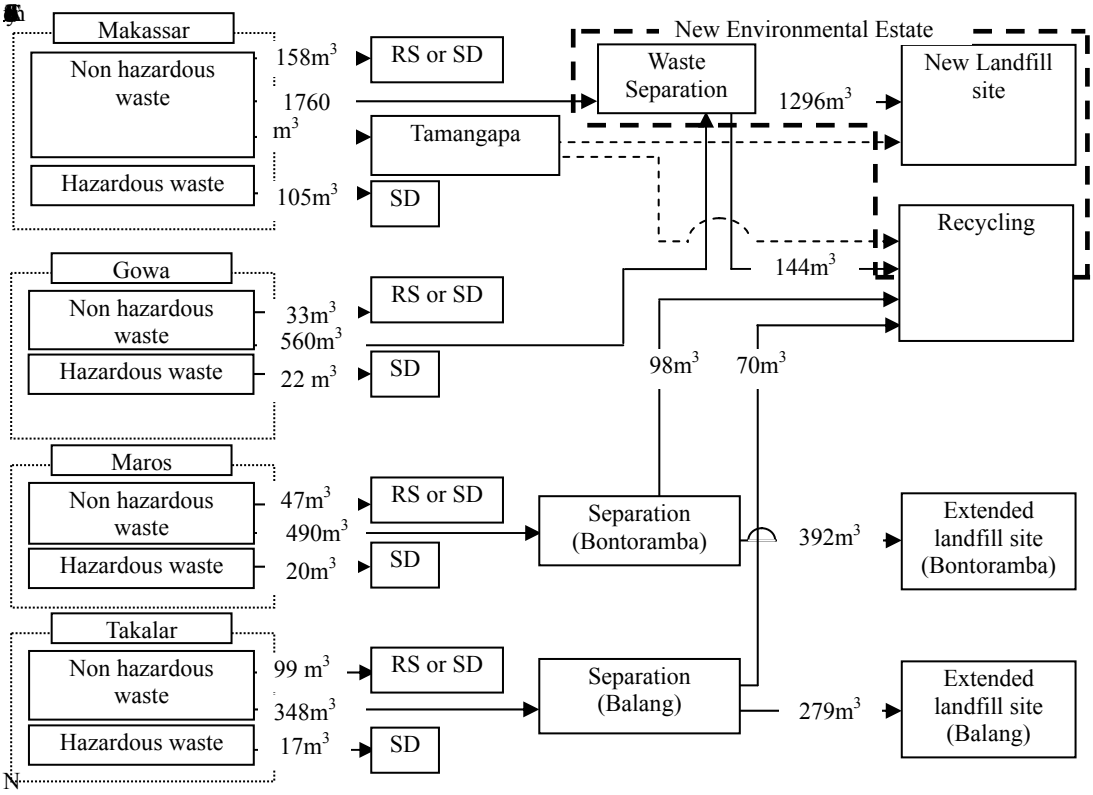
Based on the above background, the objectives of this projects are summarized as follows:

- Preparation of a new landfill site for Makassar and Gowa to improve solid waste management, and
- Establishment of coordination among the Mamminasata regencies, particularly Makassar and Gowa, regarding solid waste management, especially for landfill management and development of recycling industry.

2. PLANNING POLICY

2.1 Future Waste Stream in the Mamminasata Area

Based on the basic strategies of SWM in the Master Plan Study, municipal solid waste should be collected as the responsibility of the cleansing department in each city and regency, even though there is a case for contracting out the work to a private company. On the other hand, industrial waste, including hazardous waste, should be collected and disposed of as the responsibility of the producers of the waste. After completion of new landfill construction, the collected waste in Makassar city and Gowa regency will mainly be transported to the landfill site. At the landfill sites in Maros and Takalar, there is available area for extension of those landfill sites, though the landfill method should be improved. The collected waste in Maros and Takalar will be mainly transported to current landfill sites except some areas near Pattallassang, which is the location of the proposed landfill site.



Source: JICA Study Team

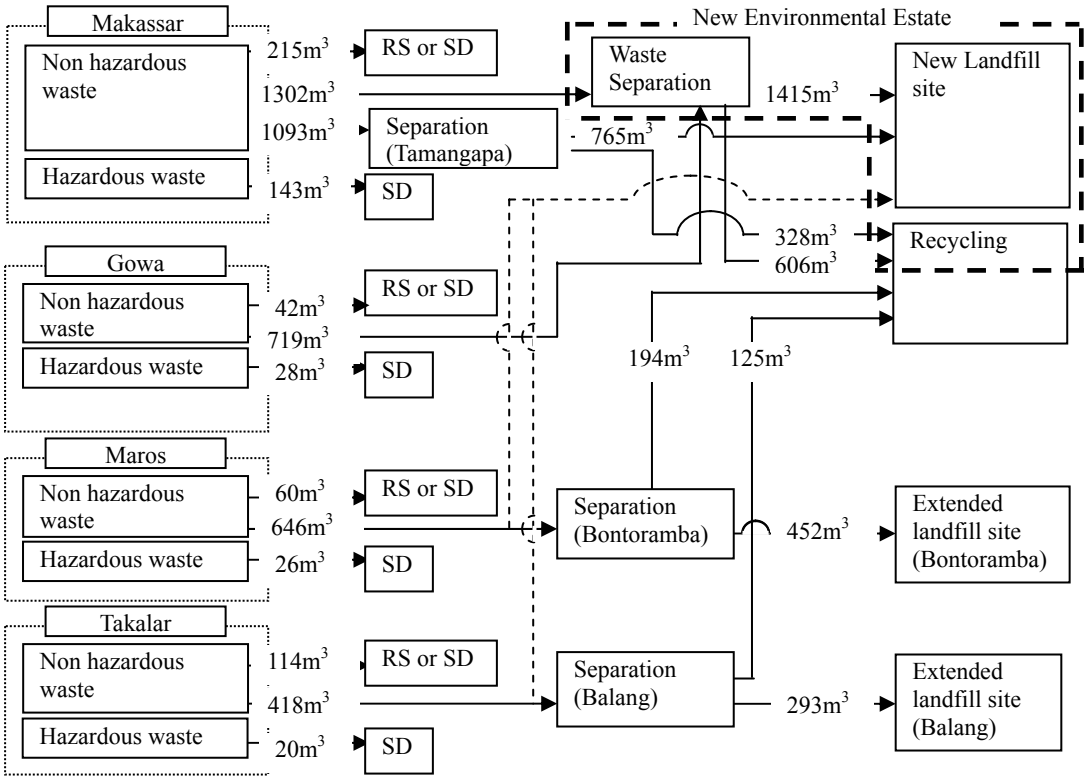
Note: (1) "RS": Recycling by Source Separation, "SD" : Self Disposal.
(2) Waste separation in the new landfill site will be carried out in a waste separation area.

Figure 2.1 Future Waste Stream in Mamminasata Area towards 2010

After closure of the current landfill site in Tamangapa, the closed landfill site can have the role of a transfer station for effective transportation for comparatively distant areas

from the new landfill site. Before preparing the transfer station, environmental monitoring of the closed landfill site should be implemented to confirm the suitability for that ultimate land use for a certain term. Therefore, the preparation of the transfer station in Tamangapa can be considered after 2010. The transfer station can include a separating facility or composting facility to establish a society with a sound material recycling awareness and application of 3R (Reduce, Reuse and Recycle) activities.

The future solid waste stream in Mamminasata area will be directed towards a flow as illustrated in the following figure.



Source: JICA Study Team
Note: (1) "RS": Recycling by Source Separation, "SD" : Self Disposal.
(2) Waste separation in the new landfill site will be carried out in a waste separating facility.

Figure 2.2 Future Waste Stream in the Mamminasata Area towards 2020

2.2 Scope of Pre-feasibility Study

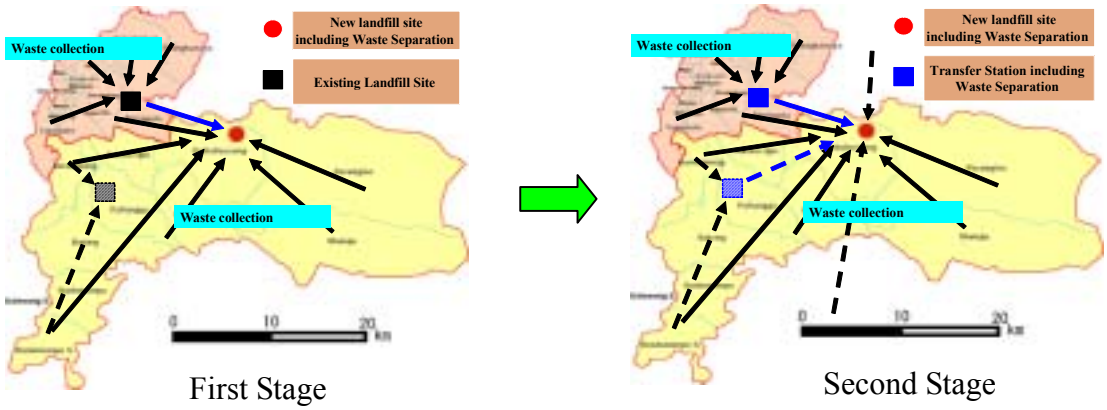
Actual implementation of the plans proposed in the Master Plan Study should be carried out with a step-wise approach due to consideration of the likely future changes through public awareness regarding waste reduction or separation activity or of economic and social development or change of the life style of the public. Therefore, the plan proposed in the Master Plan study has been divided into a first stage and a second stage including the following scopes. The pre-feasibility study has been carried out for the first stage.

First Stage (Scope of this Project)

1) Construction of new landfill site
2) Capacity Building including Public Awareness

Second Stage (Future Plan)

1) Closure of existing landfill sites in Makassar and Gowa
2) Improvement of collection and transportation system including consideration of a secondary transportation system
3) Construction of a recycling facility
4) Expansion of existing landfill sites in Maros and Takalar and the new landfill site
5) Public awareness raising activity



Source: JICA Study Team

Figure 2.3 Waste Stream in Each Stage

The above figure indicates the step-wise approach for improvement of the solid waste management in the Mamminasata area. By 2010, the new landfill site will be constructed in Gowa and the solid waste from Gowa and Makassar will be disposed of there. Up to 2020, a transfer station can be constructed in the location of the Tamangapa landfill site, after its closure, for effective transportation. In addition, part of the solid waste generated in Maros and Takalar can also be disposed of in the new landfill site.

2.3 Received Waste Quantity

According to the estimate of future discarded solid waste up to 2020 (the target year of the M/P), the total volume of solid waste will be approximately 8,362,500m^3 at a bulk density of approximately 0.4 kg/L generated in Makassar and Gowa.

Table 2.1 Solid Waste to be Handled in Makassar and Gowa

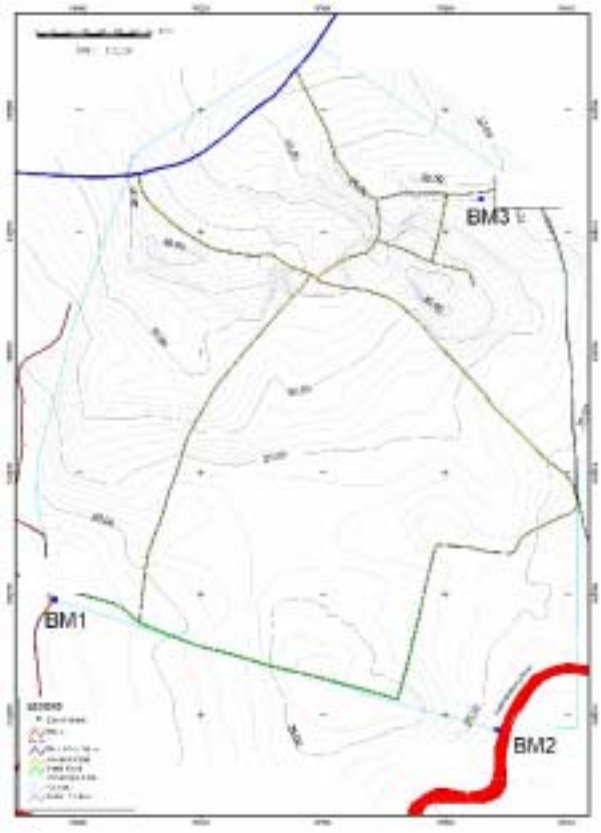
	Collected		Land filled in Panaikang landfill site	Separated in sorting area in Panaikang landfill site	Separated in Tamangapa
	The amount of waste collected in Makassar	The amount of waste collected Gowa			
2005	1,458 m^3/day	489 m^3/day	0 m^3/day	0 m^3/day	195 m^3/day
2010	1,760 m^3/day	560 m^3/day	1,296 m^3/day	88 m^3/day	146 m^3/day
2015	2,085 m^3/day	641 m^3/day	2,181 m^3/day		545 m^3/day
2020	2,395 m^3/day	719 m^3/day	2,180 m^3/day		934 m^3/day
Total until 2020	—	—	8,362,500[m^3] (at a bulk density of 0.4)	—	—

Source: JICA Study Team

3. SITE CONDITION AND PRELIMINATY SURVEY FOR PROJECT IMPLEMENTATION

3.1 Topographic Survey

The proposed area of Panaikang landfill site is located in the Tanah Karang area in Panaikang village in Pattallassang district in Gowa regency. The area is characterized by gentle slopes with the lowest points at EL.17 m and the highest points at EL. 47 m above sea level (over about 1km), which indicates an almost flat area. Pabundukkang river flows on the east side of the area from east to west. The north and east sides are bordered by Parangloe village. The landfill area should be located near the highest points to reduce the amount of excavation and embankment. On the other hand, a leachate treatment facility should be located at the mid-point between the discharge point (somewhere along the Pabundukkang river) and the landfill area, with consideration of the requirement for gravity flow in the process of leachate collection from the landfill area and discharge to river. The topographic map prepared in the course of this Study is prepared in a reduced scale in the following figure.



Source: JICA Study Team

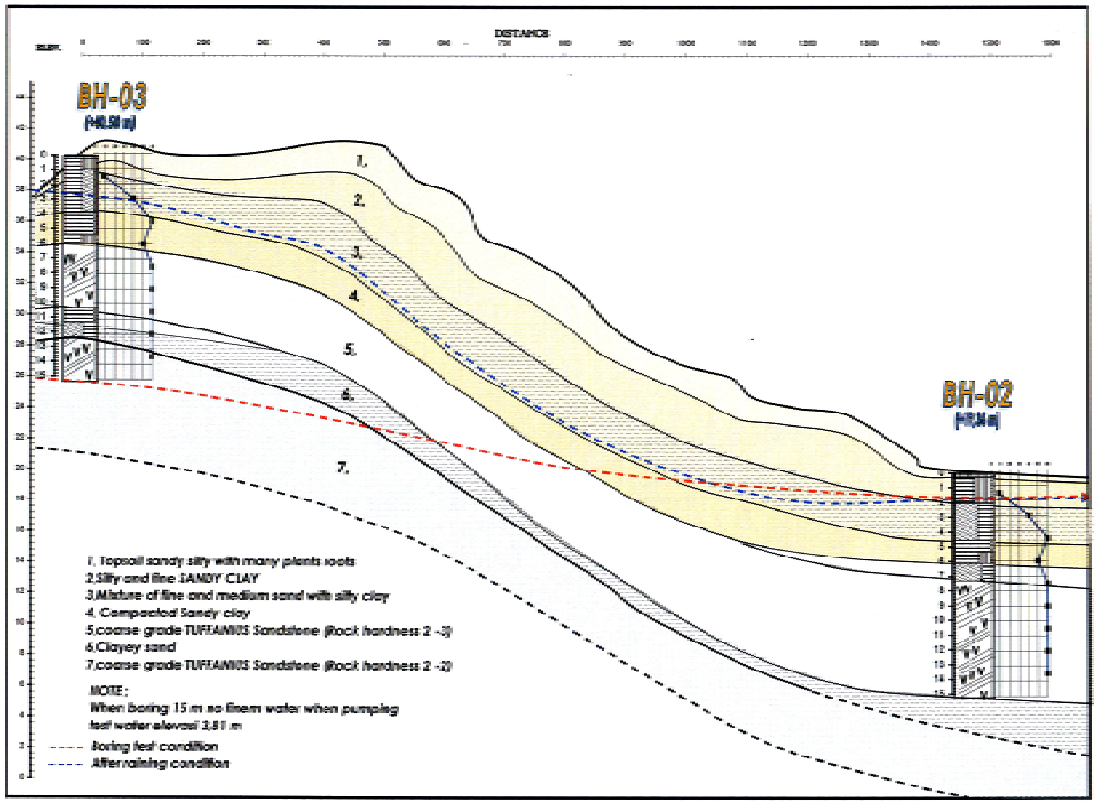
Fig 3.1 Topographic Map of Tanah Karang Area in Panaikang Village

3.2 Geological and Soil Investigation

The geological survey and soil investigation has been carried out in the course of this study to identify the geological features and soil characteristics of the proposed landfill site. The survey items are as follows:

- To dig three boreholes with a standard penetration test at 1.5 m intervals and undertake undisturbed soil sampling
- To carry out laboratory soil tests for the undisturbed soil samples
- To present factual results of the soil investigation.

The result of soil investigation is summarized in the following table. Geological features of the area are summarized in following figure.



Source: JICA Study Team

Figure 3.2 Geological Profile of the Proposed Landfill Site

The results of laboratory tests of undisturbed sampling are summarized as follows.

Table 3.2 Result of Laboratory Test of Undisturbed Sample

Sample		BH1	BH2		BH3	
Sample depth [m]		4.00 – 4.50	4.50 – 5.00	7.00 – 7.50	3.00 – 3.50	4.50 – 5.00
Gradation	Gravel	-	-	1.00	-	-
	Sand [%]	28.0	27.0	80.0	21.0	46.0
	Silt [%]	34.0	23.0	19.0	35.0	17.0
	Clay [%]	38.0	50.0	-	44.0	37.0
Liquid limit [%]		45.3	64.8	-	66.4	65.2
Plastic limit [%]		25.93	36.20	NP	35.32	35.41
Plasticity index [%]		19.37	28.60	-	31.08	29.79
Shrinkage limit [%]		-	-	-	-	-
Specific gravity		2.50	2.45	2.57	2.47	2.63
Dry density [kg/L]		1.66	1.45	1.74	1.24	1.42
Coefficient of Permeability [cm/s]		7.01E-06	5.84E-06	1.45E-04	5.80E-04	6.60E-06
Natural state	Water content [%]	29.81	51.00	28.50	35.43	39.79
	Wet density	1.28	0.96	1.35	0.92	1.02
	Valid ratio	0.51	0.69	0.48	0.99	0.85
	Porosity	0.34	0.41	0.32	0.50	0.46
	Degree of saturation [%]	78.20	80.49	81.88	51.84	66.32
Compressive Strength [cm^2/s]		9.25 (0.085)	8.24 (0.08)	-	18.27 (0.167)	23.06 (0.211)
Sensitivity		1.68	1.49	-	1.25	1.25
Coefficient of consolidation		3.8E-03	6.0E-03	5.0E-03	4.3E-03	6.0E-02
Complex index		0.5814	0.2492	0.3648	0.4319	0.3821

Source: JICA Study Team

From the geological and soil survey, following points have been identified.

i) Consideration of Excavation

The 4th layer below 7.0m is weathered rock or a sandstone layer and the N value is more than 55. This indicates that the layers to be excavated will be slightly difficult considering the composition of the 1st to 3rd layers which include sand, silt or clay.

ii) Artificial Liner System

There seems to be a sandy compacted clay layer of permeability coefficient 5.8 - 7.1E-06 cm/s and the thickness of the layers is less than 3 m. That being the case, based on the soil profile, the impermeability of the soil, in consideration of the thickness of the low permeability layer, will not be sufficiently low to utilize it as a natural liner. Therefore, sufficient compaction of the clay layer combined with an artificial liner, such as a geomembrane, should be utilized to prevent infiltration to groundwater. In addition, the permeability based on the well pumping test is approximately 1.0E-05~1.5E-03. However, rainfall may cause the coefficient of

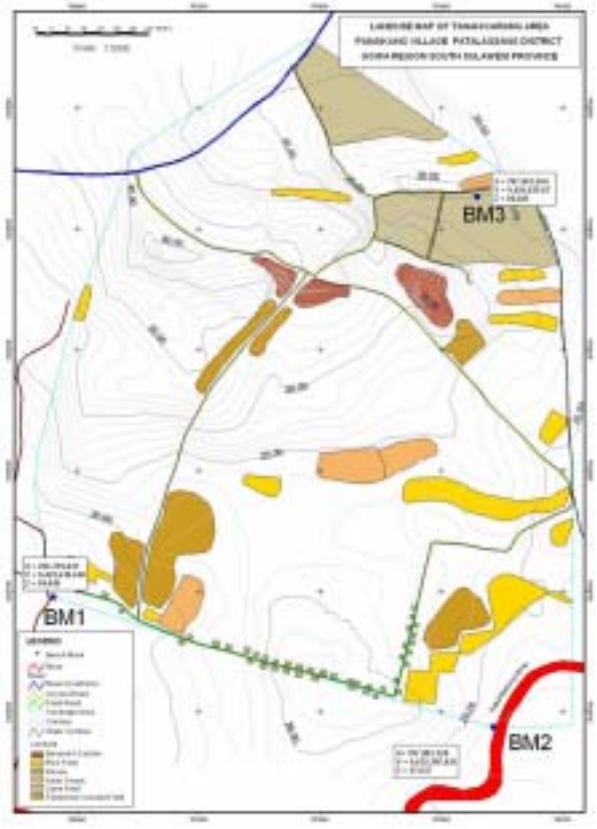
permeability to increase. Therefore, it may be less than 1.0E-05~1.5E-03. It indicates that the layer is not suitable to be used as a natural barrier.

Though the requirement to determine design conditions is identified in this survey, the number of boreholes is not adequate to identify a suitable liner system, the requirement for a groundwater collection facility or the conditions for excavation in the construction stage. Therefore, an additional geological survey, soil investigation and hydrological survey should be executed in later stages.

3.3 Land Use in Surrounding Area

The site has been chosen in the area reserved for industrial use in Gowa. In the process of discussion with Gowa, the local government proposed the site for utilization as a sanitary landfill site including a sorting area. The recyclable waste, which will be separated in a sorting area, can be used as recycled resource material for industrial activities. In addition, the solid waste generated in industrial activities can be disposed of in the landfill site. In this context, one of the roles of the sanitary landfill site is to promote industrial activities making use of recyclable material. Industry will be developed to use waste generated from industrial activities as well as other infrastructures such as water supply, road and transportation, electricity, and so on. Therefore, the new landfill site will have an important role in the aspect of coordination with the land use plan for the surrounding area.

The land in this area is mostly used for plantations consisting of mixed plantations, sugar cane plantations, rice fields, mixed forest and settlement areas. Other cultivation includes corn and cassava. On the east and south borders of this area is the Pabundukkang River, and on the north side is the Parangloe sub-district. There are 53 houses in the survey area. The occupation of surrounding residents is almost all farming. The current land use map is shown in the following figure.



Source: JICA Study Team

Figure 3.3 Current Land Use Condition in the Project Area

The survey also identified that there are some people who will be affected by the project implementation, directly or indirectly. Public involvement therefore should be considered through their participation in the technical committee (refer to chapter 6.2) that will be formed by stakeholders who have direct or indirect impacts on this Project.

The land acquisition and resettlement plan, as well as public involvement, would be prepared under the following principals.

- Minimize involuntary resettlement as much as possible by preparation of alternative resettlement plans with plenty of time for deliberation and contemplation.
- Introduce public involvement including indirectly or directly affected people.

