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SOLID WASTE MANAGEMENT STUDY FOR PULAU PINANG AND SEBERANG PERAI MUNICIPALITIES

MAIN REPORT

PART II

FEASIBILITY STUDY FOR PULAU PINANG

AUGUST 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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ABBREVIATION

ABC	:	Action Plan for a Beautiful and Clean Malaysia
BSDS	:	Bakau Street Disposal Site
BPTS	:	Balik Pulau Transfer Station
CIF	:	Cost, Insurance and Freight
DBKL	:	City Hall of Kuala Lumpur
DID	:	Drainage and Irrigation Department
DOE	:	Department of Environment
EIA	:	Environmental Impact Assessment
ENSEARCH	:	Environmental Management and Research Association of Malaysia
EPU	:	Economic Planning Unit
FTZIP	:	Free Trade Zone Incineration Plant
FTZTS	:	Free Trade Zone Transfer Station
GRDP	:	Gross Regional Domestic Product
IKU	:	Public Health Institute
JICA	:	Japan International Cooperation Agency
JKKK	:	Village Development and Security Committee
JMPDS	:	Jelutong Mole Previous Disposal Site
JMTS	:	Jelutong Mole Transfer Station
JPBD	:	Town and Country Planning Department
KEMAS	:	Community Development, Ministry of National and Rural Development
KMDS	:	Kuala Muda Disposal Site
LWL	:	Low Water Level
LA	:	Local Authority
M	:	Million
MC	:	Municipal Council
MMTS	:	Mak Mandin Transfer Station
MPPP	:	Majlis Perbandaran Pulau Pinang
MPSP	:	Majlis Perbandaran Seberang Perai
MOH	:	Ministry of Health
MHLG	:	Ministry of Housing and Local Government
M/P	:	Master Plan
MSWM	:	Municipal Solid Waste Management
M$	:	Malaysian Dollar
NEB	:	National Electricity Board
NEP	:	New Economic Policy

PADS	:	Pantai Acheh Disposal Site
PBDS	:	Pulau Burong Disposal Site
PDC	:	Penang Development Corporation
PERDA	:	Penang Rural Development Authority
PHA	:	Public Health Assistant
PHI	:	Public Health Inspector
PICIP	:	Prai Industrial Complex Incineration Plant
PSD	:	Public Services Department, Prime Minister's Department
JKR/PWD	:	Public Works Department
PPC	:	Penang Port Commission
S/R	:	Supporting Report
SWM	:	Solid Waste Management
SWMIS	:	Solid Waste Management Information System
TDC	:	Tourist Development Corporation
UDS	:	Urban Drainage System
USD	:	Urban Service Department
USM	:	University Sains Malaysia

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1. Phase I Project

This Feasibility Study Report covers the Phase I Project identified in the Master Plan Study for MPPP.

1.1 Preliminary Financial Evaluation

As referred to in the Master Plan, the introduction of sanitary landfill will require a large investment relative to the financial scale of the Council.

This section examines an appropriate level of disposal system to be constructed in Phase I in view of the required investment amounts and the financial situation of MPPP.

In general, the landfill system for waste disposal can be categorized into the following four levels.

a. Level 1 Controlled Tipping

- Consolidation of roads on premises
- Periodical soil covering
- Introduction of haulage control system

b. Level 2 Sanitary Landfill

- Clear determination of a disposal site; to be separated from surrounding areas to prevent entry by scavengers

- Clear determination of the disposal site by construction of embankments

- Restricting the landfill; introduction of compartmental system to decrease volume of leachate

- Establishment of a rainwater drainage system to prevent flow of rainwater into the landfill site from surrounding areas

- Introduction of instruments to prevent environmental pollution, including a buffer zone, facility to prevent waste and odour dispersion, gas extraction facility

- Introduction of welfare facilities

- Partial introduction of quasi-aerobic landfill structure by gas extraction facility

c. Level 3 Sanitary Landfill

- Introduction of proper leachate control system by introducing leachate drainage and circulation facility with monitoring system

- Introduction of quasi-aerobic landfill structure by leachate drainage

- Prevention of dust by water sprinkling

d. Level 4 Sanitary Landfill

- Introduction of leachate treatment facilities
- Introduction of impermeable structure on site

Local authorities in any country select certain levels of the landfill system depending on their respective local conditions.

In view of the soil investigation data on the proposed disposal site, the estimated investment costs for the Phase 1 are as follows:

Level 3: M$ 6.2 million
Level 4: M$13.8 million*

* This amount does not include costs for bottom liner because it is not necessary in view of very low permeability of the bottom soil.

As can be seen from the above, Level 3 disposal system costs less than one half of Level 4.

In view of the facts that the implementation of a project which requires substantial investment against limited financial resources may destroy the financial basis of the municipality and that the balanced development of the infrastructures including sewage system, solid waste management system and flood control, etc. is essential for the environmental conservation, it has been decided that the disposal facilities to be constructed in Phase I will be of Level 3, and that these will be improved to Level 4 in Phase II onwards. This decision is also supported by the preliminary environmental impact assessment results which show the impact of Level 3 sanitary landfill on the surrounding environment is minimal.

If a sanitary landfill would be introduced without measures for the improvement of collection and cleansing works proposed in this First Phase Project Plan, it will be necessary to increase the budgetary allocation by at least 4% annually. That is why the improvement of collection and cleansing works plays an important role in Phase I arrangement.

1.2 Contents of Phase I Project

To complete the Master Plan by 2005, the stage plan for MPPP (see Chapter 12 of Part I) will be actually implemented in the following 3 phases.

Phase I : 1991 - 1995
Phase II : 1996 - 2000
Phase III : 2001 - 2005

Phase I Project will consist of the consolidation of the foundations of solid waste management in MPPP. Its successful implementation is a precondition for the achievement of the various targets given in the Master Plan. The Master Plan for solid waste management in MPPP is considered important on a national level.

As shown in Fig. 1.2-1, the objectives of Phase I Project are the achievement of a pleasant living environment and contribution to the socio-economic development of the city by improving the living environment, in turn achieved by improving the service level, expanding the service area and implementing sanitary landfill at disposal sites far from urban areas through a reduction of solid waste collection and cleansing costs.

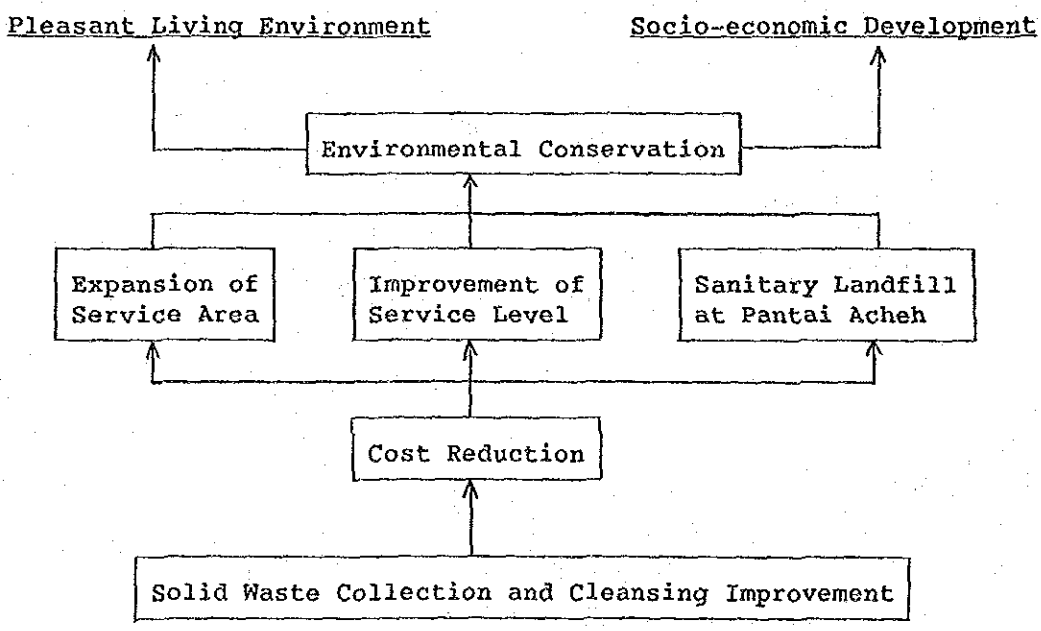


Fig. 1.2-1 Objectives of Phase I Project

Fig. 1.2-2 shows the concrete contents of each component of the Phase I Project.

o Collection Improvement

- 3 times/week door-to-door collection (urban areas)
- Establishment of bulky waste collection system
- Introduction of 10 m^3 compactors

o Construction of Pantai Acheh Disposal Site

- Development area : 25 ha
- Landfill volume : 1,540,000 m^3
- Daily disposal amount: 539 tons
- Operation period : 6 years

o Contracting-Out

- Maintaining 87% contracting-out ratio (in terms of waste amount)
- Review of collection zones (1 zone: 30 t/day)
- Advice on introduction of 10 m^3 compactors

o Disposal Method

- Target level : Level 3
- Landfill method : Cell method

o Cleansing Improvements

- Introduction of team work and weekly cleansing (Residential areas)
- Mechanization of the sweeping of main roads
- Introduction of grass cutters

Fig. 1.2-2 Phase I Project of MPPP

1.3 Design Conditions

(1) Target Year

Target year is 1995 due to the limited disposal capacity of the present site, the disposal operation will be transferred to the Pantai Acheh disposal site in 1992 and operation will be continued till 1996.

(2) Target Area

While the entire MPPP is the target area, collection will be limited to the Priority Operational Areas as shown in Fig. 1.3-1.

(3) Design Population

As shown in Table 1.3-1, the design population for 1995 is 615,700. Population of the Priority Operational Areas is 584,300, the collection rate will be 95% in terms of population.

Table 1.3-1 Design Population and Service Population

(persons)

	PRESENT (1987)	1992	1995
a. Design Population			
- City	255,300	260,200	268,700
- Rural	304,000	326,800	347,000
Total	559,300	587,000	615,700
b. Service Population			
- City	255,300	260,200	268,700
- Rural	264,800	290,100	315,600
Total	520,100	550,300	584,300
c. Collection Rate (%)			
- City	100	100	100
- Rural	87	89	91
Total	93	94	95

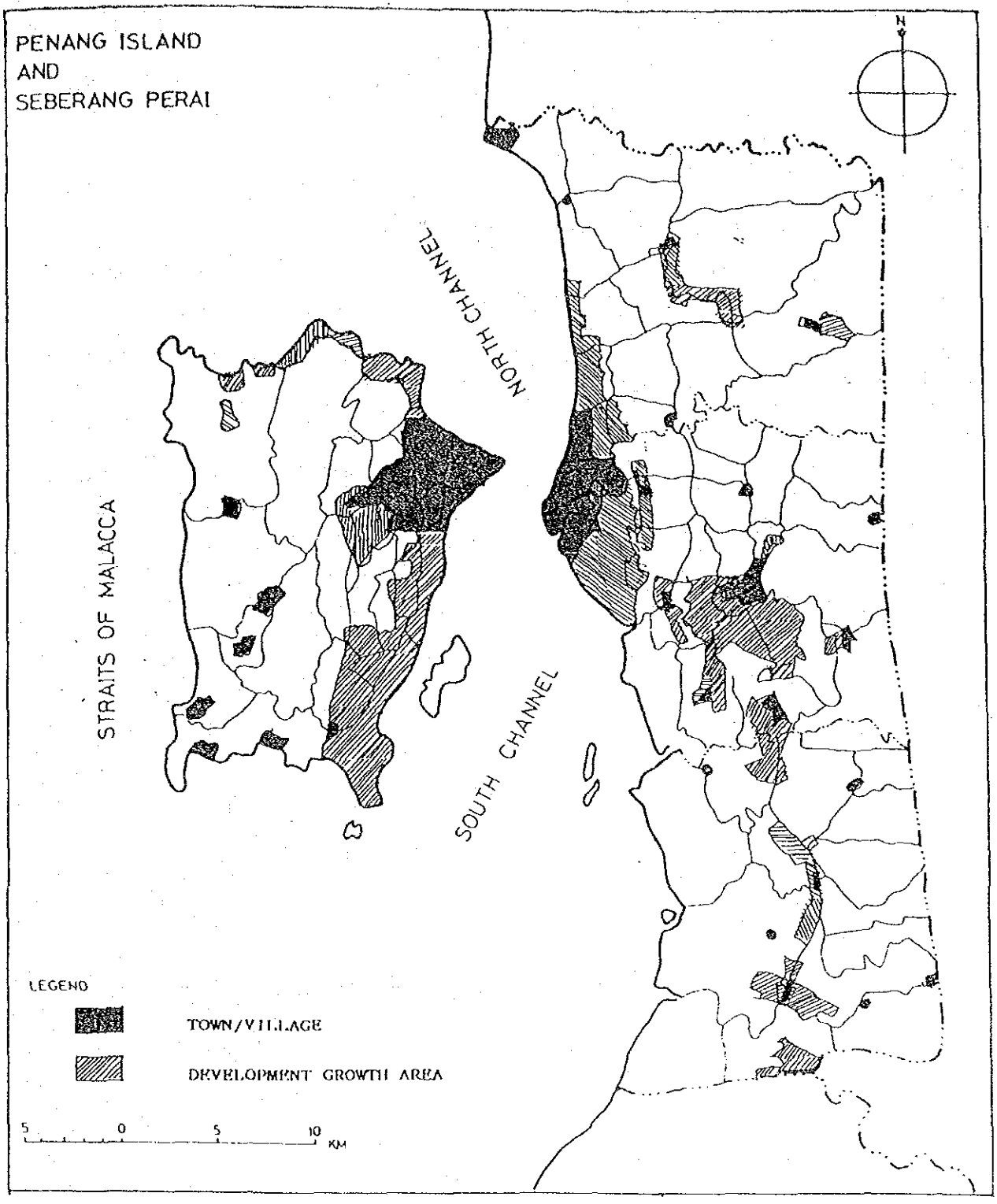


Fig. 1.3-1 Priority Operational Area

(4) Design Collection Amount of Solid Waste

Three collection systems will be employed, i.e. for domestic waste, bulky waste and large amount waste. Table 1.3-2 shows the design collection amount for each system.

Table 1.3-2 Design Collection Amount

(t/day)

	PRESENT (1987)	1992	1995
a. Domestic Waste			
- City	158	173	190
- Rural	122	144	165
Total	280	317	355
b. Bulky Waste			
- City	-	3	6
- Rural	-	2	5
Total	-	5	11
c. Large Amount Waste			
- City	41	46	50
- Rural	39	47	53
Total	80	93	103
Grand Total	360	415	469

(5) Roads Subject to Sweeping

As shown in Table 1.3-3, the total road length subject to sweeping in 1995 will be 735 Km.

Table 1.3-3 Road Length Subject to Sweeping

(Km)

	PRESENT (1987)	1992	1995
Federal Roads	68	68	68
State Roads	280	280	280
City Roads	206	206	206
Newly Developed Areas	0	113	181
Total	554	667	735

The proposed length of drain cleansing will be 1,470 Km, double of the road length, and the proposed length of beach cleansing will be 30 Km.

(6) Design Disposal Amount

The daily disposal amount of collected waste and directly brought-in waste will be 539 tons in 1995 as shown in Table 1.3-4.

Table 1.3-4 Design Disposal Amount

(t/day)

	PRESENT (1987)	1992	1995
Collected Waste			
- Domestic Waste	280	317	355
- Bulky Waste	0	5	11
- Large Amount Waste	80	93	103
Sub-Total	360	415	469
Directly Brought-in Waste	50	63	70
Total	410	478	539

(7) Design Composition of Solid Waste

The design composition of solid waste is given in the Master Plan and is shown in Table 1.3-5.

Table 1.3-5 Design Composition of Solid Waste

	DOMESTIC WASTE		COMMERCIAL WASTE	
	(1987)	1992	(1987)	1995
a. Composition (%)				
- Paper	25.5	27.5	31.5	34.0
- Textile	3.4	3.4	2.9	2.9
- Plastic	11.2	12.1	11.8	12.7
- Rubber	0.8	0.8	0.8	0.8
- Wood	14.4	13.3	9.7	8.9
- Garbage	32.8	30.2	30.9	28.5
- Metal	2.6	3.3	3.3	4.1
- Glass	1.4	1.7	1.0	1.2
- Stone	0.2	0.2	1.0	1.2
- Others	7.8	7.6	7.3	5.8
Total	100.0	100.0	100.0	100.0
b. Moisture Contents (%)	55.2	54.1	53.5	52.3
c. Organic (%)	35.4	35.6	36.1	36.3
d. Ash (%)	9.4	10.3	10.4	11.3
e. Net Calorific Value (kcal/kg)	1600	1600	1600	1700
f. Density (t/m^3)	0.19	0.19	0.17	0.16

2. Preliminary Design

2.1 Collection Improvement

2.1.1 Collection Methods

(1) Collection System in 1995

The collection system to be achieved by 1995 is shown in Table 2.1-1.

Table 2.1-1 Collection System to be Achieved by 1995

a. Collection Rate	95% in terms of population		
b. Collection Frequency and Discharge Points	- Commercial Areas	:	Daily, door-to-door
	- Residential Areas	:	3 times/week, door-to-door
	- Housing Complexes with bulk bin	:	Daily, dust chute
	- Housing Complexes without bulk bin	:	3 times/week, station
	- Kampongs	:	3 times/week, station
c. Waste Discharge Method		:	Plastic Bags
d. Collection Amount	- 470 t/day		
e. Collection System	- Ordinary Waste Collection - Bulky Waste Collection - Large Amount Collection		
f. Collection Vehicle	- Ordinary Waste	:	Compactor
	- Bulky Waste	:	Dump truck
	- Large Amount Waste	:	Compactor and arm roll
g. Share of Private Companies	- 87% in terms of waste amount collected		

(2) Promotion of Discharge Using Plastic Bags

The planned methods of waste discharge are shown in Table 2.1-2. The use of standard plastic bags for the discharge of domestic and commercial waste will be promoted together with the introduction of 3 times/week collection.

Table 2.1-2 Waste Discharge Methods

TYPES OF DISCHARGER	DISCHARGE METHOD
Shop-houses	Plastic Bags + House Bins
Houses	Plastic Bags + House Bins
Housing Complexes	Bulk Bins + Dust Chute
Kampongs	Plastic Bags + Bulk Bins
Large Amount Waste	Bulk Bins or Hauled Containers

Table 2.1-3 shows the standard plastic bag and bin sizes.

Table 2.1-3 Standard Plastic Bag and Bin Sizes

a. Plastic Bags	: 50 cm x 80 cm
b. House Bins - Fixed Type	: 80 - 110 ℓ
- Mobile Type	: 40 - 70 ℓ
c. Bulk Bins	: 1 m^3
d. Hauled Containers	: 10 m^3

Due to the fact that collection of large amount waste is entrusted to the private sector, bulk bins for large amount dischargers are prepared by consignors.

In principle, plastic bags and bins will be provided by the waste generators while the Council will be responsible for the provision of bulk bins/ containers in kampongs.

(3) Introduction of 3 Times/Week Collection System

The present daily door-to-door collection service will be continued in commercial areas and shopping streets in the Project Areas, and an efficient 3 times/week collection service will be introduced in all the residential areas by 1995 with the cooperation of residents. This 3 times/week collection service will be provided first in places where its introduction appears easy and will then be extended to all other areas as shown in Fig. 2.1-1. The order of its introduction is as follows.

a. First Step (1989)	- Introduction to Model Area	. Bayan Baru
b. Second Step (1989 - 1991)	- Expansion to Other Residential Areas	. Tanjung Tokong . Georgetown . Gelugor . Bayan Lepas
c. Third Step (1992 - 1995)	- Expansion to Kampongs	. Georgetown South . Ayer Itam . Balik Pulau

Collection from housing complexes with bulk bin will be conducted daily as part of the large amount collection service. Plastic bags will be used and station collection will be conducted 3 times/week for housing complexes where bulk bins are not provided.

