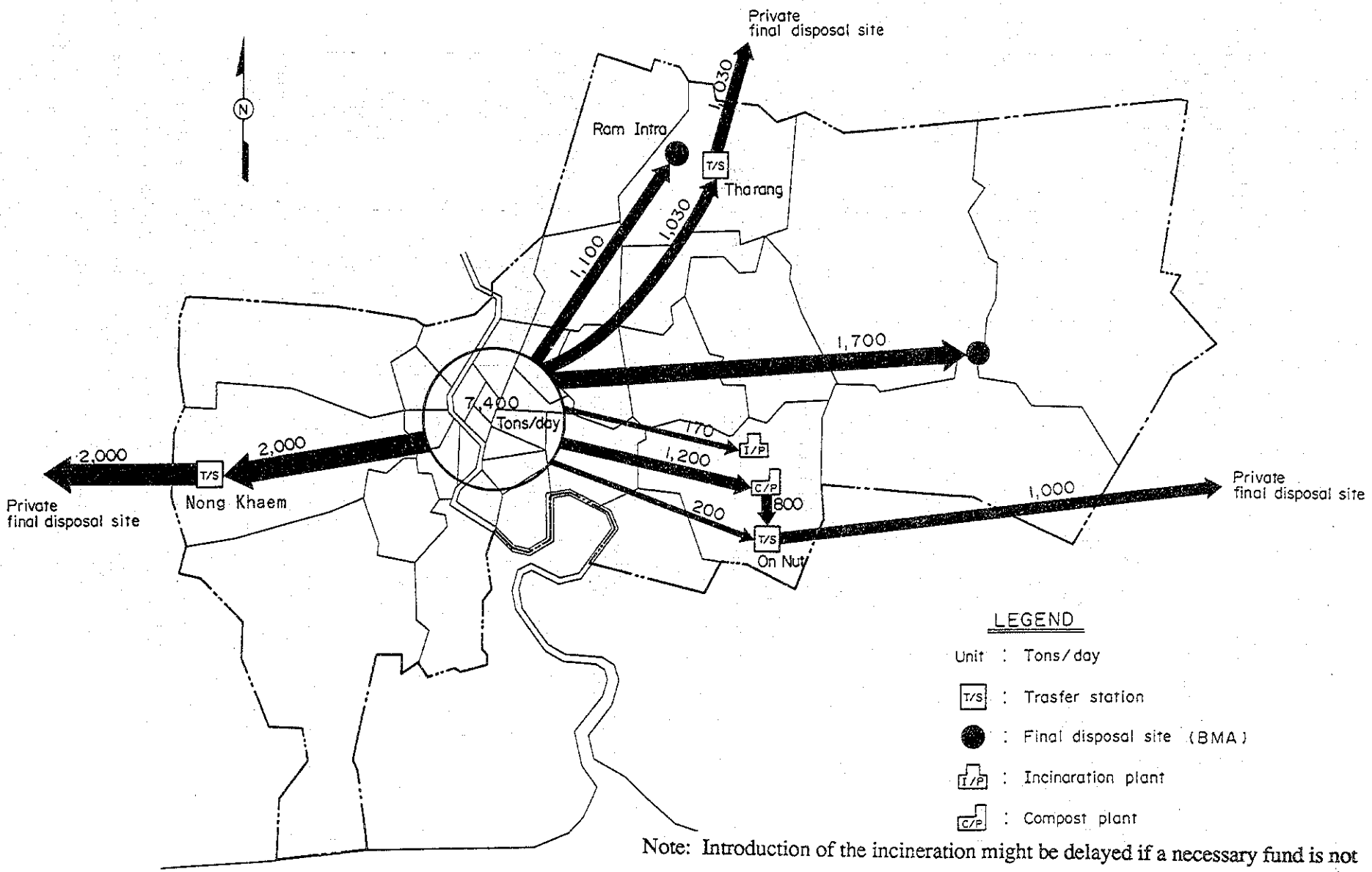


Note: Introduction of the incineration might be delayed if a necessary fund is not avilable on the scheduled timing.

Fig. 8.1-2 Disposal Plan in 1997

Table 8.1-1 Amount of Incoming Waste according to Sites

Unit: Tons/day

YEAR	ESTIMATED TOTAL DISPOSAL AMOUNT	1 ON NUT	2 NONG KHAEM	3 THA RANG	4 FUTURE RAM INTRA SITE (SITE 1)	5 A FUTURE SITE IN THE EAST PART OF BANGKOK (SITE 2)
1991	5,100	2,500	2,600	-	-	-
1992	5,500	1,800	2,200	1,500	-	-
1993	5,800	2,550	1,600	1,650	-	-
1994	6,200	2,500	1,450	1,750	500	-
1995	6,600	2,500	1,550	1,850	700	-
1996	7,000	2,570 (170)	1,400	2,000	1,030	-
1997	7,400	1,570 (170)	2,000	1,030	1,000	1,700
1998	7,800	1570 (170)	2,500	1,030	1,000	1,700
1999	8,300	1,920 (170)	2,580	1,330	470	2,000
2000	8,700	2,270 (520)	3,100	1,330	0	2,000

Notes: 1. A part of waste to be carried into the On Nut site will be taken to a new compost plant (1,000 tons/day), and an incinerator.

2. The waste amounts indicated in the parentheses are those to be carried to an incinerator to be constructed at On Nut.

Table 8.1-2 Amount of Waste to be Removed by Contractors from On Nut, Nong Khaem and Tha Rang

Unit: Tons/day

YEAR	1 ON NUT	2 NONG KHAEM	3 THARANG	4 = 1+2+3 TOTAL
1991	0	800	0	800
1992	2,000	2,300	1,500	5,800
1993	2,200	1,650	1,650	5,500
1994	2,400	1,800	1,750	5,950
1995	2,600	2,000	1,850	6,450
1996	2,800	2,200	2,000	7,000
1997	1,000	2,000	1,030	4,030
1998	1,000	2,050	1,030	4,080
1999	1,350	2,580	1,330	5,730
2000	1,350	3,100	1,330	5,780

Notes: 1. Waste amounts indicated in columns 1 and 2 till 1996 include both fresh and old waste to be removed. See Table 8.1-3 and Table 8.1.-4 for respective amounts of fresh and old waste.

2. Removal of old waste will be completed by the end of 1996.

3. Waste amount 2,300 tons/day to be removed from Nong Khaem in 1992 consists of two parts: 800 tons/day to be removed by the existing contractor which will complete the contract at the end of 1992, the remaining 1,500 tons/day will be removed under a different contract which will last till the end of 1996 from the beginning of 1992.

Table 8.1-3 Waste Balance in the On Nut Site During 1991-2000

Unit: Tons/day except figures in column 8

YEAR	FRESH WASTE				OLD WASTE			
	INCOMING WASTE	REDUCED BY COMPOST-ING	REDUCED BY INCINERA-TION	TRANSFERRED & REMOVED BY CONTRACTOR	REMOVED BY CONTRACTOR	CARRIED AWAY BY PEOPLE	TOTAL (5+6)	REMAIN-ING WASTE AT YEAR END((TONS)
	1	2	3	4	5	6	7	8
1991	2,500	-	-	-	-	-	-	876,000
1992	1,800	-	-	1,800	200	50	250	784,750
1993	2,550	400	-	2,150	50	100	250	693,500
1994	2,500	400	-	2,100	300	100	400	547,500
1995	2,500	400	-	2,100	500	100	600	328,500
1996	2,570	400	150	2,000	800	100	900	0
1997	1,570	400	150	1,000	0	0	0	0
1998	1,570	400	150	1,000	0	0	0	0
1999	1,920	400	150	1,350	0	0	0	0
2000	2,270	400	470	1,350	0	0	0	0

Notes: 1. Waste reduction amounts by incineration indicated in Column 3 are about 90% of the waste to be incinerated.

2. Amounts of waste indicated in Column 6 are those to be carried away by persons who want to use the old waste as compost or filling material.

3. Introduction of the incineration might be delayed if a necessary fund is not available in the scheduled timing.

Table 8.1-4 Waste Balance in the Nong Khaem During 1991-2000

Unit: Tons/day except figures in column 6

YEAR	FRESH WASTE		OLD WASTE			
	INCOMING WASTE	TRANSFERRED & REMOVED BY CONTRACTOR	REMOVED BY CONTRACTOR	CARRIED AWAY BY PEOPLE	TOTAL (3+4)	REMAINING WASTE AT YEAR END(TONS)
	1	2	3	4	5	6
1991	2,600	800	-	-	-	839,500
1992	2,200	2,200	100	50	150	784,750
1993	1,600	1,600	50	100	150	730,000
1994	1,450	1,450	350	100	450	565,750
1995	1,550	1,550	450	100	650	328,500
1996	1,400	1,400	800	100	900	0
1997	2,000	2,000	0	0	0	0
1998	2,500	2,500	0	0	0	0
1999	2,580	2,580	0	0	0	0
2000	3,100	3,100	0	0	0	0

8.2 Selection of the Most Appropriate Disposal System

This section shows why the sanitary landfill has been chosen as the most appropriate major disposal system among various disposal system options.

8.2.1 Disposal System Options

The following options have been identified through the discussions made between the BMA and the Study Team.

Option 0. The existing SWM with dump sites at Nong Khaem, On Nut and Ram Intra

Option 1. A SWM system with open dumping (haulage distance 45 km) and transfer stations without any intermediate treatment facility

Option 2. A SWM system with sanitary landfill (haulage distance 45 km) and direct haulage without any intermediate treatment facility.

Option 3. Option 2 + Transfer Stations (20 km from the city center).

Option 4. A SWM system with the seashore sanitary landfill in Bang Khun Thian and transfer stations (20 km from the city center).

Option 5. A SWM system with compacting and binding plants (20 km from the city center) and reclamation of compacted waste (haulage distance 45 km).

Option 6. A SWM system with incinerators (20 km from the city center) and sanitary landfill for incineration ash (haulage distance 45 km).

8.2.2 Evaluation Criteria and Grading

The following two criteria and grading are used for the evaluation of the options:

Grade	CRITERIUM 1 Environmental Soundness and Technological Reliability	CRITERIUM 2 Cost
A	Good	Low cost
B	Need further assessment before making a decision	Reasonable
C	Risky	Costly
D	Bad (Not acceptable)	Very costly

8.2.3 Evaluation of Respective Options

1) The respective options are evaluated as follows:

OPTIONS	EVALUATION COMMENTS	CRITERIA 1	CRITERIA 2
OPTION 0 The existing solid waste management (SWM) system with open dumping sites at On Nut, Nong Khaem and Ram Intra	This option is neither advisable (because of environmental problems caused through the open dumping) nor sustainable (because the remaining capacity of the existing sites is small). This option is included just for comparison with other options.	D-	A+
OPTION 1 A SWM system with open dumping (haulage distance 45 km) and transfer stations without any intermediate treatment facilities	Although this option is the cheapest, the option is not advisable because the open dumping causes both environmental and aesthetic problems. This option cannot satisfy the minimum environment-sanitation standards required by the authorities concerned (the ONEB and the Ministry of Industry) in Thailand.	D	A
OPTION 2 A SWM system with sanitary landfill (haulage distance 45 km) and direct haulage without any intermediate treatment facility	Sanitary landfill is judged the most appropriate disposal method to Bangkok. As shown in Table 8.2-1, haulage system with transfer stations (as in Option 3) will be less costly than that without transfer stations.	A	B
OPTION 3 Option 2 + Transfer station (20 km from the city center)	This option is the most appropriate both in terms of Criteria 1 and 2.	A	B+
OPTION 4 A SWM system with the seashore sanitary landfill in Bang Khun Thian and transfer stations (20 km from the city center)	The seashore landfill may cause some marine environmental problems, i.e. it may affect Mangrove. This option is not a recommendable means of waste disposal though it may be feasible as means of construction of a public park provided that appropriate environmental measures are taken.	B	C
OPTION 5 A SWM system with compacting and binding plants (20 km from the city center) and reclamation of compacted waste (haulage distance 45 km)	The compaction and binding system is very costly and has technological defects. The Japanese experience shows that waste-packed-fill materials produced through this system cause serious problems such as shrinkage and breaking, further causing structural and environmental problems.	C	C-
OPTION 6 A SWM system with incinerator (25 km from the city center) and sanitary landfill for incineration ash (haulage distance 45 km)	This option is very costly. This option will be justified if the BMA cannot obtain land necessary for sanitary landfill. See Section 8.2.4 Item 5 for more discussion on this option.	A	D

Estimated costs are summarized in Table 8.2-1 and Fig. 8.2-1.