According to the available data of Gowa regency, the number of landowner in Tanah Karang area in Panaikang village, which includes the proposed landfill area, is approximately 100 peoples though location or area of each landowner has not been identified. The identification of land owners should be addressed in a technical committee (refer to Chapter 6.2) to prepare the land acquisition and resettlement plan. Though land acquisition and resettlement of surrounding residents will be required for project implementation, consensus formation with affected residents is needed for smooth implementation of the project, not only in the construction stage but also during operation and post-operation. Public opinion will be reflected in the plan through meetings as much as possible.

4. DESIGN POLICY FOR NEW LANDFILL SITE

4.1 Waste Acceptance

The target waste will be basically collected from Gowa and Makassar. The hauled quantity and quality will be measured to identify the remaining capacity of landfill sites and to adjust the plan to the actual situation. Accepted waste should not include hazardous waste, according to B3 waste regulation (Decree of Head of Environmental Impact Management Agency concerning Procedures and Requirements for Disposal of Treated Hazardous and Toxic Waste Treatment and Landfill Sites, KEP-04/BAPEDAL/09/1995, etc.) in Indonesia. Basic inspection procedures are summarized in the following table.

Table 4.1 Inspection Method regarding Waste Acceptance

	Item	Procedure and purpose
Off-site inspection	Document inspection	In terms of the application of received waste, documented information regarding type, vehicle number, area in which it is prepared beforehand, will be checked and directions given. In addition, this document will also provide useful information for inspection of actual received waste in the process of on-site inspection.
On-site inspection	Document Inspection	Waste management sheet prepared beforehand, and data sheet with received waste will be checked.
	Appearance inspection without unloading	This is the most simple on-site inspection. This will be carried out at the gate house or weigh bridge. If there are some concerns about the inspected waste, it will be sent for the next inspection process, such as appearance inspection with unloading or random
	Appearance inspection with unloading	It would be difficult to inspect the appearance by unloading all the waste to be received. This inspection will be carried out for randomly sampled loads of waste or if there is some concern about the
	Random analysis inspection	Analysis will be carried out for especially suspicious waste or randomly sampled waste. Even though the number of cases of sampled waste is small, the penalty works as a deterrent for illegally carrying.

Source: JICA Study Team

4.2 Semi Aerobic Landfill Procedure

Semi aerobic landfill is the procedure of the air ventilation without mechanical system to keep the waste layer aerobic condition. Leachate is generated because of infiltration of rainwater percolated through a waste layer or by moisture generated from waste. The leachate in a waste layer should be quickly removed or put in contact with open air through a perforated pipe for speedy decomposition by aerobic action. The leachate

collected is quickly removed by natural gravity through the perforated pipes (main pipe and branch pipes). This leads to the intake of fresh air to the waste layer and to quick decomposition of organic components of the waste.

A semi-aerobic landfill system will be applied to reduce the potential environment risks of landfill operations by accelerating the stabilization of landfilled waste. Moreover, acceleration of the stabilization of landfilled waste is important for the safe closure and subsequent effective utilization of the landfill site. In order to minimize the environmental impact caused by the landfill site, introduction of the semi-aerobic system and proper operation of the landfill accordingly is necessary.

4.3 Landfill Method and Environmental Consideration

(1) Landfill Method

The cell method and the push-up method with daily cover soil should be utilized as the landfill methods. After unloading from collection vehicles, solid waste is spread by bulldozer and compacted by landfill compactor. Sufficient compaction is important to utilize the landfill site for a long time. In addition, daily cover soil should be implemented to prevent odor and vermin.

(2) Environmental Consideration

Based on the IEE, environmental considerations will be applied in various stages of construction, operation and post-operation. The main environmental considerations will also be applied to mitigation measures and environmental monitoring in the design, construction, operation and post-operation stages. The magnitude or intensity of the impact affecting the environment should be reduced by implementation of the mitigation measures with due consideration of the existing standards. Daily cover soil for odor, leachate treatment for water quality and liner protection will be applied to mitigate the identified potentially significant environmental impacts. On the other hand, environmental monitoring should be carried out at the stages of construction, operation and post-operation. Monitoring of landfill gas, water quality in the river, and groundwater, should be carried out in respective stages.

(3) Utilization of Land after Closure of Landfill Site

The landfill site will be used for some other purpose, such as a recreation park or sports field for soccer or baseball, as well as to increase real estate values in the future. The area could be planned as an eco-industrial park. Therefore, the land use plan after closure of the landfill site should be considered with sufficient monitoring periods and environmental protection facilities that would include the following.

(i) Surface water drainage facilities

(ii) Leachate collection and treatment facilities

(iii) Gas vent facilities

(iv) Final cover soil.

In addition, during the period after closure of the landfill site, environmental monitoring should be considered for the following components.

(i) Degree of subsidence of final cover soil layer

(ii) Landfill gases such as CH4, NH3, H2S, etc.

(iii) Water quality of leachate.

5. FACILITY AND EQUIPMENT PLAN

Proper operation of the proposed sanitary landfill site, including proper collection and transportation systems as well as an appropriate haulage system, requires various kinds of facilities and equipment. Major facilities and equipment are listed in the following table.

Table 5.1 List and Specification of Facilities

Facility Item	Specification
Landfill area	35 [ha] (Including division into 5 areas (A,B,C,D,E))
Waste retaining facility	15m, soil embankment
Liner	Geomembrane sheet (thickness : more than 1.5mm)
Leachate collection facility	(PVC perforated pipe, main φ600 mm, branch φ300mm)
Rain water collection facility	W450mm×H450mm～W3000mm×H2000 mm
Leachate treatment facility	3000m^2
Sorting area	30 m x 30 m
Site perimeter road	Road width 7m (Concrete paved)
On site road	Road width 7m, 5m (Gravel paved)
Administration building	15m×20m
Maintenance workshop	20m×40m
Washing station	10×15m
Gatehouse	5×10m
Weigh-bridge	30 ton
Heavy equipment and vehicles	Bulldozer, landfill compactor, wheel loader, excavator and dump truck
Approach road	13.7km (From Balangbalang through Sangngisangngi to the landfill site (Panaikang))
Electricity	About 500kW (for leachate treatment facility and administration building, etc.)
Water supply	-
Buffer zone (trees planted)	5.3ha

Source: JICA Study Team

5.1 Facility Location and Layout

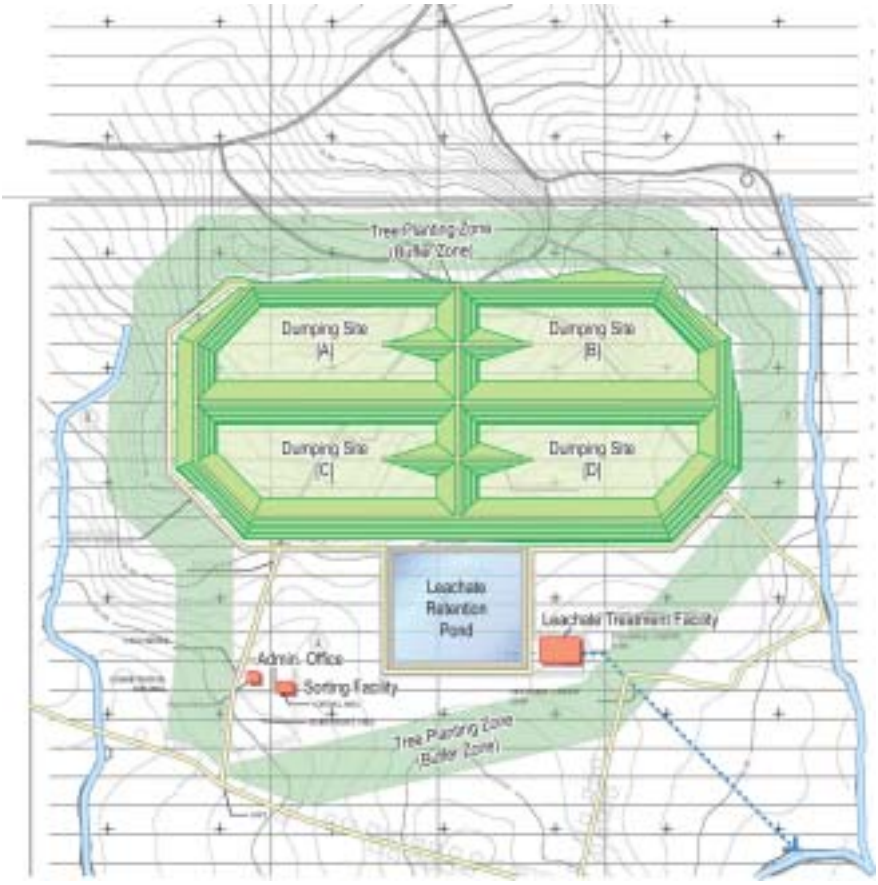
According to the topographic and geological survey, the facility location for the landfill site has been selected. The following points with respect to location of facilities have been taken into account.

Table 5.2 Conditions of Facility Location

Identified matter	Condition for location
The result of borings shows that the surface layer is almost a mixed layer of sand, silt and clay. Below 7 to 10m weathered rock appeared.	It is desirable that the depth of excavation of the landfill area be less than 7 to 10 m. Therefore, the landfill area should be located on the site to reduce the amount of excavation.
There are some residential houses in the area and some fields including a cassava field and a rice field.	The location of each facility is selected to mitigate the environmental impact for surrounding residents and a buffer zone of plants is to be prepared, though resettlement may be needed for some residents.

Source: JICA Study Team

With the above in view, a layout of facility location in Pattallassang landfill site has been elaborated as shown in the following.



Source: JICA Study Team

Figure 5.1 Facility Location of Pattallassang Landfill Site

5.2 Landfill Area

The landfill area is selected in the area of gentle slope in due consideration of reduction of the required volume of excavated soil and of the flow conditions for leachate. It is to be divided into four sections (A, B, C, D,) of 15m in height as the

bottom layer and, after filling the four bottom sections, one section (E) of 5m in height as an upper layer.

An earth embankment for the area is to be applied as a waste retaining structure. The slope of the embankment has been preliminarily determined to be 1:2 in due consideration of slope stabilization. A slope stabilization analysis is needed at a later stage to select a suitable slope of embankment for maximum utilization of the landfill area.

Table 5.3 Summary of Landfill Areas

Landfill area		(ha)	35
Total area of landfill site		(ha)	95
Height of embankment		(m)	40.0
Foundation level		(m)	25.0
Height of cell		(m)	15.0
Landfill capacity (including cover soil)		(m^3)	5,400,000
Top height		(m)	45.0
Number of layers			4 (12)
Earth work	Excavation	(m^3)	2,090,000
	Embankment	(m^3)	895,700
	Surplus soil	(m^3)	1,194,300

Source: JICA Study Team

The landfill capacity in each area is described as shown in the following table.

Table 5.4 Landfill capacity of Each Landfill Areas

	Gross capacity (including soil cover)
Area A	925,000 m^3
Area B	925,000 m^3
Area C	925,000 m^3
Area D	925,000 m^3
Area E	1,700,000 m^3

Source: JICA Study Team

The bulk density of accepted waste in the landfill site, the settled waste in the landfill layers, the layers of cover soil and waste are determined in the following manner to calculate the waste capacity of the landfill.

i) Bulk density of accepted waste

According to the solid waste quantity and quality survey, the bulk density of accepted waste has been estimated as approximately 0.4 kg/L.

ii) Settled waste (when the landfill is filled up with waste)

The bulk density of waste settled for a long time after dumping is assumed to be 0.85 kg/m^3 [5]

iii) Soil covering and waste layer

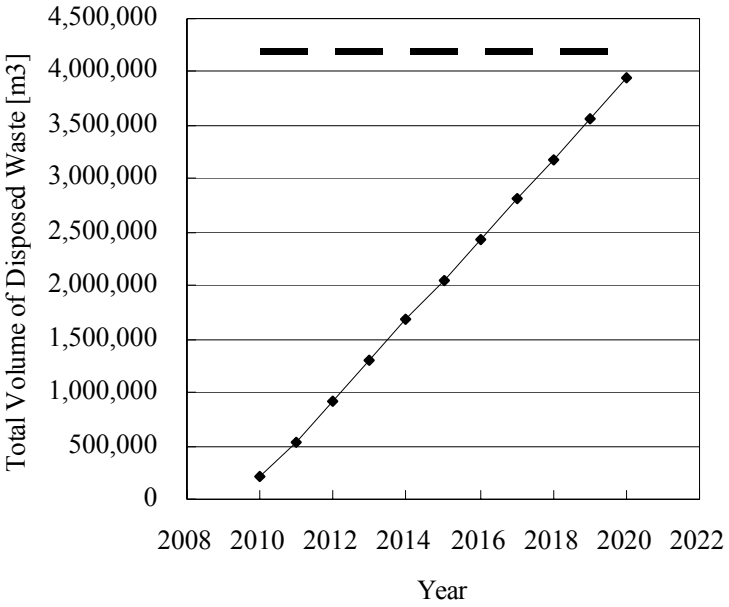
The height of each waste layer and cover soil layer has been determined as shown in the following table.

Table 5.5 Thickness of waste layers and cover soil

Height of waste layer (first layer [m])	1.30
Daily cover soil [m]	0.30
Intermediate cover soil [m]	0.50
Final cover soil [m]	1.00

Source: JICA Study Team

According to the above conditions, a landfill capacity of 4,170,000m^3 (excluding cover soil) is available in the area and the waste quantity to be land filled is shown in following figure.



Source: JICA Study Team
Note: Total waste volume is estimated as settled waste explained in "5.3 (ii)" (the bulk density is 0.85m^3)

Figure 5.2 Landfill Capacity in Pattallassang Landfill Area

5 The survey report of old landfill sites which has been passed for 10 years after their closing in Tokyo, Japan which had buried the non-treated (non-incinerated) waste such as organic waste for 10 years, the bulk density of buried waste was 700 – 1,000 kg/m^3. Therefore in this study, the middle point of this range which is 850 kg/m^3 will be adopted at the time when the landfill is full on the average.

5.3 Leachate Collection System

The leachate collection facility has the roles of collecting the leachate generated from rainfall on the land filled waste layers and transporting it to the leachate treatment facility quickly. For the proposed landfill area, the main leachate pipes and branch leachate pipes should be hydraulically suitable for spacing to discharge leachate quickly and be structurally strong enough against maximum static and dynamic loads coming over them from the ultimate height of the waste filling and from equipment in operation.

Leachate volume depends on rainfall intensity, catchment area, topography and land-use. It is estimated from the following equation:-

$$Q = I(C_1 \times A_1 + C_2 \times A_2)/1000$$

Where;

- ID : Daily rainfall intensity [mm/day]
- Q : Leachate generation amount [m^3/day]
- A_1 : Landfill operating area [m^2]
- C_1 : Infiltration coefficient for landfill operating area
- A_2 : Closed landfill area [m^2]
- C_2 : Infiltration coefficient for closed landfill area

$$C_1 = 1 - E_T/I_M$$

Where;

- ET : Monthly possible evaporation [ET = 0.7 Et]
- E_t : Monthly evaporation amount [mm]
- I_M : Monthly rainfall intensity [mm/month]

$$Et = 0.245 \times K \times C_j \times t_j \qquad (C_j = d_j/(\sum d_j \times 100))$$

- d_j : Monthly sunshine hours (hours)
- t_j : Monthly average air temperature (Fahrenheit)
- K : Empirical crop coefficient

Table 5.6 Leachate Amount During the Operation of Each Area

	Area 1	Area 2	Area 3	Area 4
Landfill operating area	1 ha	1 ha	1 ha	1 ha
Closed landfill area	7.8 ha	16.6 ha	25.4 ha	34.2 ha
Maximum leachate amount	1,592 m^3/d	3,071 m^3/d	4,549 m^3/d	6,028 m^3/d

Source: JICA Study Team

Based on the total leachate volume calculated, the leachate amount for each area has been estimated and the diameter of main and branch pipes and their intervals have been determined. A sufficient slope for quick removal of leachate, and a diameter to

promote natural ventilation of air for the semi aerobic landfill method to operate, are required. Perforated pipes of 600 mm internal diameter have been selected for the main leachate collection pipe and 300 mm in diameter for branch pipes.

Main leachate collection pipes should be installed over the prepared protection soil and top layer of artificial liner and along the gutter of the base layer prepared with gravel or permeable material. The pipe should be perforated in the upper part with circular holes of sufficiently large diameter and at a distance interval and pattern to collect leachate effectively and to prevent clogging. The lower part should be non-perforated (full section) to allow smooth flow of the leachate collected without leaking out from the pipe. The top of its lower 1/3 non perforated part should be level with the finished level of the top clay liner to prevent long-term storage of the leachate in an anaerobic condition.

The leachate pipe is to be covered with well-compacted filter material (grain size: 50 – 150 mm) packed in suitable shapes and sizes. The proposed width (more than 3d at the top and bottom) and thickness of the packed filter material should not only facilitate the filtration of leachate entering into the perforation of the pipe, but also increase the bearing capacity of the pipe under static and dynamic loading during operation under critical conditions.

In addition, the route of leachate collection should be separate for each area (Area A to D) until reaching the leachate treatment facility. Any surface water collected in the leachate collection pipe installed in an area in which waste has not been dumped can be discharged along with the surface water that is not leachate from the other areas pipes and combined as storm water drainage. This system can reduce the leachate in the early stages of landfill operation such as during landfill use of Area A or B.

5.4 Leachate Treatment System

(1) Quantity and Quality

i) Quality

The leachate in the existing landfill sites has been sampled and the water quality has been analyzed to estimate the water quality of leachate of the new landfill site. The result of analyzed water quality is summarized in following table.

Table 5.7 Water Quality of the Leachate of Existing Landfill Sites

Parameters	Existing landfill site			Standard South Sulawesi Governor's Standard No.14-2003 (Class IV)
	1	2	3	
	Tamangapa landfill site in Makassar (Leachate L.1)	Tamangapa landfill site in Makassar (Leachate L.2)	Bajeng landfill site in Gowa (L.3)	
Physical				
Temperature	29	30	31	-
Color	30	30	20	-
Total Suspended Solids (TSS)	420.15	550.23	600	400
Chemical				
pH	7.4	7.2	7.5	5-8.5
BOD5	2,475.01	2,340.14	1,297.03	12
COD	4,590.64	4,375.34	2,316.07	100
Dissolved Oxygen (DO)	0	0	0	0
Phosphorus (P)	30.0	25.0	10.0	5
Nitrate (NO3-N)	12.79	14.57	8.22	20
Ammonium (NH3-N)	14.0	16.0	15.0	-
Arsenic (As)	N.D.	N.D.	N.D.	1.0
Cadmium (Cd)	N.D.	N.D.	N.D.	0.01
Chromium (Cr6+)	0.02	0.02	N.D.	1
Lead (Pb)	0.05	0.01	0.002	1.0
Mercury (Hg)	N.D.	N.D.	N.D.	0.005
Mineral oil	0.02	0.01	0.015	-
Detergent	N.D.	N.D.	N.D.	-
Phenol compounds	0.3	0.2	0.1	-
Bacteriology :				
Faecal Coliform	350	350	250	2000
Total Coliforms	4,000	4,000	3,000	10000

Source: JICA Study Team

There is no effluent standard for leachate generation in landfill sites. Therefore, the environmental standard of class IV river[6] in South Sulawesi province is preliminarily

[6] Class IV is environmental standard regarding the water quality of river for irrigation purpose.

used for comparison as the water quality standard.

According to the water quality survey, TSS, BOD, COD and Phosphorous are above the environmental standard. The following items have been considered for the application of a suitable standard for technical, financial and environmental aspects in Indonesia and South Sulawesi province as follows:

Though there is an environmental standard for COD and BOD in rivers in Indonesia. Only BOD is utilized as an indicator of the water quality in rivers in Japan instead of COD. Furthermore, advanced treatment is required to remove COD and the operation and maintenance cost would be high and it would require advanced techniques for operation.

(i) Heavy metals have not been detected or are sufficiently below the environmental standard.

(ii) N-NO3 levels in each sampling point were not over the environmental standard.

(iii) A biological treatment system cannot reduce the pollutant load regarding phosphorous and COD to a sufficiently low level. If a reduction is required, a physical-chemical treatment system such as chemical oxidation and coagulation to remove COD or T-P and another biological treatment to remove T-N would be needed. However, the operation and maintenance cost is high and the operation needs highly experienced technicians who have advanced skill and knowledge.

(iv) Because both the landfill sites seem to be in an anaerobic condition, the water quality of the target leachate due to design of a new landfill site with an aerobic condition will be slightly improved.

(v) Based on the above consideration, BOD and TSS have been selected as the indicators for design and discharge water standards for public houses or offices in South Sulawesi province. The following table shows the design values of leachate treatment facilities.

Table 5.8 Water Quality Standard of Water Discharge for Public Housing Areas, Restaurants, Offices, Trading and Apartment Buildings

Parameters	Unit	A	B	C
PH		6.0-9.0	6.0-9.0	6.0-9.0
BOD5	mg/L	25	40	75
COD	mg/L	80	100	125
TSS	mg/L	20	35	50
Mineral Oil	mg/L	5	8	10
Total Coliforms	mg/L	2500	5000	-

With the water quality standard in view, as well as the light of operation cost and maintenance cost, the design value of water quality in inlets and outlets of leachate treatment plants has been set as shown in following table.

Table 5.9 Design Values of Leachate Treatment

	Inlet	Treated water
BOD	2500 mg/ℓ	75 mg/ℓ
TSS	500 mg/ℓ	50 mg/ℓ

ii) Quantity

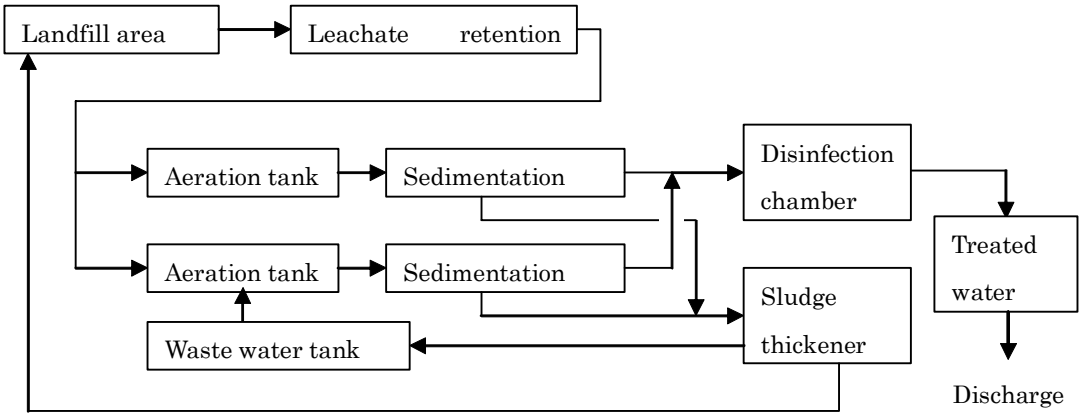
The landfill area is divided into 4 areas (1 area: 8.8 ha) and the landfilling order is planned as 1 to 4. The maximum volume of leachate will be generated in the final stage of landfilling (accomplished area: 34.2ha, landfilling area 1.0ha) in Area 4. For the accomplished area, more than 30 mm/day must not infiltrate underground and flow as surface water in case of silt covering[7] . Under the assumption of clay or silt as cover soil, the volume of leachate is calculated as the cut off of more than 30 mm/day and any surplus of rainfall will flow as surface water.

In consideration of the time series and actual operation load, the capacity of the leachate treatment facility is preliminarily planned as 2,000 m^3/day. During the operation of areas 1 and 2 only, the leachate treatment facility will be operated in one unit operation due to the small amount of leachate and the capacity being 1,000 m^3/day. On the other hand, it will be operated as two unit operation of 2,000 m^3/day during the operation of areas 3 and 4. A leachate retention pond requires the capacity of more than 110,000 m^3 due to the capacity of the leachate treatment plant (2,000m^3). In the beginning of the dry season, the leachate retention pond will have approximately 54,000 m^3 of leachate and the leachate will be supplied to the leachate treatment plant constantly through the dry season. The treatment system has two systems and only a part of one system will be utilized in the dry season due to the low BOD load to prevent over aeration which causes an increase of TSS (total suspended solids) including surplus activated sludge.