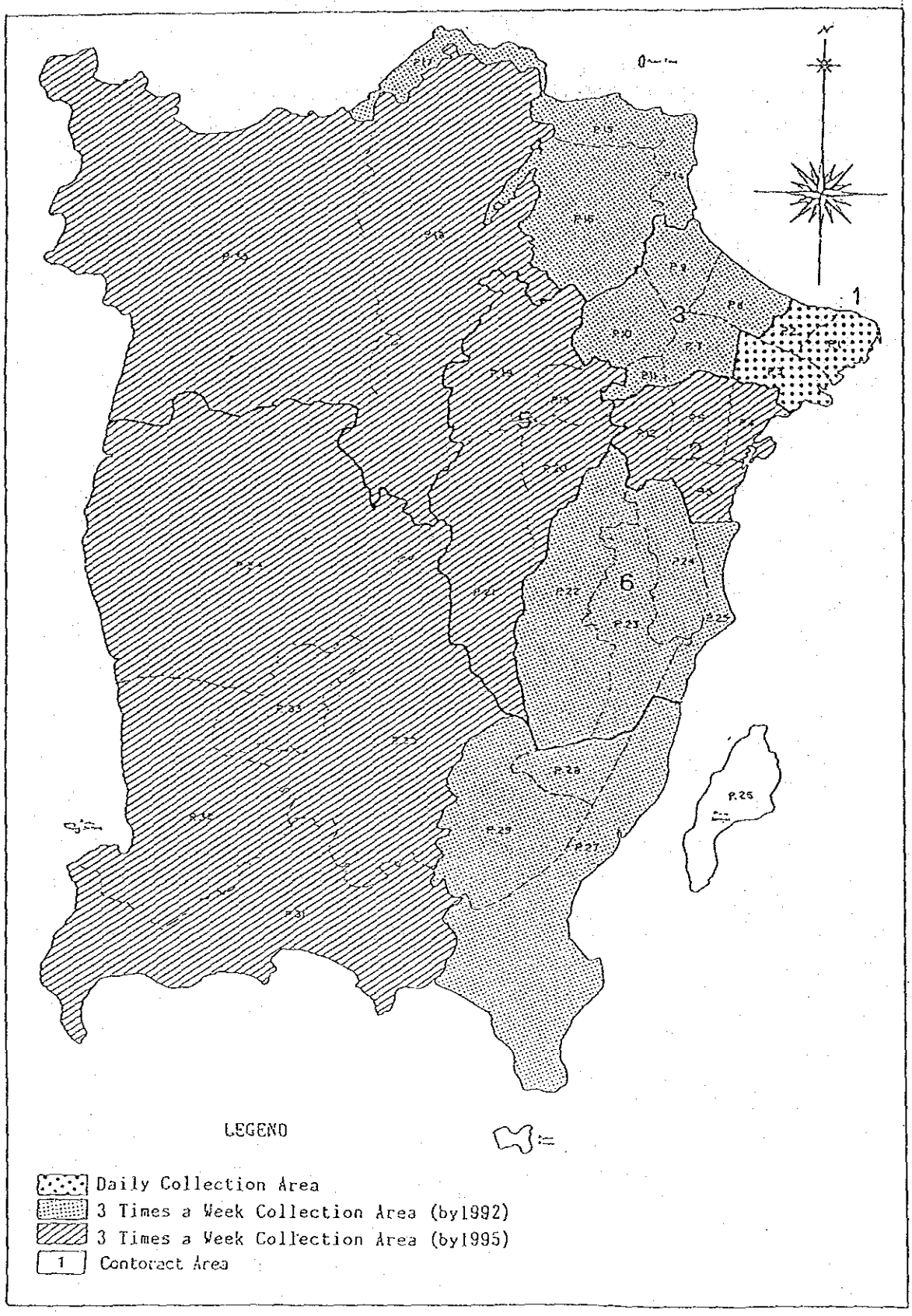


Fig. 2.1-1 Collection Improvement Plan

(4) Bulky Waste Collection

Bulky waste collections will be regularly conducted to maintain environmental sanitation with a collection frequency of once a month in 1995. The initial introduction of bulky waste collection will be conducted together with the 3 times/week collection described in (3) above, and the initial collection frequency will be once a week in order that residents may obtain a proper understanding of the system. Residents will be reminded to keep the following rules in mind at the time of discharging bulky waste.

a. The maximum length of items discharged is less than 1 m and the waste should be bundled.

b. The waste should only be discharged on actual collection days.

(5) Large Amount Collection

Large amount collection will be conducted in the same manner executed at present in MPPP.

(6) Collection Amount by Different Collection Systems

Table 2.1-4 shows the collection amount according to the different collection systems.

Table 2.1-4 Collection Amount

(t/day)

	PRESENT (1987)	1992	1995
a. Daily Collection			
- Ordinary Waste	280	199	78
- Bulky Waste	-	-	3
Sub-Total	280	199	81
b. 3 Times/Week Collection*			
- Ordinary Waste	-	125	276
- Bulky Waste	-	4	9
Sub-Total	-	129	285
c. Large Amount Collection	80	93	103
Total	360	421	469

* Commercial areas will be subject to daily collection.

(7) Withdrawal of Double Handling System

MPPP, in principle, employs the door-to-door single handling collection system, while the double handling collection system is employed in Tanjung Tokong, Bayan Baru etc. The double handling system requires a large number of heapers for primary collection, resulting in a high collection cost. The single handling system will, therefore, be adopted instead, together with the introduction of the 3 times/week collection system and discharge using plastic bags. In regard to collection from kampongs with poor access, assistant collection workers will be employed for each collection vehicle and the residents will be requested to cooperate by taking their waste to the collection points.

2.1.2 Introduction of Large Collection Vehicles

(1) Domestic Waste Collection

As 2 hours are required for a return journey between the Pantai Acheh disposal site and Georgetown, current side loaders can only make a maximum of 2 trips a day, largely reducing the vehicle operation efficiency and consequently increasing collection costs. However, collection costs will be reduced by the introduction of compactors (10 m^3) and the reduction of loading time with the introduction of the 3 times/week collection system and the use of plastic bags. Therefore, compactors will be used for collection in the future, with a target of 2 trips a day on average. With regard to vehicle size, compactors with a loading capacity of 10 m^3 will be used, as the introduction of larger vehicles than those currently used is impossible because of road conditions. Conversion to comactor type of vehicle will take place by 1992 in accordance with the commencement of operations at the Pantai Acheh disposal site.

(2) Bulky Waste Collection

Given the nature of this collection service, dump truck which does not depend on waste size will be used despite their relatively low collection efficiency.

(3) Large Amount Collection

For large amount collection, arm rolls with large containers will be introduced, particularly to the markets generating large volume of waste as at present. Compactors will be used at hotels and housing complexes.

(4) Haulage Route

Most of the collected waste will be hauled to the PADS through Tun Sardon road. Teluk Kumbar road will be used as an occasional route if any damages would arise on Tun Sardon road. In the meantime, collected waste in Batu Feringgi will be hauled by means of Teluk Bahang road. These routes are shown in Fig. 2.1-2.

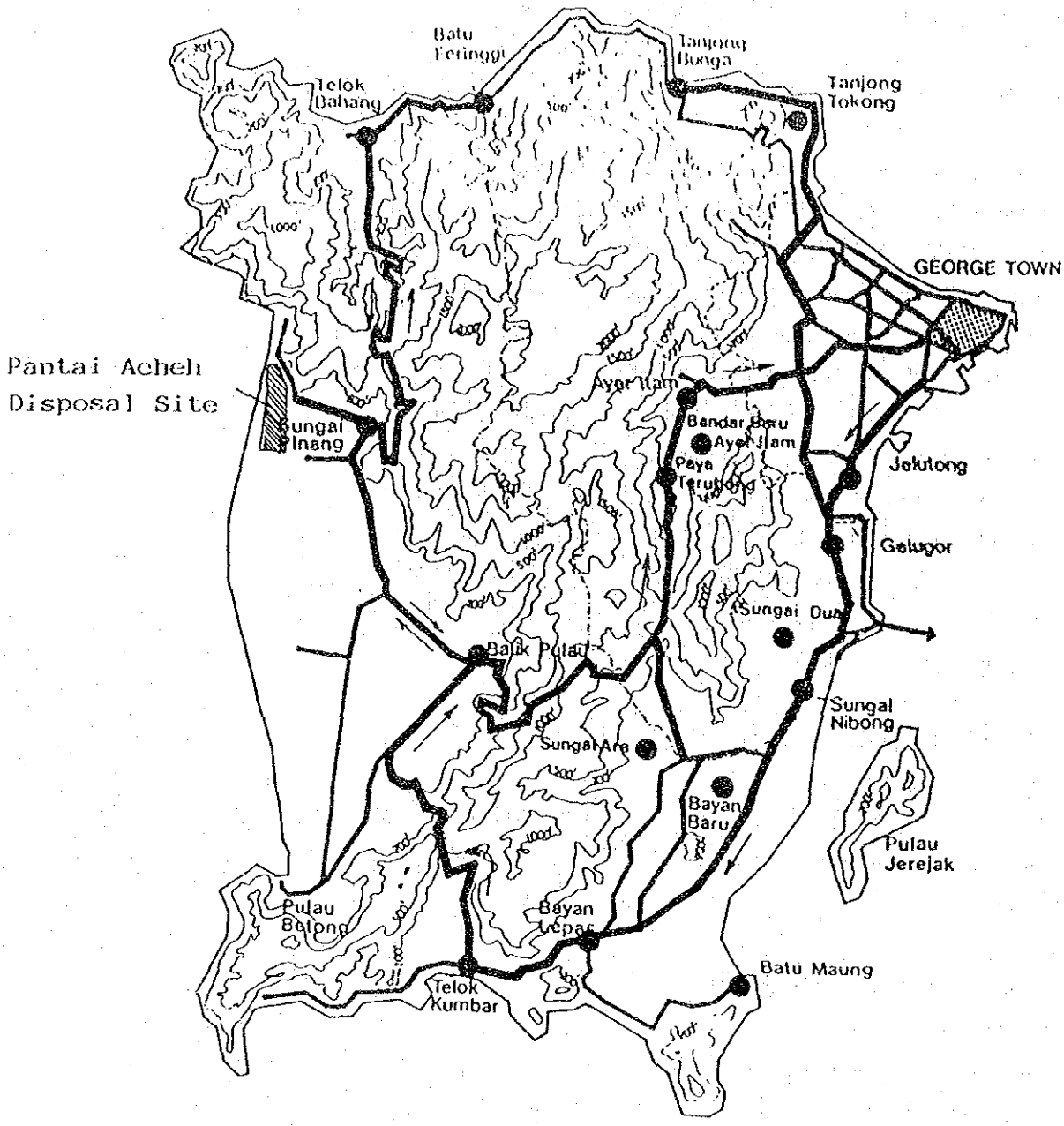


Fig. 2.1-2 Haulage Routes

2.1.3 Review of Collection Zones for Private Contractors

(1) Contract Rate

At present, 87% of the solid waste is collected by private contractors. This is to be maintained. The collection of domestic and bulky waste will also be contracted to the private sector. In the case of large amount collection, all works will be conducted by private contractors.

(2) Collection Zones

The present collection zones assigned to private contractors will be expanded, as shown in Fig. 2.1-3, on the basis of a daily collection amount exceeding 30 tons with the introduction of 3 times/week collection system and using compactor vehicles.

a. The four present zones in Georgetown will be divided into three; Central, South and North zones.

b. In the Tanjung Tokong/Tanjung Bungah area, the volume of waste is so small that there will be one zone, and Batu Feringgi will be covered by the same private contractors.

c. The two present zones in Ayer Itam will be combined into one. Gelugor will remain as same of present condition.

(3) Collection Amount

As shown in Table 2.1-5, the daily collection amount by private contractors will be 369 tons and 411 tons in 1992 and 1995 respectively.

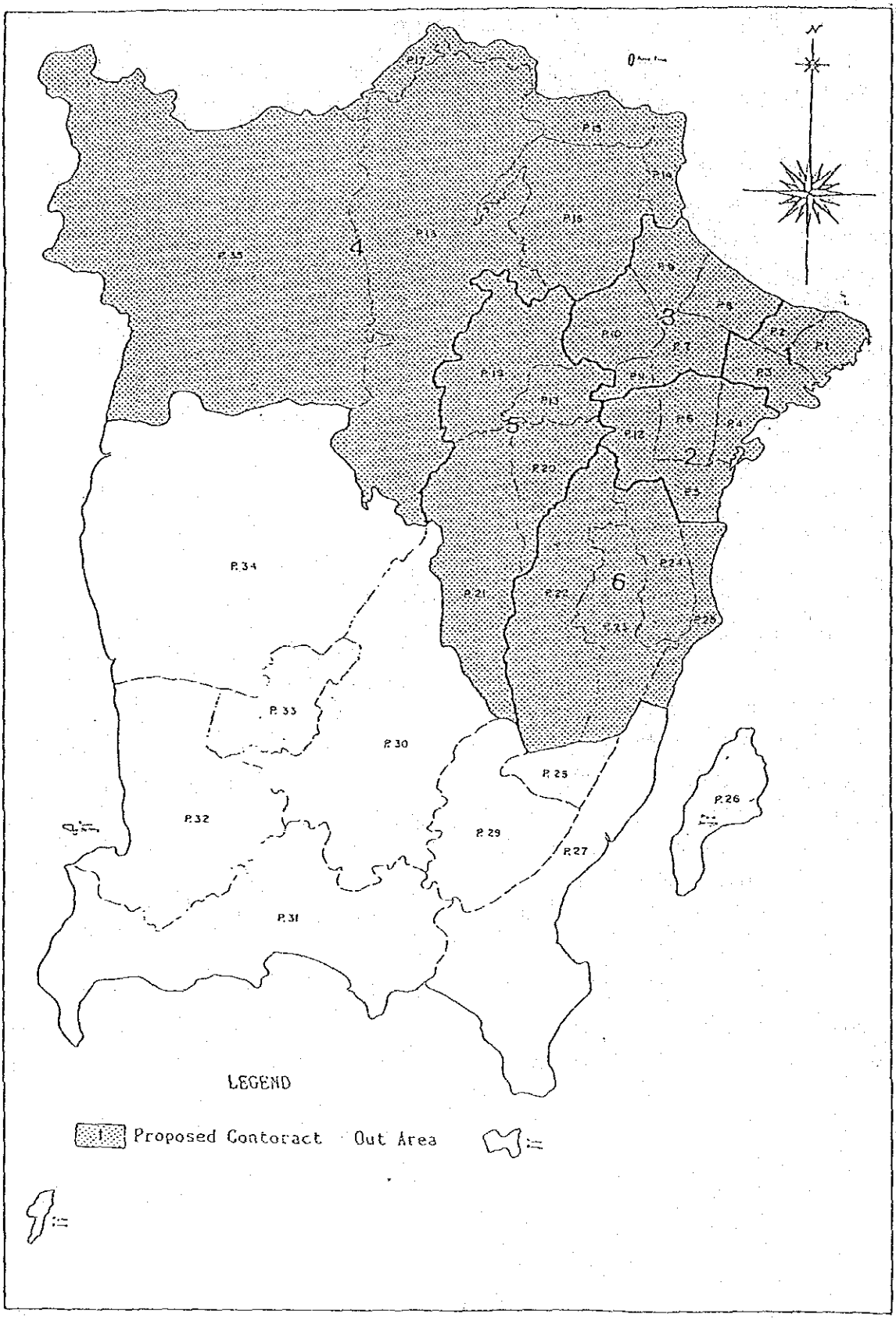


Fig. 2-1-3 Area to be Contracted out

Table 2.1-5 Collection Amount by Contract Zone

(t/day)

ZONE NO.	Area	COLLECTION AMOUNT 1992	1995
1	Georgetown (Central)	75.3	80.8
2	Georgetown (South)	34.8	38.6
3	Georgetown (North)	68.5	76.3
4	Tanjung Tokong, Tanjung Bungah, Batu Feringgi	28.4	33.4
5	Ayer Itam	38.7	43.7
6	Gelugor	30.0	34.7
7	All Areas (Large Amount)	93.0	103.4
	Total	368.7	410.9

As a result, the Council's collection service will be provided in the South-West district of the MPPP for domestic and bulky waste collections. The collection amount will be 58.1 t/day in 1995 with a contract-out rate of 87%.

(4) Contract Changes

In view of the locations of the Pantai Acheh disposal site, the introduction of the 3 times/week collection system, and expansion of contract zones and the present contract periods, the present contracts must be accordingly changed.

It is proposed that contracts be changed on the following basis.

a. As regards zones 1, 2, 3 and 6, the present contract period will be extended until Pantai Acheh disposal site will be opened in 1992. As for zones 3 and 6, contract conditions will also be changed due to introduction of 3 times/week collection system and a bulky waste collection systems.

b. As for zones 4 and 5, the contracts will be changed in 1992, and the zone areas will be altered together. A 3 times/week collection system will be introduced in zone 5 after 1992.

c. A new contract will be concluded for a bulky waste collection in 1992 when the disposal site will be moved.

The above results are summarized in Table 2.1-6.

Table 2.1-6 Change of Contract-out for Private Sector

ZONE	PRESENT CONTRACT	CHANGE OF CONTRACT ZONE	INTRODUCTION OF 3 TIME/WEEK COLLECTION	EXTENSION OF PRESENT CONTRACT	NEW CONTRACT
1	Feb. 1990	Expansion of Zone	Continuation of Daily Collection	2 years	1992
2	Feb. 1990	Expansion of Zone	Till 1992	2 years	1992
3	Feb. 1990	Expansion of Zone	Till 1995	2 years	1992
4	(Feb. 1990) Extension of Contract	Addition of Batu Feringgi	Till 1992	Nil	1992
5	(Feb. 1990) Extension of Contract	Expansion of Zone	Till 1995	Nil	1992
6	Feb. 1990	-	Till 1992	2 years	1992
7	Dec. 1990	-	Continuation of Daily Collection	2 years	1992

2.1.5 Collection Equipment and Manpower

(1) Collection Amount and Standard Collection Methods

Since 87% of the solid waste to be collected in MPPP will be collected by private contractors in the same manner as at present, the Council's service will be only Bayan Lepas and Balik Pulau area, with a collection amount of 58.1 t/day in 1995. Table 2.1-7 shows the collection amount according to the different collection systems.

Table 2.1-7 Collection Amount by the Council in 1995

(t/day)

TYPE OF WASTE	FREQUENCY	AMOUNT
Domestic Waste		
- Commercial Areas	- Daily	6
- Residential Areas	- Daily	-
-	- 3 Times/Week	50
Bulky Waste	- Monthly	2
Total		58

Domestic waste collection amount will vary depending on the day of the week, i.e. 6 tons on Sundays, 81 tons on Mondays and Tuesdays and 56 tons on the remaining days. Only some collection vehicles will operate on Sundays while overtime will be necessary on Mondays and Tuesdays. 2 trips a day to Pantai Acheh will be possible with the introduction of 3 times/week collection system. The standard work for each collection system will be as shown in Table 2.1-8.