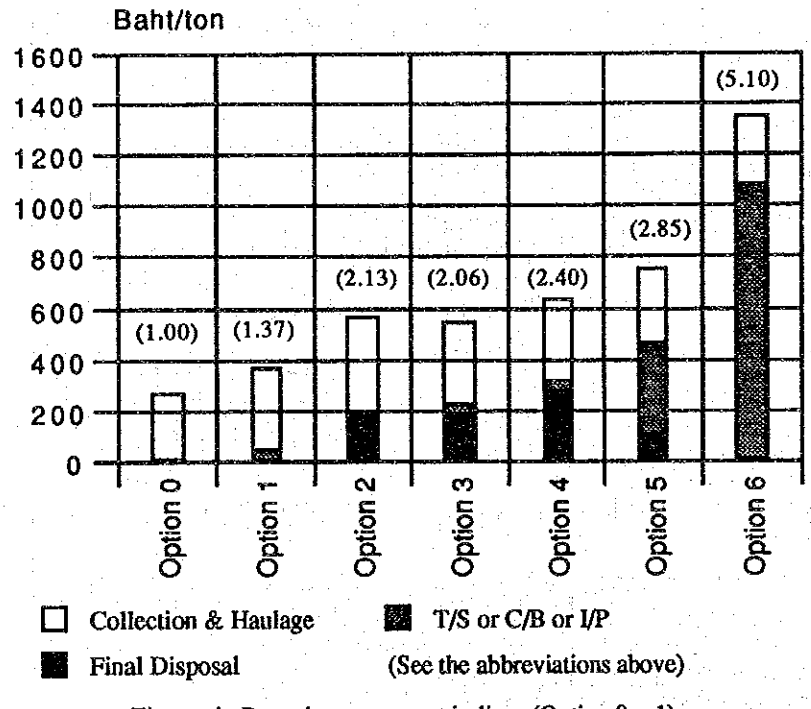
Table 8.2-1 Estimated Costs of Respective Options

Unit: Baht per ton of waste on collection basis

	Option 0	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Description	O/D at Existing Sites	O/D at Distant Places (45 km)	S/L at Distant Places (45 km)	Option 2 + T/S	Sea + S/L (45 km)	C/B + S/L (45 km)	I/P + S/L (45 km)
1. Collection & Haulage	255	315	375	315	315	285	265
2. T/S or C/B or I/P	0	(11) 50	0	(11) 50	(11) 50	(32) 394	(32) 1,107
3. Final Disposal	10	(68) 78	(87) 278	(87) 278	(65) 347	(52) 160	(5)15
Total	265	(79) 443	(87) 653	(98) 643	(76) 712	(84) 839	(37) 1,387
Total Excluding Land Cost	265	364	566	545	636	755	1,350
Cost Index Option 0 = 1.00	1.00	1.37	2.13	2.06	2.40	2.85	5.10
Cost Ranking	1	2	4	3	5	6	7

Abbreviations: O/D: Open Dumping, S/L: Sanitary Landfill, T/S: Transfer Station,
Sea: Seashore landfill, I/P: Incineration Plant,
C/B: Compaction & Binding,

Note: Figures indicated in parentheses are land purchase costs calculated for each one ton of waste.



Figures in Parentheses are cost indices (Option 0 = 1)

Fig. 8.2-1 Cost Comparison

2) Selection of the Most Appropriate Option

Option 3 (Sanitary landfill and Transfer stations) is judged as the most appropriate, and therefore the best option through the following evaluation process:

(1) Both Options 0 and 1 with open dumping were rejected because these options do not satisfy the minimum environment-sanitation standards required by authorities concerned (the ONEB and the Ministry of Industry) in Thailand.

(2) The comparison between the remaining Options 2-6 shows that Option 3 dominates the other options because Option 3 scores the highest grading for both Criteria 1 and 2.

8.2.4 Conclusions

1. The BMA should apply the sanitary landfill (Option 3) as the major means of waste disposal in terms of environmental soundness, technological reliability and cost-effectiveness.

2. The choice of Option 3 does not mean that all the Bangkok waste will have to go through transfer stations. The choice of Option 3 means that it is more economical to use transfer stations if the haulage distance is about 45 km or longer in general. Some waste collected near to disposal sites should be transported directly to the sites without going through transfer stations.

3. Although the cost difference between Options 2 and 3 is small at present, the cost difference may be greater in the future in view of that:

   a. The long haulage with transfer stations would require less manpower than that without transfer stations would. The faster increase in emoluments (personnel costs) than equipment costs will make Option 3 (equipment-intensive system) more economical than Option 2 (more labor-intensive system) in the future.

   b. Sites of transfer stations can be converted to those for incinerators when needed. This is a very important point to be considered in view of the increasing costs and difficulty of land acquisition that is likely to happen in the future.

4. Therefore, it is advisable for the BMA to acquire as many transfer stations as possible within the areas reasonably near to the waste generation centers.

5. Introduction of Incinerators

a. The most important factor to decide on the introduction of incinerators is the availability of land for sanitary landfill. If land is not available, incinerators will have to be introduced inevitably.

b. In this sense, it is very important for the BMA to have an accurate forecast on the availability of the land and reliable contractors for waste disposal.

c. Even if land prices increase sharply, the sanitary landfill will never be more costly than incinerators from the view point of Bangkok Citizens as a whole because the land value will never disappear after the completion of the sanitary landfill operation. As a matter of fact, it is very likely that the value of the land will substantially increase after the completion of the landfill if the BMA uses old borrow pits which exist in Bangkok.

Note: Financial cost of the sanitary landfill will be equivalent to that of incinerators if the land price of sanitary landfill increase 10 - 25 times. Assuming that the land price would increase by 10 % every year, it would take 25 years to reach to a land price 10 times higher than the current price, and take 34 years to reach to a price 25 times higher than the current one.

d. Although it is likely that the BMA would find land for sanitary landfill either by itself or through contractors during the current planning period till 2000, the introduction of an incineration plant as proposed in Section 8.4 might be advisable for the BMA in view of acquiring the plant-operation know-how and experience which may be needed in the future.

8.3 Plan for the Sanitary Landfill

8.3.1 Functions of a Sanitary Landfill and Major Facilities Required

Sanitary landfill is a solid waste disposal system which controls dumped waste, leachate (water generated as a result of the compaction and decomposition of dumped waste) and gas. Sanitary landfill systems have the following functions and facilities:

Table 8.3-1 Functions and Facilities Required for Sanitary Landfill

REQUIRED FUNCTIONS	REQUIRED FACILITIES
a. Dumped waste must be confined.	1. Embankment or borrow pits 2. Waste scattering prevention facilities
b. Dumped waste must be covered (to avoid the generation of bad odor and flies, and also to prevent waste scattering).	3. Cover soil with either daily or periodic application
c. Leachate must not escape outside the sites without treatment.	4. Lining (clay or rubber or plastic or concrete) 5. Leachate collection & drain facilities 6. Rain water collection & drain facilities Leachate pond
d. Leachate must be treated.*1	7. Leachate treatment facilities
e. Gas must be released.*2	8. Gas ventilation pipes
f. Site must be accessible.	9. Access roads and onsite roads
g. Operation must be controlled.	10. Control office 11. Weighbridge (Truck scale) 12. Fire fighting facilities

Technical Notes

*1. Leachate Treatment

It is advised that the BMA apply chemical treatment of leachate judging from the quality of leachate generated in the existing disposal sites. As can be noted from Table 8.3-2, COD values are very high, i.e. 6,201 mg/l in Nong Khaem and 2,850 mg/l at On Nut on average. BOD values are also high enough to necessitate biological treatment.

Table 8.3-2 Quality of leachate from disposal sites Oct. 1988 - 1989

Item		Nong Kheam		On Nut	
		Range	Average	Range	Average
Temperature	°C	24.5 - 30.4	28.6	25.8 - 33	29.8
pH		8.1 - 9.0	8.4	8.2 - 8.5	8.3
Alkalinity	mg/l	2,200 - 11,000	7,875	2,040 - 8,500	5,198
BOD	mg/l	108 - 26	222	48 - 682	258
COD	mg/l	2,040 - 10,041	6,201	2,400 - 3,840	2,850
T-KN	mg/l	224 - 867	736	224 - 1,625	682
Suspended-Soil	mg/l	69 -238	121	76 - 1,177	276
Total Solid	mg/l	1 432 - 74,188	25,242	9,232 - 11,013	9,335
Volatile-Soild	mg/l	2,428 - 6,580	4,899	1,708 - 4,964	2,789

In Thailand, there is no effluent standard that is to be legally applied to leachate generated on disposal sites. However, it is advised that the BMA will follow the relevant part of the Industrial Effluent Standards (Ministry of Industry) with respect to BOD, suspended solid, pH, and other factors.

Table 8.3-3 Industrial Effluent Standard on BOD, Suspended Solid and pH (Ministry of Industry)

	BOD	SUSPENDED SOLID	pH
Standards	60 mg/l	30 mg/l	5 - 9

The planned sanitary landfill sites at Ram Intra and in the east part of Bangkok have leachate treatment facilities that can satisfy the above-shown standards.

*2. Gas

As a result of decomposition of waste, landfill sites generate gas, such as hydrogen, methane, nitrogen, carbon monoxide, hydrogen sulfide, and carbon dioxide, etc.

These gases may cause explosion or fire if not exhausted properly to air. Therefore, gas ventilation pipes should be provided for landfill sites. Fire fighting equipment is also required.

8.3.2 Major Points to be Considered for the Selection of Landfill Sites

Major Points to be considered for the selection of landfill sites include the following:

1) Geological conditions
2) Surrounding environment
3) Land price
4) Distance to collection area and haulage costs

Refer also to the Technical Guidelines for the Construction of the Sanitary Landfill (Appendix 4).

1) Geological Conditions

a. In Bangkok, from geological point of view, flat land is more suitable as a disposal site than a borrow pit because Bangkok soil is clay, which is distributed over almost entire area of Bangkok with about 10 m thickness on average. Clay lying on the bottom of landfill sites can serve as a natural lining. In the case a flat land is used as a sanitary landfill, a few meters of the soil (clay) will be removed at the time of construction. All the removed clay will be later used to cover dumped waste during landfill operation. On the other hand, if a deep borrow pit is used as a site, clay has to be purchased to prepare a lining on the bottom of the pit. The case of Ram Intra pit is shown below:

Soil Required for the Lining in the Ram Intra Pit

Depth of the Ram Intra hole is about 18 m, while the thickness of the clay layer is 10 m. It is therefore necessary for the BMA to purchase clay for a natural clay liner to the pit bottom. The amount of clay to be purchased for this purpose is estimated at about 700,000 m^3 more than 30 % of the soil (about 2,200,000 m^3) excavated and sold by the land owner. (Additional 550,000 m^3 of soil will have to be purchased to use it to cover dumped waste.)

b. It is beneficial for the citizens of Bangkok to use old borrow pits as sanitary landfill sites because the value of the holes can be increased by filling it with waste. In the case of the Ram Intra pit, such increase in the land value is estimated at 211 million Baht according to the following calculation:

A - B = 306 million Baht - 95 million Baht
= 211 million Baht

where A is the value of the land after filling with waste. (3.6 million Baht/rai x 85 rai = 306 million Baht)

B is the current market value of the pit. (1.12 million Baht x 85 rai = 95 million Baht)

Note: It is assumed the future land value after filling the pit with waste will be 3.6 million Baht/rai, 60 % of the current market price (6 million Baht/rai) of the flat land adjacent to the pit.

2) Surrounding Environment

a. Areas with many residents, hospitals, schools and special plants and animals living nearby are not suitable as disposal sites.

b. Areas with large rivers and drainage canals nearby may be suitable as the treated leachate may be drained to them.

3) Land Price

a. There exists, in general, a trade-off relationship between land prices and distance to collection area; shorter the distance, higher the land price is.

b. It is not reasonable to put full land prices in disposal costs because land continues to have some value after the completion of sanitary landfill (S.L.) as it can be used as a public parks or some other purpose.

c. From the citizens' point of view, costs of land purchase for sanitary landfill must be equivalent to the difference between market land prices before the commencement of S.L. and those after its completion.

4) Distance to Collection Area and Haulage Costs

a. What have to be compared in the site selection are total costs which include not only land costs but also collection and haulage costs as there usually exists a trade-off between the land costs and haulage costs.

b. Purchase of the planned site at Ram Intra can be justified when comparing the total cost of land and haulage for the Ram Intra site to that of a more distant site. The following table shows that the financial cost of disposal at the Ram Intra site is about 135 million Baht lower than that to be incurred at a place in an east part (e.g. Nong Chok) of Bangkok if other conditions are identical.

	PLANNED RAM INTRA SITE (1)	A PLACE IN NONG CHOCK (2)	DIFFERENCE (3) = (2) - (1)
(1) Land Purchase Cost (85 rai)	95.2	47.6	-47.6
(2) Additional Haulage Cost	0.0	182.5	182.5
(3) Total [(1) + (2)]	95.2	230.1	134.9

Note: It is assumed that financial costs of land purchase are 1.12 million Baht/rai at Ram Intra, 0.56 million Baht/rai in Nong Chock, 2) additional haulage cost is 100 Baht/ton, and 3) total disposal amount is 1,825,000 tons.

8.3.3 Two Types of Sanitary Landfill in Bangkok--Advantages and Disadvantages

There are the following two major methods of sanitary landfill in Bangkok considering geological and geographical conditions in Bangkok.