[7] Consideration of macro water balance model based on the questionnaire of leachate from landfill sites (1998) Tojo, et.al.

(2) Selection of appropriate leachate treatment process

The leachate treatment facility has the purpose and function to purify the leachate collected so that, when discharged, it will not pollute the surrounding water bodies or underground water. Considering the water quality and quantity of inlet and outlet as design values, the activated sludge method will be a suitable treatment method. The aeration pond and sedimentation tank will have two flows to prevent surplus aeration by preparing two systems. The system flow of leachate treatment is proposed as shown in Figure 5.3.



Source: JICA Study Team

Figure 5.3 Schematic diagram of leachate treatment system

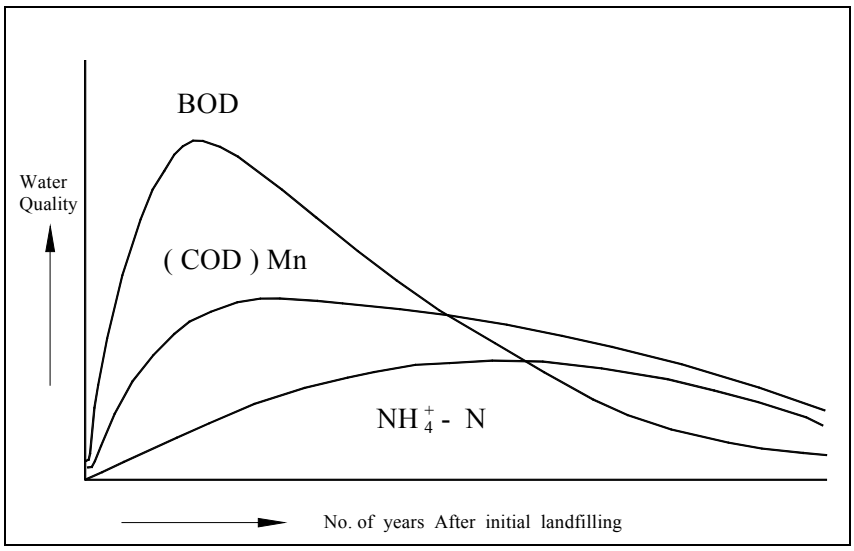
Table 5.10 List of Main Facilities in Leachate Treatment Facility

Name	Required capacity	Dimension	Designed capacity
Leachate retention pond		(approximately 5.3ha)	136,000 m^3
Aeration tank	9000 m^3	60m×20m×4m×2 system	9600 m^3
Sedimentation tank	350 m^3	8m×8m×3.7m×2 system	470 m^3
Water treatment tank	250 m^3	9.4m×9.8m×3.2mWH×1 system	295 m^3
Disinfection chamber	21 m^3	2.0m×9.8m×3.2mWH×1 system	63 m^3
Sludge thickener	400 m^3	9.8m×11.7m×3.7mWH×1 system	424 m^3
Waste water tank	20 m^3	1.5m×16.3m×1.0mWH×1 system	24 m^3

Source: JICA Study Team

(3) Countermeasures for leachate quality fluctuations

The leachate is usually highly concentrated during the early stages of landfilling but as time passes, the concentration will drop. Leachate at an early stage can be easily treated biologically but it becomes more difficult to treat later on as shown in the following figure.



Source: Waste Management Paper 26B Landfill Design, Construction and Operational Practice. Department of the Environment, HMSO, London, 1995

Figure 5.4 Water Quality of Leachate

Therefore, careful consideration must be given to issues like the original typical leachate quality assumed during the design stage when selecting the leachate treatment method. Leachate that is difficult to treat biologically has to be either reduced in volume or treated by a physical-chemical based system. However, physical-chemical treatments such as coagulation or activated carbon adsorption methods cause a high operation and maintenance cost and require an advanced technique. Therefore, a physical-chemical based system is not recommended in this Study.

Due to the difference of the water quality between the low load period in the dry season and the high load period in the rainy season, aeration ponds and activated sludge tanks need to be prepared with a two system flow to prevent both surplus aeration and low load operation.

(4) Countermeasures for leachate volume fluctuations

Basically, the volume of leachate changes with the amount of rainfall but there is a limit to the treatment capacity of the facilities. Thus, in order to operate the facilities at a constant level throughout the year, leachate retention ponds are prepared as a volume control facility.

Therefore, it is desirable to consider countermeasures to channel out rainwater or to prevent rainwater seepage into the landfilled layers by using sectionalized landfill or separate landfills or an appropriate selection of the cover soil so as to reduce the leachate volume. Leachate must be treated and meet the Indonesian standard shown in the following table through the biological and physical treatment process before discharging into the river.

Table 5.11 Leachate Amount under Operation of Each Area

Under landfill	Area A	Area B	Area C	Area D
Operation of facility	1000 m^3/d	1000 m^3/d	2000 m^3/d	2000 m^3/d
Maximum leachate amount (m^3/d)	1,592	3,071	4,549	6,028
Maximum leachate amount in leachate retention pond (m^3)	5,600	55,600	50,750	106,939

Source: JICA Study Team

The capacity of the required leachate retention pond has been designed as 136,000 m^3 due to the consideration of sedimentation of 0.5m in addition to 110,000m^3 based on time-sequence data in 1999. In the leachate retention pond, an aerator is to be installed for oxidization of BOD and for prevention of corrosion. The depth of leachate in the leachate retention pond is set as 2.5m to promote surface aeration. The mixing of the pond is difficult due to the large area of the leachate retention pond. Therefore, the leachate at a low level cannot be circulated, and precipitated sludge will be in an anaerobic condition. 30% of BOD in the leachate at the inlet will decrease in the inlet.

5.5 Storm Water Drainage

The surface water management facility should be provided to reduce leachate volume through removal of rainwater and being part of the overall drainage network in the sanitary landfill system. The perimeter drain is constructed around the landfill site before the commencement of the landfilling operation. It collects rainfall in the surrounding area and functions to prevent run-off from seeping into the landfill. The catchments area for design discharged volume should be established so that the drain would be able to handle run-off from the surface of the final cover upon completion of landfill operation. After application of the final cover soil, landfill surface drains are installed to drain off surface run-off. They are laid out to give the most efficient run-off drainage. A surface drain is dug on the required slope (approximately 2%) on the fully compacted final cover layer.

The probable daily rainfall for a 10 year return period is calculated from the daily rainfall data in Makassar station by utilizing rational methods which use the following equation.

$$Q = 1/360\ C.\ I.\ A$$

Where,

- Q = Storm water volume (m^3/sec)
- C = Coefficient of flow (select appropriate volume in accordance with topography of landfill catchments area or vegetation, etc.)
- I = Rainfall intensity (storm recurrence interval of 10 years (mm/hr))
- A = Catchment area (ha)

The parameter values to calculate the cross section of drainage are shown in the following table.

Table 5.12 Parameter for Storm water Drainage Calculation

Item		Parameter
Run-off coefficient	for landfill area	0.9
	for outside of landfill area	0.65
Rainfall intensity [mm/h]		133.8
Roughness coefficient		0.013
Slope		0.5～6%

Source: JICA Study Team

The cross-sectional area of surface water drainage has been calculated by using the rational method based on probable daily rainfall for a 10 year return period calculated from the daily rainfall data in Makassar station. It has been calculated for the period of maximum value of surface water flow.

$$S = Q/V$$

Where,
S = Cross-sectional area of flow (m^2)
Q = Discharge volume (m^3/sec)
V = Average flow velocity (m/sec)

The average flow velocity has been be calculated by using Manning's equation as:-

$$V = 1/n\ R2/3\ T1/2$$

Where,
V = Average flow velocity (m/sec)
N = Manning's coefficient of roughness
T = Gradient of channel
R = Hydraulic Radius (m) = S/P
Where,
S = Cross-sectional area of flow (m2)
P = Wetted perimeter (m)

The cross section of storm water drainage is thus calculated as summarized in the following table.

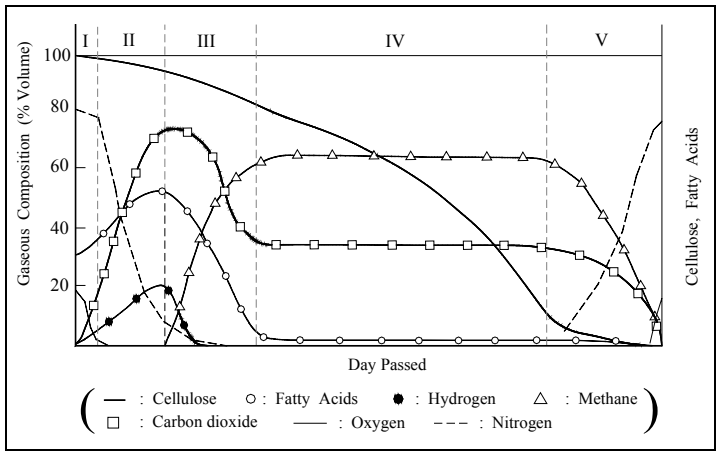
Table 5.12 Cross Section of Storm water Drainage

Rain water area No.	Cross section	Roughness coefficient	Slope	Velocity	Flow amount
	B[mm]×H[mm]	n	%	V [m/sec]	Q[m^3/sec]
A1	1000×800	0.013	0.50	2.332	1.492
A2	1000×800	0.013	3.00	5.712	3.656
A3	1000×800	0.013	3.00	5.712	3.656
A4	1300×900	0.013	0.50	2.658	2.488
A5	1800×1400	0.013	0.50	3.422	6.899
A6	2000×1500	0.013	0.50	3.631	8.714
B1	450×450	0.013	6.00	5.043	0.817
B2	1300×900	0.013	0.50	2.658	2.488
B3	1300×900	0.013	0.50	2.658	2.488
B4	1500×1200	0.013	0.50	3.056	4.401
B5	1800×1400	0.013	0.50	3.422	6.899
B6	1000×800	0.013	0.50	2.332	1.492
B7	1000×800	0.013	0.50	2.332	1.492
B8	1000×800	0.013	0.50	2.332	1.492
B9	1600×1300	0.013	0.50	3.204	5.331
B10	2600×1800	0.013	0.50	4.219	15.796
C1	3000×2000	0.013	0.50	4.586	22.013
C2	3000×2000	0.013	0.50	4.586	22.013
C3	3000×2000	0.013	0.50	4.586	22.013
D1	1300×900	0.013	0.50	2.658	2.488
D2	1500×1200	0.013	0.50	3.056	4.401

Source: JICA Study Team

5.6 Gas Control

Landfill gas is generated by decomposition of organic materials in the landfill sites, which may cause fire disasters or affect the surrounding environment and human health. Therefore, it is necessary to provide a gas venting facility at landfill sites in order to prevent the adverse impact caused by these gases. Furthermore, the gas venting facility also has an effect on promoting the decomposition process of organic materials and contributes to the stabilization of a sanitary landfill site. Therefore, a gas venting facility is needed for the landfill site.



Source: J.F. Ree (1980): The Fate of Carbon Compounds in the Landfill Disposal of Carbon Matter, J Chem. Tech. Biotech., 30.

Figure 5.5 Gas Composition of Landfill Gas in Each Term

The semi-aerobic sanitary landfill system is effective for early decomposition and

stabilization of the waste layer than generation and recovery of CH_4 rich gas under an anaerobic condition. Organic substances in landfilled wastes generate various kinds of gas in accordance with the decay, decomposition and stabilization caused by the anaerobic micro-organisms. The decomposition process varies due to the micro-organisms involved. They are generally divided into aerobic decomposition by the action of micro- organisms that need oxygen and anaerobic decomposition by the action of micro-organism that do not need oxygen.

It is actually not possible to keep the whole landfill layer in an aerobic state on a landfill site. It is, therefore, unavoidable in practice to leave it in an anaerobic state.

In anaerobic decomposition, methane (CH_4), carbon dioxide (CO_2), ammonia (NH_3) are generated with a very small amount of hydrogensulfide (H_2S), methyl sulphide $(CH_3)_2S$ and methyl mercaptan (CH_3 SH). It is necessary to treat the gas appropriately because it can have some undesired effects like withering of living trees, obstruction to compaction, spread of wastes and cover material and it can also cause fire and explosion.

A gas treatment facility must be able to remove the gas generated within the landfill layers. It should have gas venting pipes, and in the cases where the gas is released into the atmosphere, appropriate final treatment facilities must also be considered so as to prevent air pollution.

A gas treatment facility must be constructed at the same pace as the landfill operation advances. This is unlike other treatment facilities or those to be used at sites after a landfill is completed. Vertical gas vent pipes need to be installed connecting with leachate collection pipes at the bottom. The required distance between the gas collecting facilities is 30-50m.

The places where gas is released must be arranged down-wind in airy places without obstacles, which may make the gas accumulate.

5.7 Liner

The liner facilities can be classified as vertical liner facilities and surface liner facilities with respect to structure and type of material used.

According to the geological survey, insufficient impermeable and stable layers have been identified in the layers of the site. The geological profile includes a sandy clay layer of which the permeability is approximately 5.84E-06 to 7.01E-06 cm/s and thickness has been preliminarily identified as less than 1m. Though sufficient thickness of a clay layer will protect against infiltration of leachate, the existing

natural clay without sufficient compaction or consolidation should not be utilized. In addition, the leachate cannot be collected into a leachate treatment pond if consideration is given to the existing situation at the Tamamgapa landfill site. When considering the geological condition of similar locations, artificial liners should be considered to protect leachate from infiltration to groundwater. Although a more detailed geological survey, including soil investigation and a hydro-geological survey, is needed for a final decision the following liner system, which is a composite of soil and geo-membrane, results in a liner system that has a much lower leakage potential than either material alone. The membrane sheet liner system is composed of an underlying 50 cm layer of compacted low permeability soil with a 1.5 mm high-density polyethylene (HDPE) geo-membrane. The composite of compacted clay soil and geo-membrane results in a liner system that has a much lower leakage potential than either material alone. In areas that have the potential for high groundwater, an under-drain trench filled with gravel around a pipe needs to be installed.

Table 5.13 Depth of Each Layer for Liner

Layer	Depth
Double-sided High Density Poly Ethylene Sheet	1.5mm
Penetration Clay covering (Compacted Clay Soil)	0.5 m
Protection layer	0.5m

From the geological and hydrological survey, though existence of unconfined aquifer has been identified in the area, the level of the water table and capacity of the aquifer could not be identified in this survey, in spite of implementation of boring and a well pumping test, due to the insufficient monitoring period of groundwater level and pumping capacity.

From only this information it is not possible to conclude the requirements of the necessary groundwater collection system or the specification of the collection pipes.

The groundwater collection facility will be determined from further study, such as sufficient monitoring of groundwater and a pumping well test with a pump of high capacity.

5.8 Sorting Area

The sorting area is not only to be used for the separation of recyclable material but also to enable the separation and control of each material. In this area, separation of recyclable material will be implemented. The inspection and separation of

non-acceptable waste also utilizes the sorting area. The checking and recording of non-acceptable waste will be carried out in the sorting area. In particular, hazardous waste, infectious waste, radioactive waste, liquid waste and other waste not considered as municipal waste shall be rejected at the landfill site by inspection at the gate house, weighbridge or sorting area.

5.9 Approach Road

A transportation route to the landfill site should be established. Based on the survey of existing road conditions, expansion of the existing road width and improvement of the pavement and some bridges is needed for effective transportation. A general map of the approach road (blue line approximately 14 km in total length) to be repaired is shown in the following.

Figure 5.6 General Map of Access Road

5.10 Building and Utilities

(1) Weighbridge

A weighbridge is to be installed to record the quantity of incoming waste to the landfill site. In the landfill site, a lane for collection vehicles to pass through the weighbridge is to be prepared on the left side for incoming vehicles to be weighed with hauled waste and on the right side for outgoing empty vehicles to be weighed. Two center lines will be prepared for other non-waste transporting vehicles, such as

vehicles belonging to staff or visitors. The proposed weighbridge should have a weighing capacity of 30 ton. The total area of the weighing bridge (including ramps) will be approximately 20 m x 15m. The collection vehicles with pre-recorded empty weights do not need to be re-weighed empty. Other vehicles, when leaving the site after unloading waste, should use the weighbridge on the right side to calculate the difference between the two weights which should be the weight of incoming waste carried by the waste collection vehicles.

(2) Fence

The site is to be surrounded by a fence to maintain access control and to prevent illegal trespass. The fence will also function to retain plastics and papers blown by the wind from leaving the site. From the point of view of coordination with the surrounding landscape, the fence can be covered and coordinated with trees or plants which will be planted in a buffer zone (approximately 100m).

(3) Gates

An entrance gate is to be installed along with the fence to control the site where it is located in the south west of the landfill site, and is to have a width of approximately 9m. In addition, a notice sign board is to be installed to clearly indicate the names of the site and the responsible organization.

(4) Maintenance Workshop

In order to improve the capability of repair and maintenance of heavy equipment and collection and transportation vehicles, the cleaning department in Makassar has had a maintenance workshop for collection vehicles and heavy equipment. This workshop will function as the main facility in the subsequent period and hence shall be reinforced with provision of machines and equipment used for repair and maintenance at the Tamangapapa landfill site.

(5) Administration Building

The administration building provides office space for the landfill staff and a weighbridge operator room. The utilities, such as water and electricity supply, should be considered to secure a suitable work environment.

(6) Washing Station

A washing station is to be installed to wash the collection vehicles and landfill equipment. The water supplied for washing can be from rain water collected by storm water drainage or groundwater.

(7) Water Supply

Water supply is required at the site for the staff. Water is also needed for land filling purposes, such as extinguishing fires, washing equipment or watering dirt roads. For the present, water shall be supplied from a groundwater well located near the landfill site.

(8) Electric Power Supply

Electric power is required for operation of the weighbridge, aerator and other pumps. Electric power is also required for the administration area. The electric power supply is three phase, which shall be extended to the site from an existing distribution line. The line shall be overhead at the site and extended to the leachate pond area to power the aerator and pumps.

5.11 Environmental Monitoring Equipment

Environmental monitoring equipment should be prepared for daily or periodical monitoring according to the environmental monitoring plan, which will be prepared in the term of further study or project implementation. According to the IEE, lowered air quality from transportation and landfill gas, water quality degradation from leachate and odor from landfill gas have been identified as significant impacts regarding pollution and the natural environment. Monitoring equipment (portable equipment is identical) for air and water quality should be prepared to identify the environmental conditions in a timely manner as well as monitoring the well for water quality.

5.12 Heavy Equipment

Heavy equipment is one of the resources for landfill management and equipment should be selected after consideration has been given to the land structure, size, landfill method and solid waste type used in the sanitary landfill system.

Bulldozers and landfill compactors are required for bedding and compaction of waste and cover material in the project. A bulldozer, excavator, and dump truck to move cover material from the stock yard to the landfill site will also be required for the planned sanitary landfill operation judging from the amount of waste and cover material to be handled. The purpose of each item of equipment and the number required are described in the following table.

Table 5.14 List of Heavy Equipment to be Required for Landfill Operation

Equipment	Role of equipment	Number of items equipment
Bulldozer (more than 18ton) [m^3/day]	to spread and compact a landfill layer of uniform thickness,	4
Wheel loader (capacity more than $2m^3$)	to carrying cover soil, to spread the waste to be sorted	1
Excavator	to dig cover soil equipment, cover soil spreading equipment	1
Landfill compactor	to compact the waste	2
Dump truck	to carry cover soil and solid waste	3

i) Bulldozers

The number of required bulldozers has been calculated according to the condition summarized as follows.

Amount of landfilled waste per day [m^3/day]	2190
Bulk density [kg/L]	0.4
Operational hours [min/day]	720
Cycle time [min]	1.6
Amount of pushed soil [m^3]	3
Operation rate	0.6
Vehicle operation rate	0.85
Number of required vehicles	4

Note: Cycle time, amount of pushed soil and operation rate referred to are the cost estimation standard for civil works by the Ministry of Land, Infrastructure and Transport in Japan.

Source: JICA Study Team

ii) Wheel loader

The number of required wheel loaders has been calculated according to the condition summarized as follows.

Handled soil amount per day for cover soil [m^3/day]	403
Operational hours [min/day]	480
Cycle time [min]	1.13
Bucket capacity	2.1
Operation rate	0.6
Bucket coefficient	0.85
Vehicle operation rate	0.85
Required number of vehicles	1

Note: Cycle time and operation rate referred to are the cost estimation standard for civil works by the Ministry of Land, Infrastructure and Transport in Japan.

Source: JICA Study Team

iii) Excavator

The number of required excavators has been calculated according to the condition summarized in the following table.

Handled soil amount per day for cover soil	403
Operational hours [min/day]	480
Cycle time [min]	0.6
Bucket amount	0.8
Operation rate	0.7
Bucket coefficient	0.85
Vehicle operation rate	0.85
Required number of vehicles	1

Note: Cycle time, operation rate and bucket coefficient referred to are the cost estimation standard for civil works by the Ministry of Land, Infrastructure and Transport in Japan

Source: JICA Study Team

iv) Landfill Compactors

The number of required landfill compactors has been calculated according to the condition summarized as follows.

Amount of landfilled waste per day [m^3/day] for landfill compaction[8]	1100
Operational hours [min/day]	720
Cycle time [min]	0.49
Amount of pushed soil[m^3]	4
Soil amount transformer coefficient	1.3
Operation rate	0.7
Vehicle operation rate	0.85
Required number of vehicles	2

Note: Cycle time, amount of pushed soil and soil amount transformer coefficient referred to are the cost estimation standard for civil works by the Ministry of Land, Infrastructure and Transport in Japan.

Source: JICA Study Team

v) Dump Trucks

The number of required dump trucks has been calculated according to the condition summarized as follows.

Handled soil amount per day for cover soil	403
Operational hours [min/day]	480
Cycle time [min]	4.8
Body capacity [m^3]	7
Operation rate	0.6
Body coefficient	0.85
Vehicle operation rate	0.85
Required number of vehicles	3

Note: Body capacity, operation rate and body coefficient referred to are the cost estimation standard for civil works by the Ministry of Land, Infrastructure and Transport in Japan.

Source: JICA Study Team

[8] The target waste to be compacted by landfill compactor (the waste which cannot be compacted by bulldozer) is assumed as 50% of total received waste in landfill site

6. OPERATION AND MANAGEMENT PLAN

6.1 Technical Plan

(1) Waste Acceptance and Inspection of Incoming Waste

The collection and transportation is currently carried out in the early morning or late evening to escape traffic jams. An adjustment of the collection and transportation plan in Makassar and Gowa is needed to determine the operation hours and to consider the peak period for collection vehicles which haul the waste to the landfill site. A waiting lane for collection vehicles will be prepared to prevent traffic jams at the site. Inspection of incoming waste is required for sanitary landfill operation to meet the design standard. Incoming waste should be inspected and separated using suitable methods for each condition as shown in following table.

Table 6.1 Inspection Procedure of Incoming Waste

Item	Contents	Procedures
Inspection of collection vehicles (for normal inspection)	Check of official vehicles, number, driver, collection area and target and time record and schedule, etc.	- Document checking - Eye observation
Inspection of hauled waste (for random inspection in special periods and against doubtful collection vehicles)	Random inspection or inspection based on the result of preliminary inspection	- Eye observation - Random observation
Separation after inspection (for unsuitable waste such as hazardous or infectious waste)	Separation of unsuitable waste for the landfill area and of recyclable material in sorting area.	- Separation by waste pickers or staff in sorting area with suitable health protection measures, if it is hazardous waste.