Table 2.1-8 Standard Work

ITEMS	3 TIMES/WEEK	DAILY	MONTHLY (BULKY WASTE)
a. Type of Vehicle	Compactor (10 m^3)	Compactor (10 m^3)	Dump truck (9.5 m^3)
b. Loading Capacity	5 tons	5 tons	2 tons
c. No. of Trips/Day	2 trips	1.5 trips	2 trips
d. Haulage Amount	8 t/day	6 t/day	4 t/day
e. No. of Workers			
- Driver	1 person	1 person	1 person
- Collection Workers	4 persons	4 person	4 persons
- Heapers	2 persons	2 person	2 persons
f. Working Hours	7 hrs	7 hrs	7 hrs
g. Reserve Vehicle Ratio	20%	20%	20%
h. Reserve Manpower Ratio	20%	20%	20%
i. Fluctuation Coefficient of Waste Amount	1.15	1.15	1.15

(2) Required Number of Vehicles

The required number of vehicles in order to deal with the waste to be collected on Wednesday, Thursday, Friday and Saturday is as follows:

a. Domestic Waste

- Required vehicles

  56 t/day x 1.15 ÷ 8 t/day/unit = 8.1 units → 9 units

- Reserved vehicles

  9 units x 0.20 = 1.8 units → 2 units

Since the amount of waste is big on Mondays and Tuesdays, collection work can be done by overtime to cope with big amount of waste. Sunday collection is likely to be inefficient because of 2 unit operation be required even though waste amount to be collected is small. Furthermore, 6 units and 3 units will be respectively deployed in Bayan Lepas and Balik Pulau according to the waste amount to be collected.

b. Bulky Waste Collection

- Required vehicles

  2 t/day x 1.15 ÷ 4 t/day/unit = 0.6 unit → 1 unit

- Reserved vehicles

  1 unit x 0.2 = 0.2 unit → 1 unit

Each unit will be deployed in Bayan Lepas and Balik Pulau.

(3) Required Manpower

On the assumption that each vehicle requires 1 driver, 4 collectors and 2 heapers, the manpower required in 1995 is listed in Table 2.1-9. Operation will be led by a driver, and 3 overseers will be assigned for supervising.

Table 2.1-9 Required Manpower

(persons)

	Necessary Number	Reserved Number	Total
Drivers	11	3	14
Collectors	44	9	53
Heapers	22	5	27
Total	77	17	94

(4) Vehicle Purchasing Schedule

In light of the replacement of side loaders to compactors, vehicles will be purchased as scheduled in Table 2.1-10.

Table 2.1-10 Vehicle Purchasing Schedule

(units)

	1990	1991	1992	1993	1994	1995
Compactor						
- Purchasing	3	4	4	0	0	0
- Scrapping	(3)	0	0	0	0	0
- Operating	3	7	11	11	11	11
Tipper						
- Purchasing	-	2	0	0	0	0
- Scrapping	-	(9)	0	0	0	0
- Operating	(9)	2	2	2	2	2

Note 1: ( ) means existing vehicles
2: This figure includes stand-by vehicles

(5) Manpower Schedule by the Year

About 200 workers are currently employed for waste collection services with daily collection and double handling collection systems.

Around 50% of these workers will be relocated until 1995 in accordance with the introduction of a 3 times/week collection system, as shown in Table 2.1-11.

Table 2.1-11 Required Manpower by the Year

(persons)

	1990	1991	1992	1993	1994	1995
Driver	14	14	14	14	14	14
Collection	53	53	53	53	53	53
Heaping	114	96	79	62	45	27
Total	181	163	146	129	112	94

2.1.6 Management Plan

(1) Working Time

A working day of 8 hours is set from 6:30 a.m. to 2:30 p.m.

(2) Work Load

The standard work load for domestic waste collection is 8 t/day per collection vehicle or 1.2 t/day per worker, while the standard work load for bulky waste collection is 4 t/day per collection vehicle or 0.6 t/day per worker. It is a fact, however, that the actual work load declines up to 65% because of daily fluctuation in the waste amount to be collected, and the number of reserve vehicles and workers, as calculated below.

- Domestic waste : 56 t/day ÷ 11 units = 5.1 t/day/unit
  56 t/day ÷ 77 workers = 0.7 t/day/worker

- Bulky waste : 2 t/day ÷ 2 units = 1.0 t/day/unit
  : 2 t/day ÷ 17 workers = 0.1 t/day/worker

(3) Formation for Collection Work

The collection work will be conducted by 12 overseers for private operations and 3 overseers for Council's operation.

(4) Management Plan

Waste collection services will be managed under the following plan:

- Collection route and zoning maps;
- Vehicle arrangement plan for Sunday collection;
- Maintenance schedule for collection vehicles;
- Assignment schedule of workers;
- Daily and monthly role call records;
- Maintenance records of each vehicle;
- Daily and monthly records of operation for each vehicle;
- Daily and monthly work load of each vehicle;
- Record of claims and transactions.

(5) Rules and Standard

Rules and standards should be prepared in order to encourage public cooperation.

- Waste discharge
- Illegal dumping
- Fee collection

2.2 Cleansing Improvement

2.2.1 Cleansing Method

(1) Cleansing System in 1995

The following improvement measures for cleansing work will be implemented in Phase I.

a. Introduction of weekly cleansing in residential areas.
b. Mechanization of the sweeping of main roads and grass cutting.
c. Introduction of team work.

The cleansing system and subject length are shown in Table 2.2-1.

Table 2.2-1 Cleansing System and Subject Length

(km)

	PRESENT 1987	1992	1995
a. Road Sweeping			
- Daily	554	328	128
- Weekly (Manual)	-	208	483
- Weekly (Mechanized)	-	124	124
Total	554	660	735
b. Drain Cleansing			
- Daily	1,108	656	256
- Weekly	-	664	1,214
c. Grass Cutting (Monthly)	1,108	1,320	1,470
d. Beach Cleansing (Daily)	30	30	30

(2) Introduction of Once-a-Week Cleansing System in Residential Areas

Once-a-week cleansing system will be introduced in residential areas together with the introduction of the 3 times/week collection system. In view of the fact that cleansing work is currently conducted by 1,150 workers, the once-a-week cleansing system will be gradually implemented, as shown in Table 2.2-1, to avoid a drastic cut in manpower.

(3) Mechanization of Cleansing Work

Mechanical sweeping of main roads currently conducted in MPPP will be continued in the same manner. While grass cutting is currently conducted manually together with drain cleansing, mechanized grass cutters will be introduced to improve work efficiency, and each worker will be provided with a cutting machine which can be carried by hand.

(4) Introduction of Team Work

In principle, a weekly street sweeping and drain cleansing by team work system will be introduced in residential areas. Streets in markets and commercial areas will, however, be swept daily. A sample system of team work for standard residential areas is as follows:

Total Area to be assigned for a team	:	180 ha
Total Street Length	:	36 Km
Number of Households	:	9,000 households
Street Length Subject to Daily Sweeping	:	3.6 Km
Street Length Subject to Weekly Sweeping	:	32.4 Km
Drain Length Subject to Cleansing	:	72 Km
Grass Cutting Length	:	72 Km
Manpower - Daily Sweeping	:	4 persons
- Team Sweeping	:	18 persons
- Grass Cutting	:	4 persons
- Mandor	:	3 persons
- Overseer	:	1 person
Total	:	30 persons

A total of 14 teams will be required to cover all residential areas and each team will comprise 30 workers for cleansing in their assigned area.

2.2.2 Equipment and Manpower

The main equipment for cleansing work will be mechanical sweepers, trucks and grass cutting machines, and the required number of equipment in 1995 is as follows:

a. mechanical sweepers : 1 unit + 1 unit (reserve)
b. trucks : 8 units (1 unit for each district)
c. grass cutting machines : 74 units (1 unit for each worker)

The required manpower is as shown in Table 2.2-2.

Table 2.2-2 Required Manpower

(persons)

WORK ITEMS	TOTAL LENGTH	NO. OF WORKERS
a. Worker		
- Street Sweeping		
* Daily	128 Km	147
* Weekly	483 Km	81
* Mechanized	124 Km	6
- Drain Cleansing	1,470 Km	245
- Grass Cutting	1,470 Km	74
- Beach Cleansing	30 Km	41
- Reserve	-	119
b. Mandors	-	71
Total	-	784

2.2.3 Management Plan for Cleansing Works

(1) Working Hour

Daily working schedule is from 6:30a.m. to 2:30 p.m.

(2) Work Standard

a. Street Sweeping
   - manual : 1.2 Km/worker/day
   - mechanical : 20 Km/vehicle/day

b. Drain cleansing : 1.2 Km/worker/day

c. Grass cutting : 0.5 Km/worker/day

(3) Management System

cleansing services are provided by the Council in 8 cleansing zones and 8 waste collection zones with an independent team for mechanical street sweeping.

Cleansing works are controlled by means of providing several planning maps with working schedule and records as follows:

a. Maps of roads and streets to be swept;
b. Route maps for mechanical sweeping;
c. Zoning maps for cleansing works;
d. Daily working schedule for cleansing works;
e. Purchasing schedule for equipment and tools;
f. Role call record including overtime work;
g. Operation and maintenance records of equipment and vehicles;
h. Working records by work and zone;
i. Record of complaints.

2.3 Final Disposal Site at Pantai Acheh

2.3.1 Planning Conditions

(1) Basic Policy

The basic policy for the preliminary designs regarding Phase I project has been conceived of and is arranged in the following.

a. An adequate landfill volume exists.
b. The design appropriately pertains to the topography, geology and surrounding environment.
c. The waste disposed of at the site is to be harmless and stabilized quickly.
d. During and after completion of the filling, the area does not become a pollution outbreak source.
e. During and after completion of the filling, safety from disaster is guaranteed.
f. The completed site will be of a configuration harmonious with the surrounding environment.
g. Throughout and after completion of the filling, the operation and maintenance costs will be kept low.

(2) Designed Landfill Volume

a. Conditions for Estimation of Landfill Volume

i.	Landfill periods	: 1992 - 1996 (Phase I)
ii.	Unit weight of waste disposed (after compaction)	: 0.8 t/m^3
iii.	Cover material	: 30% of the waste volume

b. Designed Landfill Volume

The designed landfill volumes for the Pantai Acheh disposal site within Phase I, II and III are listed below.

Table 2.3-1 Designed Landfill Volume

ITEM	UNIT	PADS		REMARKS
		PHASE I	PHASE II & III	
Disposal Amount	t/day	560	770	Phase I 1996 Phase II & III 1997 - 2005
Cumulative Disposal Amount	1,000 t	950	2,159	
Cumulative Disposal Volume	1,000 m^3	1,188	3,949	Specigrav. 0.8 t/m^3
Cumulative Cover Material	1,000 m^3	356	1,185	30% of above volume
Cumulative Landfill volume	1,000 m^3	1,544	5,134	

(3) Topography and Geology

a. Topography

The site is located on the northwest side of Penang Island, as a flat marsh along the coast.

b. Geology

Characteristics of marine clay

Laboratory testing on selected soil samples has been performed to evaluate the engineering parameters of the subsoil encountered. Based on soil testing, the characteristics of marine clay are summarized in Table 2.3-2, and geological profile is shown in Fig. 2.3-1.

Table 2.3-2 Characteristics of Marine Clay

ITEMS	UNIT	CHARACTERISTICS
- Natural Moisture Content	%	80 - 100
- Bulk Density	ton/m^3	1.5 - 1.6
- Specific gravity		2.4 - 2.6
- Atterberg limit		
* Plastic limit	%	25 - 40
* Liquid limit	%	47 - 70
- Permeability coefficient	cm/sec	10^{-6} - 10^{-7}

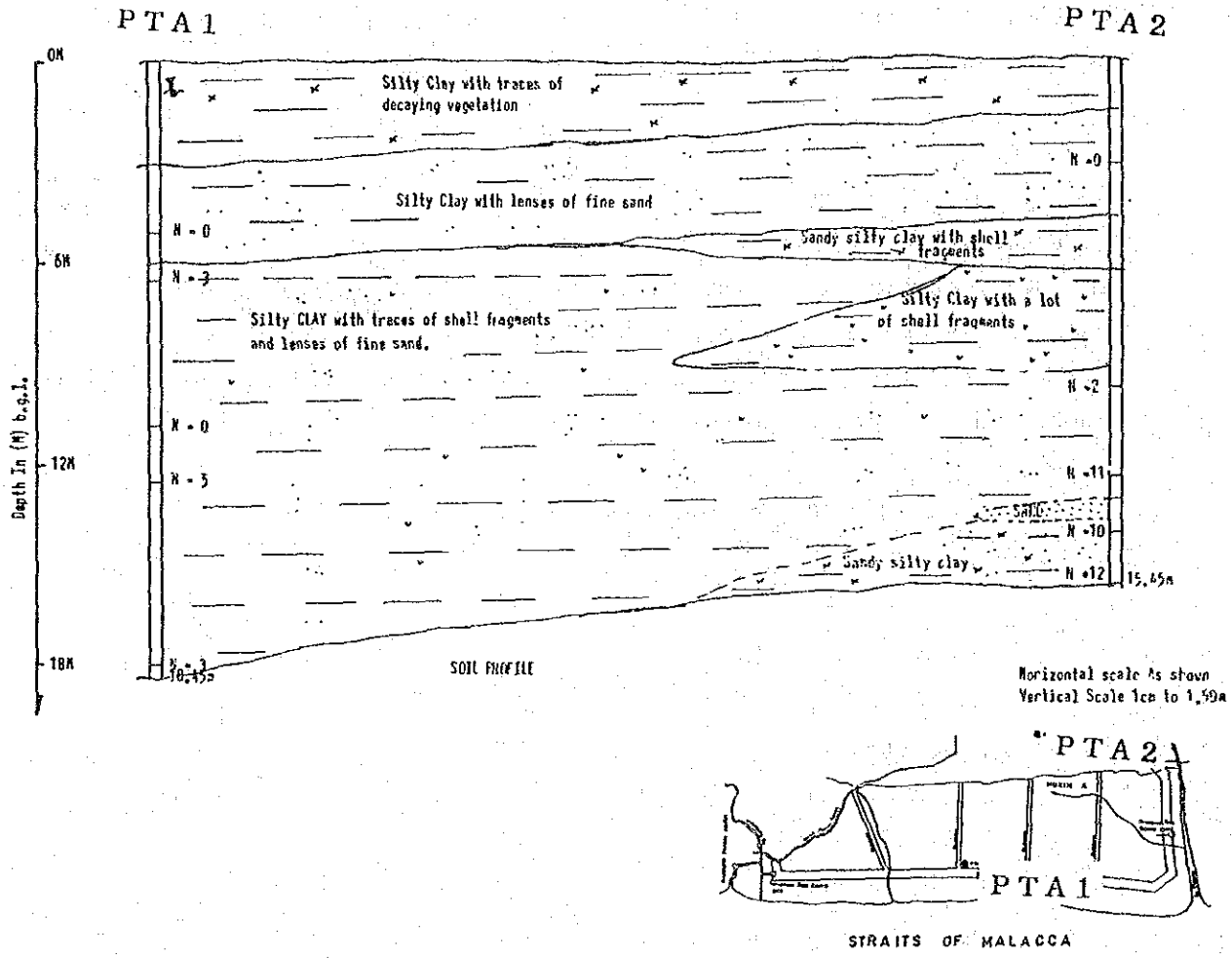


Fig. 2.3-1 PADS Geological Profile

2.3.2 Facility Design

(1) Facility Lay-out

a. Basic Considerations

The basic considerations for the facility lay-out are as follows.

i. The design is to smooth the execution and transitions in the work from Phase I through to Phase III.
ii. Regarding the surrounding land use conditions, the consideration is that each facility casts no bad effects on the local area.
iii. The on-site roads/or landfill flow are to be uncomplicated and harmonious.
iv. The administration facilities are to be erected near the entrance of the disposal site for full supervision of the waste collection vehicles.
v. The leachate circulation facilities are to be placed as far away as possible from residential areas.

b. Facilities to be Constructed

i. Main Facilities
- Enclosing structure
- Drainage system
- Access

ii. Environmental Protection Facilities
- Buffer zone
- Litter protection facilities
- Gas removal facilities
- Leachate collection facilities
- Leachate circulating facilities
- Leachate outlets
- Monitoring facilities

iii. Building and Accessories

- Site office
- Weighbridge
- Storage building
- Safety facilities
- Fire prevention facilities
- Other

c. Lay-out

The lay-out of the major facilities for PADS is planned as shown in Fig. 2.3-2.

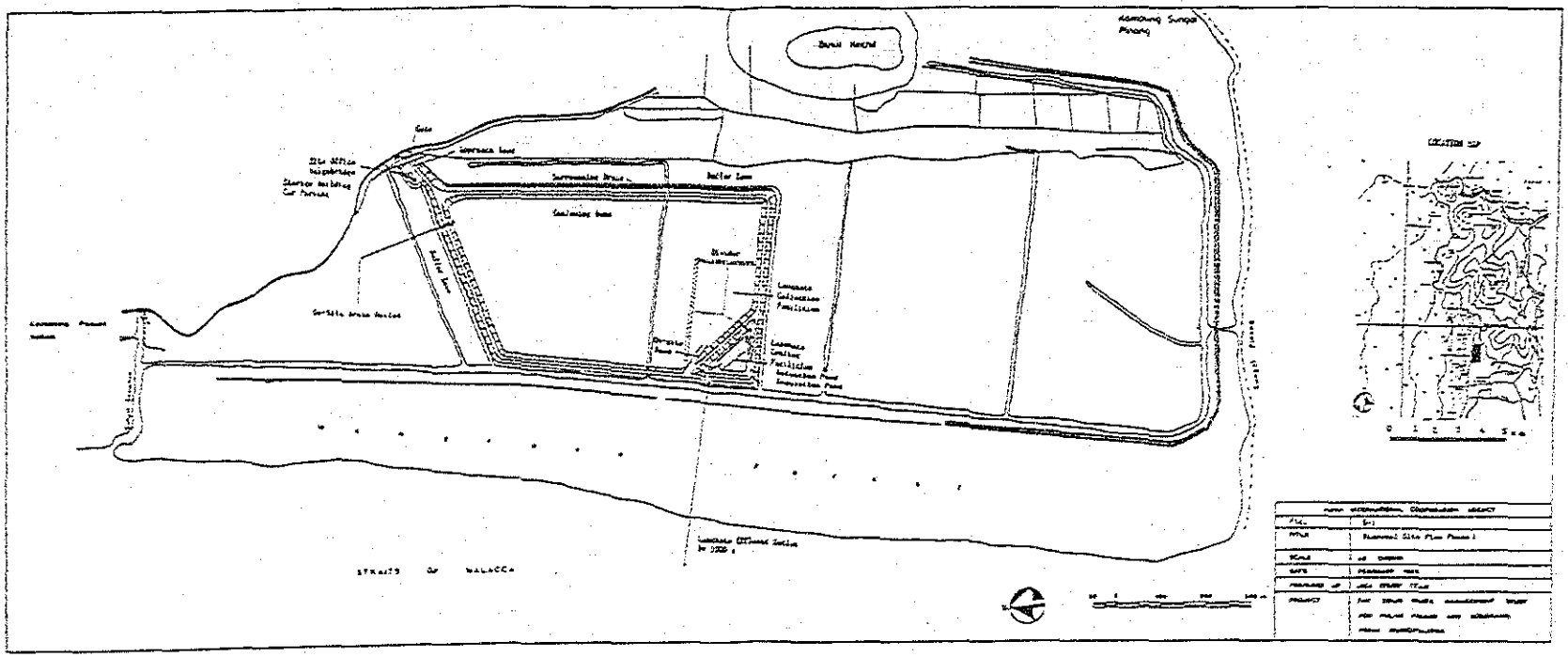


Fig. 2.3-2 Lay-out of Major Facilities for PADS

(2) Main Facilities

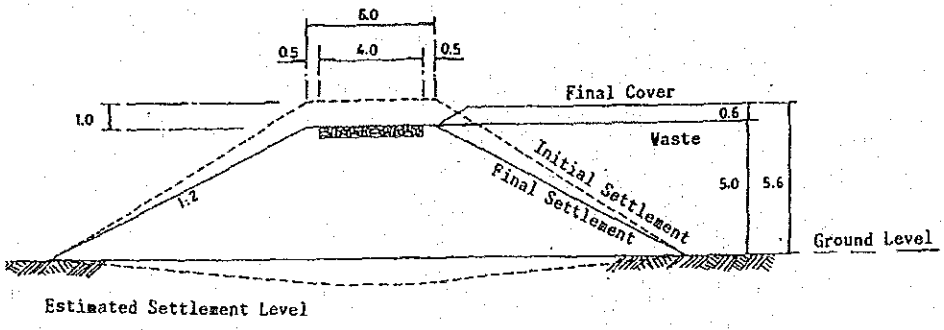
a. Enclosing structures

i. Enclosing bund

Since the disposal site is located on flat land, enclosing bund will be constructed earth for the prevention of rain water invasion and the guarantee of the designed landfill volume.