1. Sanitary landfill using flat land
2. Sanitary landfill using borrow pits made after soil removal.

Advantages and disadvantages of the two methods are summarized in Table 8.3-4.

Table 8.3-4 Advantages and Disadvantages of Sanitary Landfill using Flat land and Borrow Pit

	ADVANTAGES	DISADVANTAGES
Sanitary Landfill Using Flat Land	1. Less risk of damaging environment in the sense that the method will not affect underground water (Natural Bangkok clay will prevent leachate water from seeping into underground water.) 2. Economical in the sense that the method do not require: a. Purchase of artificial lining materials b. Purchase of cover material to cover waste Note: Under this method, about 3 m of top soil will be removed. Removed soil can be used as cover material.	1. Disposal capacity with this method may be smaller than that with the other method.
Sanitary Landfill Using Borrow Pits	1. Purchase cost of land (borrow pits) are lower than that of flat land if other conditions being equal. 2. This method will make possible to create a flat land which can be more useful and valuable than pits. Considering 1) the existence of many borrow pits in Bangkok and, 2) the expected increases in land values, this method would be very beneficial to Bangkok citizens. (See Fig. 8.3-1 for the location of the existing borrow pits in Bangkok.) It might happen that such benefit (increases in land value) might exceed the cost of waste disposal.	1. If pits are deeper than the depth of the existing clay, clay or artificial lining has to be purchased to lay it on the bottom of pits. (If no lining applied, this method may cause pollution of underground water.) 2. Cover soil has to be purchased if it is not available from pits.

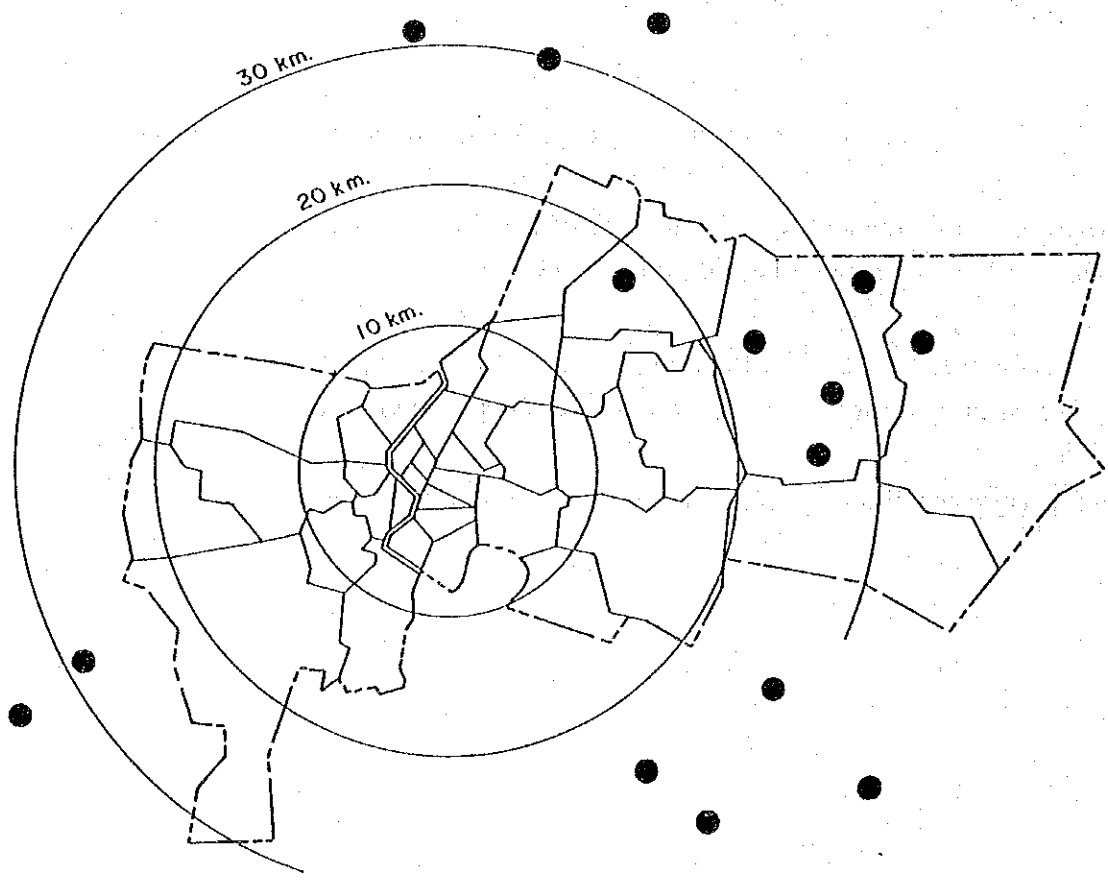


Fig. 8.3-1 Location Map of Big Borrow-pits in Bangkok

8.3.4 Plan for Sanitary Landfill

The BMA will construct and operate the following two sanitary landfill sites during the master plan period:

1. Sanitary landfill at Ram Intra using the existing borrow pit (85 rai)
2. Sanitary landfill in the east part (Its location has not been decided yet.) using a flat land (700 rai for the first phase)

Note: Refer to Volume 3 Feasibility Report Part 1 for the detail plan of the sanitary landfill at Ram Intra.

Ideally, the BMA should have disposal sites both in the east and west parts of Bangkok. In reality, however, the acquisition of a large land in the west part of Bangkok is extremely difficult. Therefore, it is planned that the BMA will purchase two sites both in the east part of Bangkok.

The reasons for choosing a borrow pit at Ram Intra as a disposal site are given below:

1. The land is readily available if the BMA wishes to purchase it.
2. The landfill in the chosen site will contribute to a large increase in the land value, through the conversion of the pit to flat land, that could be used as a public park or some other purpose, which can be beneficial to the citizens of Bangkok.
3. The successful implementation of sanitary landfill in the Ram Intra pit will imply that the BMA can possibly use many other borrow pits (similar to that at Ram Intra) in the future which exist in Bangkok.
4. The pit is not so far from the core districts. (about 20 Km)
5. The Ram Intra pit is an ideal location for "Incineration and Park Plan" in the future. (A public park can be constructed after the completion of sanitary landfill. It is then necessary for the BMA to purchase the land lying between the closed compost plant site and the pit for the realization of the Incineration and Park Plan.)

Outline of the planned two sites is summarized in Table 8.3-5.

Table 8.3-5 Outline of the Planned Two Sanitary Landfill

	SANITARY LANDFILL SITE 1 (RAM INTRA)	SANITARY LANDFILL SITE 2 (EAST PART OF BANGKOK)
1. Location	Ram Intra	A place (not decided yet) in the east part of Bangkok
2. Land condition	Borrow pit	Flat land
3. Site Area	85 rai	700 rai for the first phase (1,700 rai in total)
4. Effective Disposal area	80 rai	500 rai for the first phase (1,500 rai in total)
5.Capacity		For the first phase:
a. Total Waste Disposal Capacity	2,300,000 m^3	4,700,000 m^3
	(1,825,000 t)	(3,650,000 t)
b. Covering Material	700,000 m^3	1,4000,000 m^3
	(910,000 t)	(1,800,000 t)
c. Total (a + b)	3,000,000 m^3	6,100,000 m^3
	(2,735,000 t)	(5,450,000 t)
7. Layout Plan	Refer to Fig. 8.3-2 & Fig. 8.3-3	Refer to Fig. 8.3-4 & Fig. 8.3-5
8. Period of Operation	1994-1999	1997-2001
	Refer to Fig. 8.3-7	Refer to Fig. 8.3-7
9. Costs		(for the First Phase Only)
1) Land Purchase	95,200,000 Baht	392,000,000 Baht
2) Construction	356,500,000 Baht	478,000,000 Baht
3) Total (1+2)	451,700,000 Baht	870,000,000 Baht
4) Operation & Maintenance	210,370,000 Baht	277,400,000 Baht
5) Grand Total	662,070,000 Baht	1,147,400,000 Baht
	Refer to Table 8.3-6.	Refer to Table 8.3-6.