(2) Landfill Activity

Implementation of a sanitary landfill method can be adopted as follows.

- Sufficient spreading and compaction using the push up method
- Application of daily cover soil should be carried out to prevent odor or vermin. The source material for cover soil may be difficult to obtain but substitute material such as residue from the composting process or construction / demolition waste can be utilized for cover soil.
- Periodical monitoring should be carried out in existing wells of surrounding areas of the landfill sites.

(3) Cover Soil

The excavated soil generated in the process of land reclamation will be mainly used for cover soil. The cover soil should be selected for each purpose as shown in following table. The quantity of covering soil required, including intermediate cover soil and daily cover soil, is estimated at approximately 1,227,000m^3. Surplus soil has been estimated as 775,000m^3 after excavation and establishing the embankment.

Table 6.2 Purposes and Suitable Type of Cover Soil

	Purpose of cover soil	Suitable type of soil
Daily Cover Soil	After the completion of a specified thickness of the landfill layer or one day's portion of the landfilling work is completed, a daily cover soil layer is arranged to prevent odor and reduce vermin generation.	Permeable and porous sandy types should be used for daily covering to ensure easy spreading and compaction of the solid wastes, and stabilize the landfill waste layers by not hindering the waste decomposition process.
Intermediate Cover Soil	Intermediate cover soil is carried out according to the landfill work progress. The function is more for providing a foundation for dumping activity by the collection vehicles and to drain the surface water from landfill areas quickly and effectively.	Clay soil is suitable for intermediate covering to prevent gases from dispersing or rainwater from seeping into the waste layers.
Final Cover	When all the overall landfilling work has been completed in a landfill site, the final cover soil is laid on the top of the landfilled waste layers. The types and thickness of final cover soil depends on the planned usage of the completed landfill site.	The final cover soil should be resistant to erosion by rainwater, have low permeability and be suitable for plants.

(4) Leachate Treatment

In the dry season, the half year from May to October, it is estimated that there is little leachate generation and the leachate stored in the leachate retention pond will be treated in the leachate treatment facility with only one system in operation due to the low BOD load condition.

In the rainy season, as a countermeasure for storm water, some of the leachate will be directly discharged to the river with water quality monitoring. In case the maximum amount of water in the rainy season is more than the maximum capacity of the leachate retention pond, the surface part of the leachate will be discharged to the river from the leachate retention pond. The maximum amount of direct discharge is planned as 47,000 m^3/d in the case where there is no reduction of the peak maximum daily rainfall data as in 1999. In the case of direct discharge, the aerator will be stopped to settle the suspended solids and discharge only the surface part of the leachate to the river with water quality monitoring. However, the water quality should be monitored

to prevent water pollution in the river and if the water quality deteriorates, a part of the effluent treated in the leachate treatment facilities can be re-circulated to the landfill area for emergency purposes.

(5) Management of Liner Facility

A visual inspection of the covered liners may not be possible. The condition of the liners will have to be determined based on signs such as the presence of cracks or a cavity on the surface, floating, slipping, collapse of the liner, groundwater leaking, escaping landfill gas, etc. After the liner is buried, indirect signs such as the water quality of the outlet from the leachate collection facility and groundwater collection facility or of the groundwater inspection well as well as cracks and cavities in the surface soil.

(6) Environmental Monitoring

The amount and quality of landfill gas should be monitored and analysis carried out periodically in order to determine the condition of the landfill and the potential impact on the environment. The data can also be used to determine the rate of stabilization of the landfill.

The water quality of the surrounding area should be monitored regularly to ensure that the contaminated water from the landfill site has not polluted the surrounding water sources.

(7) Waste Pickers Activity

Currently, there are many waste pickers in existing landfill sites in Mamminasata area. For example, more than 100 waste pickers collect recyclable material from dumped waste in the Tamangapa landfill site in Makassar. The sorting area is to be prepared to assist waste pickers to collect the recyclable material effectively. Also, it is necessary to prepare some regulations to protect the health of waste pickers and avoid accidents with heavy equipment or collection vehicles. Procedures for waste picking activities should be prepared to fit in with the unloading of collection vehicles.

6.2 Administrative Plan

6.2.1 Organization

(1) Organization for Project Implementation

For project implementation, the executing organization should be established under the supervision of PU South Sulawesi province. To implement a smooth operation, not only for the landfill site but also for collection and transportation and other related activities in solid waste management of both Makassar and Gowa, the establishment of an inter-regional organization is needed. The organization would have the responsibility of managing all the activities regarding Gowa and Makassar even though the Cleaning Departments of Makassar or Gowa may contract out the work to the private sector for collection and transportation of solid waste.

(2) Organization of New Landfill Site

Permanent staff shall operate the site. Although both Makassar Municipality and Gowa Regency shall provide the required personnel, the permanent staff shall operate as one team under the direct instructions of the site manager. The required number of staff and their duties are preliminarily outlined in the table below. This should be reviewed and discussed in the technical committee.

Table 6.3 Preliminary Required Number of Staff and Their Duties (1/2)

Name of role	No.	Responsibility
Landfill Manager	1	- Manage the landfill staff and assume responsibility for their safety - Prepare the budget and review the expenditure - Continue contact with the local community
Asst. Manager/ Weighbridge Operator	1	- Prepare a daily record of the incoming waste - Check on incoming waste - Develop waste disposal plan and waste cell preparation - Maintain the operations expenditure accounts - Prepare the daily operation records - Others as directed by Landfill Manager
Asst. Manager/ Leachate treatment and Environmental Monitoring	1	- Manage the leachate aeration and re-circulation system and leachate pond - Responsible for environmental monitoring and participate in environmental coordination committee activities - Others as directed by Landfill Manager
Overseers	2	- Direct the waste trucks to the disposal cell - Manage the heavy equipment operations - Application of daily cover soil - Manage spraying of insecticides and odor suppressants - Others as directed by Landfill Manager or Assistant Manager

Table 6.3 Preliminary Required Number of Staff and Their Duties (2/2)

Name of role	No.	Responsibility
Assistants	2	- Assist the Overseer - Assist mechanical works - Assist heavy equipment operations - Clear litter scattered away from waste disposal area - Others as directed by Site Manager or Assistant Manager
Public Relations Officers	2	- Compilation and analysis of public complaints or comments - Liaison with surrounding community residents - Prepare and disseminate information on site operation - Arrange site explanatory visits - Others as directed by Site Manager or Assistant
Mechanics	5	- Daily inspection of landfill equipment, leachate treatment facilities including aerators & pumps and maintain maintenance records - Simple repair and maintenance works - Maintain sufficient spare parts on site for simple repairs - Maintain records of heavy repairs and maintenance works carried out on equipment - Others as directed by Site Manager or Assistant Manager
Operators	15	- Operation of the landfill equipment or leachate treatment facility under the direction of the Overseer - Daily inspection of landfill equipment or leachate treatment facility - Assist in simple repair and maintenance works - Others as directed by Site Manager, Assistant Manager or Overseer
Guards	2	- Landfill access control - Protection of landfill facilities and equipment - Others as directed by Site Manager or Assistant Manager

Source: JICA Study Team

6.2.2 Financial Management

(1) Current Financial Conditions

The current financial position of cleaning departments is summarized as follows.

Table 6.4 Financial Condition of Cleaning Department in Makassar [million Rp.]

		Activities	Target	Realization	Rate
General Administration Expense	General Administration Expense	Sub Total	6,177	5,998	48%
		Personnel and officers	2,530	2,454	20%
		Goods and services	3,222	3,162	25%
		Official trips	55	53	0%
		Maintenance	370	329	3%
O&M expenses	O&M expenses	Sub Total	7,507	6,329	51%
	Waste services	Waste services	6,030	5,289	43%
		Revenue administrative enhancement and management	172	68	1%
		Ditch/drain cleaning	250	246	2%
		Waste sweeping/ collection	483	463	4%
		Waste transportation & heavy equipment operation	4,671	4,134	33%
		Workshop	55	52	0%
		Supervision staff, money collector and staff	303	258	2%
		Waste processing at Tamangapa final disposal	96	68	1%
	Other than waste services	Sub Total	1,477	1,040	8%
		Park maintenance	1,300	896	7%
		Graveyard Maintenance	177	144	1%
Capital expense	Capital expense	Sub Total	92	83	1%
		Communication tool procurement	92	83	1%
Revenue			13,776	12,410	100%
Revenue coverage			2,659	1,984	

Source: Cleaning department in Makassar

Note: General administration cost includes salary of permanent and non permanent staff. Staff and maintenance and operational expenses include allowance for them.

According to the above table, the administration expense is nearly 50% of the total expenses. That may indicate that the financial condition of the cleaning department in Makassar is worse than appears at first sight. The various activities should be subject to capacity building for the new organization in addition to institutional improvement to improve the financial condition of the organization with respect to solid waste management.

(2) Tariff System

Approximately 25 % of the operation and maintenance cost is covered by a service fee collected from each generation source, such as household, restaurant, hotel, office, factory, etc. The service fee has varied from 1000 Rp./month to 60,000 Rp./month. The collection rate of the service fee is approximately 50 to 60 % according to the cleaning and beautification department in Makassar. Some beneficiaries do not pay the service fee.

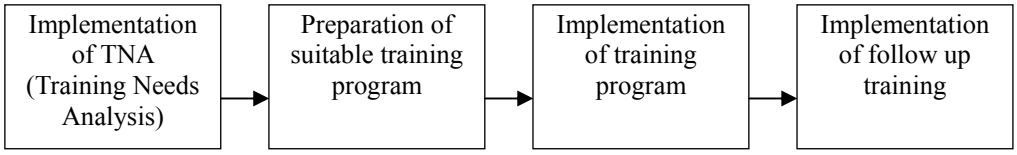
A suitable tariff system will be considered during the organization of the new landfill site through the project implementation. The waste disposal fee, including a collection and transportation fee, is estimated to be 22,000 Rp./ton.

In addition, the new organization managing final disposal may not have the responsibility of collection and transportation and will not be able to collect a service fee from waste generators in cases where there is a different organization from the cleaning departments in Makassar and Gowa. In that case, a distribution system for service fees from waste generators should be considered.

6.2.3 Capacity Building and Public Awareness Raising

(1) Capacity Building for New Organization regarding Landfill Operation

The new organization should be established at an early stage before the completion of landfill site construction. The maintenance or operation skills for some equipment will be developed through training during the stage of construction. The procedure of capacity building for each member of staff and organization is summarized as follows.



Source: JICA Study Team

Figure 6.1 procedure of capacity building for each member of staff and organization

Table 6.5 Required Skills for Each Staff

	Required skill
Landfill Manager	-Management ability to manage the landfill staff -Preparation ability for the budget and review of expenditure -Diplomatic talent or communication ability with the local community
Asst. Manager/ Weighbridge Operator	-Handling and checking ability for incoming waste -Planning ability for waste disposal and cell preparation -Ability to maintain the operational expenditure accounts -Data management ability for incoming, separated and disposed waste including recycled waste -Other required general ability as a member of society
Asst. Manager/ Leachate Treatment and Environmental Monitoring	-Knowledge and technical skill relating to leachate treatment -Knowledge and technical skill regarding environmental monitoring and ability to arrange environmental coordination with committee activities -Other required general ability as a member of society
Overseers	-Management ability for operation of landfill by collection vehicle and heavy equipment -Management ability, knowledge and technical skill regarding cover soil and spraying of insecticides and odor suppressants -Other required general ability as a member of society
Assistants	-Knowledge and technical skill regarding operation of landfill activity by collection vehicle and heavy equipment -Knowledge and technical skill to apply cover soil and spray with insecticides and odor suppressants -Other required general ability as a member of society
Public Relations Officers	- Compilation and analysis of public complaints or comments - Communication ability with surrounding community residents - Presentation and dissemination ability - Planning ability for dissemination by workshops or explanatory meetings -Other required general ability as a member of society
Mechanics	- Knowledge and technical skill regarding landfill equipment, leachate treatment facilities including aerators & pumps and maintaining maintenance records - Skill of simple repair and maintenance work - Management ability with spare parts on site for simple repairs and heavy repairs and maintenance work carried out on equipment -Other required general ability as a member of society
Operators	- Knowledge and operation skill with the landfill equipment or leachate treatment facility under the direction of the Overseer - Skill of simple repair and maintenance works -Other required general ability as a member of society
Guards	- Observation and control ability for landfill access control -Other required general ability as a member of society

Source: JICA Study Team

(2) Public Awareness Raising and Public Involvement

i) Public Awareness Raising

Public awareness raising activities have been carried out through the Pilot Projects in the Master Plan Study. Through a healthy exchange program (a program in which becak drivers receive rice as remuneration for collecting waste from each household) as well as a community and school based waste collection in separation, the public has participated actively even though only for a short time. A community-based organization is effective in public awareness raising. The organization will be established through the project implementation. The target group for promoting the awareness-raising and participation will be the general population of the whole city or in the particular project area, depending on the type of project. There are two specific groups that should deserve special attention. The first group is adults, especially housewives and housekeepers, who are responsible at home for daily waste handling. The second group is children and students. It is known that there are many opportunities for children and students to influence their parents. Though the chosen activities should be finally decided through discussion with participants, some of the promotion programs that are conceivable for each population group are as follows:

Table 6.6 Participants for Public Awareness Raising

Target Group	Activity	Awareness Raising Procedure
Adults, especially housewives and housekeepers	- cleaning activities on determined special days - Involvement in waste separation	- Distribution of awareness-raising materials (leaflets, posters, bulletins, T-shirts, caps, etc.) - Information dissemination by Pete-Pete or audio-visual products (spots for radio and television, videos), with promotion of the subject for inclusion in the content of mass media where possible - Workshops and presentations for communities
Students	- cleaning activities on determined special days - Bringing recyclable waste to school for recyclable material collection - School compost as a part of a social class	- Provision of necessary information for school boards - Preparation of a social class for awareness raising - Workshops for all school staff (teaching and non-teaching) - Discussions at parent meetings - Developing training and education aids (video, printed material, etc.) - Establishment of discussion groups at schools - Creation of student brigades, who will make visits to local families with the objective of awareness-raising - Organization of contests, festivals and technical-scientific events

Source: JICA Study Team

Public Involvement in Source Separation

A sorting area is prepared at the new landfill site in due consideration of the promotion of the 3Rs. The waste separation in the sorting area will be mainly carried out under the direction of cleaning departments. Considering current public awareness regarding separation and discharge of waste, it appears difficult to introduce many kinds of waste separation. However, concise separation (e.g. separation of dry waste and wet waste) can be adopted in combination with the program for raising the public awareness. The separated dry waste can facilitate sorting in the new landfill.

7. PRELIMINARY COST ESTIMATION AND IMPLEMENTATION SCHEDULE

7.1 Construction and Procurement Cost

The initial investment cost including the construction cost and procurement cost has been preliminarily estimated in the following manner.

- Direct construction and equipment procurement
- Engineering cost: 10% of capital cost for construction work and for equipment procurement work
- Administrative cost: 2% of the capital cost and engineering cost will be defrayed as indirect costs.
- Physical contingency: 10% of the capital cost and consultant engineering cost and indirect cost
- Land acquisition and compensation cost: Land to be used for new landfills will be separately managed by the government, and it is excluded from the cost estimate.

7.1.1 Condition and Assumption for Cost Estimate

(1) Exchange Rate

The base date for the cost estimate is May 2006, with an exchange rate of 1 US$ = 8,760 Rp.

(2) Foreign and Local Currency Portions

Project cost estimates have been divided into a foreign currency portion and a local currency portion. Civil work and materials are available locally in Indonesia and it is estimated in local currency. On the other hand, equipment and machine are not available locally and are to be imported.

(3) Direct Construction Cost

The unit construction price was collected from recent tender rates for the construction of similar works, with consideration of price escalation, and suppliers quotations for material. These rates have been used to make an estimate of the construction costs of the proposed project. To facilitate the cost estimate, these rates were also used to calculate “all in” costs for concrete and pipe construction using different materials. The equipment and facilities for the new system introduced in this project, such as the

liner system or leachate treatment facility, have been estimated referring to a recent similar project and quotation.

(4) Land Acquisition Cost

Landfill area is approximately 95 ha. The unit cost for land acquisition was obtained from Gowa regency and Head of Pattallassang district, which is Rp.17,500/m^2. The land acquisition costs have been preliminary estimated by utilizing the unit cost.

(5) Government's Administration Cost

The Government's administration expenses for the project implementation were in proportion to the amount of the local portion of the direct construction cost. Two percent was applied and incorporated into the local currency portion.

(6) Engineering Services Expenses

The engineering services expenses were estimated in proportion to the direct construction cost to cover for the tender design and construction supervision. Ten percent was applied excluding contingency and incorporated into foreign and local currency portions at 80 percent and 20 percent, respectively.

(7) Capacity Building and Public Awareness

In the context of the implementation of the project, it will be necessary for various levels of new organization related to the landfill site to have proper training for respective issues. For this purpose, approximately three percent of the direct construction cost has been added in for the cost of capacity building and public awareness.

(8) Physical Contingency

The physical contingency was provided to cover minor differences between actual and estimated quantities, omissions of minor items of work, payment for incidental items, difficulties unforeseeable that are dependent on the site condition, possible changes in plans, and other uncertainties. Ten percent of the base cost was applied.

Table 7.1 Estimated Cost of Construction and Procurement

	Facility/Equipment	Unit	Unit cost (Local) [mil.Rp]	Unit cost (Foreign) [mil. yen]	Quantity	Cost [mil.Rp.]
I Approach Road	1. Approach Road	Unit	9400		1	9,400
II Main Facilities	1. Stormwater drainage					
	1.1 Stormwater drainage [450×450]	m	0.09		190	17
	1.2 Stormwater drainage [1000×800]	m	0.22		1,580	354
	1.3 Stormwater drainage [1300×900]	m	0.29		1,120	319
	1.4 Stormwater drainage [1500×1200]	m	0.39		480	187
	1.5 Stormwater drainage [1600×1300]	m	0.43		250	108
	1.6 Stormwater drainage [1800×1400]	m	0.49		730	356
	1.7 Stormwater drainage [2000×1500]	m	0.55		260	142
	1.8 Stormwater drainage [2600×1800]	m	0.73		150	110
	1.9 Stormwater drainage [3000×2000]	m	0.86		920	796
	2. Road (in Landfill Site)					
	2.1 Access road	m	2.16		2500	5,400
	2.2 Peri-site road (concrete paved)	m	0.80		2500	1,989
	2.3 Onsite road (gravel paved)	m	0.63		1800	1,134
	3. Landfill area					
	3.1 Excavation (normal)	m3	0.01		1,392,000	19,210
	3.2 Excavation (hard)	m3	0.05		348,000	16,070
	3.3 Embankment	m3	0.01		965,000	12,738
	4. Liner Facility (Geomembrane, Protection layer)	m2				
	4.1 Penetration clay covering	m2	0.04		270,500	11,848
	4.2 Geomembrane FML(PE t=1.5mm)	m2	0.13		541,000	68,437
	4.3 Sand protection layer (500mm)	m2	0.02		270,500	5,450
	5. Leachate Collection Pipe					
	5.1 PVC perforated pipe (300mm)	m	0.79		9234	7,282
	5.2 PVC perforated pipe (600mm)	m	1.19		1859	2,210
	6. Gas Removal Facility					
	6.1 PVC perforated pipe (200mm)	m	0.36		2340	842
	6.2 Structural material, etc	m	0.09		2340	211
	7. Leachate Treatment Plant	Unit	22872	502	1	61,511
	8. Leachate Discharge Facility					
	8.1 PVC : dia 600mm	m	1.19		730	868
	8.2 Pump station	Unit	1750		1	1,750
	9. Monitoring Well (100mm * 20m * 6 places)	Unit	90		6	540
III Building and Accessories	1. Office Building	m2	3.60		300	1,080
	2. Weigh Bridge (Building)	m2	4.50		150	675
	3. Weigh Bridge:(Facility, load cell type : 30 ton cap	Unit	1.08		2	2
	4. Gate House	m2	1.80		30	54
	5. Washing Station (Building)	m2	1.80		150	270
	6. Washing Station (Facility)	L.S.	405		1	405
	7. Maintenance Workshop	m2	3.60		800	2,880
	8. Sorting Area	m2	1.80		900	1,620
	9. Safty Facility (Fence, gate, lightening pole, etc)	L.S.	999		1	999
	10. Planting for Landscape and Buffer Zone	L.S.	500		1	500
IV Utiities	1. Electricity	L.S.	412		1	412
	2 .Water (deep well 6 inch 100m)	L.S.	160		1	160
V Landfill Equipment	1. Buldozer (more than 18 ton)	Unit		20	4	6,153
	2. Excavator (more than 1m3)	Unit		14	1	1,077
	3. Landfill Compactor (more than 20 ton)	Unit		30	2	4,615
	4. Wheel Loader (more than 2.0m3)	Unit		14	1	1,077
	5. Dump Truck (more than 7 ton)	Unit		8.7	2	1,338
Total Construction Cost						252,595

Table 7.2 Initial Cost Estimation

Item		Foreign (1,000 US$)	Local (1,000 US$)
1 Construction and Procurement Cost			
1) Construction Works (Main Facility)			
a Approach Road		0	1,073
2) Construction Works (Main Facility)			
a Storm water Drainage		0	273
b Internal Road		0	973
c Landfill Area		0	5,481
d Liner Facility		0	9,787
e Leachate Collection Facility		0	1,084
f Gas Removal Facility		0	120
g Leachate Treatment Facility		4,411	2,611
h Leachate Discharge Facility		0	299
i Monitoring Well		0	62
3) Construction Works (Building & Accessories)			
a Office Building		0	123
b Weigh Bridge		0	77
c Gate House		0	6
d Washing Station		0	77
e Maintenance Workshop		0	329
f Sorting Area		0	185
g Safety Facility		0	114
h Planting		0	57
4) Utilities		0	65
5) Procurement of Equipment			
a Landfill equipment		1,628	0
Sub Total	a	6,039	22,796
2 Land Acquisition & Compensation	b	0	1,898
3 Engineering Services	c=d+e	2,151	1,434
1) Engineering Design and Construction Advice (10%)	d=a×10%	1,632	1,088
2) Capacity Development	e=a×3%	519	346
Sub Total	f=a+c	8,190	26,129
4 Administration (2%)	g=f×2%	164	523
Sub Total	h=f+g	8,354	26,651
5 Contingency (10%)	i=h×10%	835	2,665
Total Estimate Cost	j=h+i	9,189	29,316

7.2 Operation and Maintenance Cost

7.2.1 Operation and Maintenance Cost

A large part of operation and maintenance costs is salary for staff and workers and the cost for the power supply for equipment and facilities. The salary rates used are based on the current average of existing organizations of the Makassar city and Gowa regency. The total operation and maintenance cost is estimated as summarized in the following table.

Table 7.3 Initial and Recurrent Cost Estimation [thousand US$]

	Landfill Site				Collection & Transportation
	Initial Cost			O&M	O&M
	Total	Domestic	Foreign		
2008	19,253	14,658	4,595	0	646
2009	19,253	14,658	4,595	0	669
2010	0	0	0	1,013	953
2011	0	0	0	1,035	987
2012	0	0	0	1,051	1,020
2013	0	0	0	1,053	1,054
2014	0	0	0	1,055	1,088
2015	0	0	0	1,051	1,122
2016	0	0	0	1,051	1,154
2017	0	0	0	1,052	1,187
2018	0	0	0	1,052	1,219
2019	0	0	0	1,051	1,252
2020	0	0	0	1,051	1,284
Total	38,506	29,316	9,189	10,966	13,635

7.2.2 Collection and Transportation

Operation and maintenance cost has been preliminarily estimated on the collection and transportation due to movement of the location of the landfill site for Makassar in addition to the total price based on unit cost for one ton of solid waste and an increasing quantity of collected waste for each year.