The enclosing bund is designed at 5 m height. The top of the bund, functioning as the on-site road and the administrative road, is of a 4 m width and a gravel pavement.

Land sliding and settlement were examined based on the geological data for safety and typical cross section is determined as shown in Fig. 2.3-3.



TYPICAL CROSS-SECTION OF AN ENCLOSING BUND

Fig. 2.3-3 Typical Cross Section of Enclosing Bund

ii. Divider

The divider is constructed within the enclosing bund so as to reduce the leachate quantity generated and achieve efficient landfill operations.

The divider is constructed by imported soil and a typical cross section is shown in Fig. 2.3-4.

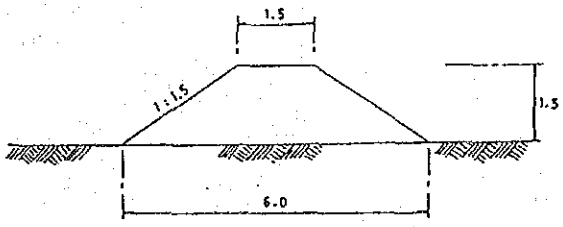


Fig. 2.3-4 Typical Cross Section of Divider

b. Drainage Systems

i. The purposes by drainage system

The purposes by drainage system are as follow:

- Surrounding Drain : Elimination of rainwater inflow from outside of the landfill site.
- On-site Drain : Elimination of rainwater from the non-landfill site partitioned-off by the divider within the enclosing bund.
- Drain for Reclaimed Area: Elimination of rainwater inflow after the completion of the landfill operations.

ii. Design conditions

The drainage system is designed in accordance with the "Urban Drainage Design Standards and Procedures for Peninsular Malaysia".

Designed discharge by drain system will be calculated by the unit discharge per ha as shown in Table 2.3-3.

Table 2.3-3 Designed Discharge

DRAIN SYSTEMS	RETURN PERIOD (year)	UNIT DISCHARGE (m^3/sec/ha)	REMARKS
Surrounding Drain	2 / 5	0.064 / 0.078	Rainfall duration is one hour
On-site Drain	0.5	0.167	Rainfall duration is 30 min.
Drain for Reclaimed Area	0.5	0.150	- ditto -

iii. Design of drainage systems

1) Surrounding drain

The typical cross section of a surrounding drain is illustrated in Fig. 2.3-5.

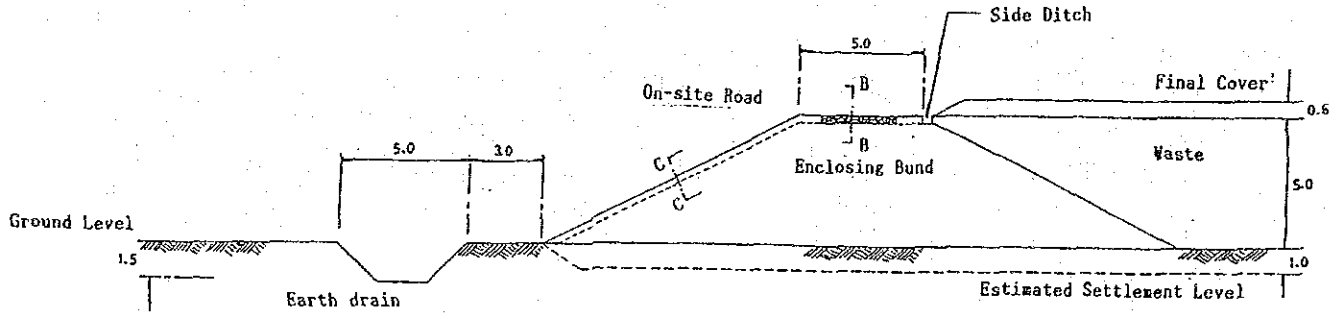


Fig. 2.3-5 Typical Cross Section of Surrounding Drain

2) On-site drain

Since the ground is composed of marine clay, an unlined drain area is installed.

The drainage from the inside of the enclosing bund to outside is discharged by gravity flow as shown in Fig. 2.3-6.

3) Drain for reclaimed area

This drain is established after the completion of the final covering. Rainwater is discharged outside of the enclosing bund.

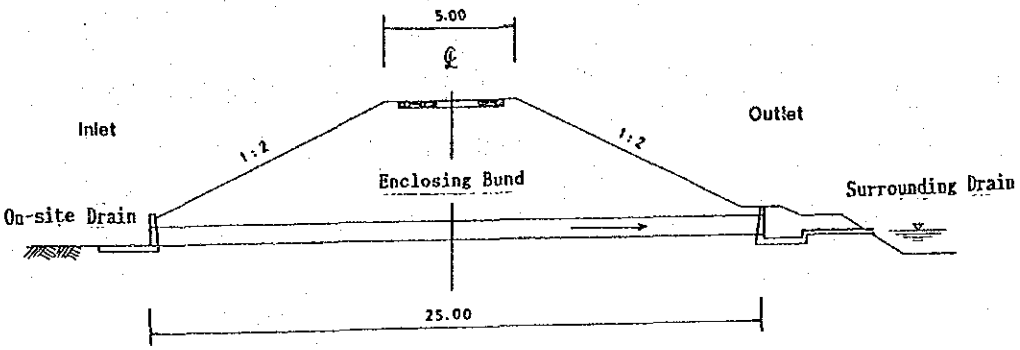


Fig. 2.3-6 Drain Outlet Profile

c. Access

i. Approach Road

This road will link the disposal site to the public road.

The road will be wide enough for two-way traffic with a carriageway of 6 m width paved by asphalt concrete. Typical cross section is shown in Fig. 2.3-7.

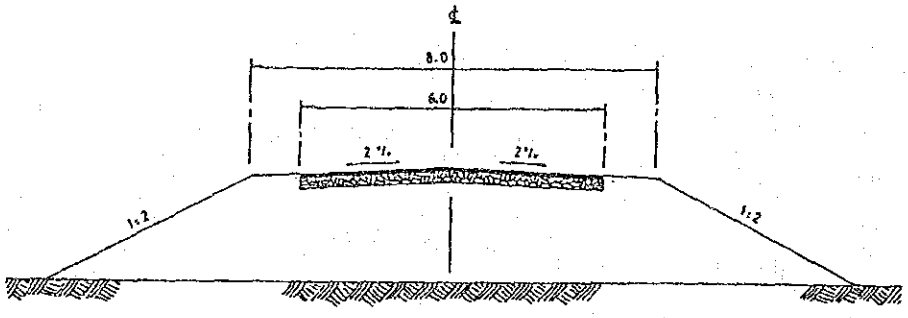


Fig. 2.3-7 Typical Cross Section of Approach Road

ii. On-site Road

The typical cross section of on-site road is shown in Fig. 2.3-8.

The road width is to be 4 m with gravel paved at a thickness of 30 cm.

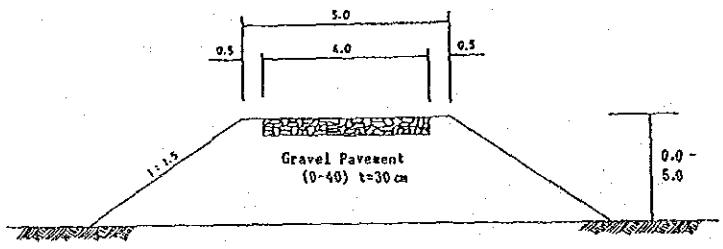


Fig. 2.3-8 Typical Cross Section of On-site Road

iii. Reconstruction of the Existing Bridge

Existing bridge located in the vicinity of Kampong Bukit Kechil, it will be reconstructed with 6 m width and 15 m length as shown in Fig. 2.3-9.

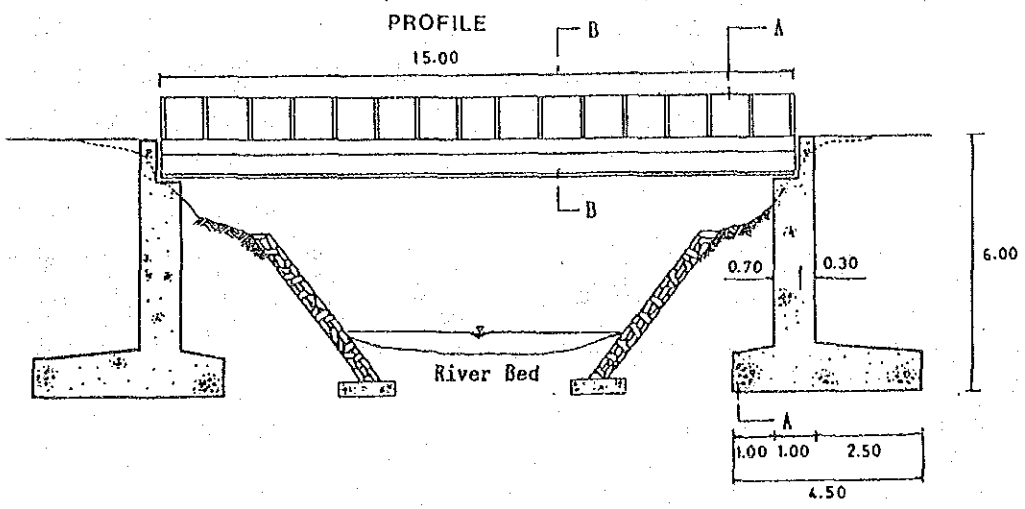


Fig. 2.3-9 Bridge Reconstruction Profile

(3) Environmental Protection Facilities

The facilities are for the prevention of primary and secondary pollution out break during and after completion of landfill.

a. Buffer zone

From environmental view point, a part of the existing Mangrove forest should be used as a buffer zone, which will have a 50 m width.

b. Litter Control Facilities

There looms the inevitability of litter scattering during the landfilling operations before the cover materials has been placed. As a means of prevention, a movable fence to catch flying litter will be installed.

c. Gas Removal Facilities

As for the out break of gas in landfill sites, gushing and exhaust are common at the weak points on the boundary surface between landfill sites and surrounding structures.

In order to prevent disasters such as fires and odor dissemination by unexpected gushing, gas removal facilities by evacuation are to be installed.

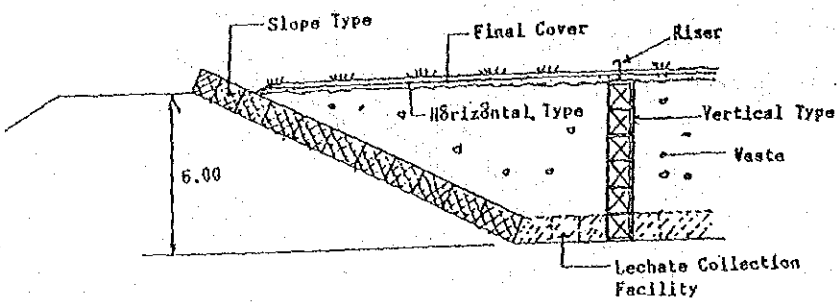
The waste characteristics, stratum thickness and operational conditions for the design conditions of the gas removal facilities by evacuation are the following.

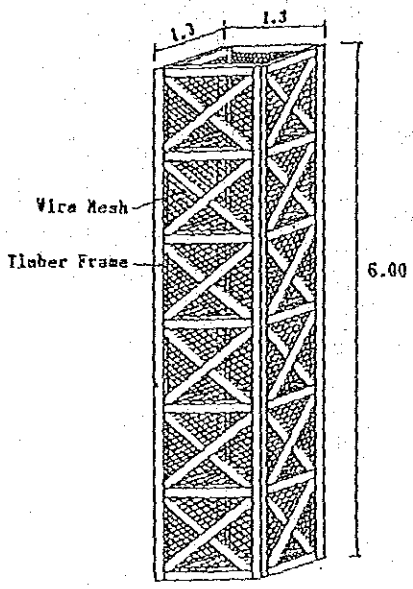
1) waste type ..... municipal waste
2) landfill layer thickness ... approx. 6.6 m
3) operational conditions ..... the landfill site area is at 24 ha at PADS, with a divider occupying 2-3 ha.

Based on the above conditions, during landfilling operations the individual gas evacuation method is followed and after the completion of landfill, from the point of view of safety and control, the collective gas evacuation method is followed by connecting individual vertical shafts with a horizontal shaft.

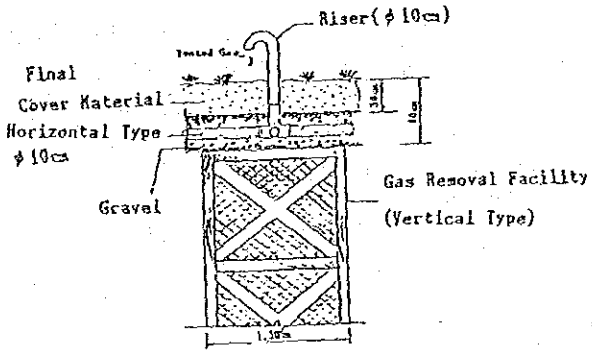
An outline of the gas removal facilities is shown in Fig. 2.3-10.

3 to 4 gas removal facilities will be proposed per hectare. Cover material is most important, as it is necessary not to leave waste exposed over a long term.





VERTICAL TYPE



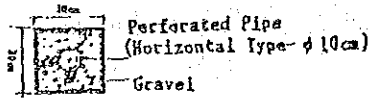


Fig. 2.3-10 Gas Removal Facilities by Evacuation

d. Leachate Collection Facilities

i. Purpose and design flow

The purpose of these facilities is

1) to discharge to retention pond
2) to reduce the leachate head (pressure) in the landfill
3) for the expansion of the aerobic area in the landfill layer by their (leachate collection facilities) connection to the gas removal facilities

The following is a flowchart on the design of the leachate collection facilities.

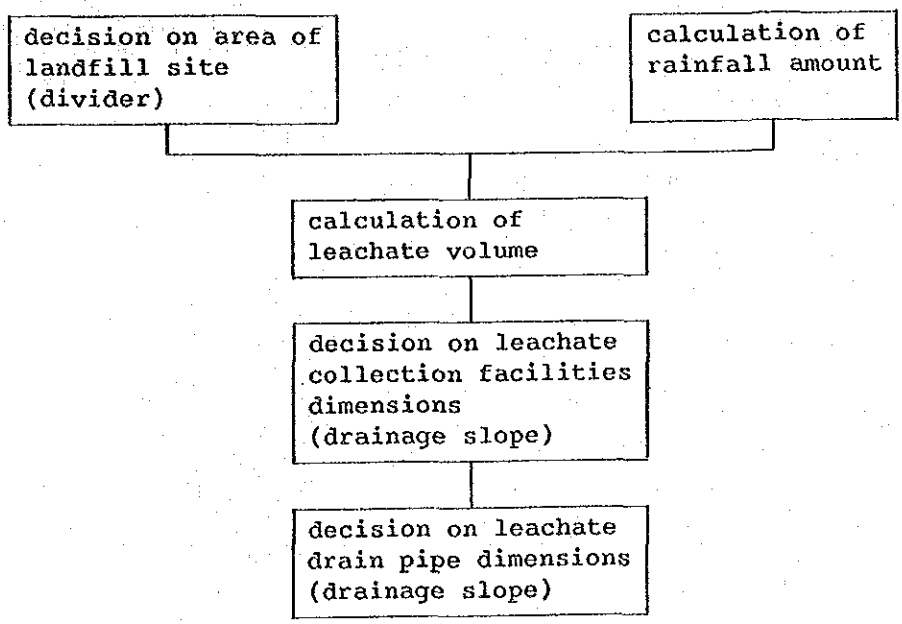


Fig. 2.3-11 Design Flowchart of Leachate Collection Facilities

ii. Area of landfill site

The study done on the area in relation to the divider is described as follows:

Rainy season	(Jul. - Nov.)	2.0 ha
Dry season	(Dec. - Jun.)	3.0 ha

iii. Calculation of Leachate Volume

The leachate volume in the month of the largest average rainfall is calculated as follows.

Site	Leachate volume (m^3/day)
PADS	188

iv. Decision on dimension of leachate collection facilities

As collection facilities, gabions are constructed of which the dimensions are shown in Fig. 2.3-12.

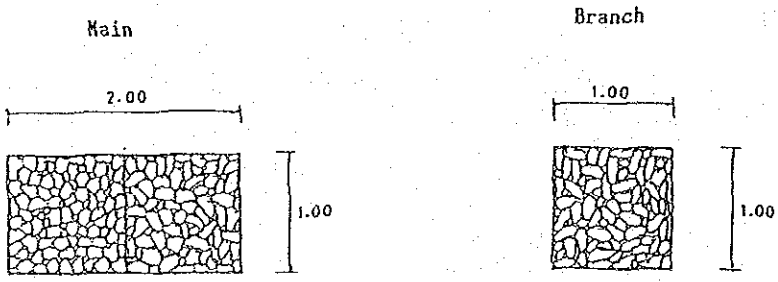


Fig. 2.3-12 Leachate Collection Facility Dimensions

v. Leachate Drain Pipe

The leachate drain pipe diameter is selected to be 0.30 m. The leachate is drained to the leachate collection facility situated within the site.

Finally it is discharged out into the retention pond through drain pipe.

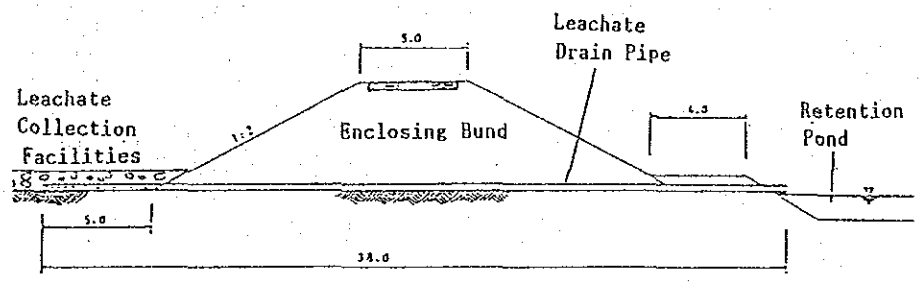


Fig. 2.3-13 Leachate Drain Pipe

e. Leachate Circulation Facilities

The leachate circulation facilities are established in the third level of sanitary landfill development and operations which is the prestage of the fourth level where leachate treatment is established. With the leachate circulation facilities, some purification by disposed waste and cover materials at the disposal site can be achieved. Leachate control and monitoring system are established, offering valuable data on the quality and quantity of leachate.

i. Design flowchart

The design flowchart for leachate circulation facilities is shown in Fig. 2.3-14.