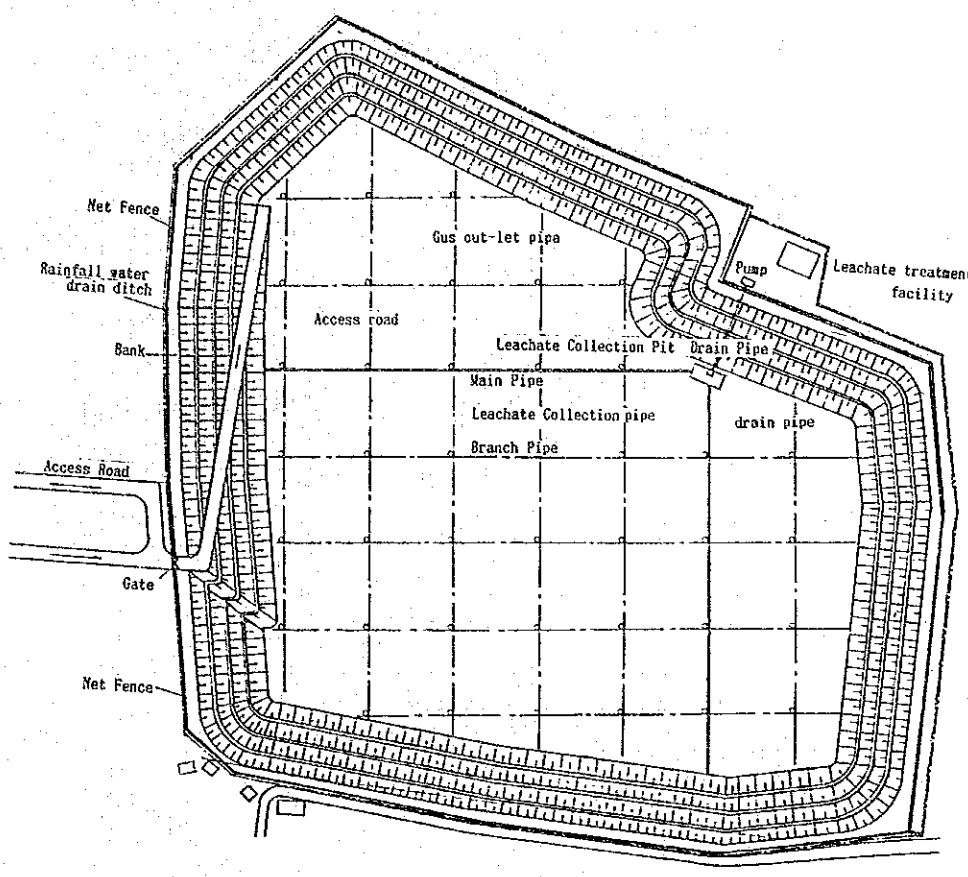


Fig. 8.3-2 Layout Plan for the Sanitary Landfill in Ram Intra

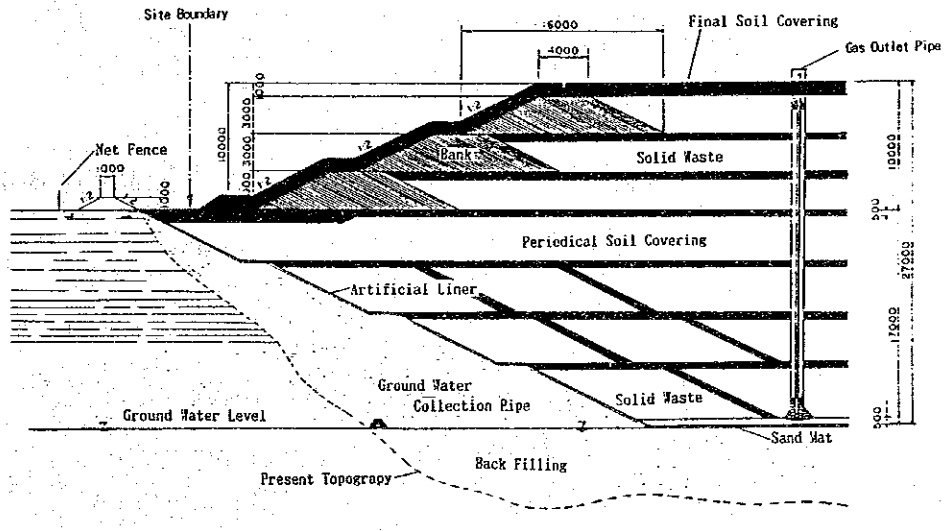


Fig. 8.3-3 Typical Cross Section of the Sanitary Landfill in Ram Intra

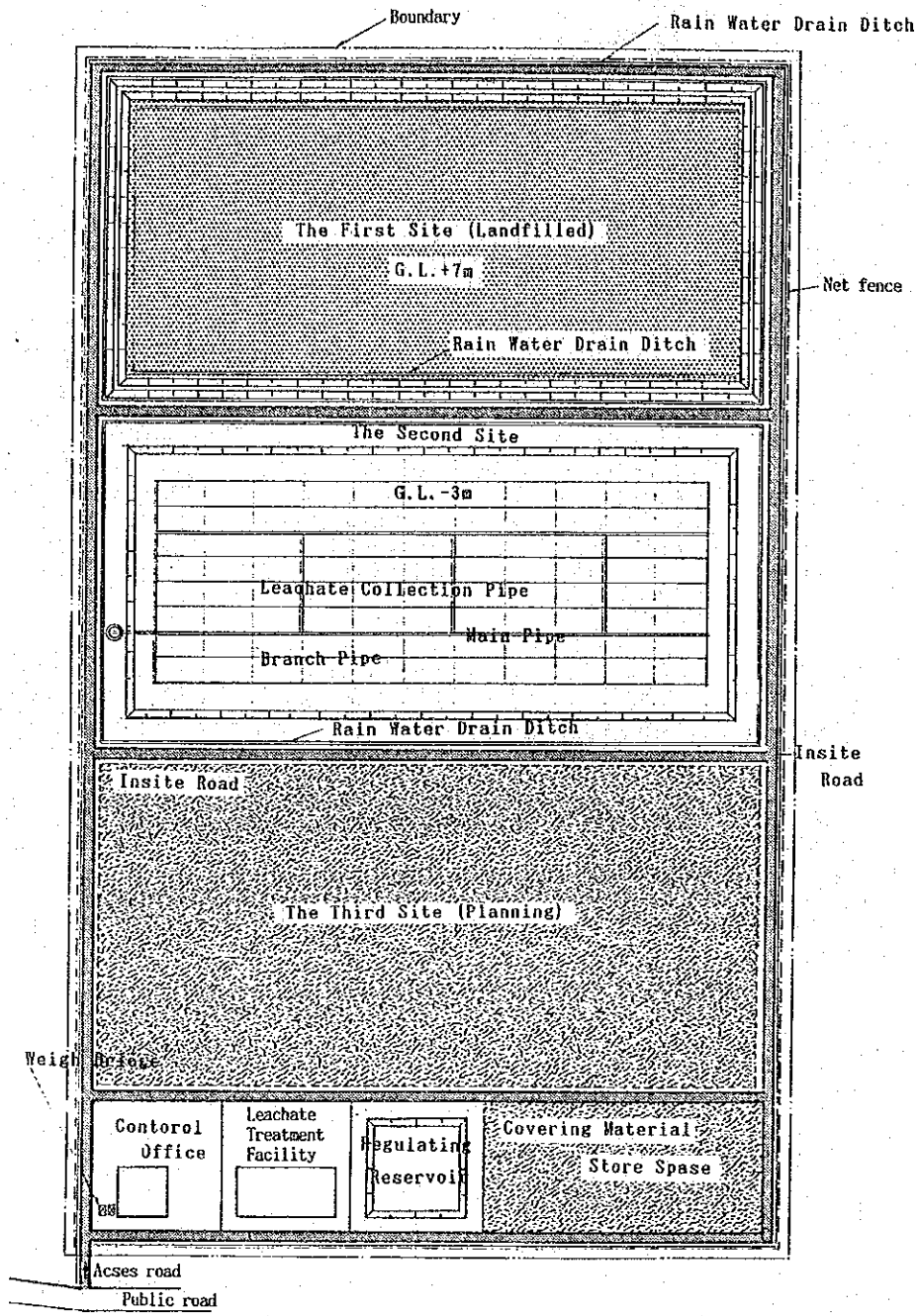


Fig. 8.3-4 Layout Plan for the Sanitary Landfill in the East Part of Bangkok

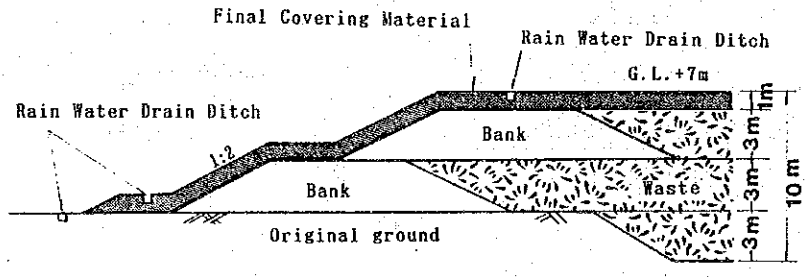


Fig. 8.3-5 Typical Cross Section of the Sanitary Landfill in the East Part of Bangkok

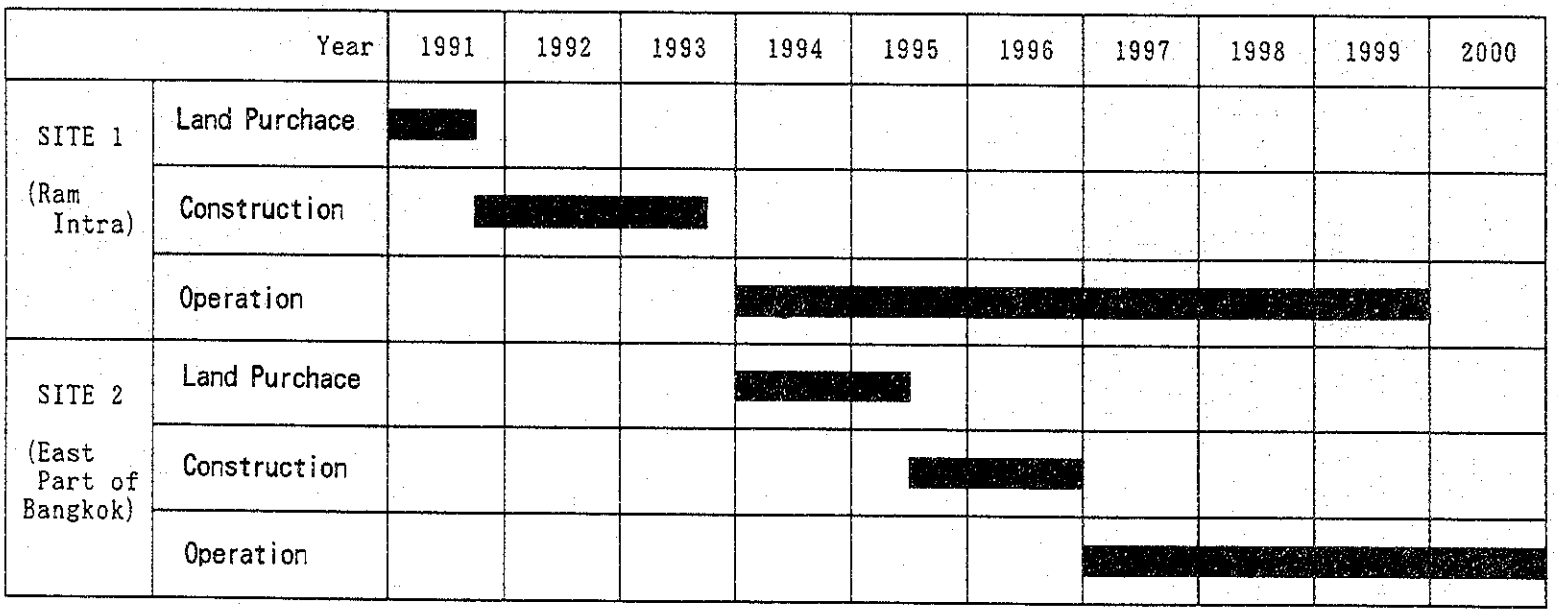


Fig. 8.3-6 Construction and Operation Schedule for the Two Sanitary Landfill Sites

Table 8.3-6 Estimated Costs of Construction and Operation/Maintenance of the Two Sanitary Landfill Sites

Items	Site 1 (Ram Intra)		Site 2 (East Part of Bangkok)		
	Total	Per Ton Cost	1st Phase Only	Total	Per Ton Cost
1. Land Purchase	95,200,000	52	392,000,000	952,000,000	87
2. Construction	356,500,000	195	478,000,000	1,178,000,000	107.7
a. Civil Work	(304,500,000)	(167)	(350,000,000)	(1,050,000,000)	(96)
b. Water Treatment Facility	(52,000,000)	(28)	(120,000,000)	(120,000,000)	(11)
c. Control Office	(0)	(0)	(6,000,000)	(6,000,000)	(0.5)
d. Weigh Bridge	(0)	(0)	(2,000,000)	(2,000,000)	(0.2)
3. Total (1+2)	451,700,000	247	870,000,000	2,130,000,000	194.7
4. Operation/ Maintenance	210,370,000	115	277,400,000	832,200,000	76
5. Grand Total (3+4)	662,070,000	362	1,147,400,000	2,962,200,000	270.7

8.4 Treatment Plan

Introduction

It is planned that the following treatment facilities will be constructed during the master plan period:

1. An incineration plant (600 tons/day)
2. An incineration plant (20 tons/day) for hospital waste (The budget for this incineration plant is included in the 1991 DPC's budget.)
3. A compost plant (1,000 tons/day of incoming waste) (The contract for the compost plant was concluded in August 1990.)

The Planned facilities are outlined in the table below:

FACILITY	CAPACITY	OPERATION PERIOD	COST OF CONSTRUCTION
Incineration Plant	200 tons/day/unit x 3 units = 600 tons/day (200 t/d during 1996 - 1999, and 600 t/d in 2000 and there after)	1996 - 2014 (Introduction of the incineration might be delayed if a necessary fund is not available in the scheduled timing.)	1,842 million Baht (1,209 million Baht for the first phase and 633 million Baht in the second phase)
Incineration Plant for Hospital Waste	20 tons/day	1993 - 2013	40 million Baht
Compost Plant	Incoming waste amount: 1,000 tons/day	1993 - 2008	370 million Baht

The remaining part of this chapter will concentrate on the plan of the incineration plant (600 tons/day) because 1) the BMA has already planned an incineration plant for hospital waste, and appropriated a 1991 budget (40 million Baht) for the construction of the plant, 2) the BMA, in August 1990, signed a contract with a contractor for the construction of the compost plant. Refer to Vol. 3 Part 2 for a more detailed study of the planned incineration plant (600 tons/day).

8.4.1 Reasons for the Introduction of an Incineration Plant

It has been agreed by both the BMA/DPC and the Japanese side that it is advisable for the BMA to construct an incineration plant during the planning period up to 2000 in view of the following:

1. Incineration would contribute to the stable disposal management of waste. (It will alleviate problems that will arise from the difficulty in land acquisition for disposal sites.).

2. Earlier introduction of an incinerator will be helpful for the BMA in the sense that it would enable the BMA to acquire the incineration know-how and experience, and to prepare for the future situation where substantial amounts of waste would have to be incinerated due to the difficulty in land purchase for sanitary landfill.

8.4.2 Design Policy for the Incineration Plant

An incineration with capacity of 600 tons/day has been planned based upon the following design policy:

Policy 1. WORKABLE INCINERATOR

A proposed incinerator should be the one which can incinerate the current waste of ordinary characteristics (in terms of calorific values and waste composition) without choosing a particular waste having higher calorific values.

Policy 2. USE OF RELIABLE TECHNOLOGY

A proposed incinerator should be the one which employs reliable technology that has been tested and proved in many places.

Policy 3. ECONOMICAL INCINERATOR

A proposed incinerator should be the most economical one under such conditions as waste quality and, environmental standards to be met.

Policy 4. PREVENTION OF THE SECONDARY POLLUTION

The prime objective of an incinerator is to dispose of waste in a sanitary manner by incinerating and reducing waste volume. It, however, may cause

a secondary pollution such as air pollution if adequate measures are not taken.

A proposed incinerator should be the one with facilities necessary for avoiding the secondary pollution. It should be the one which will meet both the Proposed Industrial Emission Standards, and the Industrial Effluent Standards of Industrial Environment Division, Ministry of Industry.

8.4.3 Outline of the Planned Incineration Plant

The proposed incinerator is outlined as follows:

1) Capacity of Incineration

- 600 tons/day: 200 tons/day/unit x 3 units
- Annual incineration amount: 600 tons/day x 315 days/year* = 189,000 tons/year
  (* 315 days/year is an average number of operation days per year calculated on the following conditions: Overhaul 20 days/year and monthly maintenance check 2-3 days/month.)

Reason for Proposing a Furnace of 200 ton/day/unit

Given the total capacity being 600 tons/day, and the calorific values of waste of Bangkok, 3 units of 200 tons/day/unit with a water injection system is judged most cost-effective and technically appropriate. A gas cooling system by water injection type does not function properly if the capacity of a furnace is over 200 tons/day/unit approximately. (A furnace of sizes bigger than about 200 ton/day are feasible in the case that a boiler system is applied as a gas cooling system.)

Reason for Proposing an Incinerator of 600 tons/day (200 tons/day/unit x 3 units)

An incinerator with the capacity of over 600 tons/day is not physically feasible in view of 1) size of the required waste pit and facilities and 2) size of the planned site at On Nut (Approx. 10.6 rai). An incinerator with the capacity of over 600 tons/day may put a very heavy financial burden on the BMA.