7.2.3 Landfill

(1) Personnel Cost

Personnel cost has been estimated based on new staff and current unit personnel costs for both contractors and official staff.

(2) Operation Cost

Operation costs, including electricity for the leachate treatment facility, the collection system and the administration building and fuel for heavy equipment, etc., have been calculated based on the unit cost of electricity for the public service (more than 200kVA) and the fuel cost for heavy equipment has been estimated based on the unit cost for disposed waste quantity.

(3) Maintenance Cost

Maintenance costs have been estimated at a certain rate of the procurement or construction cost as shown in the following table.

Table 7.4 Maintenance Cost regarding Landfill Operation

Item	Maintenance cost
Heavy equipment	5% of procurement cost
Site maintenance (roads, grass, cutting, drainage)	1.5% of construction cost
Leachate treatment	5% of construction cost

Source: JICA Study Team

7.3 Implementation Schedule

Table 7.5 shows a schedule for the implementation of the Pattallassang landfill site in Gowa. The construction is not divided into two phases because it is difficult to construct the remaining portion of a landfill site after it has been put into operation.

The schedule has been prepared under the following conditions.

- Rainy season in the project area
- Special long holiday such as Ramadan or other national holidays

Table 7.5 Implementation Schedule regarding Construction, Procurement and Consulting Services

Items	2006				2007				2008				2009				2010				2011			
	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV	I	II	III	IV
Basic Design																								
Detail Design																								
Tendering & Others																								
Procurement																								
Construction																								
Operation																								
Capacity Buildin																								
Public Awarness																								

8. INITIAL ENVIRONMNETAL EXAMINATION

8.1 Approach to Assessment

The Environmental Impact Assessment (EIA) is conducted in accordance with the relevant laws, regulations and standards applicable in Indonesia, as well as the JICA Environmental Guideline.

8.1.1 Legislation and Procedure

(1) Laws and Standards

There are separate environmental legislation at the national and provincial level as listed below.

Table 8.1 Law and Regulations

Legislation	Contents
Decree of State Minister for the Environment No.17/2001	The legislation indicates types of business and/or activity plans that require an Environmental Impact Assessment (EIA) to be completed.
The Governor Decree No.494/VII/2003	The legislation indicates types and activity plans in South Sulawesi Province for which an EIA is required (AMDAL), as well as environmental management plans (RKL) and environmental monitoring plans (RPL) in addition to the Decree of the State Minister for the Environment No.17/2001.
The Decree of the Ministry of Living Environment No.40/2000	The legislation indicates the responsibility and relationship of Central Government and Regency/City in assessing environmental impact analysis. If there is one project to be established and it is located in, and/or will impact on, more than one province then the EIA analysis will be conducted by the Central Government.

Requirement for EIA is decided in accordance with the scale and category of projects. If EIA is needed, BAPEDALDA at the provincial/regency level will determine whether EIA should be conducted at central, provincial or regency-city level. After presenting the framework as required by the EIA guideline, the EIA document (AMDAL), Environmental Management Plan (UKL/RKL) and Environmental Monitoring Plan (UPL/RPL) are prepared by the project organization.

When EIA is required, the area of influence must be ascertained inclusive of indirectly affected areas.

The existing procedure for EIA is shown in Figure 8.1. An EIA study usually starts at the end of the planning phase when the basic design and implementation program

is completed by the project executive organization.

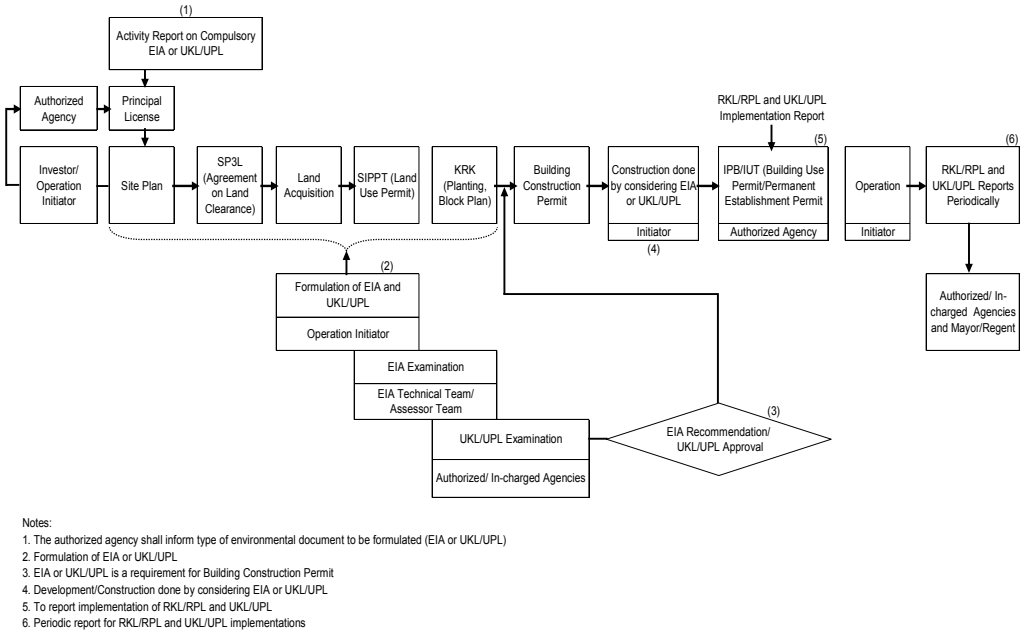


Figure 8.1 Existing EIA Procedure

Environmental standards are also defined at national and provincial level as listed below.

Table 8.2 List of Main Environmental Standards and Regulations

Standard and Regulation	Contents
The Government Regulations No.82/2001	Including the physical, chemical and bacteriological criteria value for every water type.
The Government Regulation No.41/1999 concerning Ambient Air Quality Standards	Including 13 parameters, i.e.: SO_2, CO, NO_2, O_3, HC, PM10, PM2.5, TSP, Lead (Pb), dust and so on.
Decree of State Minister for the Living Environment No.KEP-48/MENLH/XI/1996	Including the Ambient Noise Level Standard and Vibration Level Standard.
South Sulawesi Provincial Government, Governor's Decree No.14/2003	Including a) environmental water quality, b) discharged wastewater quality, c) ambient air quality, d) industrial emission gas quality, e) noise and f) vibration.

Table 8.3 Offensive Odor Level Standard

A. Smell from Single Source

No.	Parameter	Unit	Limit Value
1.	Ammonia (NH_3)	ppm	2.0
2.	Methyl Mercaptan (CH_3SH)	ppm	0.002
3.	Hydrogen Sulfide (H_2S)	ppm	0.02
4.	Methyl Sulfide $(CH_3)_2)S$	ppm	0.01
5.	Styrene ($C_6H_5CHCH_2$)	ppm	0.1

Notes: ppm = parts per million

B. Smell from Mixed Source

An odor level resulting from mixed sources shall be stated as odor limit detectable if sensed by more than 50% of members of a team of 8 (eight) testers at a minimum.

The effluent standard of water quality in South Sulawesi province stipulates three criteria as shown in following table.

Table 8.4 Water Quality Standard of Waste Discharge for Public Housing Areas, Restaurants, Offices, Trading and Apartments

	Unit	A	B	C
pH		6.0-9.0	6.0-9.0	6.0-9.0
BOD5	mg/L	25	40	75
COD	mg/L	80	100	125
Total Suspended Solids	mg/L	20	35	50
Mineral Oil	mg/L	5	8	10
Total Coliforms	MNP/100mL	2500	5000	-

A: Public housing area >200Ha, Restaurants >2300m^2, Offices, Trading and Apartments > 50,000 m^2

B: Public housing area 16-200Ha, Restaurants 1,400-2,300 m^2 , Offices, Trading and Apartments 10,000-50,000 m^2

C: Restaurants 500-1400 m^2, Offices, Trading and Apartments 5000-10,000 m^2

The odor level standard in the Decree of the Ministry of Environmental Affairs is reproduced in following table.

8.1.2 Scope of EIA

The target project is a new landfill site (TPA) with an area is approximately 95 ha and landfill capacity of approximately 5,400,000 m^3 including the required capacity for cover soil in Pattallassang district in Gowa regency. EIA is required for an open

dumping landfill site project of more than 10ha or a total capacity of 10,000 ton in sanitary /controlled landfill in Indonesia, according to the "Decree of the State Minister for the Environment" No. 17 of 2001 on Types of Business and /or Activity Plans that are Required to Complete an Environmental Impact Assessment". Certain items may not need to be covered by EIA depending on the magnitude, type of projects or the site conditions to focus on potentially significant impact items. Therefore, EIA for the project should define its scope to focus on relevant items and evaluate based on an Initial Environmental Examination (IEE).

In the following table, items marked with ○ require investigation of the existing conditions, forecast and assessment of the impacts in detail and proper countermeasures should be taken. Regarding items with △, soundness of the plan should be assessed by evaluating the contents and schedule of the preventive and countermeasures for the environment.

Table 8.5 Summary of Environmental Impacts and Effective Factors

Environmental Impacts / Effective Factors		Pollution						Natural Environment									Social Environment													
		1 Air Pollution	2 Water Pollution	3 Soil Contamination	4 Noise and Vibration	5 Land Subsidence	6 Offensive Odor	7 Topography and Geology	8 Soil Erosion	9 Groundwater	10 Hydrological Situation	11 Coastal Zone	12 Biology (Flora and Fauna)	13 Meteorology	14 Landscape	15 Global Warming	16 Resettlement	17 Economic Activities	18 Landuse and Resional Resource	19 Social Communities	20 Infrastructure and Public Service	21 Minorities and Low Income People	22 Uneven Distribution of Interest	23 Gendor	24 Right of Children	25 Cultural Property	26 Public Health Condition	27 Waste and Garbage	28 Water Rights・Right of Common	29 Hazards and Accident
General		△	○		△		○			△	△		△		△		△	＋				＋					△	△	△	△
Construction Phase	Change of Topography・Occupation		△				△	△	△	△	△		△		△		△	＋	△			＋	△					△	△	△	△
	Construction Vehicles	△			△																										
	Construction Machines	△			△																										
Operation Phase	Occupation									△	△		△		△	△	△			△											
	Operation	△	○	△	△		○									＋		＋	＋		＋	＋					△	△	△	△

○ : significant negative impact
△ : less negative impact
brank : no effect
＋ : positive impact as expected

As identified in above table, offensive odor and water pollution have the possibility of significant negative impacts on the implementation of this project. Offensive odor from the landfill site would be a significant impact, especially during landfill operation.

The water quality in Pabundukkang River will be affected by leachate from the new landfill site, if leachate is not treated properly. Therefore, suitable mitigation measures should be taken to prevent the deterioration of water quality of

Pabundukkang River or groundwater. The other items will have less negative impact or the impacts are negligible. But suitable mitigation measures should be undertaken for such less negative impacts.

8.2 Potential Environmental Impacts and Mitigation Measures

8.2.1 Pollution

(1) Offensive Odor

Offensive odor in this area is not problem at present. Around the project area, the main sources of odor are the domestic waste water and garbage from each household. However, it is not so significant because their volumes are currently very small. In evaluating the construction scheme it has been determined that there will be no big sources of offensive odor during construction phase at the project site.

During the operation phase, large volumes of solid waste will be hauled into the landfill site (TPA), and some impacts of offensive odor on the surrounding area is predicted. Therefore, in the management plan, compaction of disposed waste and use of daily cover soil and preparation of buffer zone by planting tree are programmed as protection measures for the environment. Therefore, offensive odor to surrounding residents can be reduced. If complaints of offensive odor are received from the surrounding residents, an examination of offensive odor should be undertaken around the landfill site to evaluate it against the environmental standard.

(2) Water Pollution

Currently, the surface water quality in the upstream of the Tallo riverat Pacelekang bridge, BOD_5 and COD exceeded the water quality standard Class IV, with respect to Manganese (Mn), Hydrogen Sulphite (H_2S-), Nitrite (NO_2-N), Zinc (Zn), Organic matter ($KMnO_4$), Cadmium (Cd), BOD_5, COD, Fecal Coliform and Total Coliforms values, as shown in the following table.

Table 8.6 Result of Water Quality Survey Upstream of Tallo River [mg/L]

	2003		2004		2005		2006	
	Dry	Rainy	Dry	Rainy	Dry	Rainy	R-1	R-2
pH	7	6	-	7.2	7.2	7	7.2	7.1
DO	5.4	2.4	-	6.5	-	-	6.3	6.4
BOD_5	50	150	-	1.4	2.5	0.7	72.4	75.2
COD	85	360	-	10	11.8	4.4	124.7	130.4
TDS	407	60	-	125	107	107	-	-
TSS	19	22	-	227	30	50	6.8	10.9

The Tallo river around the project area is polluted by domestic waste water from neighboring households. However, there are few pollution sources around the project area and the density of heavy metals is very low.

During the construction stage, the construction of the landfill site will cause an increase in TSS in the near-by river bodies. However, it can be minimized by utilizing a sedimentation pond, downstream of the leachate retention pond, to be constructed at an early stage of the construction phase. The pollution is thought to be limited also because turbid water will only be generated during a limited period of excavation and ground filling. The drainage water should be discharged after proper treatment for TSS. It is also important to enforce regular monitoring to evaluate the conditions against the river water standard.

Stormwater from the construction site is difficult to analyze because it is affected by a variety of conditions such as rainfall, reclamation, ground and soil. Therefore, the environmental impact may be evaluated based on the planned studies, programmed countermeasures and the scheduled monitoring of water pollution.

During the operation stage, leachate would have a significant impact on rivers. As designed under this project, a leachate treatment facility is to be prepared to mitigate the impact on the water quality of surrounding rivers. The target criteria of the design standard are set at BOD_5 of 75 mg/l and TSS of 50 mg/l. However, it is necessary to monitor the water quality of the drainage after leachate treatment periodically. The analysis items are to be decided referring to the standard of river water quality and drainage in South Sulawesi province. Surveys of surrounding river water quality should be also undertaken by the project organization.

(3) Air Pollution

Currently, there is no big pollutant source impacting on air quality around the project area. During the construction stage, exhaust gases will be generated by the operation of trucks and construction machines. After completion of the project, waste collection vehicles will be moved to the site and bulldozers for spreading and leveling the garbage will be operated at the site. Dust will also be generated for a short period during the land leveling stage (excavation and filling). It can be minimized by countermeasures such as sprinkling water.

During the operation stage, it is predicted that dump trucks and operational machines at the site will be limited. Therefore, the influence on ambient air quality is not so serious, but it is necessary to monitor regularly the number of conveyance trucks and operational machines at the landfill site. It is important to consider an

effective transportation plan, machine operation programs and manpower planning.

For the long term, the number of collection vehicles will be increasing gradually. Therefore, regular monitoring, analysis and evaluation are recommended. An environmental buffer zone surrounding the site should be considered, including at the basic design stage and before there is an increase of air pollution sources.

(4) Noise and Vibration

According to the survey result, there is no source of sound around the project area. During the construction stage, there will be noise and vibration from the construction machines and trucks, which generate noise and vibration, but it can be reduced by regular maintenance and an efficiently scheduled operation. In addition, the number of the machines and vehicles will be limited and there are few affected residences. Therefore, it is not necessary to monitor the noise and vibration level around the construction areas. However, the number of operational machines and vehicles should be monitored so that countermeasures can be taken in a timely manner if justified. After the completion of the project, it is considered that the noise and vibration impact on the surrounding residential people will be low, because the conveyance trucks and operational machines will be relatively few in number compared with the general traffic volume on the road or the number of machines during the construction stage. It is recommended that the number of conveyance vehicles and operational machines be verified, along with their hours of operation and maintenance condition.

8.2.2 Natural Environment

(1) Groundwater

Most residents around the project area use the dug wells that provide water mainly for daily use. From field reconnaissance, it is found that the well depth is about 10 m and groundwater level is - 5~ -6 m.

A groundwater quality survey in the project area has been conducted in the course of this study, as shown in Table 8.7. Except for the pH at one point, fecal coliform and total coliforms, test results conform to the National Standard for Drinking Water (No.907-2002).

Table 8.7 Result of Groundwater Quality Survey around the Project Area

Parameters	Governmental Regulations No.82-2001				National Standard for Drinking Water (No.907-2002)	Unit	Wells around the Landfill Dumping Site		
							2006/2/14		
							1	2	3
	Class I	Class II	Class III	Class IV			Panaikang proposed site (PW.1)	Panaikang proposed site (PW.2)	Panaikang proposed site (PW.3)
Physical :									
Temperature	±3℃	±3℃	±3℃	±5℃	±3℃	℃	29.6	29.2	29.1
Color	(-)	(-)	(-)	(-)	15	TCU	1	1	1
Total Suspended Solid (TSS)	50	50	400	400	1,000	mg/l	4.65	7.35	5.28
Chemical									
pH	6-9	6-9	6-9	5-9	6.5-8.5	-	6.1	5.2	6.0
BOD_5	2	3	6	12	(-)	mg/l	1.09	1.08	0.91
COD	10	25	50	100	(-)	mg/l	3.14	2.76	2.87
Disolved Oxigen (DO)	6	4	3	0	(-)	mg/l	6.0	5.0	6.0
Phosphorus (P)	0.2	0.2	1	5	(-)	mg/l	tt	tt	tt
Nitrate (NO_3-N)	10	10	20	20	50	mg/l	0	0.27	0.18
Amonium (NH_3-N)	0.5	(-)	(-)	(-)	1.5	mg/l	0.020	0.021	0.01
Arsenic (As)	0.05	1.0	1.0	1.0	0.01	mg/l	tt	tt	tt
Cadmium (Cd)	0.01	0.01	0.01	0.01	0.003	mg/l	tt	tt	tt
Chromium (Cr^{6+})	0.05	0.05	0.05	1.0	0.05	mg/l	tt	tt	tt
Lead (Pb)	0.03	0.03	0.03	1.0	0.01	mg/l	tt	tt	tt
Mercury (Hg)	0.001	0.002	0.002	0.005	0.001	mg/l	tt	tt	tt
Mineral oil	0.6	0.8	1.0	(-)	(-)	mg/l	tt	tt	tt
Detergent	0.2	0.2	0.2	(-)	0.05	mg/l	tt	tt	tt
Phenol compounds	0.001	0.001	0.001	(-)	(-)	mg/l	tt	tt	tt
Bacteriology :									
Fecal Coliform	100	1,000	2,000	2,000	0	MPN/100ml	2	3	3
Total Coliforms	1,000	5,000	10,000	10,000	0	MPN/100ml	45	50	50

Source : Mamminasata JICA study team data Year 2006

Source: JICA Study Team

Figure 8.1 Water Quality Survey Points around the Project Area

The residents around the project area utilize the groundwater for daily life. All of the

groundwater sources are shallow dug wells and their water quality is not so good regarding fecal coliform and total coliforms. A pumping survey showed that groundwater flow runs from the north where there are two small hills to the southwest to a small river.

During both construction and operation phases, monitoring of groundwater level and quality should be executed regularly. If there is a sharp decline of groundwater level or deterioration of water quality confirmed through the monitoring tests, proper countermeasures should be implemented by the project executive organization. In addition, they should consider alternative measures including a deep well exploration for the project site.

(2) Hydrological Situation

The Tallo River, which flows down the southeast side, has a catchment area of 407 km^2, but the discharge data is not measured along this river. Its river-bed is about 6 m lower than the ground level.

The Tallo river flows around the project area. It is anticipated that the drainage flow from the project area will be increased, because the land surface condition will be changed by land excavation. Storm-water will flow into the river through side drains and from the leachate treatment pond at the site. The leachate treatment pond, which is also to be used as a regulation pond as planned, has a storage capacity of about 140,000 m^3. Drainage facilities and this pond are planned to meet a 10-year return period flood so that storm water to the river will be regulated.

(3) Flora and Fauna

There is no detail data regarding flora and fauna around the project area. During the field reconnaissance, land birds, mainly sparrows, muias and finches were observed. However, the existing species are mainly common ones in the rural area of South Sulawesi. It has not been possible to find any mammals of conservation species. It is considered that the vegetation consists mainly of natural plant species around the project area. The main species of tree is a kind of acacia. Cultivation species for agricultural use in the area are corn (jagung), cassava (ubi) paddy, etc. No data is available on the freshwater aquatic species in the river around the project area.

The endemic species have not been identified during field reconnaissance. All residents answered to the interview survey that endangered plants and animals do not exist. Since, some parts of land remain as copses, it cannot be denied that there is a possibility of there being a natural habitat of endemic flora and fauna. Therefore, it is necessary to investigate the flora and fauna under EIA procedure. If some

unique species and/or other precious kind of plant is found, it will be necessary to take the proper measures, e.g. create a limited protection and shift them to another place. It is quite effective for an eco-friendly landfill site to have a buffer zone including some existing copses.

(4) Landscape

The landscape like the rural area is widespread, with two hills located in the north and the remaining area being almost flat land at about 25 m in altitude. There is a relatively big river, the Tallo, flowing from east to west in the southeast of the area. The riverside land is being undermined by this river. The landscape of the project area offers a typical hilly scenery in and around the rural region of Gowa regency. During the construction phase, a large volume of excavation will bring about some changes to the area. It is recommended that green buffer zones be set in the area surrounding the project site and that relatively high trees be planted to block direct visibility of the site. These buffer zones will contribute to have an image of an environment-friendly landfill dumping site.

8.2.3 Social Environment

(1) Resettlement (Land Acquisition)

The proposed landfill site is located in Panaikang village, one of the villages in the Pattallassang region, of which the population was 19,756 persons in 2004. Though no data is available on the landownership in the proposed landfill site, around 100 people own the land in the Tanah Karang area, which includes the area of the landfill site, according to Gowa regency. The average number of family members is about 3.4 persons from the result of the interview survey around the project area. Almost all residents answered the interview survey that their average monthly income was around Rp.300,000, which is nearly half of the average monthly income of South Sulawesi province. Current land use at the proposed landfill site is mainly corn, cassava and paddy fields with some abandoned cultivation land. Most of the land appears to be low productivity land.

Because the proposed landfill site area includes privately owned cultivation fields and there are some households near the site, the land acquisition, along with the relocation and resettlement of residents will be required. According to a discussion held with Gowa regency, a technical committee will prepare a program for relocation and resettlement. The plan/program should be based on an approach with community participation and consideration of social and economic acceptability.

(2) Public Health

During the construction phase, mobilization of many labourers may cause the sanitary conditions of the project area to deteriorate. However, the problem can be avoided by organizing the management system and implementing regular monitoring. It is therefore necessary to manage solid waste and wastewater at the workers' dormitories and resting facilities. Consideration is needed to avoid flies and other noxious insects from the waste and to avoid untreated effluent discharging into the river. After the project completion, offensive odor, flies and other noxious insects from the landfill site is predicted. However, the effect on the health of near-by residents is not thought to be significant because environmental buffer zones are to be constructed surrounding this project area and daily cover soil is implemented.

(3) Hazards and Risks

It is considered that there has rarely been a significant hazard around the project area. However, the works to protect the river banks of the Tallo have not been implemented yet and there is no public health center in the project area. Therefore, soil erosion by the river and diseases are potential risks. During the construction stage, accidents with the construction work can be avoided by proper maintenance of construction machines, full attention to safety measures and safety campaigns. It is also important to establish a safety system in which every worker is assured of safe working conditions. In order to minimize risks of erosion of slopes or landslides, proper reinforcement measures should be applied.

During the operation stage, hazards include traffic accidents on the access road and operation accidents at the landfill site. However, they can be prevented by improvement of driving manners, traffic safety campaigns, proper inspection and maintenance of the road.