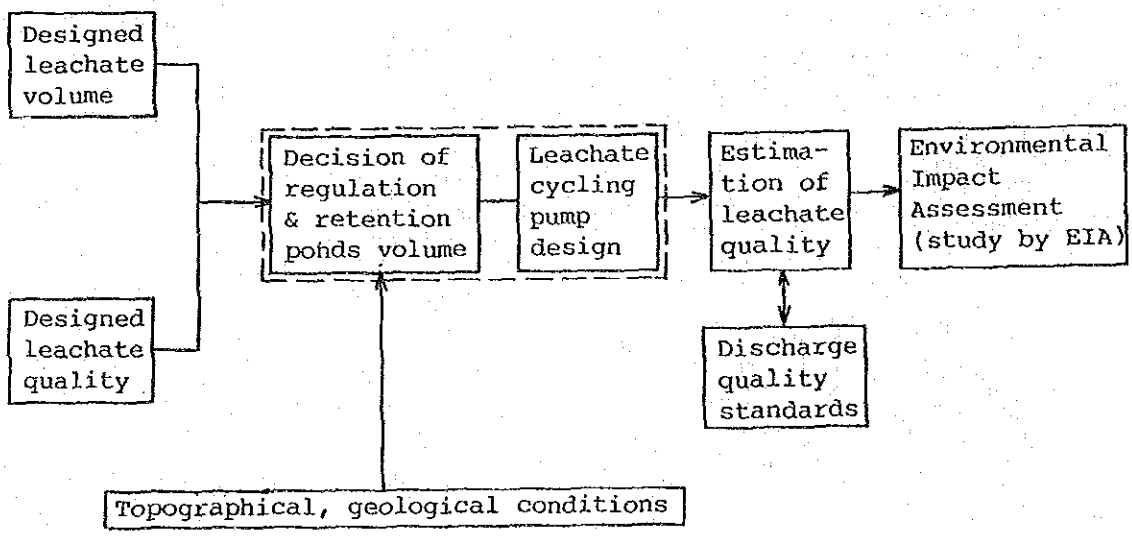


Fig. 2.3-14 Leachate Circulation Facility Design Flow chart

ii. Design conditions

1) Designed leachate volume : 188 m^3/day
2) Leachate quality estimation : BOD 1,300 mg/ℓ
COD 1,500 mg/ℓ

iii. Leachate circulation facility design

1) Decision of regulation and retention ponds capacity
Both regulation and retention ponds are to hold leachate temporarily. Because the volume fluctuates, depending on rainfall, each pond is to be big enough to hold 10 days' volume of the largest monthly rainfall. The capacity of both ponds is shown below.

ITEM	RETENTION POND	REGULATION POND
necessary capacity (m^3)	1,880	1,880
water depth (m)	1.0	1.0
pond area (m^2)	1,880	1,880

2) Leachate circulation pump
The immersed pump has a mouth diameter of 50 mm and an out-put power of 57.5 kW.

iv. Effluent leachate quality estimation

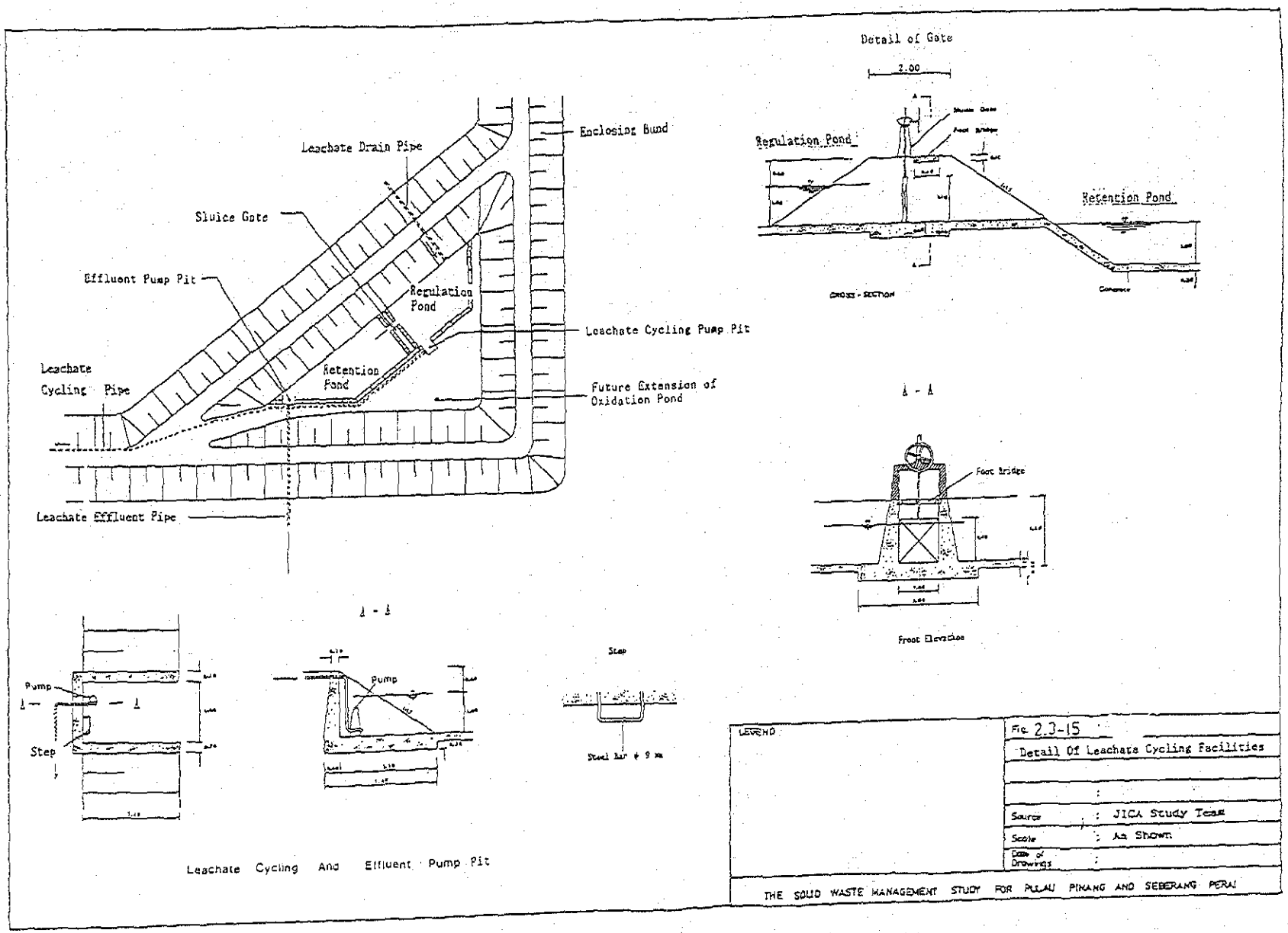
Dilution and purification rates of leachate in terms of BOD and COD are as follows:

- BOD : 40%
- COD : 20%

The estimated final leachate quality will be as follows:

- BOD : 800 mg/ℓ
- COD : 1,200 mg/ℓ

As for heavy metals within leachate, from the observation data during landfilling operations at municipal disposal sites in Japan, Hg and Cd were hardly found. The reason is that waste disposed of was municipal and not industrial one and also, soil absorption occurred by covering operations. However, Fe and Mn, in anaerobic conditions where leaching was known, were found. However, within this design, heavy metal treatment is not considered necessary.



Leachate Cycling And Effluent Pump Pit

Fig. 2.3-15 Detail of Leachate Circulation Facilities

f. Leachate effluent Facilities

It is suggested by Pre-EIA that a leachate effluent outlet from a retention pond should be set up in the sea (LWL should be deeper than 50 cm.) out of the lagoon and mangrove forest so as not to have effect on fauna which lives in the lagoon and forest.

i. Design conditions

- Designed effluent volume; 1,880 m^3
- Effluence time ; discharge every 5 days, in operation 10 hrs, a day.
- Velocity in Pipe ; approx. 1 m/sec(to avoid sedimentation)

ii. Pipeline

An outline of the pipeline is shown below.

- Pipe type ; Steel pipe
- Diameter ; 0.15 m
- Length ; 1,000 m
- Installation ; 1 m under the seabed as shown below

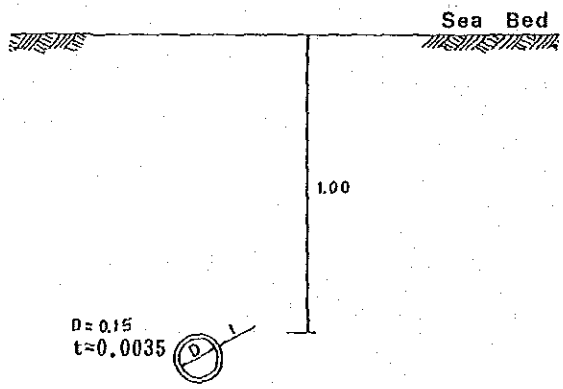


Fig. 2.3-16 Pipe Installation Profile

iii. Effluent outlet

In order not to be clogged by inflowing sand, the outlet is designed to be placed above sea level. The effluence outlet structure is shown in Fig. 2.3-17.

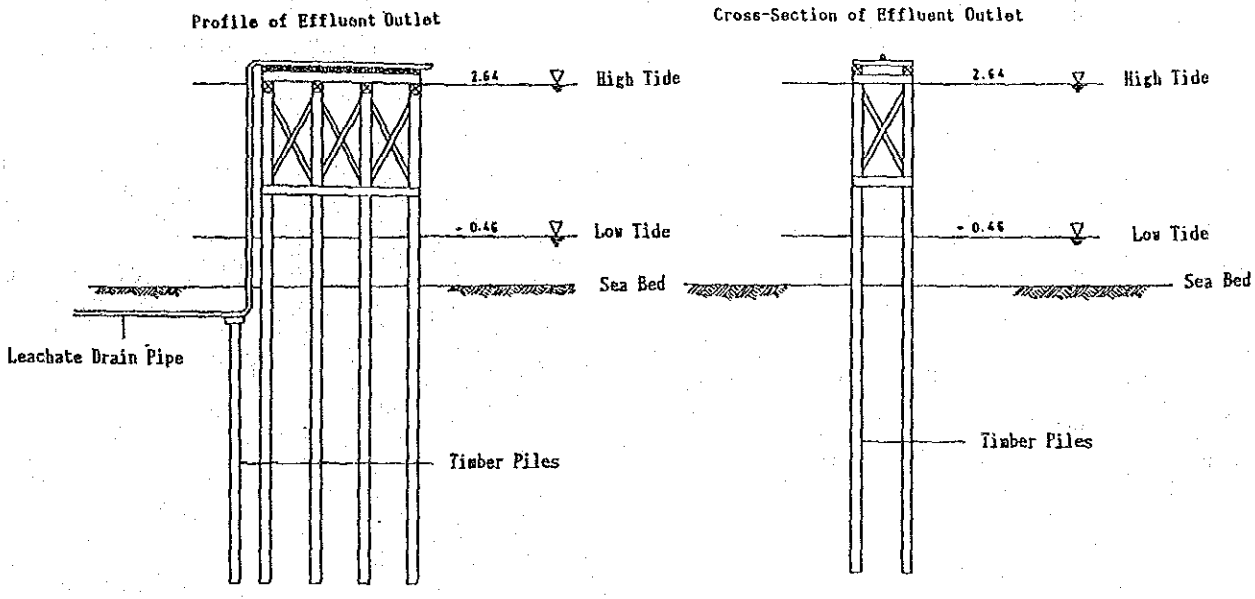


Fig. 2.3-17 Detail of Effluent Outlet

iv. Leachate circulation pump

The design calls for an immersed pump with a mouth diameter of 40 mm for output power of 57.5 kW.

g. Monitoring Facilities

The monitoring facilities are to be monitoring wells constructed in order to monitor groundwater quality.

(4) Buildings and Accessories

a. Site office

This will be established for administration of the site such as the weighing of waste and the monitoring of hygenic conditions for the employees. The floor area is about 120 m^2.

b. Weighbridge

Incoming waste must be weighed for proper operations within the disposal site. One weighbridge is to be constructed at the site. The weighbridge consists of a load-cell scale, a 4-point support system, a digital counter (separated from the main body), an underground system and a weighing capacity of up to 30 tons.

c. Fire prevention facilities

A fire extinguisher and reserve water pond are assured for the site office and other facilities for the prevention of fire.

d. Storage building

A storage building is to be constructed at disposal site for repair of landfill and other equipment.

e. Others

In order to prevent anyone from illegally entering the site, a gate and fence are to be constructed. Flashlights will also be provided for the guard.

A parking lot will be constructed for visitors and the staff. In order to prevent dirtying of public roads by collection vehicles, a car wash will be provided.

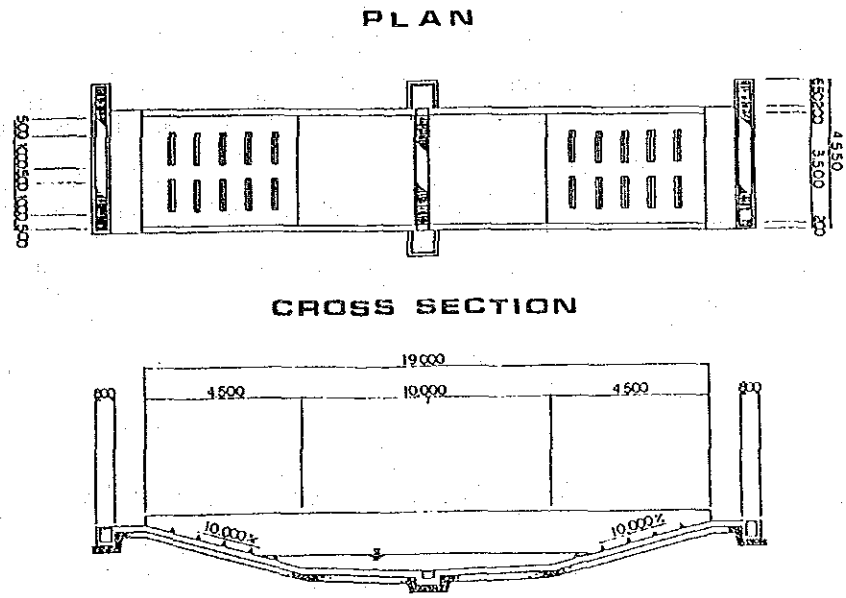


Fig. 2.3-18 Car Wash

2.3.3 Operation and Maintenance Plan

(1) Landfill Plan

a. Basic Policy

The following basic policy is sustained for the preparation of the landfill plan.

i. Solid wastes are spread and compacted sufficiently.
ii. The scattering of solid wastes is minimized.
iii. The diffusion of offensive ordor is minimized.
iv. Stabilization of wastes as early as possible is arranged.

b. Landfill structure

Regarding landfill structure, the semi-aerobic landfill method is selected.

c. Landfill method

In order to protect the surrounding environment, the cell method should be applied.

d. Cover Materials

The cover material is to be placed in the manner shown in Fig. 2.3-19 and the thickness of each covering is as follows,

- daily cover material	20 cm thick
- intermediate cover material	30 cm thick
- final cover material	60 cm thick

Accordingly, the cover material will be placed in a 30% ratio to the disposal volume of waste.

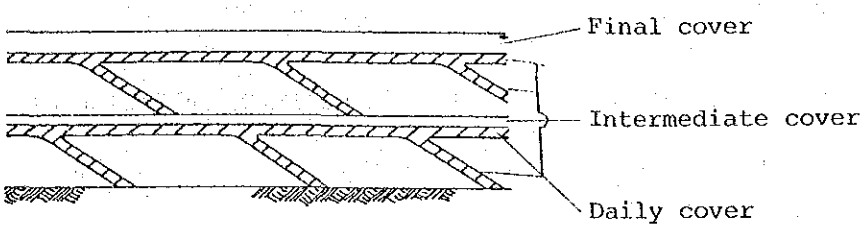


Fig. 2.3-19 Covering by Cell Method

The following cover materials are required, because of their appropriate qualities.

- daily cover material; sandy soil for good ventilation
- intermediate and final cover material; clayey silt of a small permeability coefficient, and for good vegetation in final cover.

e. Landfill equipment plan

i. Content of the work

The content of the work for the landfill equipment is summarized as follows.

WASTE HANDLING	COVER MATERIAL HANDLING	OTHER
pushing (moving)	excavation	levelling (site access road & unloading site
crushing	loading, hauling, spreading and levelling	site maintenance
compaction	compaction	

ii. Equipment selection

The following equipment is selected for efficient landfill operations and maintenance.

1) Bulldozer

For leveling and compaction of waste and cover material, a bulldozer excells in leveling and compaction of waste and cover material and has various other uses. A bulldozer for swamp use and of a 21-ton class weight is to be selected.

2) Back hoe (Hydraulic excavator)

For drain excavation, a back hoe is inferior in loading capacity to a crawler-loader, but is excellent in excavation, in which a bulldozer is inferior.

iii. Selection of number of equipment

1) Bulldozer (21-ton class)

According to the 1996 daily landfill estimations, 3 bulldozers will be necessary.

2) Back hoe (Hydraulic excavator)

Principally for drain excavation, one will be necessary.

f. Landfilling operations

The landfilling operations are outlined in the following.

i. The waste is dumped at places directed to the driver by the staff.

ii. The dumped waste is spread and crushed by a bulldozer forming a thin layer with 1:3 slope for sufficient compaction.

iii. After the completion of the compaction, the covering operations will be performed on a daily basis by the cell method.

iv. Intermediate cover material will be laid on the first layer of landfill when it has extended as far as the divider.

v. A second layer of landfill will be laid on the intermediate cover material, extending to the divider.

vi. Final cover material will be laid on top of the second layer of landfill.

vii. A divider, gas removal facilities and leachate removal facilities will be constructed in the adjacent area for the following landfilling operations.

g. Landfill plan

This is summarized in the following.

i. Divider

The divider should be constructed on a small scale during the rainy season (July - Nov.) and on a large scale during the dry season (Dec. - June) following the increase and decrease of leachate. The divider should always be constructed directly adjacent to the soon-to-be completed landfill area.

ii. Construction work

Private contractors will perform the construction of the following.

- divider
- leachate collection facilities
- gas removal facilities
- on-site road
- ditch

iii. Configuration of completed landfill area

To insure the immediate discharge of rainwater on the completed area, the following work will be completed by the MPPP.

- leveling
- temporary drain construction
  * main ..... concrete lined
  * branch ... unlined

iv. Procurement of cover material

The cover material will be procured by a bidding process involving selected suppliers.

(2) Facility Maintenance

a. On-site maintenance

i. On-site and approach roads

The on-site road is to be repaved with gravel and compacted and the approach road, with asphalt, to avoid any problems for vehicles.

ii. Fire prevention measures

Fire-fighting sand (cover soil will be applied for this purpose) and a water sprinkler truck with fire-fighting pump will be used to cope with any unexpected fire in the disposal site. Furthermore, daily covering operations will be carried out concurrently so as to prevent fire from occurring.

iii. Sanitation control

The most effective sanitation control is to carry out daily covering operations by the cell method, and it is important to prohibit solid wastes from being exposed and standing water from being produced. Only when absolutely needed should insecticides be used and only very sparsely.

iv. Waste scattering prevention

A fence will prevent waste from scattering outside the site, in addition, scattered waste within the site will be constantly checked and collected.

v. On-site maintenance (equipment)

The following is necessary equipment for effective on-site maintenance.

- Disaster prevention .... Water sprinkler truck
- On-site patrol ..... Inspection vehicle

b. Main facility maintenance

The main facilities must be maintained in top condition as one breakdown could affect all, resulting in mass damage.

i. The bund must be checked for any breaks or holes.
ii. The drainage system should be constantly checked and cleaned out as it can be stopped up by sand, leaves, weeds and other objects.

iii. The leachate volume should be checked daily. In case of sudden increase or decrease, the leachate collection facilities could become stopped up and cause leachate to discharge outside the landfill site. Also, the existence of springwater in the landfill site should be investigated.

c. Equipment Maintenance

In order to perform proper maintenance for effective operations, if problems are discovered during periodic investigation, they should be analyzed and equipment should be repaired, by only skilled mechanics. Necessary spare parts should be kept in stock.

d. Hygiene and safety control

i. Hygiene control

Periodic health check-ups are performed and medicine is given for any possible accident. In addition, the staff will possess full knowledge of hospital locations and access to go in case of any emergency.

ii. Safety control

In order to prevent fire caused by carelessly thrown cigarettes, a measure such as a no-smoking rule should be put into effect at the landfill site. The staff will be well educated on disaster prevention.