2) Gas Cooling System

- Water injection system

Reasons for Proposing a Water Injection System

The quality of waste (low heat values of waste) is the most important factor to decide on a type and capacity of an incinerator to be applied in Bangkok.

Waste of Bangkok has low calorific value as it contains a relatively high water content. It is judged that the low heat value (LHV) of waste in Bangkok will be 750 kcal/kg - 1,500 kcal/kg during the period of 1996 - 2010. Note: LHV is calory of waste calculated by subtracting water vaporation heat.

The above estimated calorific values, however, are not high enough to apply a high pressure steam boiler and generator system. The boiler and generator system is feasible if the waste constantly has low heat values of 1,400 kcal/kg or greater. Therefore, the Water Injection System should be applied as a gas cooling system.

3) Environmental Protection Measures

(1) Anti-Air Pollution

The planned incinerator will have all the facilities necessary to satisfy the "Proposed Standards by Industrial Environment Division, Ministry of Industry". The necessary facilities include the following.

a. Electric precipitator (to remove dusts and particles from ventilation gas)
b. HCl remover (dry $Ca(OH)_2$ spray) (to remove hydrogen cloride)
c. High stack (to disperse ventilation gas)

(2) Anti-water Pollution

The planned incinerator will have a closed system for discharged water, i.e. leachate generated in the waste reception pit will be put into the furnace for incineration; all other sewage water will be treated either only biologically or biologically/chemically. Treated water will be utilized to make ventilation gas cooler through the water injection system.

4) Site Location and Size

The plant site will be in the east side of the existing disposal site at On Nut. The site is 17,000 m^2 (10.625 rai). Refer to Fig. 8.4-1.

5) Layout Plan: Layout plan is shown in Fig. 8.4-2.

6) Major Specifications: Major specifications are shown in Table 8.4-1.

7) Estimated Costs

	TOTAL	PER TON
a. Construction		
- The First phase	1,209 million Baht	
- The second phase	633 million Baht	
- Total	1,842 million Baht	658 Baht
b. Operation/Maintenance for 19 years until 2014	1,965 million Baht	713 Baht
c. Total (a+b)	3,807 million Baht	1,371 Baht

(Refer to Table 8.4-2 for details of the costs.)

8) Construction Schedule

Construction will be divided into two phases in view of the required amount of investment for the incineration plant: In the first phase, the first unit (200 ton/day) and all facilities commonly used for all the three units will be constructed. In the second phase, the second and third units of furnaces will be constructed. The first furnace will start operation in 1996, the second and third furnace will start operation in 2000. Refer to Fig. 8.4-3 for the schedule.

9) Manpower Required

It is estimated that 85 persons approx. will be required for the operation of the planned incineration plant. Refer to Table 8.4-3.

10) Training of the Personnel

Training of the personnel for the plant operation should be included in a contract to be concluded between the BMA and a contractor. The training should be provided during a construction period. Refer to Volume 3 Part II Section 7.2 Training Plan.

Fig. 8.4-1 Site Location Map of the Incineration Plant

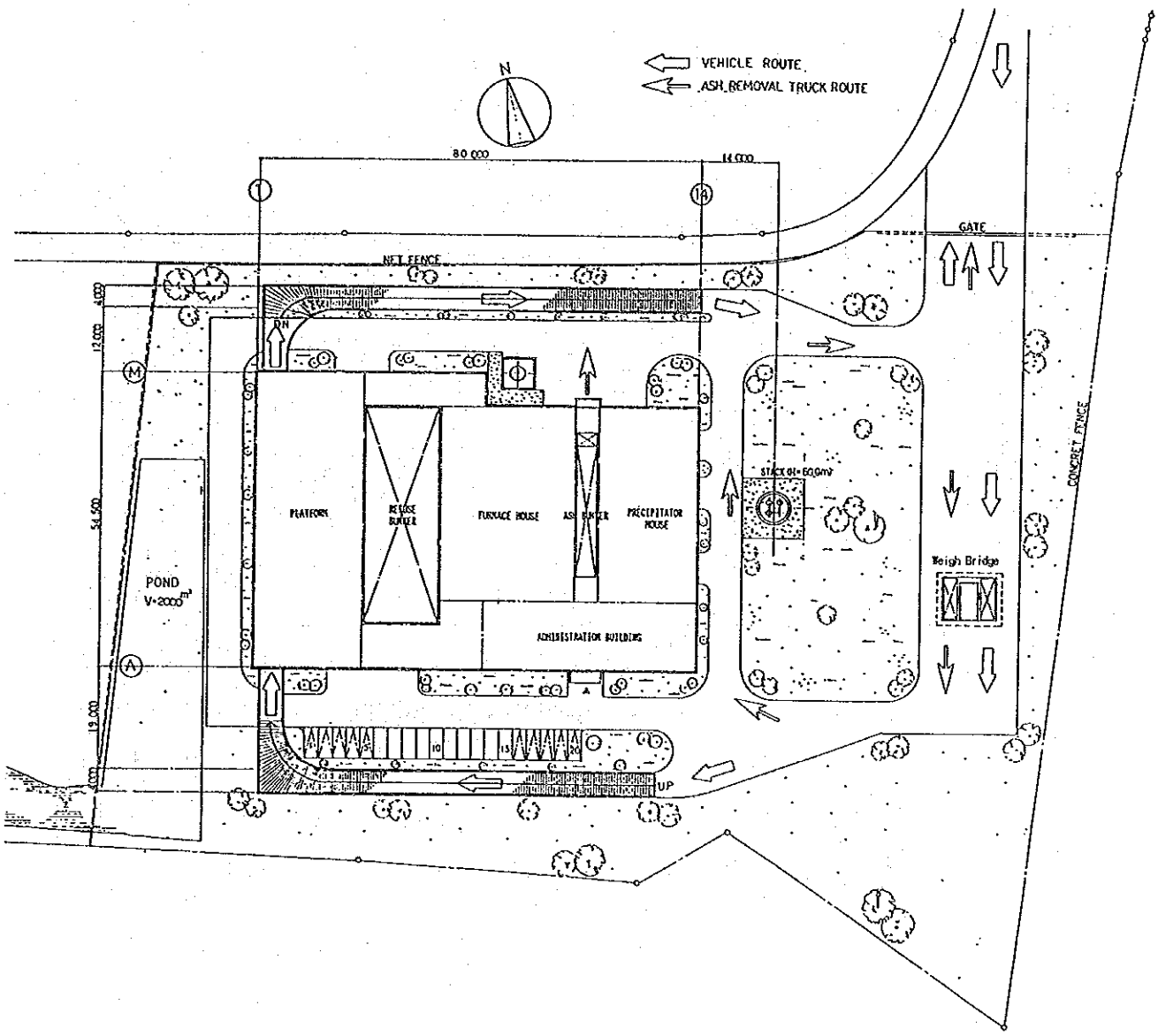
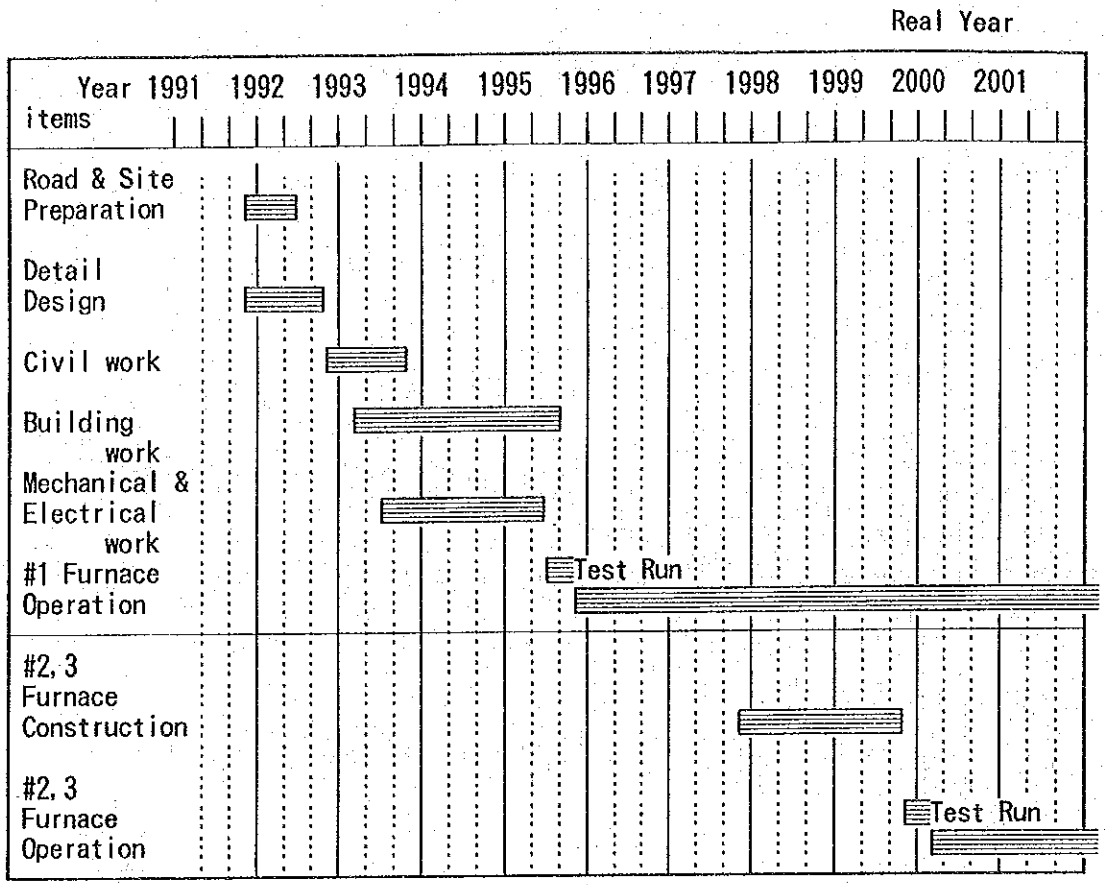


Fig. 8.4-2 Layout Plan of the Incineration Plant



Note: During the first phase construction, the first furnace together with common facilities such as waste pit, water treatment facilities for 2nd and 3rd furnaces will be constructed.

Fig. 8.4-3 Construction Schedule of the Incineration Plant

Table 8.4-1 Major Specifications of the Incineration Plant

ITEM OF INCINERATOR	SPECIFICATIONS
Furnace capacity	600 t/d (8.33 t/h x 3 units x 24 hours)
Number of furnaces	3 (200 t/d x 3 units)
Land required	17,000 m^2 in On-Nut
Low heat calorific values	750 - 1,500 kcal/kg, standard 1,150 kcal/kg
Weigh bridge	30 ton/unit x 2 units
Reception Pit	5,200 m^3 (3-days-capacity) w/v = 0.35
Number of pit gates	9, (platform, 42 m wide)
Cranes	2 units with bucket
Type of furnace	Step grate stoker
Burner	Diesel oil burner
Gas Cooling System	Water Injection System
Gas treatment for Anti-Pollution	HCl remover (dry $Ca(OH)_2$ spray) Electric precipitator
Heat utility	Hot water recovery
Draft	Induced draft fan (approx. 69,000 m^3 N/h x 3) Forced draft fan (approx. 34,000 m^3 N/h x 3)
Stack	60 m high 1 stack outside 3 inner stacks inside
Ash pit	840 m^3
Ash crane	1 unit
Water treatment	Closed system. Treated water is sprayed for gas cooling.
Guillotine shear	150 t x 1 unit

Table 8.4-2 Annual Costs of Construction and Operation/Maintenance for the Incineration Plant

(Unit: Million Baht)

Year / Items	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Construction	-	-	408	408	204	-	-	200	200	70	-
Maintenance											
Emolument	-	-	1.08	1.08	2.90	4.56	4.56	4.56	4.56	9.42	9.42
Utility	-	-	-	-	-	19.40	19.85	19.47	20.17	43.44	43.60
Parts*1	-	-	-	-	-	0.36	0.44	1.82	2.00	2.20	2.60
Repair*2	-	-	-	-	-	3.64	3.64	9.09	10.00	18.10	32.72
Subtotal	-	-	1.08	1.08	2.90	27.96	28.49	34.94	36.73	73.16	88.34
Total	-	-	409	409	207	28	28	235	237	143	88

*1: "Parts" include materials and equipment used for operation and maintenance.

*2: "Repair" means mainly overhaul which will be done by a contractor. Costs of minor repairs to be done the BMA is also included.