(4) Water Rights and Right of Common

Currently, there is one irrigation scheme downstream of this project area on the Tallo river. However, there is no available detail about water rights and right of common at this moment. During the construction phase, the rain drainage water from this site will be processed through a leachate treatment pond and discharged into the Tallo river but the discharged water will not deteriorate the water quality of the river. On the other hand, during the operation phase, the leachate water is to be treated to meet the discharge standard, and then the treated water will be discharged. It is considered that the influence on the irrigation water supply scheme will be negligible.

8.3 Environmental Monitoring

(1) Introduction

In order to identify the project's environmental impact and to minimize the negative impact on the project area, environmental monitoring should be conducted during both construction and operation phases. The aims of monitoring are to evaluate whether the construction is being implemented in accordance with the plan, with inevitable consideration for the environment, and to judge whether unexpected or serious effects are occurring as a result of the project. If a sign of serious impact is detected during the construction period, immediate action should be taken to manage the existing and/or forward impact. The following actions are needed.

- Monitor the sign of environmental change.
- Analyze the environmental impact.
- Propose possible changes of operation or mitigating measure(s).
- Implement the proposed measure(s).
- Evaluate the effectiveness of the mitigating measure(s) taken.

(2) Detailed Design – Pre Construction Phase

In the detailed design phase, it is necessary to understand the environmental conditions in order to decide on the proper construction scheme in consideration of the preservation of the environment. The project plan should be decided in due consideration of the following items:

- Selection of environmentally-sound construction technology,
- Identification of potential environmental impact associated with the work,
- Development of the details of the mitigating measures, and
- Development of the plan to audit the performance of the mitigating measures.

Before construction, a detailed investigation of the project area needs to be carried out. The objective of this investigation is to obtain background information about the surrounding environment. The results should be utilized effectively to assess the impact of construction activities. The investigation items, for which it is necessary to understand the environmental conditions, will include the following.

(a) environmental pollution

- water pollution (discharge, surface and groundwater)
- offensive odor (resources, etc.).

(b) Natural Environment

- groundwater (depth of wells and water level, etc.)
- hydrological situation (river discharge, etc.)
- flora and fauna
- landscape (photography and elements, etc.).

(c) Social Environment

- economic conditions
- present land use
- types of houses
- health conditions
- solid waste and garbage
- water rights and landownership
- traffic conditions of access road.

(3) Construction Phase

The construction should be monitored against the targets, such as the components of the construction (number of construction vehicles, machines and operating persons, etc.), the mitigation measures, the water quality of drainage, the construction noise level, and so on.

(4) Operation Phase

At the end of the construction phase, the project organization must prepare and submit the operation-phase environmental monitoring plan to AMDAL. The monitoring plan aims at identifying the environmental performance of this project, and to mitigate any unexpected environmental impact in the operation phase. The environmental elements that need to be monitored in the operation phase should include, but not be limited to:

- Conveyance vehicles and operational machines (regarding air pollution, noise and vibration, etc.)
- Water quality condition
- Offensive odor (according to complaints)
- Landscape (photographic assessment, etc.)
- Result of resettlement and land acquisition
- Public health conditions (disease and causes etc.).

9. FINANCIAL AND ECONOMIC EVALUATION

9.1 Basic Assumptions

Financial and Economic analysis were made for the proposed land fill project (hereafter the Project), in Gowa, South Sulawesi Province. It is assumed that the construction work of the Project will start in 2007 and will complete in April 2010. New land fill site will be operational on the 1st day of August 2010. It is estimated that the new land fill site will be filled up in the end of 2020. Thus, the period subject for the analysis is between January 2008 and December 2020.

Costs and benefits included in the analysis are attributed to the Project on a with-project and without project basis. The foreign currency based costs are converted to Rupiah using exchange rate of Rp. 8,670 per US$ (as of May 2006).

9.2 Financial Analysis

Same as the case in most of other areas in Indonesia, waste management service in Maminasata is provided by the respective sub-regional government. While the capital cost of waste management project (such as construction and major rehabilitation of waste treatment plant and land fill site) is mostly covered by general exchequer contribution from central government, current expenditure (such as operation and maintenance cost) is fully covered by local government.

Since, share of operation and maintenance cost of waste management service is generally higher than other infrastructure projects, most of local governments are suffering from securing adequate finance for O&M costs.

In the case of Makassar Government, in 2005, amount billed as retribution fee was Rp. 2,053.3 million. Of which, only Rp. 632.9 million was collected (collection ratio was only 30.8%). Revenue from retribution fee covered only 12.3% of O&M cost for waste management of Rp. 5,151.9 million. Even if collection ratio in the years was 100%, revenue from retribution fee would have compensated only 39.9% of actual O&M expenditure.

However, this is not only the case in Makassar. Revenue from retribution fee is generally not enough to cover O&M costs. It is almost impossible to cover the entire costs (including capital investment and O&M cost) by revenue from retribution fee. Even, there are not so many local governments collecting retribution fee for waste management service. Most of local governments in Japan

are also not collecting retribution fee. The costs for waste management service are usually covered by the budget of local government. As mentioned, land fill site project is obviously financially not viable.

Even though the project is financially not profitable, the government has to provide waste management service. There is no option but to provide the waste management service. Given the general circumstance of waste management sector, financial analysis was not executed.

9.3 Economic Analysis

9.3.1 Economic Costs

Economic costs of the Project are consists of capital investment cost and operation and maintenance cost. Following the general principles, costs and benefits are entered in the analysis in the year in which they occur, interest during construction (IDC) is excluded from the costs used in the financial analysis.

Capital investment costs consist of construction cost of land fill site, land acquisition cost, engineering service costs, facility and equipment of collection and transport of waste, government administration cost, and physical contingency. Capital investment cost of the projects is US$. 64,541.0 million for land fill site and US$ 3,114.2 million for facilities and equipments for collection and transport of waste. Local currency portion is converted to economic costs by applying a standard conversion factor of 0.85. As a result, economic cost of land fill site and facilities/ equipments for collection and transport are calculated US$ 58,709.8 million and US$ 3,105.3 million, respectively.

O&M costs include maintenance cost of project facilities, electricity tariff, staffing costs, and chemical costs. O&M costs of the land fill site are estimated US$ 1,231.7 - 1,271.7 thousand per annum. Costs of collection and transport of waste are estimated US$ 646.4 - 1284.0 thousand per annum. Present value of the economic costs during economic life, adopting 5% of discount rate, is calculated Rp. 508,330.3 million. Capital cost of the land fill site is made up of a major portion of total cost (79.0%).

Table 9.1 Present Value of Costs during Project Life (Rp. million)

Land Fill Site		Collection and Transport		Total Costs
Capital Cost	O&M Cost	Capital Cost	O&M Cost	
401,381.3 (79.0%)	53,989.9 (10.6%)	17,314.1 (3.4%)	35,644.9 (7.0%)	508,330.3 (100.0%)

Source: JICA Study Team

9.3.2 Economic Benefits

Economic benefits of waste management project can be estimated as a sum of beneficially's willingness to pay (WTP) for the project. WTP for environmental improvement project is mostly estimated by using Contingent Valuation Method (CVM). Contingent Valuation is a method of estimating the value that a person places on good or service. The approach asks people to directly report their willingness to pay to obtain a specified good/ service, rather than inferring them from observed behaviors in regular market place.

However, JICA's "Research on the Methodology of Financial and Economic Analysis for Development Project (March, 2003)" mentioned that measurement of WTP for waste management project is quite difficult, because;

- even if there is no waste management service a household can throw away garbage to such as road, river and park
- interviewee knows even if some residents show no willingness to pay the waste management service, the government have to provide the same service to them in order to kept the city clean
- sanitary landfill site and waste disposal center is normally located away from city, and thus most people have limited idea about the project effects and impacts

For these reasons, estimated WTP for the waste management based CVM service is likely to be far below the real WTP. Because of difficulty in estimating real WTP for waste management service, economic benefits are calculated based on affordability to pay (ATP).

IBRD (International Bank for Reconstruction and Development) estimates ATP for waste management service as 2% of disposable income based on past study and various experiences[*9]. Under this economic analysis, per capita average ATP for waste management service is estimated based on average monthly per capita expenditure of Rp. 139,026 per month for Gowa and Rp. 262,757 per month for Makassar[*10]. After the conversion to 2006 price using consumer price index, ATP for waste management service in Gowa and Makassar is worked out Rp. 3,492 per month and Rp. 6,150 per month, respectively. It is assumed that per capita expenditure will increase along with the anticipated GDP growth. Economic

[9] Project Appraisal Manual for Waste Management Project, IBRD

[10] Source: Socio-economic Survey of Household in South Sulawesi Province in 2004, BPS

benefits of the project are calculated using following formula;

$$EBt = \varepsilon \times \left(P_{mt} \times CR_m \times E_m + P_{gt} \times CR_g \times E_g\right) \times 365$$

Where;

EBt= Economic Benefit of the Project in year "t"
Pmt= Population of Makassar in year "t"
Pgt= Population of Gowa in year "t"
CRm=Service Coverage Ratio in Makassar (87.0%)
CRg= Service Coverage Ratio in Gowa (91.0%)
Emt= Average per capita daily expenditure of Makassar in year "t"
Egt= Average per capita daily expenditure of Gowa in year "t"
ε= Percentage of expenditure for ATP in total expenditure (2.0%)

9.3.3 Results of the Economic Analysis

Results of financial analysis are summarized as below table. EIRR is well above the cost of capital in Indonesia of 10.0%, and thus considered to be economically viable.

Table 10.2 Summary of Economic Analysis

Economic Costs			Economic Benefits			NPV	EIRR
Capital Cost	O&M Costs	Total	Makassar	Gowa	Total		
418,695	89,635	508,330	791,664	117,270	826,304	242,855	18.8%
(82.4%)	(17.6%)	(100.0%)	(95.8%)	(14.2%)	(100.0%)		

Source: JICA Study Team

Sensitivity analysis was also carried out to show various adverse impacts on the EIRR (Table 4). Even under the worst case (case 3) scenario, the project returns demonstrate a substantial economic impact.

Table 10.3 Sensitivity Analysis (EIRR percent)

Case	Description	NVP	EIRR
Case 1	Capital Expenditure: 20% Cost Overrun	159,116.1	15.1%
Case 2	Benefit: 20% Lower than Original Estimate	92,618.1	13.6%
Case 3	Combined Effect of Case 1 and 2	8,879.0	10.3%

Source: JICA Study Team

Table 9.4 Cash Flow of Economic Analysis (Base Case)

	Economic Costs					Economic Benefit			Net Benefit
	Land fill Site		Collection & Transport		Total	Makassar	Gowa	Total	
	Capital Cost	O&M Costs	Capital Cost	O&M Costs					
2007	77,145	0	0	0	77,145	0	0	0	-77,145
2008	154,289	0	0	0	154,289	0	0	0	-154,289
2009	154,289	0	8,161	0	162,450	0	0	0	-162,450
2010	128,574	10,790	8,161	4,663	152,188	60,601	8,560	69,161	-83,027
2011	0	10,983	0	6,523	17,506	98,856	14,895	113,751	96,244
2012	0	11,123	5,440	7,866	24,430	134,879	20,245	155,123	130,694
2013	0	11,140	0	8,035	19,175	147,171	22,008	169,178	150,003
2014	0	11,157	5,440	8,197	24,795	160,528	23,919	184,447	159,653
2015	0	11,122	0	7,863	18,984	140,033	20,793	160,825	141,841
2016	0	11,124	0	7,887	19,011	148,514	21,991	170,506	151,494
2017	0	11,125	0	7,901	19,026	157,369	23,240	180,609	161,583
2018	0	11,125	0	7,903	19,028	166,598	24,538	191,136	172,108
2019	0	11,124	0	7,894	19,018	176,200	25,886	202,086	183,068
2020	0	11,122	0	7,873	18,995	186,171	27,284	213,454	194,459

Source: JICA Study Team

10. CONCLUSION AND RECOMENDATION

10.1 Conclusion

(1) Technical Aspect

i) The new landfill site will serve for 10 years for the solid waste generated in Makassar and Gowa, as well as the nearly areas in Maros and Takalar.

ii) The site of the new landfill is located in the center of The Mamminasata area and this new landfill site can receive solid waste not only from Makassar and Gowa but also some areas in Maros and Takalar.

(2) Institutional, Organizational and Financial Aspects

i) The Technical Committee under PU South Sulawesi has an important role in the planning and implementation of the new inter-regional landfill site in Gowa

ii) A new organization regarding landfill operation will have the role to lead the inter-regional solid waste management in the Mamminasata area.

(3) Social and Environmental Aspect

i) In the process of IEE it has been established that there are some significant impacts, especially on odor and water quality in or near the landfill site. In the aspect of environmental pollution, the countermeasures, including preparation of a suitable environmental protection facility or buffer zone, and implementation of periodical environmental monitoring, are necessary to mitigate significant impacts.

ii) In the aspect of social consideration, periodical meetings need to be arranged in order to take care of the surrounding residents.

iii) These mitigation measures against environmental pollution and for social consideration will become suitable countermeasures for any significant environmental impact to be identified.

10.2 Recommendations

For the successful implementation of the proposed project, it is recommended that PU South Sulawesi province or some other organization under PU South Sulawesi should take appropriate actions for the following items.

(1) Institutional, Organizational and Financial Aspects

i) Technical Committee

The executing organization for project implementation should be established as quickly as possible in order to achieve smooth project implementation. It can be led by Gowa regency in close coordination with Makassar and other stakeholders from the very beginning of the planning and construction stage, under the supervision of PU South Sulawesi Province. In addition, because this project including electricity supply, road improvement and water supply, it is important to cooperate with other sections in Gowa and South Sulawesi province.

ii) Financial Arrangements

With the new landfill site construction, operation and maintenance costs will be generated as additional costs related to the new landfill site. These costs should be covered by Makassar, Gowa and Sulawesi. Through a "willingness to pay" survey or by assessing "ability to pay", a new system of solid waste management fee can be considered. On the other hand, PU and South Sulawesi province are recommended to initiate fund raising for construction of the proposed landfill site for Pattallassang.

(2) Social and Environmental Aspects

i) Public Involvement

Involvement of the surrounding residents from an early stage is important in order to implement the project smoothly. Public opinion will be reflected through meetings at suitable stages. Agreement of the residents for land acquisition at the proposed site is needed. It is also important to widely disseminate information about issues directly and indirectly affecting the surrounding residents, through workshops or meetings, in order to prepare a proper compensation plan. This activity should be led and taken by the Technical Committee.

ii) Land Acquisition and Compensation

A land acquisition plan should be prepared based on current land use conditions and landowners. Direct owners and surrounding residents should be considered in the land acquisition and compensation plan. The land acquisition and compensation should also be handled by the Technical Committee.

iii) Implementation of EIA

Environmental Impact Assessment should be carried out to identify potential environmental impacts and to undertake mitigation measure for the impacts and to prepare suitable environmental monitoring plan, especially focused on the

environmental components such as odor, water quality, air pollution, landscape.

iv) Preparation of Suitable Infrastructure (Water Supply, Electric Power Supply)

There is no electricity at the site and the residents rely on shallow wells. To implement the project, it is necessary to prepare sufficient utilities and suitable infrastructure can be set up, not only for workers but also for surrounding residents.

(3) Technical Aspect

i) Collection and Transportation System

Collection and transportation system in detail should be revised because the location of landfill site will change from Tamangapa in Makassar to Pattallassang.

ii) Detailed Geological and Hydrological Survey in Pattallassang Landfill Site

Three boreholes have been dug in the course of this Study to investigate the geological and hydrological conditions. However, the location and number of the boreholes are not enough to identify the physical property of the natural layer. Furthermore, a pumping test has been carried out but the weather conditions have not been suitable for establishing the profile of groundwater. Therefore, a more detailed survey is needed, including the following.

iii) Pumping Test

The level of the water table and the amount of draw-down could not be identified in the geological and hydrological survey due to the short period survey. Therefore, a detailed pumping test should be carried out to identify the requirement of groundwater collection facility to protect liner.

iv) Boring Test

Boring tests at more locations should be implemented to identify the characteristics of the geological layer and soil properties to confirm most suitable liner system and building structure.

v) Soil Investigation

A soil investigation should be carried out to identify physical, mechanical and hydrological properties at necessary sampling points for the basic and detailed design.

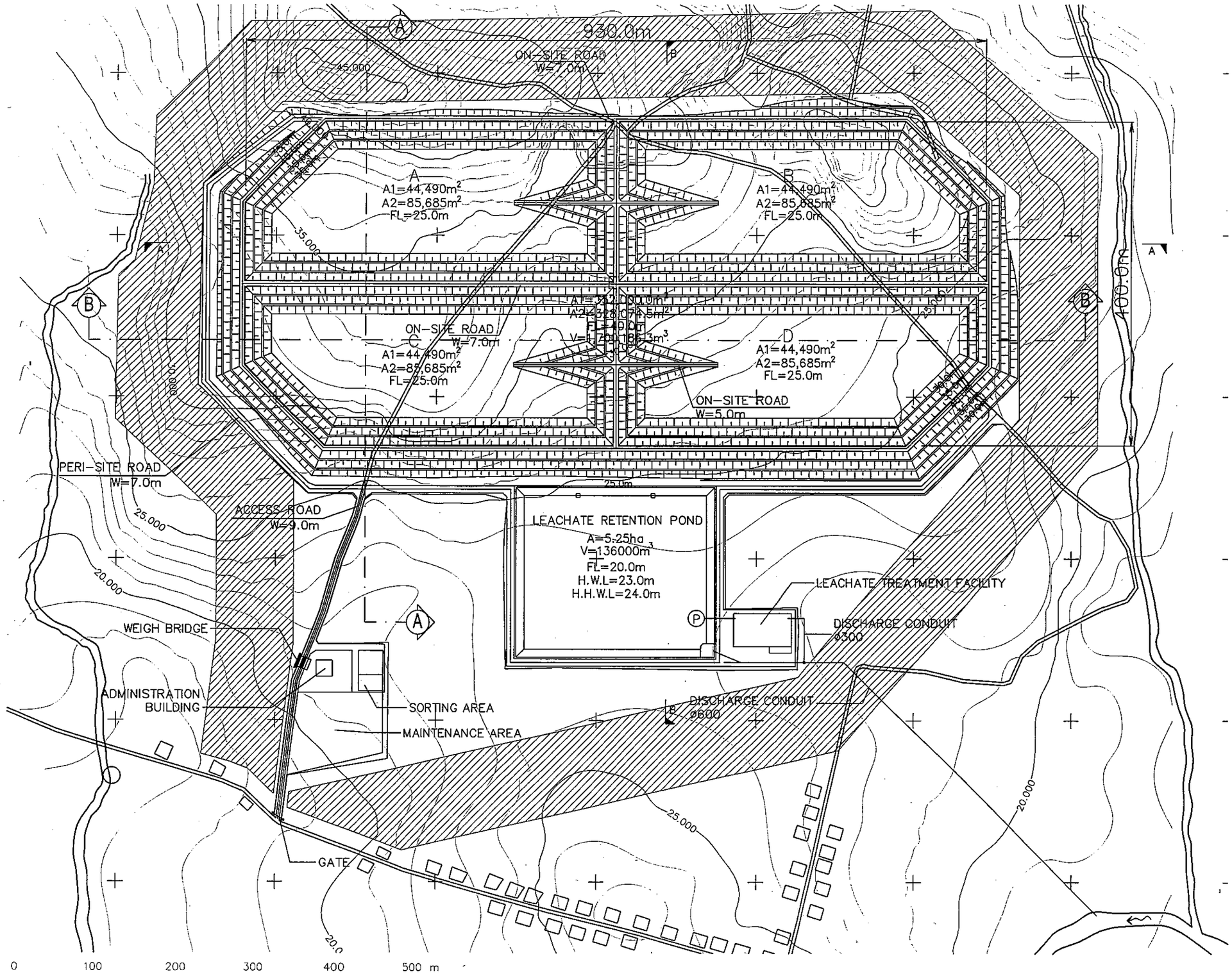
(4) Formulation of Stage 2

To establish suitable solid waste management system, the project formation of stage 2 regarding 3R or secondary transportation system should be carried out during the implementation of stage 1.

ANNEX

LIST OF DRAWINGs

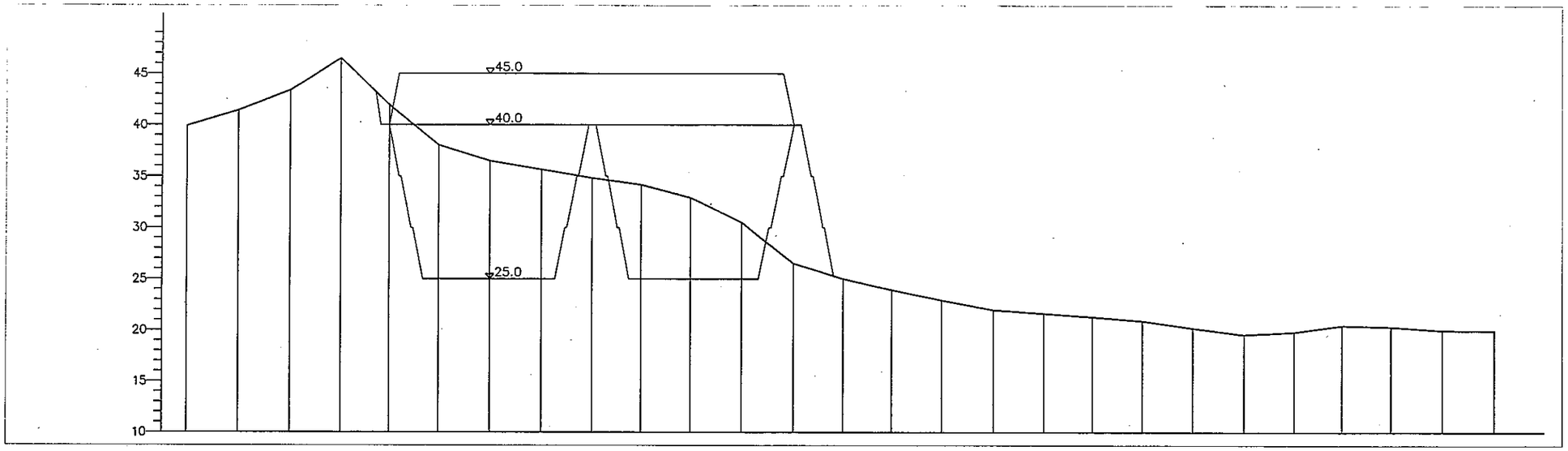
No.		*Drawing Title*
01	:	LAYOUT PLAN OF LANDFILL SITE
02	:	CROSS SECTION OF LANDFILL AREA
03	:	LAYOUTPLAN OF STORMWATER DRAINAGE
04	:	LAYOUT PLAN OF LEACHATE COLLECTION FACILITY
05	:	FLOW DIAGRAM OF LEACHATE TREATMENT FACILITY
06	:	LAYOUT PLAN OF LEACHATE TREATMENT FACILITY
07	:	STANDARD CROSS SECTION OF LANDFILL AREA
08	:	CROSS SECTION OF ACCESS ROAD AND ONSITE ROAD
09	:	CROSS SECTION OF LEACHATE COLLETION PIPE AND LINER SYSTEM
10	:	GAS COLLECTION SYSTEM
11	:	CROSS SECTION OF APPROACH ROAD
12	:	LAYOUT OF ADMINISTRATION AND MAINTENANCE AREA
13	:	LANDFILL METHOD
14	:	FUTURE LANDUSE AFTER LANDFILL OPERATION