(3) Environmental Monitoring

In the process of carrying out landfill work, the staff should prepare a monitoring (or supervision) plan, which includes water quality inspection and control of solid waste-scattering, in order to conserve the environmental conditions of the final disposal site.

a. Water Quality Monitoring

The following monitoring methods shall be effected.

i. monitoring of groundwater by the monitoring well
ii. monitoring of surrounding drain surface water
iii. monitoring of retention and regulation ponds leachate
iv. monitoring of leachate at the effluent pump and at the effluent outlet.

b. Waste monitoring

i. monitoring of directly hauled waste by generators themselves, in particular, checking of unacceptable industrial waste by refering to the scheduled waste inventory list from the DOE survey on industrial toxic waste,
ii. monitoring of scattered waste outside the site,
iii. monitoring of illegal dumping.

2.3.4 Ultimate Use

(1) Basic Conditions on Ultimate Use

There are the following basic considerations concerning the ultimate use of the completed landfill sites.

- problems related to settlement
- problems related to gas generation
- maintenance of completed landfill site

(2) Ultimate Use Plan

Due to settling and gas problems, construction of buildings on completed landfill site is not recommended for at least up to a certain amount of years (over 15 years). Thus, the construction of a park for the surrounding inhabitants is recommended due to the following reasons:

- a great contribution to the surrounding residents,
- in harmony with the existing landscape,
- compatible with the surrounding land use,
- one of the least expensive methods of land use.

Fig. 2.3-20 shows an example of the ultimate use of PADS.

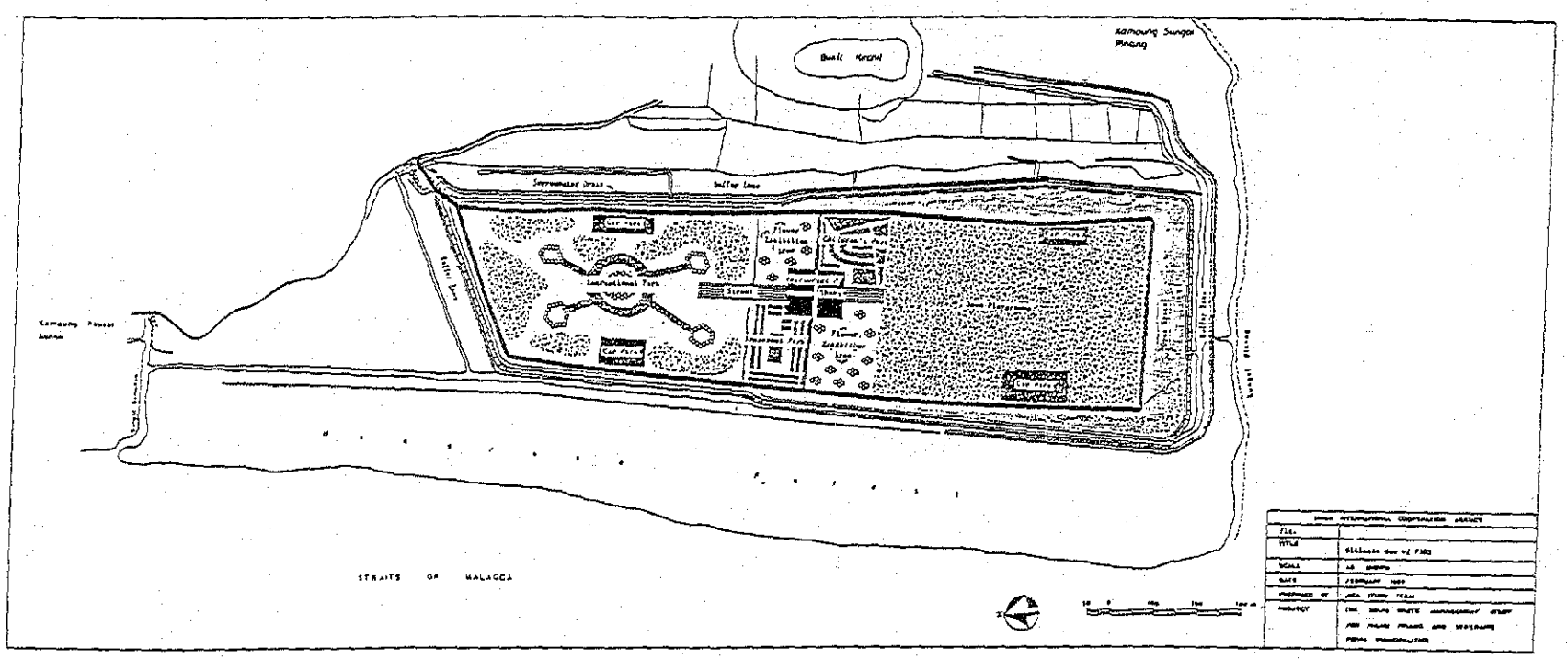


Fig. 2.3-20 Ultimate Use Plan of PADS

3. Cost Estimation

The investment and operation costs were estimated on the basis of 1987 prices by adding the cost of each facility and equipment. The unit prices used in the cost estimation were obtained from following sources:

- construction cost : Kerajaan Malaysia (JKR)
- Purchasing cost of equipment/machinery : relevant studies

3.1 Investment Cost

(1) Collection and Haulage

Investment cost for collection and haulage covers the purchasing of the collection vehicles required for the Council's service in 1995. Investment cost amounts to M$1.8 million as shown in Table 3.1-1. As the vehicles have a life expectancy of 7 years, there will be no replacement demand prior to 1995.

Table 3.1-1 Investment Cost for Collection and Haulage

(M$1,000 in 1987 price)

VEHICLE TYPE	UNITS	INVESTMENT COST
Compactor	11	1,650
Tipper	2	160
Total	13	1,810

(2) Cleansing

Investment cost for cleansing improvements covers the purchasing of mechanical sweepers, trucks and grass cutting machines, and amounts to M$1.3 million as shown in Table 3.1-2. The replacement demand is not taken into account for the investment cost.

Table 3.1-2 Investment Cost for Cleansing

(M$1,000 in 1987 price)

ITEMS	UNITS	INVESTMENT COST
Trucks	8	640
Mechanical Sweepers	2	500
Grass Cutting Machines	64	148
Total		1,288

(3) Disposal

Investment cost for disposal site consists of construction and equipment purchasing costs, and amounts to M$5.1 million as shown in Table 3.1-3.

Table 3.1-3 Investment Cost for Disposal Site

(M$1,000 in 1987 price)

ITEMS	INVESTMENT COST
Construction	
- Site Preparation	495
- Main Construction Work	2,270
- Pollution Control Facility	383
- Auxiliary Work	430
Sub-Total	3,578
Equipment Purchasing	1,503
Total	5,081

(4) Total Investment Cost

Total investment cost amounts to M$8.8 million including engineering fees, physical contingency and price contingency as shown in Table 3.1-4.

Table 3.1-4 Total Investment Cost

(M$1,000 in 1987 price)

ITEMS	INVESTMENT COST	REMARKS
Collection	1,810	
Cleansing	1,288	
Disposal		
- Construction Cost	3,578	
- Equipment Purchasing Cost	1,503	
Sub-Total	8,179	
Engineering Fee	179	3,578 x 0.05
Physical Contingency	358	3,578 x 0.1
Price Contingency	131	(8,179+179+358) x 0.015
Sub-Total	668	
Total	8,847	

3.2 Operation Cost

Operation cost consists of the depreciation cost and the operation/ maintenance cost which includes costs for fuel, personnel, contracting and management, etc.

The depreciation cost was calculated by dividing facility and equipment by their lives, taking the residual value into consideration. The maintenance cost was calculated by multiplying the construction/procurement costs by specific rates. The fuel cost was calculated on the basis of a standard unit of consumption.

(1) Collection and Haulage

The annual operation cost of collection and haulage will be M$1.4 million in 1995, as shown in Table 3.2-1.

Table 3.2-1 Annual Operation Cost of Collection and Haulage (1995)

(M$1,000 in 1987 price)

ITEMS	ANNUAL OPERATION COST
Depreciation	233
Maintenance	217
Personnel	730
Fuel and Others	218
Total	1,398

(2) Cleansing

The annual operation cost of road sweeping and drain cleansing will be M$5.4 million in 1995, as shown in Table 3.2-2.

Table 3.2-2 Annual Operation Cost of Cleansing (1995)

(M$1,000 in 1987 price)

ITEMS	ANNUAL OPERATION COST
Depreciation	200
Personnel	4,953
Fuel, Maintenance and Others	248
Total	5,401

(3) Disposal Site

The annual operation cost of the disposal site is estimated to be M$1.8 million in 1995, as shown in Table 3.2-3.

Table 3.2-3 Operation Cost of Disposal Site (1995)

(M$1,000 in 1987 price)

ITEMS	ANNUAL OPERATION COST
Depreciation	
- Disposal Site Facilities	588
- Equipment	193
Maintenance	174
Personnel	153
Fuel, etc.	643
Total	1,751

(4) Contracting to Private Sector

Private contractors are to be used only for collection work in MPPP. The cost of contractors is estimated to be 10% lower than that of work managed by the Council. The estimated cost will be M$9.0 million in 1995.

(5) Administrative Cost

Administrative cost is expected to reach M$1.1 million in 1995.

(6) Total Operation Cost

The total operation cost in 1995 is shown in Table 3.2-4, based on the above estimation.

Table 3.2-4 Total Operation Cost in 1995

(M$1,000 in 1987 price)

ITEMS	DEPRECIATION	MAINTENANCE	FUEL, ETC.	PERSONNEL	TOTAL
Collection	233	217	218	730	1,398
Cleansing	200	-	248	4,953	5,401
Disposal	781	174	643	153	1,751
Contractors	-	-	9,003	-	9,003
Administration	-	-	-	1,074	1,074
Total	1,214	391	10,112	6,910	18,627

4. Organization, Privatization and Fee Collection

4.1 Proposed Scheme for the USD Responsible for SWM

(1) Organizational Scheme

An organizational scheme, as shown in Fig. 4.1-1, is proposed for the new Urban Service Department of MPPP. The organizational scheme of the USD proposed below is one that can be implemented immediately by deploying the existing cleansing personnel.

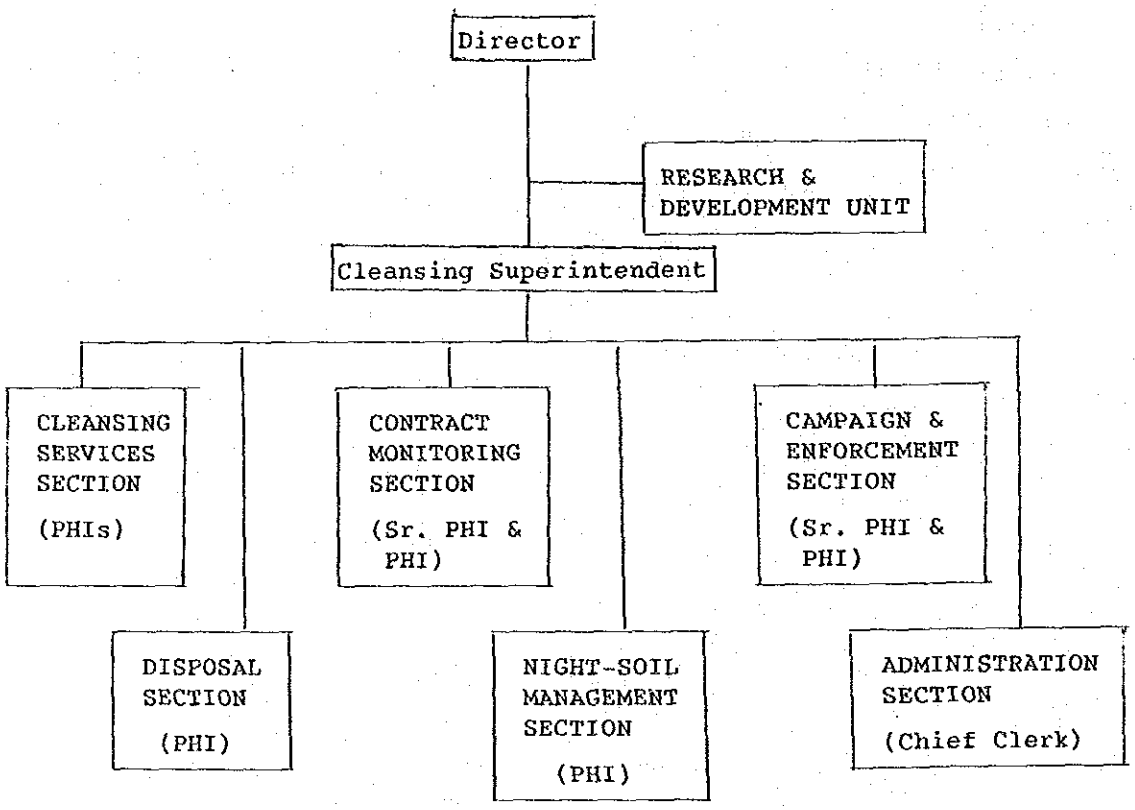


Fig. 4.1-1 Proposed Organization of the USD for MPPP

Note:

1) Responsibilities of the Cleansing Services Section will include street and drain cleansing as well as collection and haulage.
2) Positions shown below the names of sections indicate the heads of these sections. Actual appointments, however, should be made based upon the merits of individual persons.

(2) Manpower Scheme

Personnel requirements projected for 1995, according to section and position, are shown in the Table 4.1-1. In total 1,056 persons will be required which is about two third of the present manpower size. Almost all personnel can be deployed from Health Dept. and Engineering Dept.

Table 4.1-1 Proposed Number of Personnel According to Section and Position (1995)

NAME OF SECTION	PHI & ENG	TECH & Jr. CLE	OVER-SEER & Jr. TECH & CLE	DRIVER & OPE	MANDOR	LABORER	TOTAL
1. Cleansing Services	4*	-	36	24	71	783	918
- Collection				14	-	80	94
- Cleansing				10	71	703	784
2. Contract Monitoring	2	-	3	-	-	-	5
3. Campaign & Enforcement	2	-	8	-	-	-	10
4. Disposal	1	2	3	4	-	4	14
5. Night Soil Management	1	-	6	-	5	84	96
6. Research and Development	2	-	-	-	-	-	2
7. Administration	-	1	-	-	-	10	11
Total	12	3	56	28	76	881	1,056

* A director is included in this category.

Abbreviations:

PHI : Public health inspector
ENG : Engineer
TECH : Technician
Jr. CLE: Junior Clerk
OPE : Operator

MPPP will have many redundant laborers in the future when it fully introduces 3 times/week collection and once-a-week cleansing system in residential area. Those redundant laborers need to be deployed for other kinds of services such as landscaping work, which is important in view of creating more beautiful city which deserves being called "Pearl of Orient".

(3) Organizational Scheme for the Cleansing Services Section

The organizational scheme as shown in Fig. 4.1-2 is proposed for the cleansing services section of the USD.

It is proposed that both PHIs and Overseers would act as middle management who would generate more managerial and planning inputs rather than occupying themselves with daily routine.

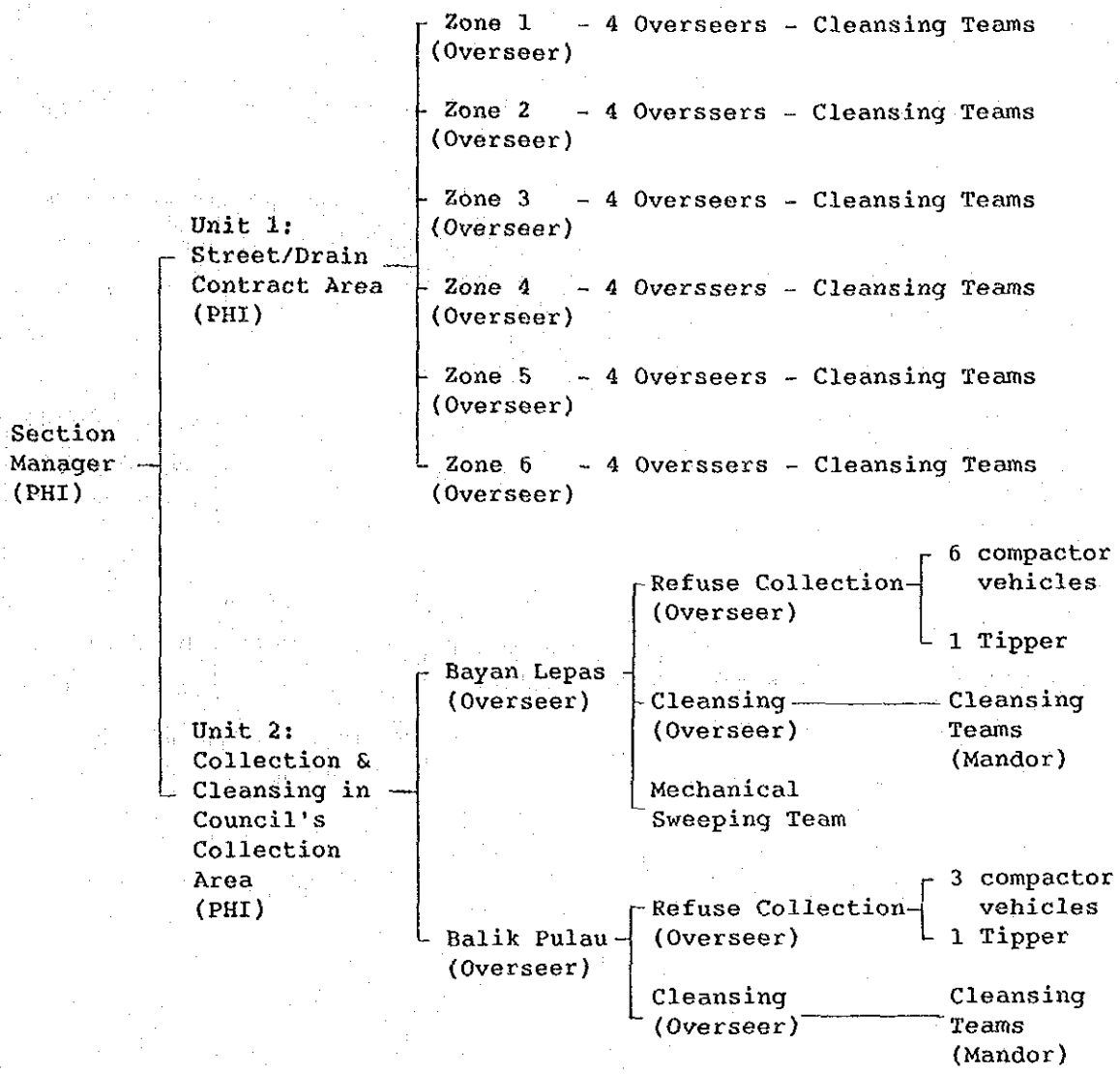


Fig. 4.1-2 Organization Scheme for Cleansing Services Section of USD

(4) Disposal Section

The organization scheme for disposal section is proposed as shown in Fig. 4.1-3.