Table 8.4-3 Estimated Manpower Required for the Operation/Maintenance of the Planned Incineration Plant

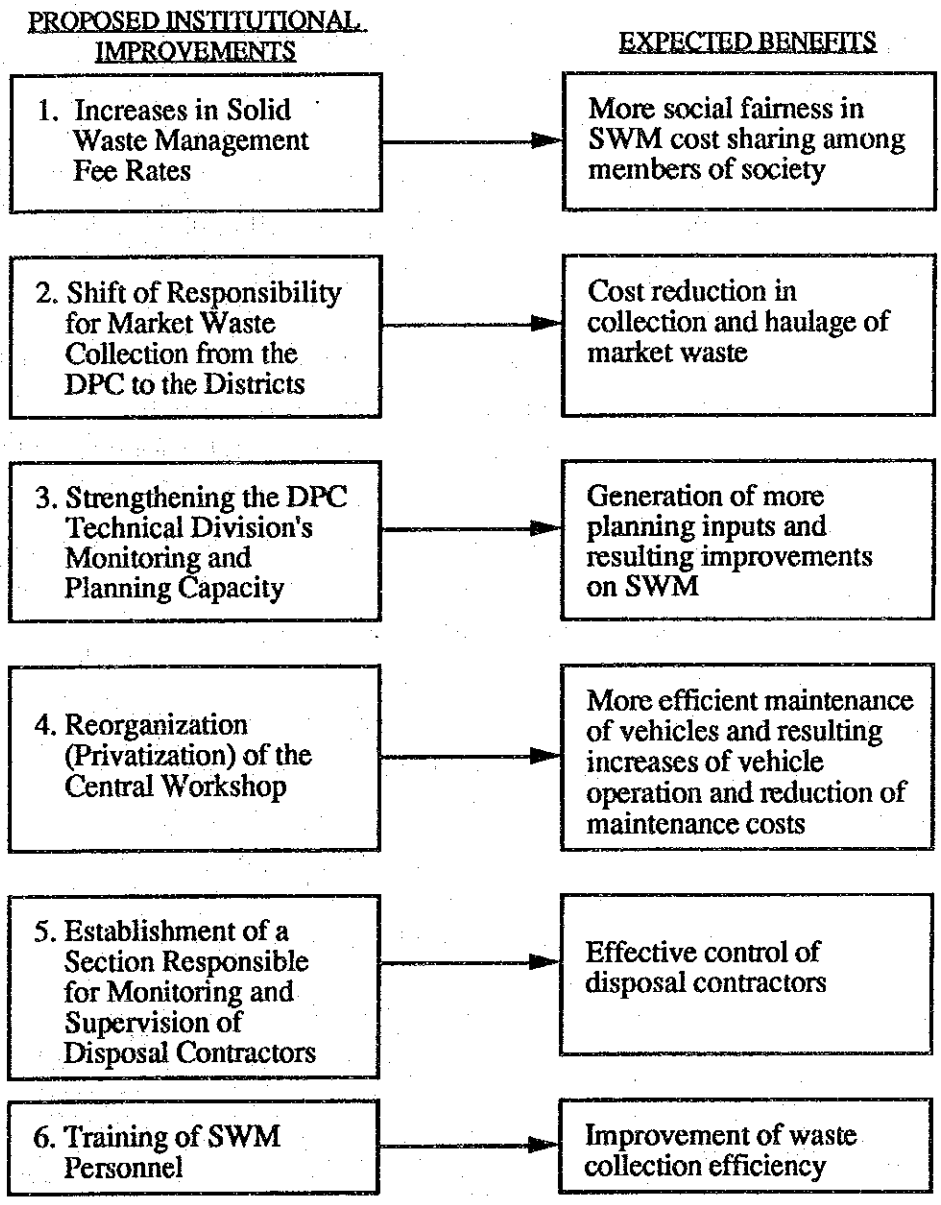
PERSONNEL	MANPOWER REQUIRED (PERSONS)
Plant Manager	1 (1)
Engineers	
- Mechanical	2 (1)
- Electrical	2 (1)
Equipment Operator	2 (1)
Operator	
- Crane	12 (8)
- Incinerator	12 (8)
- Weigh Bridge	8 (4)
Maintenance Crew	24 (8)
Cleansing Men	6 (4)
Guardmen	12 (8)
Clerk Chief	1 (1)
Assistant	3 (1)
Total	85 (46)

Note: Figures in parenthesis indicate number of persons required for the operation/maintenance of the incinerator with capacity of 200 tons/day during 1996 - 1999.

Chapter 9. Institutional Improvement Plan

9.1 Proposed Institutional Improvements and Their Benefits

The institutional improvements proposed in this chapter and their expected benefits are summarized as follows:



9.2 Increases in Solid Waste Management Fee Rates

9.2.1 Current Fees

At present, the solid waste management is financed mostly by the BMA's general revenue. The fee revenue for waste collection service was 32 million Baht in 1989, about 3.6 % of the SWM budget in the same year. According to the results of questionnaire sent to each district, there are about 70,000 business establishments paying over 40 Baht/month, of which 2,190 business establishments pay 500 Baht/month or more.

Amounts of the fee revenue depend on the two factors: fee rates and number of fee payers. It seems that the BMA is doing well in collecting the fees from as many payers as possible in each district.

The fee rates currently applied are based upon those decided in 1962 which stipulates the minimum fee rates. As can be seen in Table 9.2-1 those fee rates are very low as compared to the unit costs of waste collection actually spent. The fee rate 4 Baht/month for collection of household waste (discharged at a rate 20 liter or less per day) is less than 10 % of the actual cost 48 Baht/month, while the fee rate 40 Baht/month for collection of business waste (discharged at a rate less than 1m3/day) is less than 2 % of the actual cost 2, 400 Baht/m^3/month spent by the BMA.

The fee rates were revised in 1985. The new rate for household waste is 40 Baht/month (max), while the new rate for business waste is 2,000 Baht//month. Those new rates are very reasonable in the sense the rates are close to the actual unit costs spent by the BMA. However, the BMA has not so far applied the revised rates.

Table 9.2-1 The Fee Rates and the SWM Costs (Excluding Land Costs)

	MONTHLY FEE RATE	
	1 m^3/day of Market, Factory & Other Waste	20 liter/day of House or Building Waste
1. Minimum Fee Rate Approved in 1962 (Currently Applied)	40 Baht/month (1.7%)	4 Baht/month (8.3%)
2. Maximum Fee Rate approved in 1985 (Not Yet Enforced)	2,000 Baht/month (83%)	40 Baht/month (83%)
3. The Current SWM cost Estimated	2,400 Baht/month (100%)	48 Baht/month (100%)
4. SWM Cost with Option 3 (Longer Haulage 45 km & Sanitary Landfill)	4,446 Baht/month (185%)	89 Baht/month (185%)

Note: The figures in the parentheses indicate percentages of the fees to the current SWM costs shown in Item 3.

9.2.2 The Future Cost Increases and Strategy for the Fee Increases

It is estimated that the cost of the BMA's solid waste management will be at least 4 times larger in the year 2000 than the present cost due to increases of waste (2 times approx.) and a unit cost increase (2 times at least) due to the upgrading of the disposal method from the current open dumping to sanitary landfill, and also due to the future condition that haulage distance to the future disposal sites will be longer.

An important question is who will bear the future costs which will be at least 4 times greater than the current cost? The most reasonable answer would be that the people who receive the waste collection services should pay fees according to the amount of services consumed, in other words, the Beneficiary Pay Principle (BPP) as applied to water, electricity and telephone services.

Similarly, it is reasonable for the users of SWM services (collection service, etc) to pay fees according to what they consume. It is therefore strongly recommended that the BMA will attempt to increase the fee rates and the fee payers as much as possible.

As a realistic strategy, it is recommended that the BMA will firstly increase the fee rate for business waste (which is currently less than 2 % of the actual unit cost) because it is much lower than the rate applied to the household waste (which is currently about 10 % of the actual unit cost.) The BMA should increase the fee rate for the business waste at least to the same level as the rate for the household waste (10 % of the actual cost).

Then, after achieving the increase in the fee for business waste, fees for both household and business waste should be increased to a level as close as possible to the maximum fee rates approved in 1985. It should be noted that even those rates will be less than a half of the estimated cost of solid waste management that the BMA will have to spend in the future (Year 2000).

The future cost increases due to the introduction of advanced disposal methods (sanitary landfill or incinerators) should be explained to the citizens when raising the fees.

9.2.3 Shift of the Responsibility for Business Waste Management from the BMA to Business Establishments

In many local authorities of the world, business establishments (such as hotels, restaurants, shops and offices) are directly responsible for managing self-generated waste as a result of a thorough application of the Polluter Pay Principle (PPP).

This system is desirable in view of 1) the social fairness in cost-sharing, and 2) reflection of disposal costs in the product prices--which will lead to an efficient resource allocation without price distortion. This system will be also helpful for the BMA in reducing the future SWM costs.

Fee increases of business waste is important in the sense that it will lay a foundation for the BMA that may make possible to introduce a shift in the responsibility to the self-management of business waste.

If "the shift" is to be introduced in Bangkok, the fee for business waste must be firstly increased to the same level as the actual waste management cost spent by the BMA, because business establishments will not accept the responsibility for managing the self-generated waste in the situation where they can get rid of the responsibility by paying to the BMA a fee which is much less than actual cost of waste management.

9.3 Shift of Responsibility for Market Waste Collection from the DPC to the Districts

The Department of Public Cleansing collects about 40 tons/day of waste from the 7 BMA's markets out of 14 BMA's markets. The districts collect an average of 331 tons/day of waste from both the remaining BMA's markets and all the private markets.

The DPC collects hazardous hospital waste. This makes a sense as the collection of hazardous hospital waste involves a special techniques and equipment. There is however no rational reasons for the DPC to collect part of the BMA's market waste. It would be more cost-effective if it is collected by the districts (Huai Khwang, Bang Kapi and Dusit), where there are BMA markets, because the haulage distance can be shorter if collected by the districts than by the DPC.

Therefore, it is recommended that the DPC would transfer the responsibility for the collection of the BMA's markets waste entirely to the districts where those markets exist.

9.4 Strengthening the DPC Technical Division's Monitoring and Planning Capacity

Planning is an essential factor for improvement of solid waste management. However, the DPC's planning activities are not adequate. This Section proposes that the DPC, particularly its Technical Division should:

1. Strengthen its capacity in data collection, analysis and planning
2. Develop cost accounting methods and performance indicators
3. Set up a planning unit responsible for the study and promotion of waste recycling and waste exchange

9.4.1 Strengthening of the Capacity for Data Collection, Analysis and Planning

It is proposed that the Technical Division of the DPC should actively perform data collection and analysis, which can be used as basis for SWM planning. Data and information which may be useful for the DPC include the following:

1. Information on the costs of SWM (including maintenance and purchase of vehicles)
2. Information on business waste (amount of waste collected by type, etc.)
3. Information on recycling market (amounts, type, price, problems)
4. Information on hazardous waste generation in Bangkok

Secondly, the DPC should take a more active role in analyzing problems as well as planning and promotion of good collection systems to districts wherever applicable.

9.4.2 Development of Cost Accounting Methods and Performance Indicators

To know the costs and cost-effectiveness is the first important step for the evaluation of the current SWM performance, and for the planning for the future improvements. The BMA already has SWM cost accounting system which could however be further improved as shown below:

1. Current depreciation costs of waste collection vehicles may not be evaluated properly in connection with actual vehicle life and abandonment of vehicles.
2. The waste collection costs estimated by the BMA do not include salary (about 50 million Baht/year) of the employees of the Central Workshop. In view of the fact the about 70 % of the maintenance job provided by the Central Workshop is for waste collection vehicles, the same percentage (70 %) of such cost should be counted as a collection cost.

With the development of such performance indicators, it is then possible for the DPC to evaluate the SWM performance:

- According to vehicle type and size
- According to districts
- According to waste type
- Comparison of the BMA to contractors
- Comparison of the BMA to other cities
- Comparison of the present to the past, etc.

9.4.3 Setting-up of a Planning Unit Responsible for the Study and Promotion of Waste Recycling and Waste Exchange

There exist the following two factors relevant to the level of activities for waste recycling and exchange.

1. Availability of technology for using exchangeable materials particularly produced by manufacturing industries.
2. Market prices of recyclable materials

Waste exchange and recycling requires research and development activities. It is advised that the Government should take an active role in the research and development.

As far as the BMA/DPC are concerned, it is advised that they should take an active role in disseminating formation on the waste recycling and exchange, particularly to the industrial community in Bangkok. For this purpose, the setting-up of the planning unit will be necessary.

9.5 Reorganization (Privatization) of the Central Workshop

9.5.1 Problems

The Central Workshop (Mechanical and Maintenance Division of the Finance Department of the BMA) does not function effectively judging from the many complaints heard from the district officers and the Study Team's own observation. It seems that the majority of the district officers concerned feel that the Central Workshop is not as efficient as private garages.