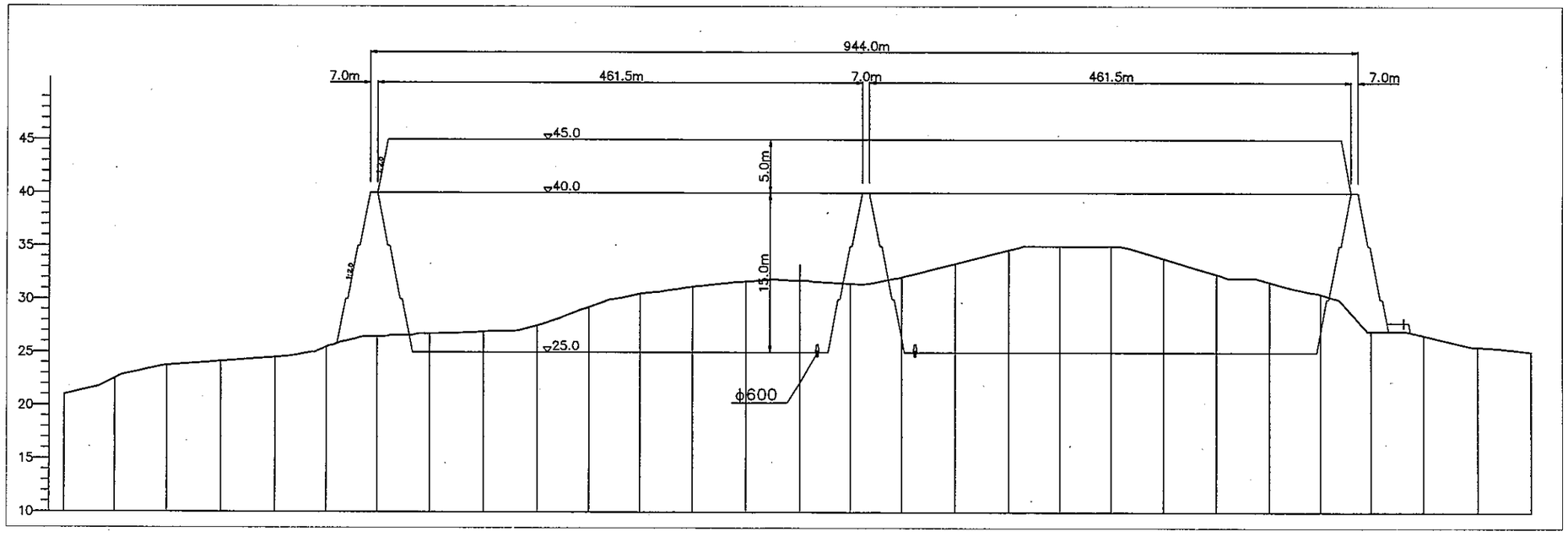
LEGEND :

- : Contour
- : River
- : On Site Road
- : Operation Road
- : Acces Road
- : Household
- : Tree Planting

JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : LAYOUT PLAN OF LANDFILL SITE SCALE = 1 / 5.000	DRAWING NO. 01 DATE: JUNE 2006

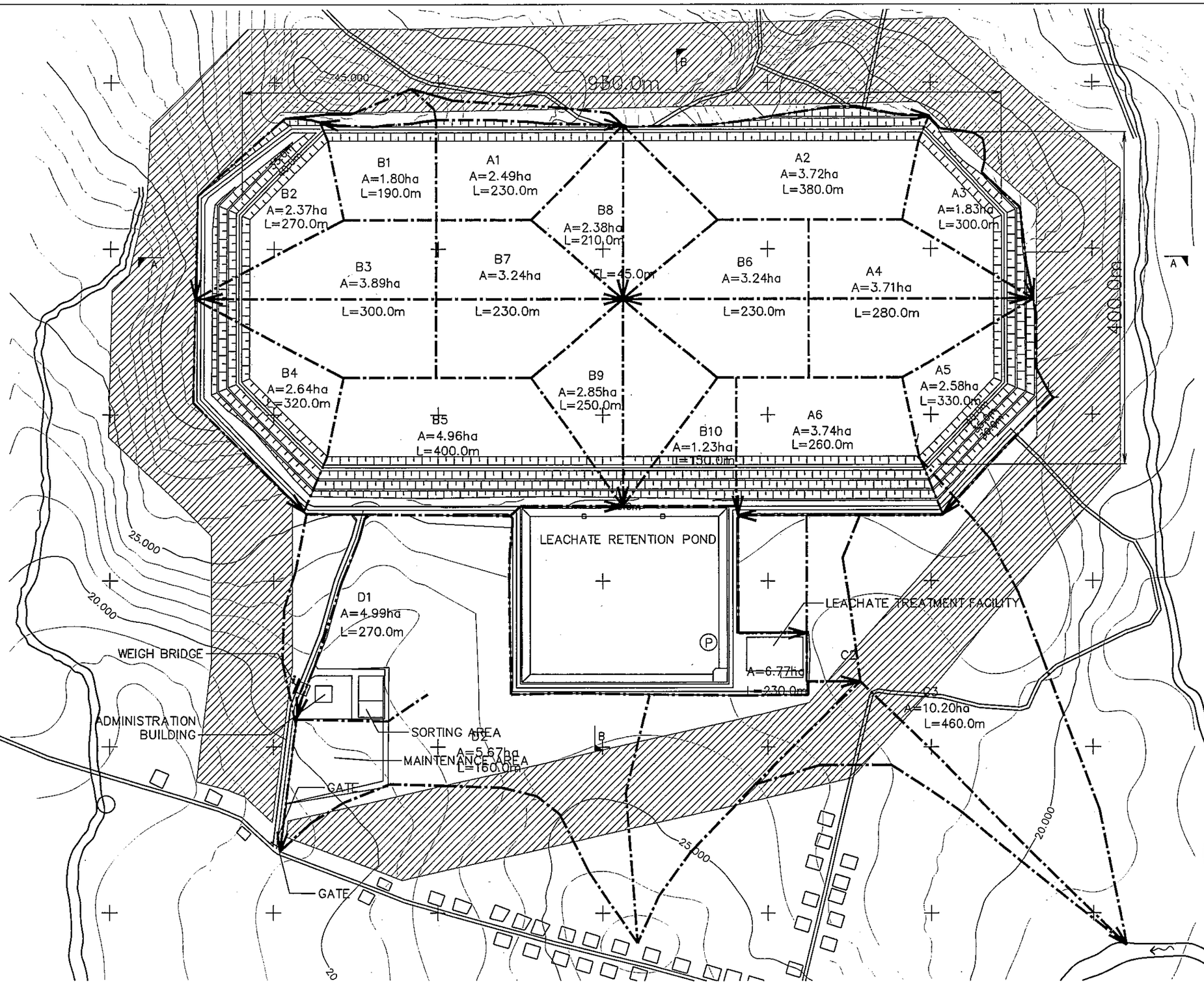


CORSS SECTION - A



CORSS SECTION - B

JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : CORSS SECTION OF LANDFILL AREA SCALE = V= 1 / 500 H=1/5.000	DRAWING NO. 02 DATE: JUNE 2006



LEGEND :

- : Contour
- : River
- : On Site Road
- : Operation Road
- : Acces Road
- : Household
- : Tree Planting
- : Storm Waste Drainage

JICA JAPAN INTERNATIONAL COOPERATION AGENCY

KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.

PROJECT TITLE:

PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT

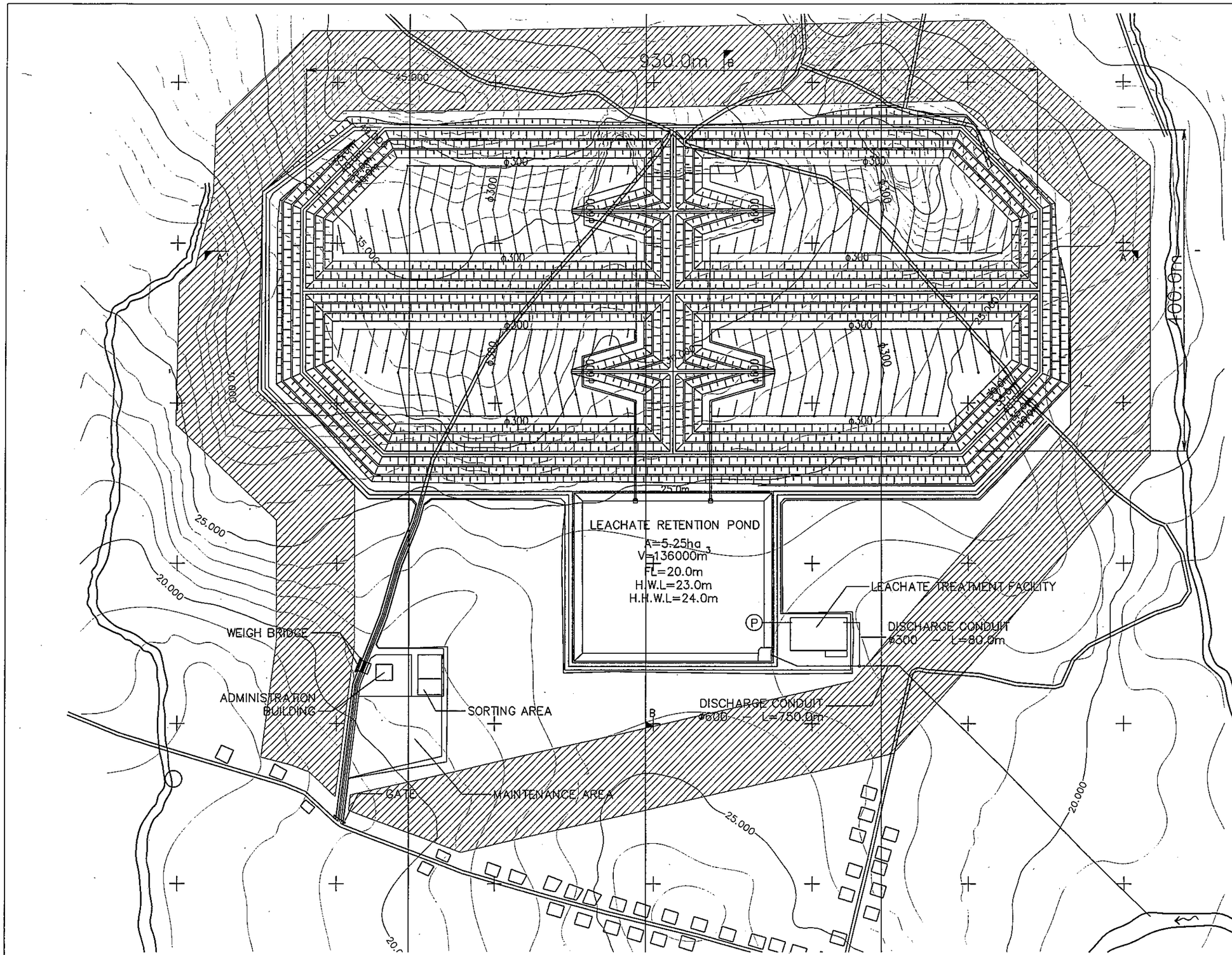
DRAWING TITLE :

LAYOUT PLAN OF STORMWATER DRAINAGE

SCALE = 1 / 5.000

DRAWING NO. 03

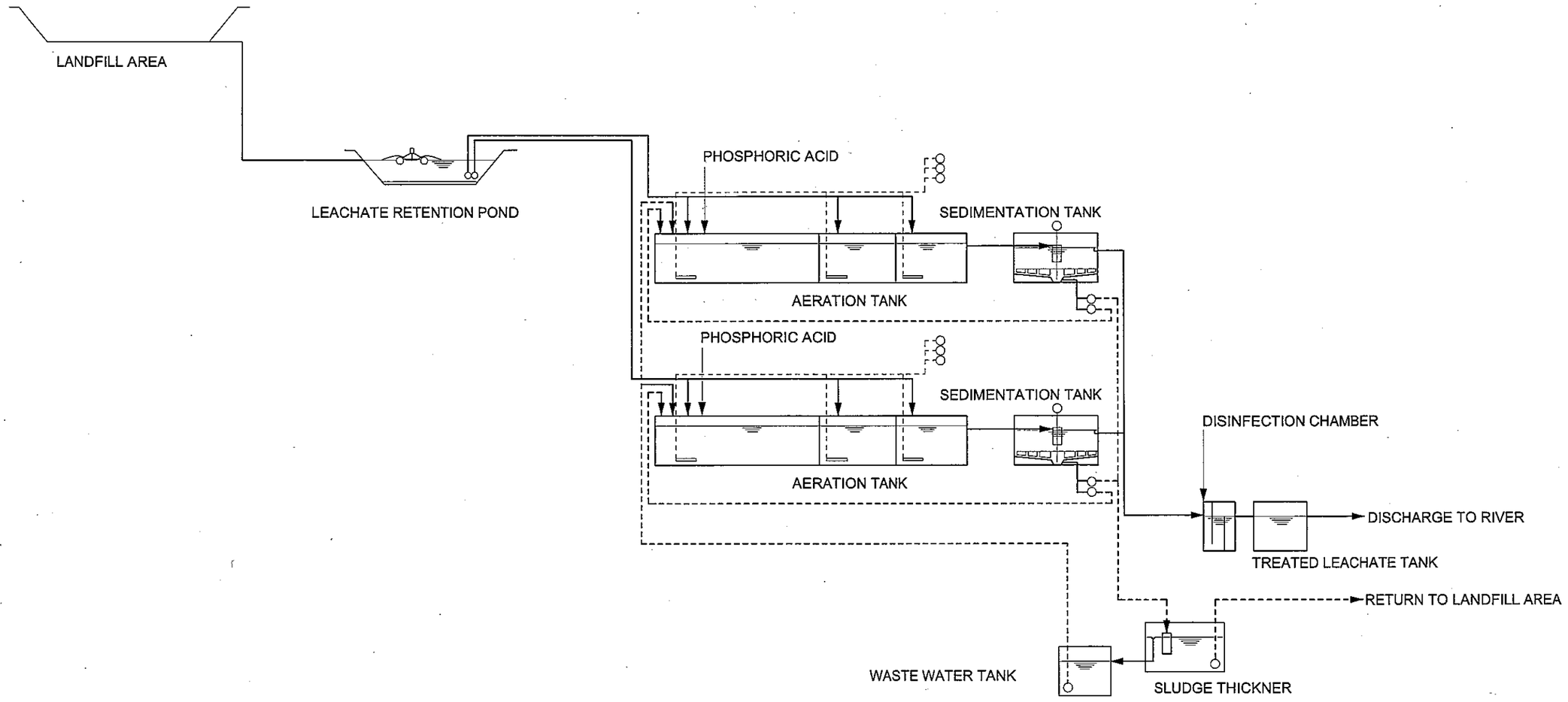
DATE: JUNE 2006



LEGEND :

- : Contour
- : River
- : On Site Road
- : Operation Road
- : Acces Road
- : Household
- : Tree Planting
- : Leachate Collection Pipe

JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : LAYOUT PLAN OF LEACHATE COLLECTION FACILITY SCALE = 1 / 5.000	DRAWING NO. 04 DATE: JUNE 2006



JICA JAPAN INTERNATIONAL COOPERATION AGENCY

KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.

PROJECT TITLE:

PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT

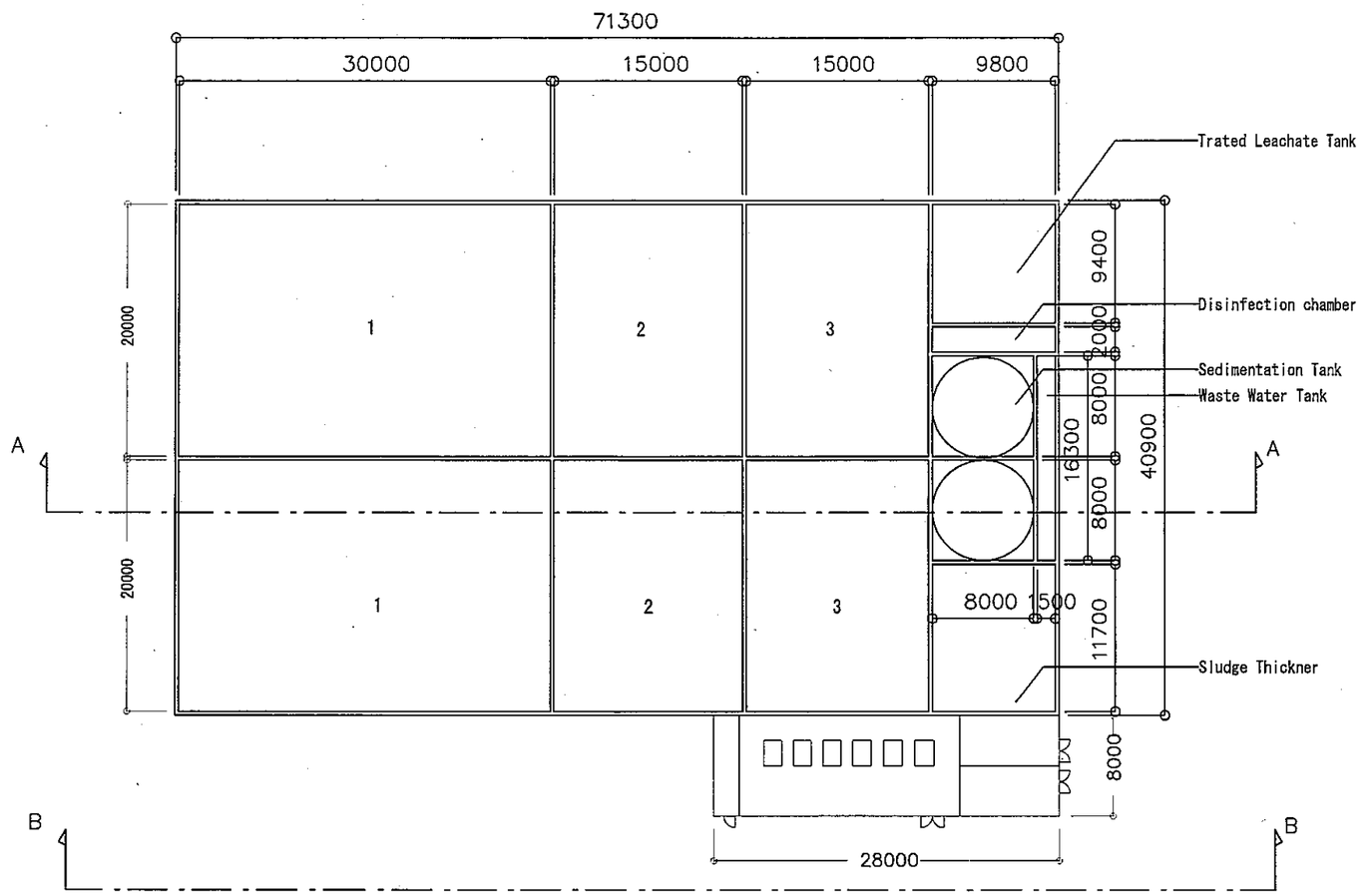
DRAWING TITLE :

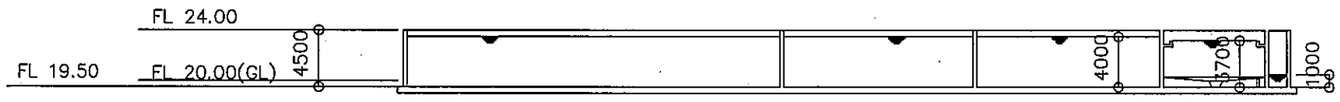
FLOW DIAGRAM OF LEACHATE TREATMENT FACILITY

SCALE = NTS

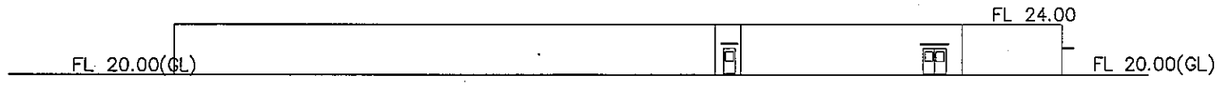
DRAWING NO. 05

DATE: JUNE 2006



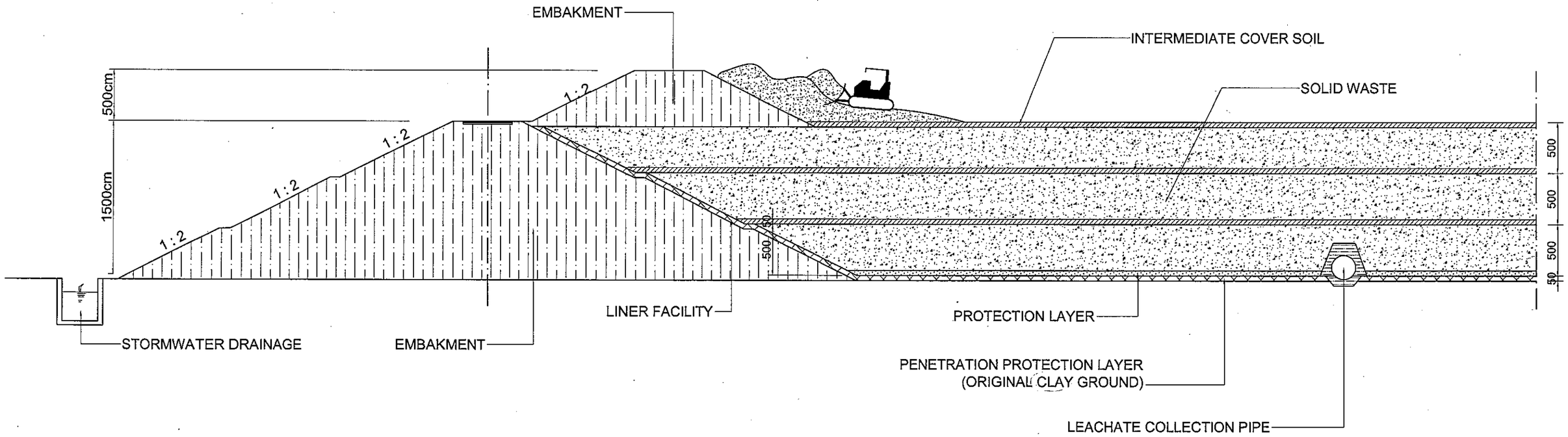


A – A



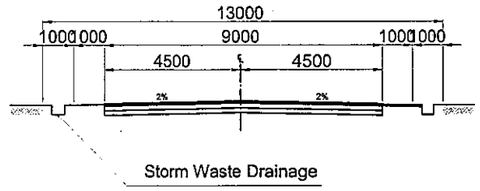
B – B

JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION BY JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : LAYOUT PLAN OF LEACHATE TREATMENT FACILITY SCALE = 1/500	DRAWING NO. 06 DATE: JUNE 2006

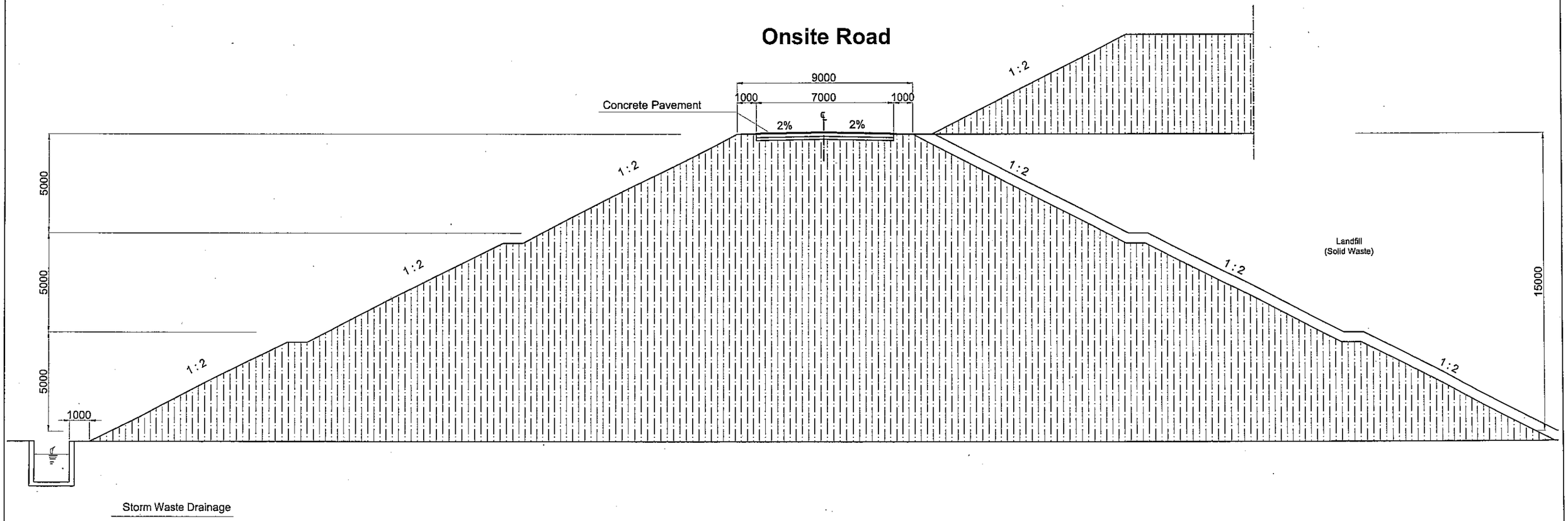


JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : STANDARD CROSS SECTION OF LANDFILL AREA SCALE = NTS	DRAWING NO. 07 DATE: JUNE 2006