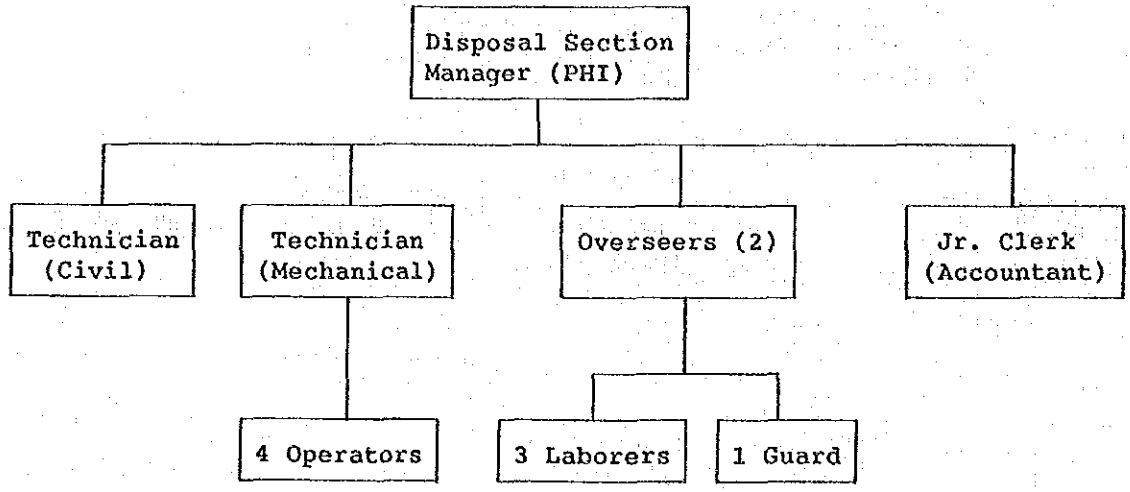


Fig. 4.1-3 Organization Scheme for Disposal Section

4.2 Privatization

(1) Rate of Privatization

It is proposed that MPPP will maintain the present rate (87%) of privatization of waste collection services in 1995. To keep the same rate of the privatization means that waste amount to be collected by contractors will increase year by year as the generation amount itself increases in the future.

It is also proposed that street/drain cleansing service will not be privatized in view of the fact that MPPP has large number of laborers.

(2) Contract Area

It is proposed that MPPP will keep privatizing the same areas as present ones, i.e. northeast part of the island for domestic waste collection, and the entire area of the island for large amount waste collection service.

4.3 Fee Collection

(1) Fee Collection System

MPPP has already introduced two kinds of fee since some years ago: commercial waste collection fee and tipping fee charged on waste directly brought into the Council's disposal site by private firms.

These fee collection systems should be further strengthened during the first phase project period so that the fee revenue be increasing.

Currently, some commercial waste collection fee is collected by means of the surcharge on the water bill. Such system should be further promoted.

As a means of collecting the disposal tipping fee, a pre-paid ticket system may be advisable.

(2) Measures to Strengthen Fee Collection System

The following measures are proposed for strengthening the fee collection systems.

1) Revision of regulations related to the fee collection.
2) Introduction of licensing system for users of the Council's disposal site
3) Introduction of severer penalties on illegal dumping.

5. Project Evaluation

5.1 Technical Evaluation

(1) Improvement of Collection and Cleansing Works

From technical view point there is no problem in the introduction of 3-times/week collection system, plastic bag for discharge and once-a-week cleansing system. These systems have been implemented smoothly as a MPPP's pilot project in Bayan Baru area and have been accepted by the residents, even though residents complained about these systems especially on use of standard plastic bags at the initial stage.

Therefore, it is feasible to introduce these systems in all residential area of MPPP by 1995 as proposed.

The MPPP's pilot project in Bayan Baru shows that these systems have following benefits:

a. Operation efficiency will be greatly improved and environment in the area will not deteriorate through residents' cooperation.
b. Collection and cleansing zones are divided into smaller zones under the reduced frequency service system. The services are provided in a smaller zone in each day. This has made it easy to control the daily operation. It has been also found that the work control is easier under the group working system introduced in the pilot project area.
c. The usage of plastic bags greatly contributes to the increase of collection efficiency and to the upgrading of sanitary conditions.

Health Department of MPPP will have some redundant laborers through the expansion of area where these systems will be applied in the near future. Therefore, it is necessary to deploy these laborers to other public services.

(2) Introduction of compactor vehicle

It is proposed that compactor vehicles with 10 cu.m body be used for domestic waste collection also in future instead of tipper vehicles. It will not cause any problem to MPPP because MPPP has been using the vehicles of this type and size already.

However, it is necessary to establish a strong preventive maintenance system.

(3) Cosntruction of level 3 sanitary disposal site in Pantai Acheh

From technical view point, level 3 sanitary disposal site which has daily soil cover and leachate circulation system to improve leachate quality does not have difficulty in construction and operation.

5.2 Preliminary Environmental Impact Assessment

5.2.1 Introduction

As part of the solid waste disposal master plan for Penang Island, a site was identified for the development of sanitary landfill that would receive the solid waste of Penang Island from 1992 to 2005.

The site was selected from a list of 4 potential sites based on a set of criteria that included environmental, economic, administrative and political considerations.

The Pantai Acheh site, on Penang Island, is located between Kampung Pantai Acheh and Kuala Sungai Pinang. The area proposed is presently covered with mangrove vegetation and the population density in the surrounding area is low.

The sanitary landfill will be constructed in two phases. Because of financial considerations, the level of landfill development and operation will be designed at level 3 in the first phase.

The level of landfill development and operation proposed for the second phase will be at level 4, where the leachate from the sanitary landfill will be treated before discharge.

A preliminary Environmental Impact Assessment for the proposed solid waste disposal site in accordance with the Environmental Quality Order 1987 was conducted by the University Sains Malaysia, and impacts on air quality, water quality and noise were evaluated by the JICA Study Team.

5.2.2 Existing Environment

(1) Physico-chemical Environment

The air quality in the area is within environmentally acceptable limits.

The site is located near the sea and away from any water catchment area. The coastal water at the site is relatively clean, but with high sediment loads.

The area is relatively quiet, with little noise generated by human activities as the population density is low.

(2) Biological Environment

The Pantai Acheh site consists of mangrove, but the coastal fringe mangrove is separated by an earth bund and a drainage canal. The mangroves are relatively poor in plant and animal species, except for birds.

There are at least 60 species of birds within the proposed site, of which a few are migratory species from North Asia and Russia.

The extensive shallow coastal mudflat adjoining the site is a natural cockle bed where cockle spats are collected. It is estimated that about 200,000 kilograms of cockle spats are collected yearly for sale and distribution to other cockle culture areas.

(3) Socio-economic Environment

The two villages nearby are Kampung Pantai Acheh and Kuala Sungai Pinang with a total population of about 2,000 persons. These are predominantly Chinese and the main occupations are related to fishing and farming. The household income for Kuala Sungai Pinang is estimated at M$814 per month or M$150 mean per capita income.

The surrounding land use is mainly agriculture with padi and coconut cultivation in the alluvial plains and rubber and fruit tree cultivation in the hillslopes.

5.2.3 Environmental Impacts

(1) Construction Phase

a. Noise

In some cases the noise level may be higher than the WHO's standard of 55 db(A), but no adverse effect in daily life is expected, because the construction period is not too long at the same place and works shift.

b. Dust

Adverse impact from dust would not be significant even if the state housing project should start to the north side of the site, because the predominant wind blows from the land to the sea.

c. Traffic Volume

Increase of traffic volume in relation to the construction will not be expected.

(2) Operational Phase

a. Leachate

When the effluent is discharged at 800 ppm BOD, the effluent is diluted to less than 3 ppm in the outer sea area of 35 m radius centering around the discharge point. This low level is because of the extremely low volume of the effluent (188 m^3/day for rainy season and 103 m^3/day for dry season).

When the effluent is discharged at 1,200 ppm COD, then it is diluted to less than 5 ppm in the outer area of 35 m radius.

These levels are below the Class II (3 ppm) for BOD and Class I (10 ppm) for COD set by the Proposed Interim National Water Quality Standards for Malaysia.

Therefore, almost no adverse effect on aquatic flora and fauna is expected in the sea along Pantai Acheh.

b. Noise

Of the sanitary landfill equipment, the major noise sources are bulldozers. However, more than 10 db(A) of noise is expected to be attenuated because of a five-meter high bund around the disposal area, and areas around the site would not be exposed to the same noise level for a long time because the landfill area will shift after three or four months.

In comparison with the existing average noise level of 72.1 dB(A) from 7:00 AM to 7:00 PM, which was measured at 106 places in Penang State in 1986, noise level from waste transportation vehicles is low.

c. Dust and Odor

The generation of dust can be controlled with the proposed plan in which water sprinkler truck will stand ready for water sprinkling whenever necessary.

The proposed sanitary landfill in which soil covering will be conducted every day can minimize the generation of odor.

d. Air Pollution

Though the most serious pollutant derived from vehicle exhaust gas in Penang is carbon monoxide (CO), estimated concentrations of CO are very low.

(3) Plant and Animal Communities

The loss of the mangroves represent a permanent loss of habitats for the animal life in the area. The most conspicuous loss would be that of habitats of the birds. A loss of the habitats would mean a reduction of these birds. Since a number of these birds feed in the mangrove mudflats, the retention of the mangrove fringe would enable some to survive.

Another concern is the likely impact on the cockles and other marine life of the surrounding coastal areas. At the proposed discharge point, there are natural cockle beds which supply the spats for other cockle culture areas. If the leachate is diluted by sea water at the discharge point, as proposed by the project, the impact would be negligible.

(4) Human Settlements

One major impact relates to the possible disruption to the state housing project which has been privatised. The area referred to is the 13-acre site on state land, situated just north of the proposed disposal site.

5.2.4 Mitigating and Abatement Measures

To reduce the impact of the removal of mangrove vegetation at Pantai Acheh, the coastal strip of mangrove should be maintained for providing habitats for the birds and animal life as well as for shore protection.

To reduce the impact of the leachate on the surrounding coastal areas, no discharge should be made on land or into the waterways. The leachate should be pumped some distance to the sea where dilution can take place to acceptable levels.

There should be regular monitoring on the area surrounding the discharge point as well as seepage into the ground water around the disposal site.

To reduce the noise levels during the operation of the site, there should be an earth bund to attenuate the noise levels as well as a buffer zone between the site and residences.

To minimise the odour problems, the sanitary landfill must be properly maintained.

There should also be green belt of trees and other plants between the disposal site and public areas for aesthetic reasons.

5.2.5 Residual Impacts

Despite above measures, some residual impact on the surrounding area would nevertheless remain.

In order to examine impacts on surrounding environment by landfill operation, monitoring systems should be introduced.

It would also be crucial to educate vehicle drivers to be careful along rural roads. Courteous behaviour in these areas can go a long way to mitigate prejudice by the local residents on solid waste disposal.

Another important feature of the overall effort is to ensure that damaged rural roads are immediately repaired so as to anticipate criticisms against the local authorities.

5.3 Social Evaluation

(1) Collection and Cleansing Improvement in Residential Area

MPPP has implemented 3-times/week collection system and once-a-week cleansing system in Bayan Baru as a pilot project in order to see whether or not these systems would be acceptable to the citizens. Though the residents were not happy in the initial stage, they have got accustomed to the new systems as the time passed. Eventually, the pilot project turned out to be successful.

MPPP is now confident that it can expand the new system to all other residential areas.

(2) Level 3 Landfill Operation

For the development of Level 3 landfill site at Pantai Acheh, the State Government has started the control over the development of the areas surrounding the site.

5.4 Economic and Financial Evaluation

5.4.1 Evaluation Framework

(1) Basic Policies

In view of the non-productive nature of solid waste management, the following basic policies were adopted to evaluate the Project.

a. While the Project was evaluated from both economic and financial aspects, priority was given to the financial evaluation based on the financial strength of MPPP.

b. A minimum cost method was employed to compare and examine the project elements.

c. In the economic evaluation, indices relating to the environment, hygiene and landscape, etc. were qualitatively analyzed, and economic benefits were calculated in regard to collection and cleansing improvement.

(2) Economic Evaluation

Although economic evaluation is essential to determine the feasibility of a project, it is difficult to calculate the benefits of solid waste management. In addition, given the nature of the work, it is generally impossible to expect direct benefits to exceed the cost. The economic evaluation, therefore, was conducted as follows.

a. The effects of sanitary landfill were qualitatively evaluated.

b. The effects of collection and cleansing improvements were both qualitatively and quantitatively evaluated in view of the expected reductions in present cost to result from improvement measures.

c. The Project was considered feasible from the viewpoint of economic evaluation if the benefit-cost ratio of solid waste management was one or higher.

(3) Financial Evaluation

In general, there are two aspects of financial evaluation, i.e. financial evaluation of the project in question and analysis of the effects of project implementation on the Council's budget.

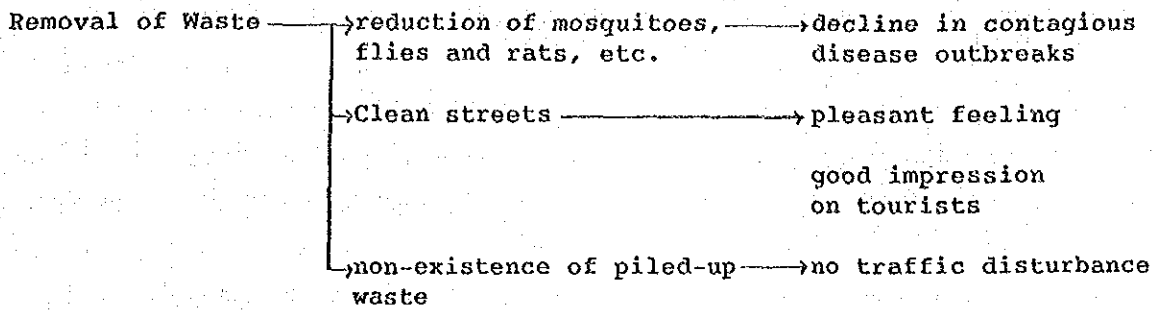
In regard to the former, a financial evaluation for a period of 15 years was conducted for MPPP based on the project cost and the expected income (including part of the assessment rate). As part of this evaluation, a sensitivity analysis was conducted to measure project cost, financial conditions and the effects of increased cost for personnel, etc.

While the willingness of the residents to pay a collection fee is not strong, various collection fees currently imposed in other municipalities were analyzed and preferable rates of commercial waste collection and tipping fees at disposal site were examined.

5.4.2 Economic Effects and Evaluation

(1) Collection Improvement

The purpose of solid waste management is the prompt collection/removal of solid waste generated by urban activities to maintain or improve the living environment and public hygiene. In general, regular collection services can achieve the following effects.



Taken together, these effects result in a good living environment.

Although the proposed collection frequency will be 3 times a week in almost all areas where a daily collection service is currently provided, regular and reliable collection will compensate for the decrease in the collection frequency. Problems of odour which may arise due to the less frequent collection service must be minimized by developing new indoor storage containers and enlisting the cooperation of the public in regard to discharging the waste just prior to collection.

The proposed improvement measures will also achieve a higher collection efficiency and will enable a considerable cost reduction as compared to the case where the present collection system were simply expanded. This means that public services provided by the Council may be either improved or expanded by utilizing the Council's resources to be saved through the above SWM improvements.

In the meantime, tourism industries on Penang Island can be further developed on the basis of a well maintained environment and landscape, provided with appropriate services which can be maintained with stable funding collected as fees for commercial waste collection.

Implementation of carefully thought-out measures will improve the understanding of the public of the importance of solid waste management, further assisting collection work efforts.

(2) Cleansing Improvements

The purpose of cleansing work is the prompt collection/removal of waste and litter on streets and in drains, in order to maintain and improve the living environment and public hygiene together with solid waste collection services.

The proposed main improvement point in cleansing work is the revision and reduction of the service frequency according to road type and the reduction of overall service frequency. It is expected that the overall cleansing service quality can be maintained through regular and reliable service though the service frequency would decrease.

As in the case of collection improvements, the implementation of carefully thought-out measures will enhance the citizens' understanding of the importance of maintaining environmental hygiene, further assisting the cleansing work efforts.

(3) Disposal Improvement

A major benefit resulting from the realization of the level 3 sanitary landfill with cell method is that the living environment and public hygiene standard would be greatly upgraded as compared to the case where the existing disposal systems continue.

The adverse environmental impact of the conventional controled tipping method on areas surrounding the disposal sites will be minimized with the adoption of the sanitary landfill method, paving the way for securing new disposal sites in the future.

While the sanitary landfill method (Level 4) which will be the model disposal method for Malaysia in the future cannot be immediately introduced at the PADS because of financial constraints, the establishment of appropriate technologies and technical transfers to other municipalities will be conducted where possible.

Moreover, the following positive effects can be achieved by adopting the landfill method.

a. Prevention of fires, scattering of waste, odours and the propagation of harmful insects and rats, etc.

b. Avoidance of adverse environmental effects on the surrounding areas by the erection of fences to prevent the scattering of waste.

c. Avoidance of adverse environmental effects on the surrounding areas by the treatment and sprinkling of leachate.

d. Improvement of environmental conservation and working conditions by the active implementation of the following measures:

- Prompt discharge of generated gas to ensure safety at the site;
- Control of the disposal of certain toxic substances;
- Introduction of a leachate effluent monitoring system;
- Prevention of scavengers and animals entering the site to secure safe landfill work;
- Improvement of staff working conditions.

(4) Economic Evaluation

Table 5.4-1 shows the cumulative SWM costs till 2005 estimated for the following two cases:

Case 1: Waste disposal system will be improved as proposed in the Master Plan. No improvements, however, will be made regarding waste collection/haulage and street/drain cleansing services.

Case 2: Improvements will be made not only for waste disposal system but also for collection/Haulage and street/drain cleansing services as proposed in the Master Plan. The improvements of collection/haulage and street/drain cleansing services include the reduction in the frequency of those services.

Table 5.4-1 Comparison of the Cumulative SWM Costs between the Two Cases

(M$ million at 1987 price)

Case 1	:	367.8 (a)
Case 2	:	272.5 (b)
Difference	:	95.3 (c)
Ratio of (b) to (a)	:	74%
Ratio of (c) to (a)	:	26%

The above table shows that the Case 2 which includes the improvements of collection/haulage and street/drain cleansing will bring about a considerable saving which would amount to M$95.3 million over the Master Plan period till 2005.

Therefore, the Case 2 which is recommended in the Master Plan, has proved to be feasible.

5.4.3 Financial Evaluation

(1) Conclusion

The results of the financial evaluation of collection, cleansing and disposal improvement are given below. The evaluation was made assuming that there will be M$21.3 million of budgetary appropriation to solid waste management per year and the improvement of fee collections in the future.

Annual expenses of solid waste management in MPPP is to be some M$18.7 million in 1987, and at present the contribution by collected fees is very low. In comparison, income from the improved fee collection system, in which fees are charged on collected commercial waste and on waste directly delivered to the disposal site, will amount to M$1.4 million in 1995 and M$3.9 million in 2005.

With the implementation of collection, cleansing and disposal site improvements, the total operation cost of solid waste management is expected to total M$19.1 million by 1995 and M$24.1 million by 2005. If budgetary appropriation to solid waste management in the municipal budget is maintained at the present level of M$21.3 million, and the fees are collected as proposed the total debt will be reduced to zero by 1995 with an internal reserve of M$14.1 million, enabling contributions to the next phase of investment.

Given the above financial evaluation results, the Project is considered financially feasible.

(2) Important Assumptions in Financial Evaluation

The following assumptions were made in the course of the financial evaluation, as in the case of the financial evaluation for the Master Plan.

a. Reduction of collection costs by the successful implementation of a 3 times/week collection system.

b. Reduction of cleansing cost by decrease of the frequency.

c. Imposition of a collection fee on commercial waste and a tipping fee on waste taken directly to the disposal site.

d. Raising investment funds at an annual interest rate of 6.0% or lower.

e. Budget of the solid waste management will remains at the same amount of M$21.3 million up to year 2005.

f. Adoption of the Level 3 landfill method.

(3) Investment Cost and Annual Expenses

Tables 5.4-2 and 5.4-3 show the investment cost and annual expenses respectively necessary for successfull implementation of the Project.