A questionnaire were sent to all the districts to know their opinions about the Central Workshop. An important finding of the survey is that most districts wish to use private garages instead of the Central Workshop if they were free to choose any workshop. The result is shown below:

Questionnaire		
Question 1:	Do you wish to use the Central Workshop if you were free to choose any workshop?	
Answer:	1. No.	16 districts (59 %)
	2. Yes, on some conditions.	7 districts (26 %)
	3. Yes.	4 districts (15 %)
	Total	27 districts (100 %)

Another important finding of the survey is that the most districts (23 districts out of 27 districts) have some complaints about the Central Workshop. The major complaints are as shown below:

	NUMBER OF DISTRICTS WHICH MADE THE BELOW COMMENTS
1. Central Workshop takes long time for repair and maintenance.	21
2. Quality of repair and maintenance by the Central Workshop is poorer than that of private workshop.	15
3. The Central Workshop charges higher prices than private workshops do.	15
4. The Central Workshop sometimes refuses to repair trucks.	
5. The Central Workshop does not give guarantees, while some private workshops give guarantees for some period of time after repair.	15
6. The Central Workshop is far.	8

9.5.2 Options for Reorganization

The BMA should set up a committee to study the problems of the Central Workshop, and find ways in which the function of the Central Workshop can be strengthened.

There exist the following two options to the BMA for the strengthening the function of the Central Workshop.

Option 1. To strengthen the managerial and operational capacity of the Central Workshop by such means as giving more authority to it in placing orders for spare parts and by renewing old maintenance equipment.

Note: At present, the Central Workshop is authorized to purchase spare parts, at its own discretion, which do not exceed 10,000 Baht for each order. Any order which exceeds 10,000 Baht has to be approved by higher authority of the BMA. It is considered that this restriction is partly responsible for delays in ordering spare parts, which is then a major reason for taking long time for repair of vehicles.

Option 2. To privatize the Central Workshop

It is expected that the privatization would lead to a more efficient management. In this case, it might be advisable for the BMA to keep a partial ownership of the Workshop.

9.6 Establishment of a Section Responsible for Monitoring and Supervision of Disposal Contractors

The BMA/DPC will use contractors for disposal of more than 5,000 tons/day of waste from 1992. Success of the use of contractors depends much on the BMA's monitoring and supervision capability.

Therefore, it is advisable that the BMA/DPC will establish a section responsible for monitoring and supervision of disposal contractors within the DPC.

9.7 Training of SWM Personnel

It is advisable for the BMA to establish some training courses for the SWM personnel including drivers, collection crew and supervisors.

9.7.1 Training for Drivers

At present, almost no drivers execute daily maintenance check of collection vehicles. As it has been discussed in Section 7.5, it is possible for the BMA to increase vehicle utilization rates and reduce repair costs of vehicle by enforcing drivers to practice daily maintenance check.

It is therefore advisable for the BMA/DPC, in cooperation with the Central Workshop, to establish a training program for drivers to teach methods of daily maintenance check and safety driving.

9.7.2 Training for Collection Crew

A training program for collection crew is necessary with respect to the following:

1. Scope and manner of their job
2. Work safety
3. Manipulation of hydraulic loading equipment
4. Work morale

9.7.3. Training for Supervisors

A training program for supervisors should include the following:

1. Basics of vehicle maintenance
2. Labor management
3. Advantages and disadvantages of various collection methods
4. Health control of workers

Chapter 10. Financial Plan

Estimated Cash Expenditures and Costs for SWM

It is estimated that the future SWM (Solid Waste Management) will require 18,781 million Baht on a cash expenditure base during 1991 - 2000, corresponding to 14.7 % of the cumulative BMA budget estimated during the same period.

The above SWM amount can be recalculated at 15,629 million Baht on depreciation cost base, and the corresponding percentage drops to 12.3%. Refer to Fig. 10-1 and Table 10-1.

Notes: 1. The above percentages are calculated by using the estimated BMA's budget without government subsidies, which were excluded because the annual amounts of subsidies have fluctuated in recent years. Refer to Table 3.4-1.

2. Land purchase expenses are not depreciated in the calculation of the above-shown SWM costs on a depreciation basis as it is correct to treat the land as an undepreciable asset.

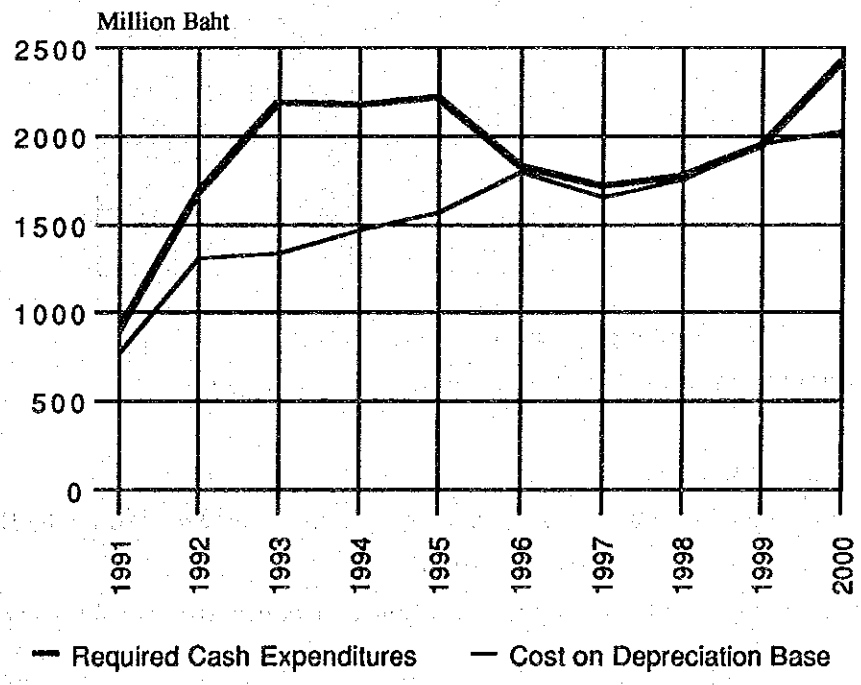


Fig. 10-1 Estimated Cash Expenditures and Costs for SWM (1991 - 2000)

Table 10-1 Estimated Cash Expenditures and Costs for SWM in Comparison to the BMA's Gross Budgets (1991 - 2000)

Unit: Million Baht in 1990 Price

	BMA'S REVENUE	SWM BUDGET (CASH EXPENDITURE)		SWM COST ON DEPRECIATION BASIS	
1991	9,140	891	9.8 %	771	8.4 %
1992	9,862	1,670	16.9 %	1,303	13.2 %
1993	10,641	2,183	20.5 %	1,338	12.9 %
1994	11,482	2,169	18.9 %	1,462	12.7 %
1995	12,389	2,214	17.9 %	1,571	12.7 %
1996	13,368	1,821	13.6 %	1,795	13.4 %
1997	14,036	1,716	12.2 %	1,657	11.8 %
1998	14,738	1,771	12.0 %	1,754	11.9 %
1999	15,475	1,938	12.5 %	1,955	12.6 %
2000	16,248	2,408	14.8 %	2,023	12.6 %
TOTAL	127,379	18,781	14.7 %	15,629	12.3 %

14.7%, an estimated percentage of the cumulative SWM cash expenditures borne to the cumulative revenue of BMA during 1991-2000, is 3.4% higher than the corresponding percentage in the past years 1985-1990.

Table 10-2 The Past SWM Budgets in Comparison to the BMA's Gross Budget (1985 - 1990)

Unit: Million Baht in 1990 Price

	BMA'S REVENUE	SWM BUDGET (CASH EXPENDITURE)	
1985	4,763	700	14.7%
1986	5,482	518	9.4 %
1987	5,255	528	10.0 %
1988	5,517	763	13.8 %
1989	6,900	793	11.5 %
1990	8,600	840*	9.8 %
Total	36,517	4,142	11.3 %

* 1990 SWM budget is the original budget.

Major reasons explaining the future high SWM expenditures are:

1. Increases in waste amount
2. Introduction of sanitary landfill, which will be implemented by both the BMA itself and contractors to be employed by the BMA
3. Waste haulage costs will be higher as haulage distance to disposal sites will be longer in the future.
4. Removal of old waste (approx. 1.7 million tons in total) from the existing sites to some remote places by employing contractors
5. Introduction of an incinerator (600 tons/day)

Financial Impact of the Planned Incinerator

The construction and operation of the planned incineration plant will cost 2,061 million Baht (Construction 1,842 million Baht + Operation 219 million Baht) during the master plan period 1991 - 2000. The estimated SWM cost with the incineration plant is 12 % higher than that without the plant as shown in Table 10-3. Treatment and disposal cost alone will be 23% higher with the incineration than that without it.

13.1%, a percentage of cumulative expenditures without the incineration during 1991-2000 will increase to 14.7% with the incineration. (An increase of 1.6%)

If the BMA wishes, loans will be available for the construction of the incineration plant from an international lending authority at an interest rate much lower than the prevailing interest rates of commercial loans in Thailand. The use of such loan will help the BMA to reduce its SWM cash expenditures required during the master plan period.

Table 10-3 Future Cash Expenditures for SWM With and Without the Planned Incineration Plant (1991 - 2000)

	SWM COSTS WITHOUT THE INCINERATOR	SWM COST WITH THE INCINERATOR	DIFFERENCE = COST OF INCINERATOR
	A	B	C = B – A
1. Amounts	16,720 M.B.	18,781M.B.	2,061 M.B.
2. Cost Index	100 %	112 %	12 %
3. Share to BMA's Gross Budget	13.1 % (11.8 %)	14.7 % (12.3 %)	1.6 % (0.5 %)

M.B.: Million Baht

Figures in parentheses indicate percentages calculated on depreciation basis.

Table 10-4 Future Cash Expenditures for Treatment and Disposal With and Without the Planned Incineration Plant (1991 - 2000)

	TREATMENT & DISPOSAL COST WITHOUT THE INCINERATOR	TREATMENT & DISPOSAL COST WITH THE INCINERATOR	DIFFERENCE = COST OF INCINERATOR
	A	B	C = B – A
1. Amounts	8,771 M.B.	10,832 M.B.	2,061 M.B.
2. Cost Index	100 %	123 %	23 %

M.B.: Million Baht

SWM Cost Composition 1 - Treatment/Disposal Cost vs Collection/Haulage Cost

During the master plan period 1991 -2000, it is estimated that treatment and disposal will cost a cash expenditure of 10,832 million, 57.6 % of the total SWM cost, while collection and haulage will cost 7,778 million Baht, 41.4 % of the SWM cost. Obviously the treatment and disposal cost is higher than the collection and haulage cost. This makes a sharp contrast to the past situation where the latter was always much higher than the former. The introduction of sanitary landfill method is a major reason explaining such situation.

Annual expenditures for collection/haulage and treatment/disposal estimated during 1991 - 2000 are shown in Fig. 10-2 and Table 10-5. Details of the respective costs are shown in Tables 10-6 and 10-7.

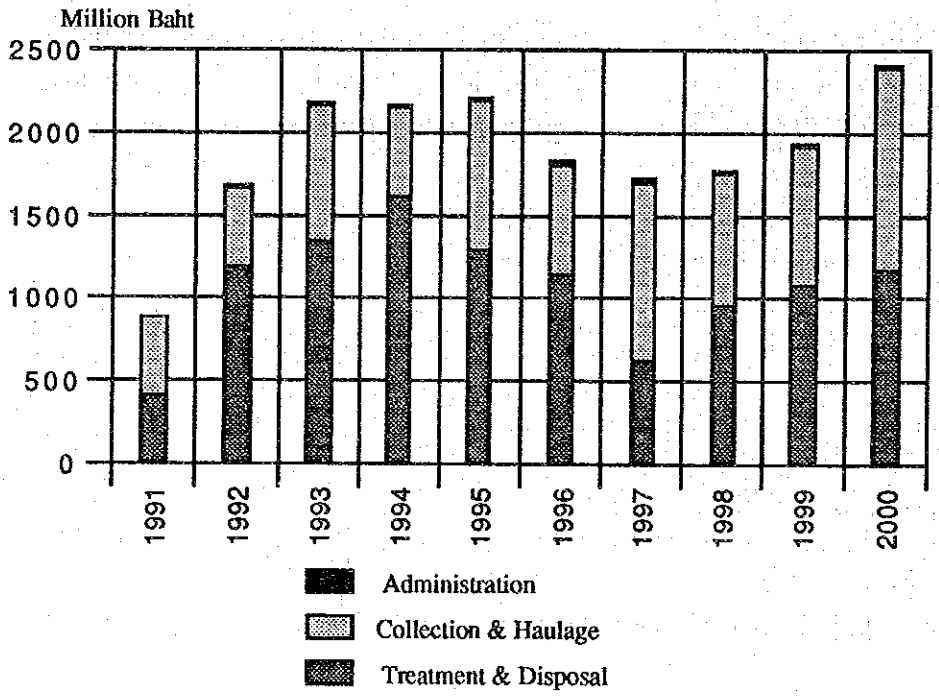


Fig. 10-2 Estimated Cash Expenditures for Solid Waste Management (1991 - 2000)

Table 10-5 Estimated Cash Expenditures Solid Waste Management (1991 - 2000)