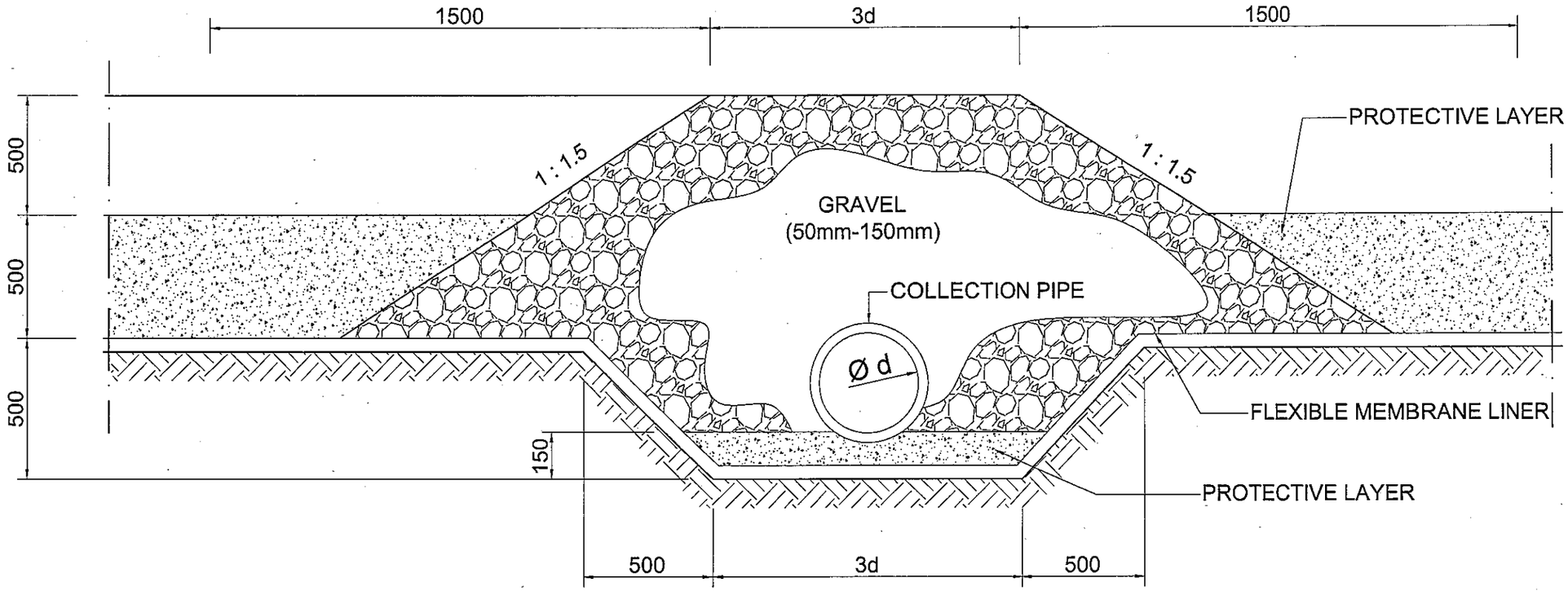
Access Road



Onsite Road

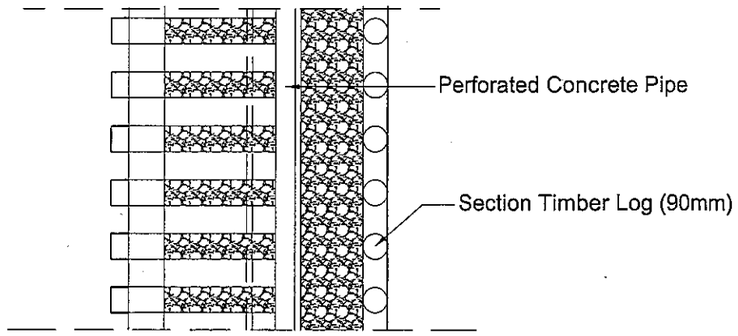


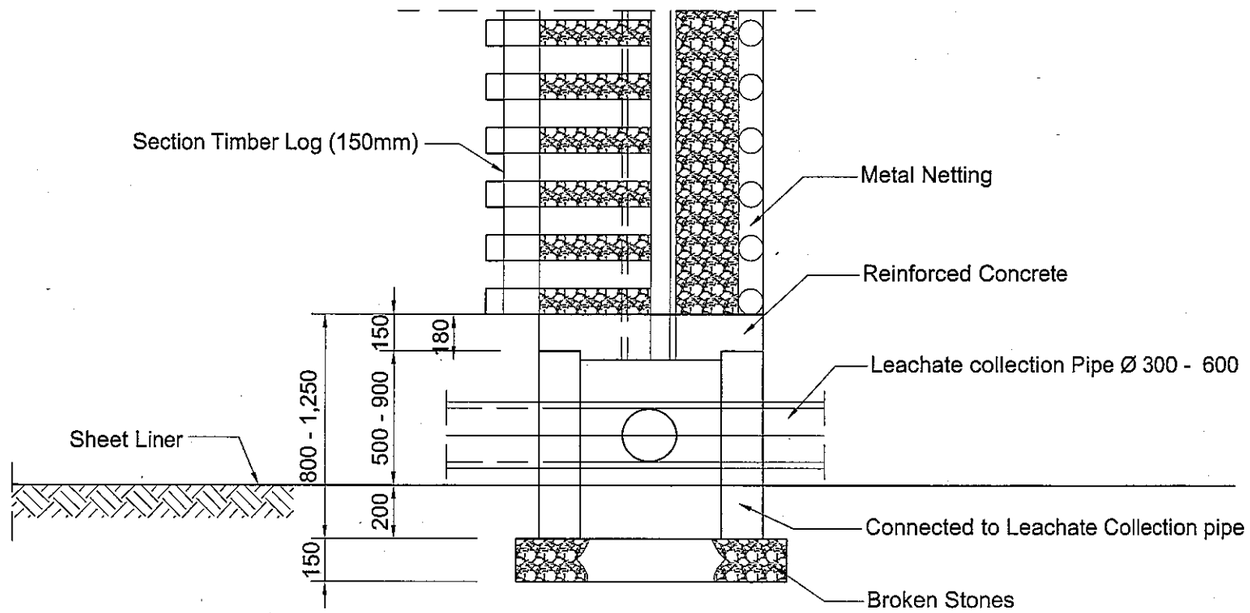
JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : CROSS SECTION OF ACCESS ROAD AND ONSITE ROAD SCALE = 1/200	DRAWING NO. 08 DATE: JUNE 2006

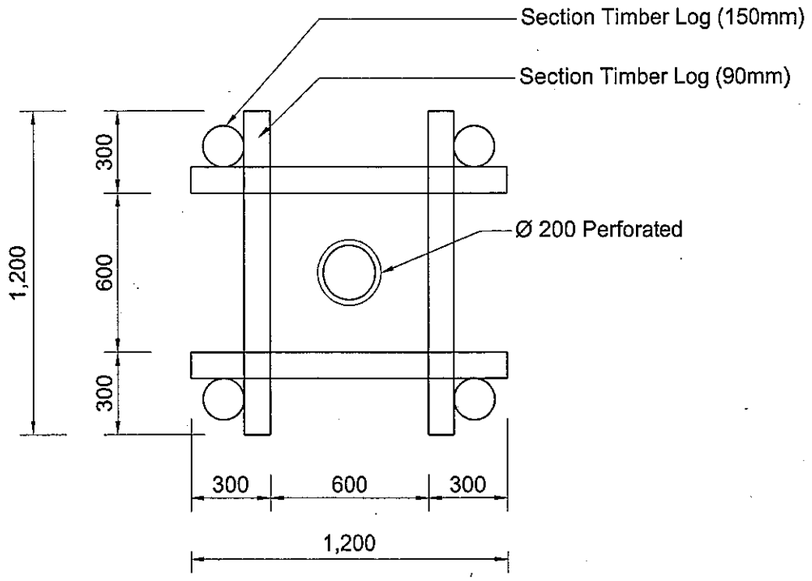


	d (mm)
Trunk Line	600
Branch Line	300

JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : CROSS SECTION OF LEACHATE COLLECTION PIPE AND LINER SYSTEM SCALE = 1/200	DRAWING NO. 09 DATE: JUNE 2006



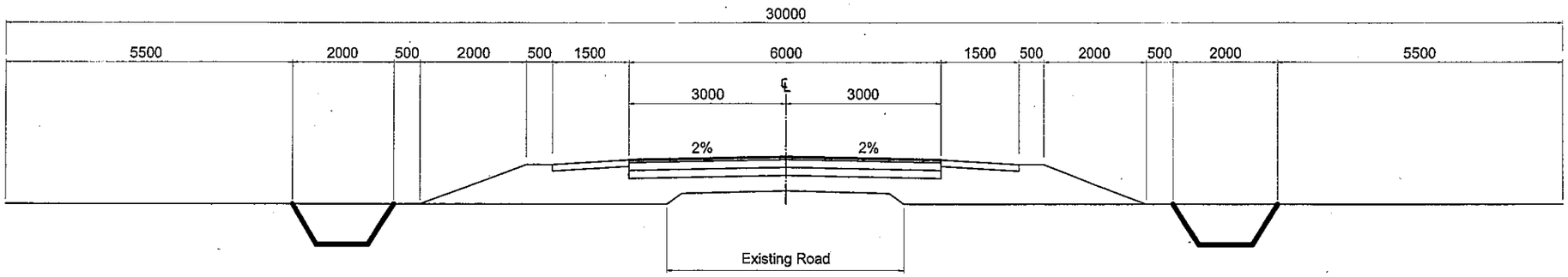




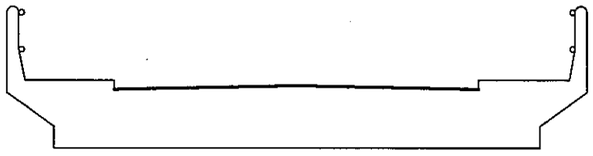
SCALE . 1 = 5.000

JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : GAS COLLECTION SYSTEM SCALE = 1/20	DRAWING NO. 10 DATE: JUNE 2006

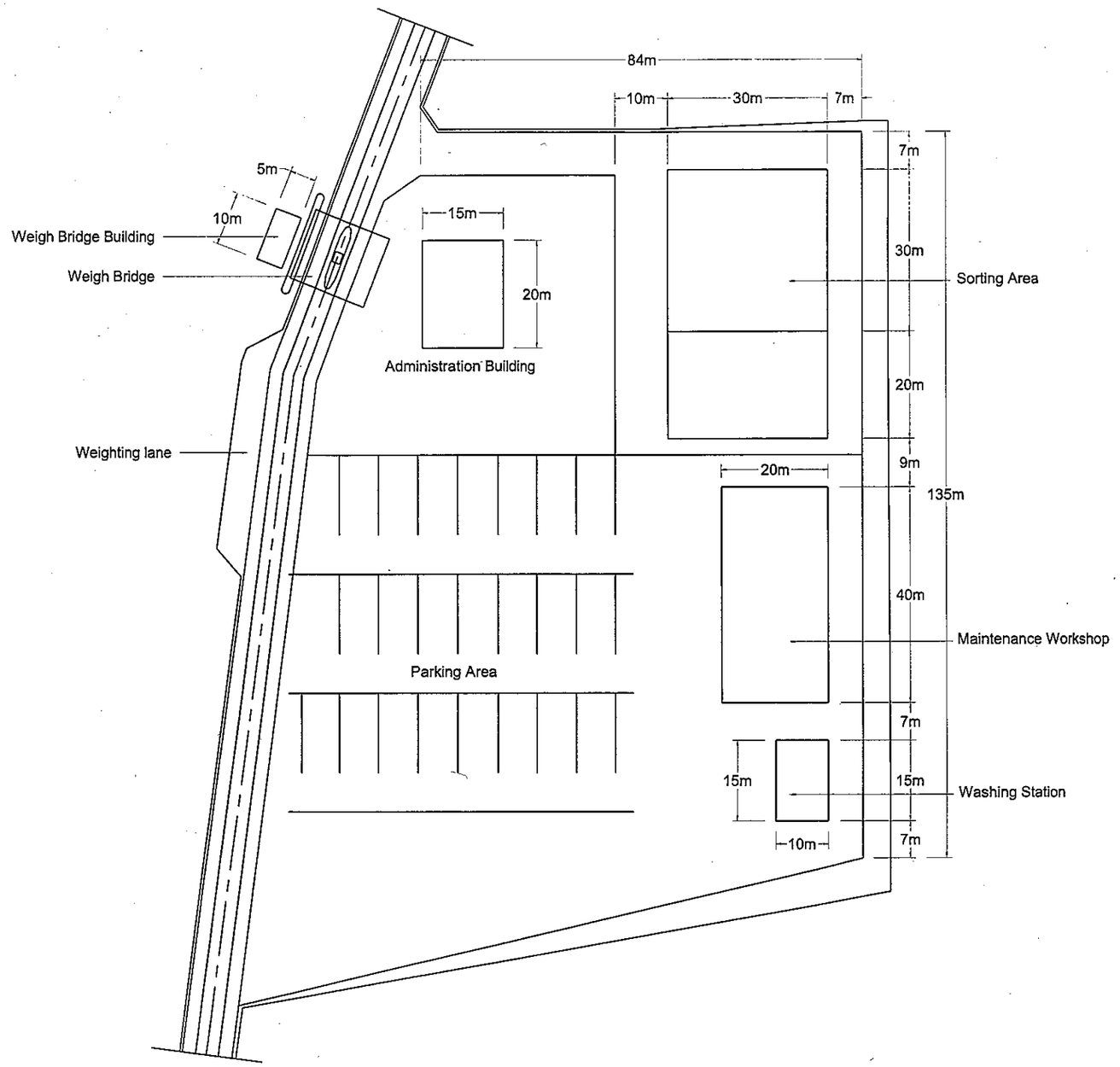
Approach Road



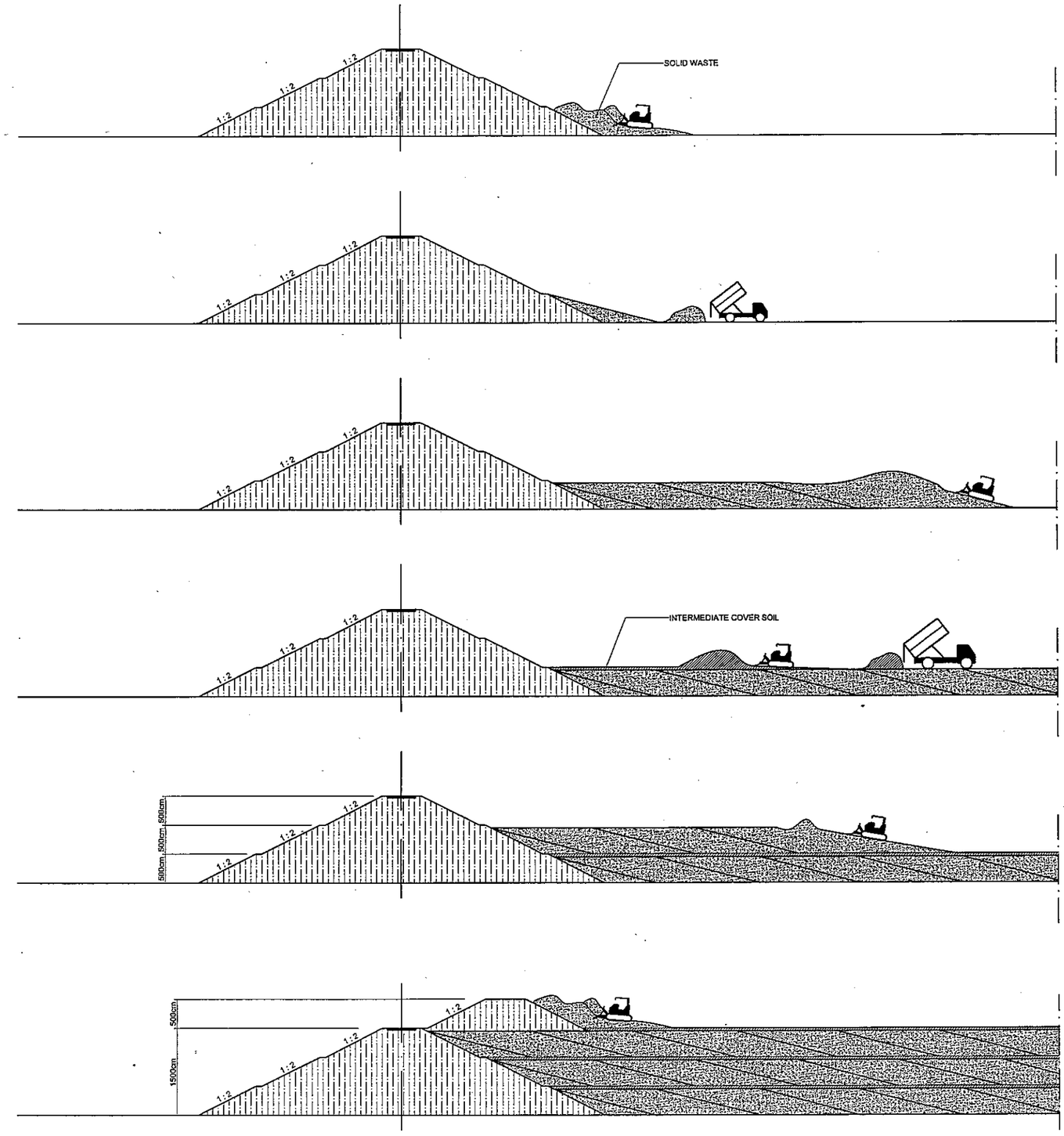
Cross Section Bridge



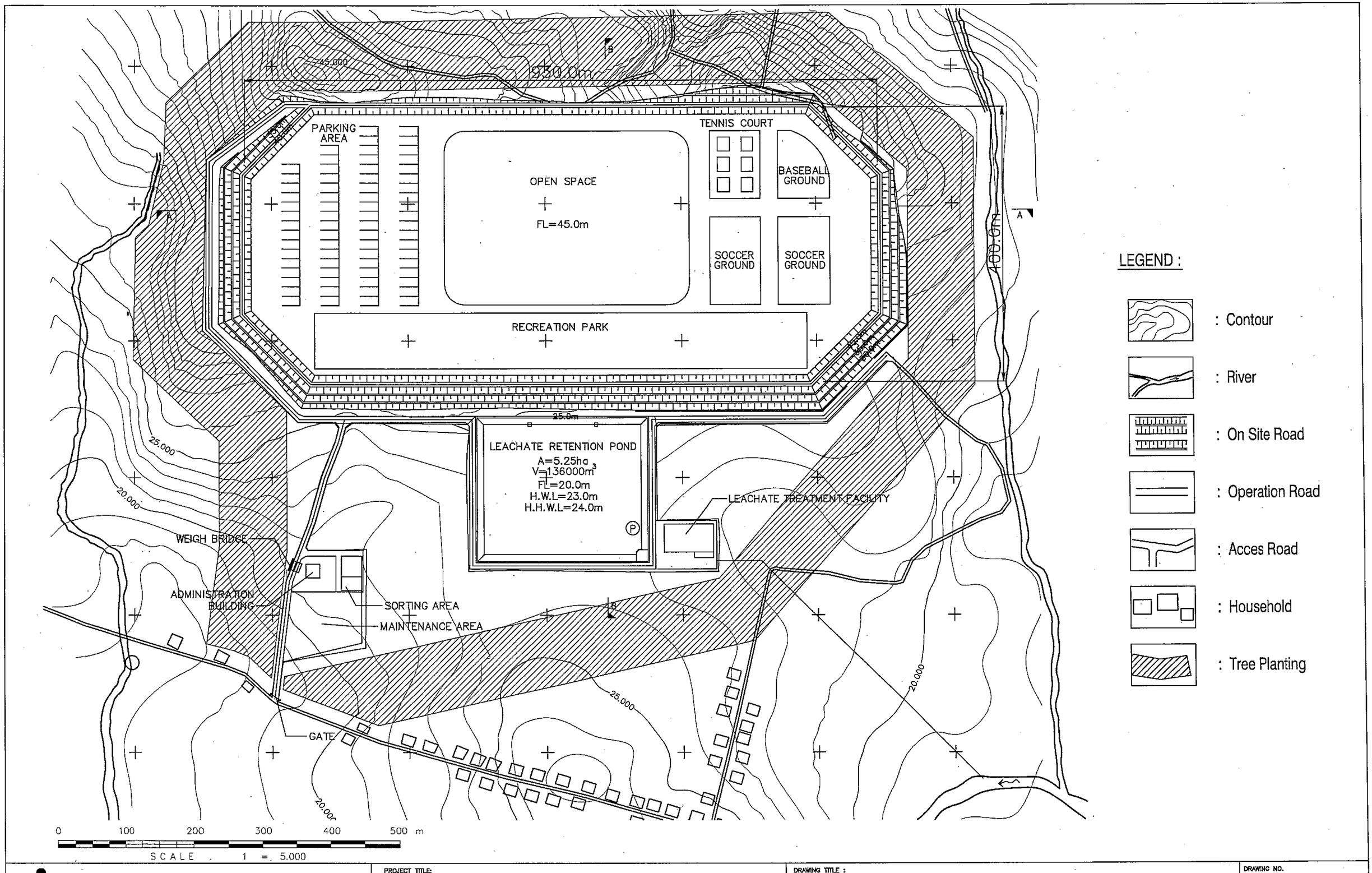
JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION in JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : CROSS SECTION OF APPROACH ROAD SCALE = 1/100	DRAWING NO. 11 DATE: JUNE 2006



JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : LAYOUT PLAN OF ADMINISTRATION AND MAINTENANCE AREA SCALE = 1 / 1.000	DRAWING NO. 12 DATE: JUNE 2006



JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : LANDFILL METHOD SCALE = NTS	DRAWING NO. 13 DATE: JUNE 2006



LEGEND :

- : Contour
- : River
- : On Site Road
- : Operation Road
- : Acces Road
- : Household
- : Tree Planting

JICA JAPAN INTERNATIONAL COOPERATION AGENCY KRI INTERNATIONAL CORPORATION IN JOINT VENTURE WITH NIPPON KOEI CO., LTD.	PROJECT TITLE: PRE FEASIBILITY STUDY ON IMPROVEMENT OF LANDFILL SITE FOR SOLID WASTE MANAGEMENT	DRAWING TITLE : FUTURE LAND USE AFTER LANDFILL OPERATION SCALE = 1 / 5.000	DRAWING NO. 14 DATE: JUNE 2006