Table 5.4-2 Investment Cost

(M$ million in 1987 price)

	PHASE I	PHASE II	PHASE III	TOTAL
Collection	1.8	2.3	1.8	5.9
Cleansing	1.4	1.3	0.6	3.3
Disposal	5.3	15.7	0.6	21.5
Total	8.5	19.3	3.0	30.7

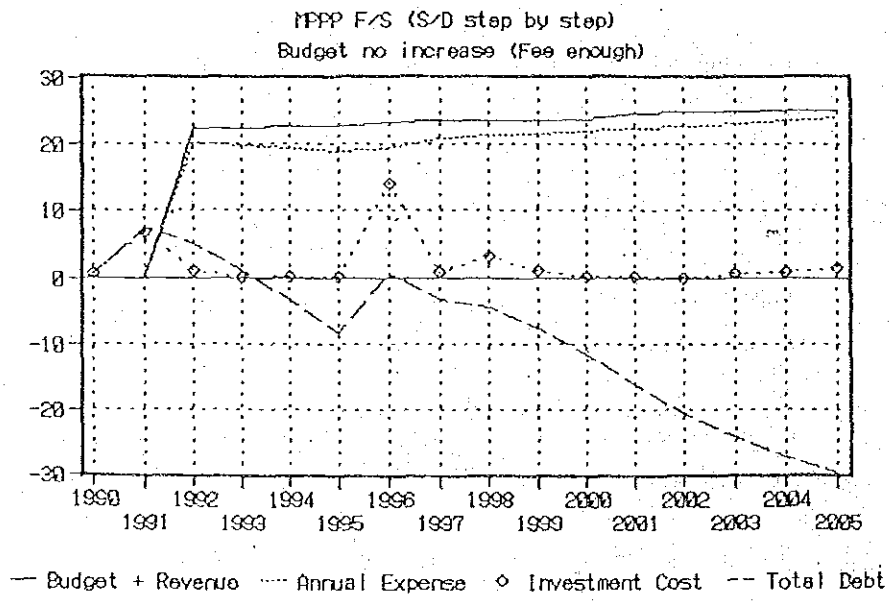


Fig. 5.4-1 Cash Flow in MPPP

Table 5.4-3 Annual Expenses and Income

(M$ million in 1987 price)

	1987	1992	1995	2005
Annual Expenses				
- Management	1.1	1.1	1.1	1.1
- Collection	8.4	10.5	10.4	13.3
- Disposal	0.5	1.7	1.8	3.7
- Cleansing	8.8	6.5	5.4	5.8
- Interest/Repayment and Others	-	0.5	0.4	0.2
Total (1)	18.7	20.3	19.1	24.1
Income (2)	0.4	1.2	1.4	3.9
Balance (1) - (2)	18.3	19.1	17.7	20.2

Note: Depreciation cost is included.

(4) Sensitivity Analysis

Sensitivity analysis is conducted by paying attention to three aspects i.e. increase of personnel cost, the change of the amount of fee collection and the change of construction cost.

The budgetary allocation must be increased by at least 0.3% a year if personnel costs increase by 2% a year (0.2% increase on base model).

If the construction cost increases by 20%, in 1999 it will become possible to repay the debt. In 2005 the internal reserve will be M$21.5 million. In case the labour cost increases by 2% relatively, the debt can be repayed in 2001. But the balance will become minus after 2002.

In case commercial waste and tipping fee is not collected, the total debt in 2005 will be M$ 8.0 million. It is necessary to increase the budget of SWM by 0.5% per year, if the debt is to be repayed completely by around year 2000.

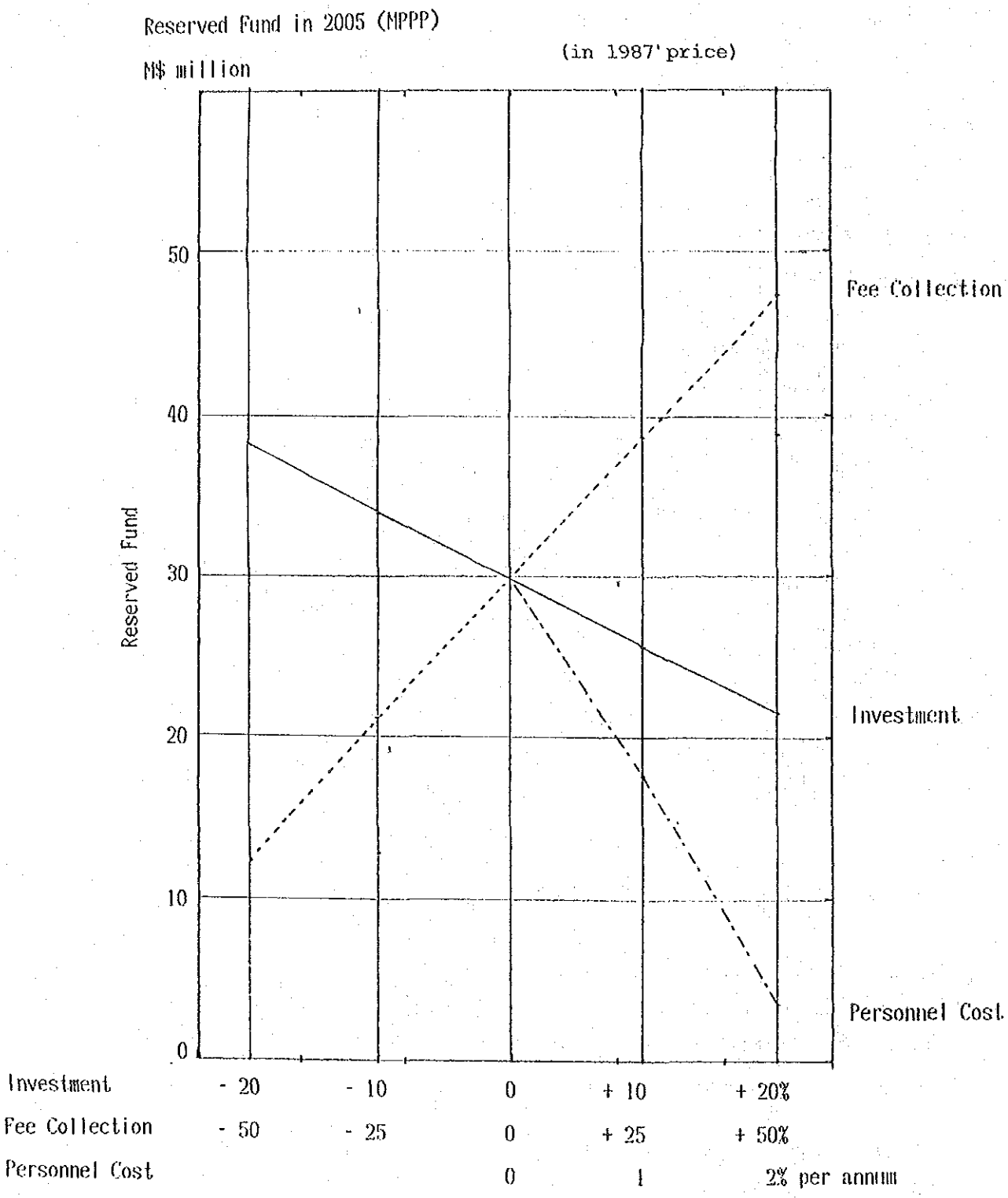


Fig. 5.4-2 Sensitivity Analysis

6. Implementation Plan

6.1 Project Implementation Body and Schedule

6.1.1 Project Implementation Body

Solid waste management is currently conducted by the Health Department and Engineering Department which are respectively responsible for collection/ cleansing and disposal. For the successful project implementation, however, the Urban Services Department should be established. In view of the fact that financial assistance from the Federal Government is expected to support the Project implementation, the Ministry of Housing and Local Government will provide the necessary funds and will supervise the implementation of the Project.

6.1.2 Implementation Schedule

(1) Implementation Conditions

Implementation conditions for the Phase I Improvement Project are as follows:

- Design Target Year : 1995
- Service Commencement Year : 1992
- Subject Area : entire MPPP

(2) Preparatory Period

The following must be conducted in the 18 month preparatory period, from the completion of the Feasibility Study to the commencement of construction work.

- Acquisition of investment funds and preparation of repayment plan
- Confirmation of facility construction site
- Preparation of detailed design and specifications for facilities as well as equipment/material
- Selection of contractor (tender, evaluation and contract)

(3) Construction Schedule

The Project is mainly divided into equipment procurement work and facility construction work, of which periods are proposed as follows:

- Equipment/material procurement : 6 months after completion of contract
- Disposal site construction : 12 months after commencement of the construction

6.2 Financial Plan

Based on the results of the financial evaluation, the financial plan for the implementation of this project will be set as follows:

(1) Required Fund

The investment cost and annual expenditure have been estimated as shown in Table 6.2-1 based upon Tables 3.1-4 and 3.2-4 making the following assumptions:

a. An additional budget amounting to 15% of the original construction cost may be required for engineering services and allowance for contingency.

b. Operation cost except emolument will increase at the rate of 1.5% per year. Emolument will increase at the rate of 2.5% per year.

c. Rates of interest on long term, middle term and short term loans will be 7%, 9% and 13.5% respectively instead of 6%, 8% and 12%.

Table 6.2-1 Investment Cost and Annual Expenditure for MPPP

(M$ million)

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
1. Investment cost																		
- Vehicle	0.0	0.5	0.8	0.6	0.0	0.0	0.0	2.7					2.4					6.9
- Cleansing	0.0	0.0	0.9	0.4	0.0	0.1	0.1	1.6					0.8					3.9
- Sanitary D/S	0.3 (0.3)	0.2	6.0	0.0	0.0	0.0	0.0	20.3					0.7					27.5
- Total	0.3 (0.3)	0.7	7.7	1.1	0.0	0.1	0.1	24.6					3.8					38.3
2. Annual Expenditure																		
- Administration	1.1	1.1	1.1	1.2	1.2	1.3	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6	1.6	1.6	1.7	20.1
- Collection	1.9	1.8	1.7	1.7	1.6	1.5	1.4	1.4	1.5	1.5	1.6	1.6	1.7	1.7	1.8	1.8	1.9	22.6
- Street/Drain	8.3	7.6	6.9	7.1	6.8	6.6	6.3	6.5	6.7	6.9	7.1	7.3	7.5	7.8	8.1	8.4	8.7	101.8
- Contract-out	6.8	7.4	8.0	9.4	9.6	9.9	10.1	10.6	11.2	11.7	12.2	12.7	13.2	13.7	14.2	14.7	15.2	168.3
- Disposal	0.6	0.6	0.6	1.0	1.0	1.1	1.1	1.1	1.7	1.8	1.8	1.9	1.9	2.0	2.0	2.1	2.2	22.9
- Interest	0.0	0.0	0.1	0.7	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	5.8
Sub-total	18.7	18.5	18.5	21.1	20.9	20.9	20.8	21.5	23.0	23.7	24.5	25.3	26.1	27.0	27.9	28.8	29.8	341.4
- Repayment			0.0	0.0	0.1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	5.7
Total			18.5	21.1	21.1	21.4	21.3	22.1	23.5	24.2	25.0	25.8	26.6	27.4	28.3	29.2	30.1	347.1

(2) Financial Resource

Financial resources for the investment are to be prepared through Federal Government loans and the MPPP's own development fund. Federal Government loans will be a combination of long term and mid term loans as shown in Table 6.2-2.

Table 6.2-2 Financial Resources for the Investment

(M$ million)

	1990	1991	1992	1993	1994	1995	Total
Long Term Loans	0.2	6.0	-	-	-	-	6.2
Middle Term Loans	0.4	0.7	0.6	-	-	-	1.7
MPPP Fund	0.0	1.0	0.5	-	0.1	0.1	1.7
Total	0.6	7.7	1.1	-	0.1	0.1	9.6

Loan condiions are assumed as shown in Table 6.2-3.

Table 6.2-3 Loan Conditions

	REPAYMENT SCHEDULE	*INTEREST RATE* REAL	NOMINAL
Long Term Loans	Repayment over 20 years with a 3 year grace period	6%	7.0%
Middle Term Loans	Repayment over 10 years with a 2 year grace period	8%	9.0%
Short Term Loans	Repayment in the following year	12%	13.5%

Annual expenditure for the SWM is to be born by a portion of the assessment (property), fees for commercial waste collection and tipping fees for landfill as shown in Table 6.2-4.

Table 6.2-4 Resources of Revenue

(M$ million)

	1992	1993	1994	1995	Total
Assessment	22.9	23.3	23.6	24.0	93.8
Fee Collection					
- Commercial Fee	1.2	1.3	1.3	1.4	5.2
- Tipping Fee	0.2	0.2	0.2	0.2	0.7
Total	24.3	24.7	25.1	25.5	99.7

Note: All the amounts shown in Table 6.2-4 are greater than the corresponding figures shown in the previous sections as a result of the reflection of an inflation which is assumed at 1.5% per year.

The SWM budget to be allocated from general budget of the MPPP is estimated to increase by 1.5% per annum which is same as of the projected infration rate.

Commercial and tipping fees are estimated to be collected at the rates of M$36.1 per ton and M$7.4 per ton respectively in 1992. Those rates will increase to M$58.4/t for commercial waste and M$12.0/t for tipping fee at 1996, and M$83.8/t for commercial waste and M$17.3/t for tipping fee at 2001.

(3) Balance of Expenditure and Revenue

Basically the balance in Phase I will keep the black figures, except in 1991 when the initial investment for the construction of disposal site is required.

The complete repayment of the total debt for Phase I investment will be possibly materialized in 1994.

(4) Proposal for Financial Plan

The Money flow of the project is shown in Table 6.2-5.

Table 6.2-5 Money Flow of the Project

(MPPP) F/S D/S step by step
unit: M$ thousand (1M$=¥50)) (considering inflation & personnel increase)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Total
Revenue																	
- SWM Budget			22,940	23,281	23,643	23,984	24,346	24,729	25,091	25,475	25,853	26,242	26,625	27,030	27,434	27,839	354,517
- Commercial Fee			1,223	1,268	1,315	1,364	2,281	2,359	2,443	2,526	2,615	3,884	4,021	4,162	4,309	4,462	38,232
- Tipping Fee			170	176	183	190	318	329	341	354	366	546	566	588	610	633	5,368
- Electrical Sale			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal (A)	0	0	24,333	24,725	25,141	25,538	26,944	27,418	27,875	28,356	28,840	30,671	31,212	31,779	32,353	32,933	398,118
Expense																	
- Depreciation			1,333	1,366	1,399	1,434	1,483	2,609	2,697	2,787	2,880	2,972	3,067	3,165	3,265	3,369	33,825
- Personnel			9,314	9,040	8,741	8,416	8,650	9,001	9,252	9,512	9,780	10,095	10,421	10,765	11,113	11,472	135,578
- Maintenance			421	427	434	440	459	667	588	610	632	651	669	689	708	728	8,025
- Fuel & Other			1,241	1,244	1,247	1,249	1,292	1,710	1,761	1,815	1,870	1,926	1,984	2,045	2,108	2,172	23,663
- Interest 1		53	536	588	579	539	499	459	418	378	338	298	266	241	215	190	5,597
- Interest 2		6	151	0	0	0	0	72	0	0	0	0	0	0	0	0	229
- Contract 1			9,405	9,649	9,893	10,137	10,644	11,151	11,658	12,165	12,672	13,178	13,685	14,102	14,699	15,206	68,335
- Contract 2																	
Subtotal (B)		60	22,402	22,314	22,294	22,216	23,033	25,568	26,374	27,267	28,172	29,120	30,092	3,396	32,108	33,137	375,253
Balance (A-B)		-60	1,930	2,410	2,847	3,322	3,911	1,850	1,501	1,090	663	1,551	1,120	383	244	-234	22,864
Investment	636	7,700	1,071	0	78	88	18,507	783	3,905	1,280	95	111	0	326	1,092	1,804	38,018
- Fund	47	1,014	489	0	78	88	18,507	783	3,905	1,280	95	111	0	326	1,092	1,804	30,112
- Budget	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Grant																	
- Contractor																	
- Loan																	
Foreign	215	5,960	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,176
Local 1																	
Local 2	424	726	582	0	0	0	0	0	0	0	0	0	0	0	0	0	1,731
Repayment		0	0	103	527	527	527	527	527	527	527	436	363	363	363	363	5,679
Remain of Lo	636	7,325	7,907	7,803	7,277	5,750	6,223	5,696	5,170	4,643	4,116	3,680	3,317	2,954	2,591	2,227	
Money Demand	47	1,074	-2,775	-3,673	-3,642	-4,141	13,640	-3,150	234	-2,070	-2,926	-3,976	-3,824	-2,665	-2,054	-999	
Short Term L	47	1,074	-2,775	-3,673	-3,642	-4,141	-13,640	-3,150	234	-2,070	-2,926	-3,976	-3,824	-2,660	-2,054	-999	-20,899
Accumulated	47	1,121	-1,654	-5,327	-8,969	-13,110	530	-2,620	-2,335	-4,455	-7,381	-1,357	-15,181	-17,845	-19,900	-20,399	
Total of Deb	686	8,446	6,253	2,477	-1,692	-6,360	6,753	3,077	2,784	188	-3,265	-7,677	-11,864	-14,892	-17,309	-18,671	

6.3 Establishment of a Monitoring System

6.3.1 Necessity for the Establishment of a Monitoring System

Once the Council decides to commit itself to achieving Master Plan targets, it will be important to establish a system within the Council to monitor closely the progress of improvements. Data will be obtained through such monitoring for self-evaluation of the Council's performance, without which the Council will be unable to assess progress.

6.3.2 Personnel Responsible for Monitoring

In the new department to be responsible for SWM, the following personnel should be involved in monitoring operations.

Personnel to be Involved in Monitoring Operations

Action Required	Personnel Responsible
Identification of useful indicators	PHIs and Senior PHIs
Data-collection & compilation	PHIs and Senior PHIs
Data-analysis, Evaluation of performance and Formulation of action plans	PHIs/Senior PHIs and Cleansing Superintendent
Review of Master Plan Targets based upon the performance evaluation	Cleansing Superintendent and Director

6.3.3 Indicators to be Used

a. Selection of Indicators

Selection of indicators are related to the Master Plan targets. Useful indicators include the following:

Principal and Supporting Indicators

Master Plan Targets	Principal Indicators	Supporting Indicators
Improvements in cost-effectiveness in services	Unit cost of service per ton	Daily waste amount collected per worker and vehicle Unit cost spent per service recipient
Expansion of service coverage	Percentage in terms of population	Percentage in terms of area
Improvement of service quality (regularity and punctuality) - residents' satisfaction	Number of complaints by residents	Number of days service was delayed or was not provided
Upgrading of the disposal standard	Standard of sanitary landfill	Leachate-quality

The above table shows some useful indicators. There may be other indicators. It is important to distinguish principal indicators from supporting indicators, as shown in the above table. Whether a particular indicator should be treated as a principal or supporting indicator depends on the purpose of the evaluation.

b. Definitions of Indicators

One of the most serious problems with respect to performance-indicators arises when considering ways to measure performance, i.e. the definition of indicators. For example, the unit-collection-cost differs greatly depending on whether or not to include certain indirect costs such as administration-costs, assumed office-rent, cost of stand-by vehicles and insurance premium paid, etc.

In view of the above, it is important for the Council to establish the precise definitions of indicators, and use indicators of the same definitions over a long period. This will enable the Council to compare past performance with the present using the same criteria.

It will be very useful for Malaysia to develop definitions of indicators to be used by all Local Authorities. The development of such definitions will enable inter-municipal comparisons on the basis of similar criteria. The initiative for such a development may most suitably be taken by the Technical Unit, Local Government Division, Ministry of Housing and Local Government.