Unit: Million Baht in 1990 Price

YEAR	TREATMENT & DISPOSAL	COLLECTION & HAULAGE	ADMINISTRATION	TOTAL
	A	B	C	D = (A+B+C)
1991	411	465	15	891
1992	1,182	473	15	1,670
1993	1,336	831	16	2,183
1994	1,611	542	16	2,169
1995	1,293	904	17	2,214
1996	1,149	655	17	1,821
1997	632	1066	18	1,716
1998	955	798	18	1,771
1999	1,089	830	19	1,938
2000	1,174	1,214	20	2,408
Total	10,832	7,778	171	18,781
Percent	57.6%	41.4 %	0.9 %	100 %

Table 10-6 Estimated Waste Collection Amounts & Costs (1991 - 2000)

Unit: Million Baht in 1990 Price

YEAR	COLLECTION AMOUNT (ton)			COST (Million Baht)						
	Total	By BMA	By Contractor	Con-tractors	BMA O/M	BMA Investment	BMA Total	Payment to Contractors	Total	Dep-reci-ation Base
1991	5,100	4,488 (88%)	612 (12%)	300	352	46	398	67	465	548
1992	5,500	4,730 (86%)	770 (14%)	300	370	19	389	84	473	586
1993	5,800	4,872 (84%)	928 (16%)	300	385	344	729	102	831	627
1994	6,200	5,084 (82%)	1,116 (18%)	300	402	18	420	122	542	666
1995	6,600	5,280 (80%)	1,320 (20%)	300	419	340	759	145	904	714
1996	7,000	5,460 (78%)	1,540 (22%)	315	440	38	478	177	655	772
1997	7,400	5,624 (76%)	1,776 (24%)	315	468	394	862	204	1066	843
1998	7,800	5,772 (74%)	2,028 (26%)	315	488	77	565	233	798	897
1999	8,300	5,976 (72%)	2,324 (28%)	315	514	49	563	267	830	963
2000	8,700	6,090 (70%)	2,610 (30%)	315	533	381	914	300	1,214	1,018
Total	68,400	53,376 (78%)	15,204 (22%)	-	4,371	1,706	6,077	1,701	7,778	7,634
Percent					55%	22%	77%	23%	100%	

O/M: Operation and Maintenance

Table 10-7 Estimated Cots of Treatment and Disposal (1991 -2000)

Unit: Million Baht in 1990 price

	INVESTMENT										OPERATION/MAINTENANCE						PAYMENTS TO CONTRACTORS				GRAND TOTAL
	LAND PURCHASE			CONSTRUCTION						TOTAL											
	SITE 1	SITE 2	TOTAL	SITE 1	SITE 2	C/P	I/P	H.I/P	TOTAL		SITE 1	SITE 2	C/P	I/P	H.I/P	TOTAL	T.R.	O.N.	N.K.	TOTAL	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1991	95	0	95	0	0	100		8	108	203	0	0	120	0	0	120	0	0	88	88	411
1992	0	0	0	178	0	270		32	480	480	0	0	121	0	0	121	110	219	252	581	1,182
1993	0	0	0	178	0	0	490		668	668	0	0	121	1	4	126	120	241	181	542	1,336
1994	0	392	392	0	0	0	490		490	882	20	0	116	1	4	141	128	263	197	588	1,611
1995	0	0	0	0	275	0	229		504	504	27	0	114	4	5	150	135	285	219	639	1,293
1996	0	0	0	0	275	0	0		275	275	37	0	113	25	5	180	146	307	241	694	1,149
1997	0	0	0	0	0	0	0		0	0	39	47	110	26	6	228	75	110	219	404	632
1998	0	0	0	0	0	0	280		280	280	42	47	110	32	7	238	75	110	252	437	955
1999	0	0	0	0	0	0	280		280	280	45	55	108	67	6	281	97	148	283	528	1,089
2000	0	280	280	0	0	0	73		73	353	0	56	112	63	6	237	97	148	339	584	1,174
Total	95	672	767	356	550	370	1,842	40	3,122	3,925	210	205	1,145	219	43	1,822	983	1,831	2,271	5,085	10,832
Percent										36 %						17 %				47 %	100 %

Abbreviations:
C/P: Compost Plant
I/P: Incineration Plant,
H.I/P: Hospital Incineration Plant
T.R.: Tha Rang
O.N.: On Nut
N.K.: Nong Khaem
Site 1: The Borrow Pit in Ram Intra
Site 2: A Place in East Part of Bangkok

SWM Costs Composition 2 -- Investment Cost vs Operation/Maintenance Cost

Total costs of investment, operation/maintenance, payments to contractors and administration required for 1991 - 2000 are estimated as follows:

	Million Baht	
1. Investment	5,631	(30.0 %)
2. Operation/Maintenance	6,193	(33.0 %)
3. Payments to contractors	6,786	(36.1 %)
4. Administration	171	(0.9 %)
5. Total	18,781	(100.0 %)

Cost details of the respective components are shown in Fig. 10-3 and Table 10-8.

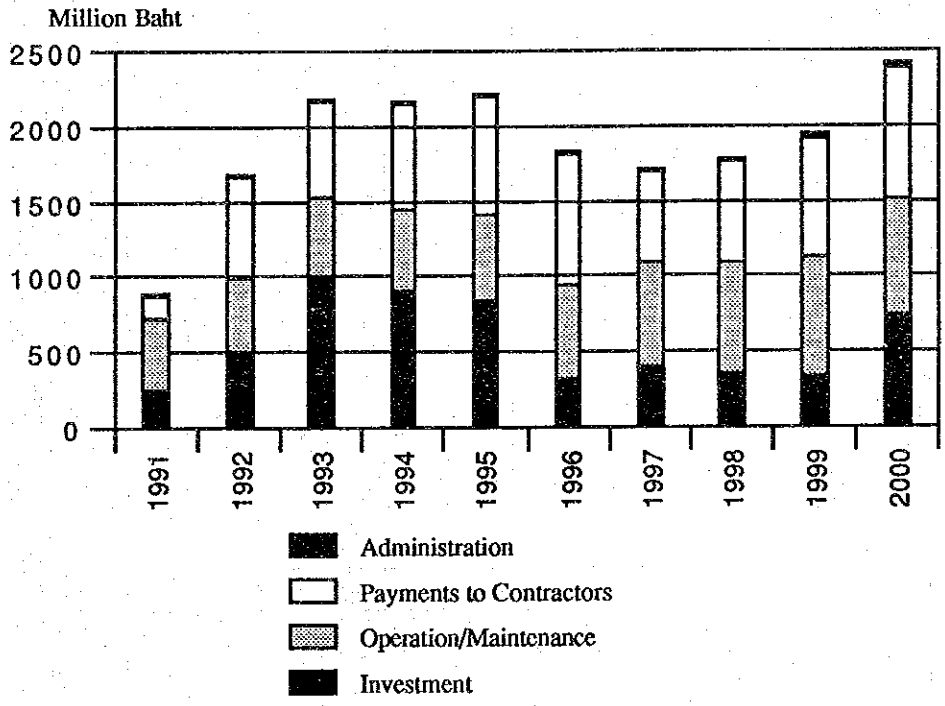


Fig. 10-3 Estimated Cash Expenditures Required for Solid Waste Management (1991 - 2000)

Table 10-8 Estimated Costs Required for Solid Waste Management (1991 - 2000)

Unit: Million Baht in 1990 Price

YEAR	INVESTMENT			OPERATION/MAINTENANCE			PAYMENTS TO CONTRACTOR			ADMINISTRATION	GRAND TOTAL
	T&D	C&H	TOTAL	T&D	C&H	TOTAL	T&D	C&H	TOTAL		
1991	203 (0)	46 (129)	249 (129)	120	352	472	88	67	155	15	891 (771)
1992	480 (0)	19 (132)	499 (132)	121	370	491	581	84	665	15	1,670 (1,303)
1993	668 (27)	344 (140)	1,012 (167)	126	385	511	542	102	644	16	2,183 (1,338)
1994	882 (51)	18 (142)	900 (193)	141	402	543	588	122	710	16	2,169 (1,462)
1995	504 (51)	340 (150)	844 (201)	150	419	569	639	145	784	17	2,214 (1,571)
1996	275 (132)	38 (155)	313 (287)	180	440	620	694	177	871	17	1,821 (1,795)
1997	0 (164)	394 (171)	394 (335)	228	468	696	404	204	608	18	1,716 (1,657)
1998	280 (164)	77 (176)	357 (340)	238	488	726	437	233	670	18	1,771 (1,754)
1999	280 (164)	49 (182)	329 (346)	281	514	795	528	267	795	19	1,938 (1,955)
2000	353 (164)	381 (185)	734 (349)	237	533	770	584	300	884	20	2,408 (2,023)
Total	3,925 (917)	1,706 (1,562)	5,631 (2,479)	1,822	4,371	6,193	5,085	1,701	6,786	171	18,781 (15,629)
Percent			30.0% (15.9%)			33.0% (39.7%)			36.1% (43.4%)	0.9% (1.1%)	100% (100%)

T&D: Treatment and Disposal, C&H: Collection and Haulage

Note: Figures in parentheses indicate costs estimated using depreciation costs assuming depreciation period is 15 years. The land purchase is not depreciated.

Conclusion

1. Unavoidable SWM Cost Increase and Necessity for Increases in Collection/Haulage Efficiency and Fee Revenues

Solid waste management during the next 10 years will require much higher cost than in the past both in terms of amounts and ratio to the BMA's revenues. An estimated cumulative SWM cost (cash expenditure) during the master plan period 1991-2000 without the incineration is 13.1% of a cumulative BMA's revenue during the same period, which is 1.8% higher than 11.3%, the corresponding percentage of the past years 1985-1990.

Like many other cities however, such a high increase in cash expenditures for waste disposal will be unavoidable because of the situation where 1) waste amount will increase, 2) disposal sites will be farther, 3) sanitary landfill has to be implemented, and 4) all the old waste will have to be removed to distant places.

In view of these situations, increases in collection and haulage efficiency as well as increases in fee revenues for waste collection services will be important issues.

2. Implementation of Incineration Project

The implementation of the planned incineration project will require additional 2,061 million Baht for its construction and operation up to 2000, causing the said share to increase to 14.7% from 13.1%. An 1.6 % increase in the said share is not small, and required an extraordinary financial arrangements. However, it is advisable for the BMA to make such arrangement in view of the significance of the incineration project as explained earlier.

There are the following options and their combinations to finance the project.

1. Use of BMA's own budget by placing an higher priority to SWM than before.
2. Increase of the fee revenue for waste collection service by raising the fee rates and number of the fee payers.
3. Acquisition of subsidies from the government.
4. Acquisition of a soft loan from an international lending authority (Refer to a financial case study shown in Volume 3 Part II Section 10.3)

It is strongly advised that the BMA will actively examine all the above shown avenues for the realization of the project.

It would be more appropriate to consider the issue of incineration as a matter of timing instead of a matter of "IMPLEMENT" or "NOT IMPLEMENT", in view of an increasing necessity for the incineration system in the future.

3. Priority Ranking

It is advisable that BMA will implement all the projects proposed in the Master Plan. However, if BMA will not have funds enough to implement all the projects, BMA will have to delay the implementation of some projects. The proposed priority ranking of the projects are as follows:

1) Implementation of sanitary landfill in Ram Intra
2) Use of contractors for hauling both old and fresh waste, and disposing it by means of sanitary landfill.
3) Construction of the incineration plant (600 tons/day)

Chapter 11. Recommendations

This chapter lists the recommendations, most of which are contained in the Master Plan (Chapters 7, 8, 9 and 10).

1. Acquisition of the BMA's Own Disposal Sites

a. The acquisition of the BMA's own disposal sites is important and an urgent issue for BMA in view of the following:

1) The remaining capacity of the existing sites is small; one or two years at maximum.
2) It is not advisable for the BMA to depend entirely on disposal contractors.

b. A major constraint on the land acquisition is the existing Government regulation which, in principle, prevents local authorities from purchasing land at prices higher than the government-regulated-prices (standard prices). The BMA should continue to negotiate with the Government to find ways in which the BMA can purchase land for waste disposal.

c. Considering locational advantage, the BMA should obtain disposal sites both in the east and west parts of Bangkok though it may be difficult to obtain disposal land in the west part of Bangkok.

2. Construction of Transfer Stations in the Core and Urban Districts

It is strongly recommended that the BMA should construct a few transfer stations of small or medium sizes in core and urban districts in view of the following:

1) Transfer stations will contribute to the reduction of waste haulage costs that will increase as a result of the future situation where final disposal sites will be farther away from the core and urban districts.
2) Transfer station sites can possibly be used as sites for incinerators that may be needed in the future. It should be noted land acquisition will be more difficult in the future.

3. Systematic Use of Borrow Pits as Sanitary Landfill Sites

The use of the borrow pits will bring about two kinds of benefits:

1) Waste disposal benefit
2) Creation of useful flat land from less useful pits made as a result of soil-digging. (The created land can be used as a public park.)

In the case of the borrow pit in Ram Intra, it is expected that the land value will increase at least 3 times by properly filling the pit with waste. It is important, however, to take adequate measures to protect the surrounding environment; especially, provision of the lining (to be placed on the bottom of pits) and leachate treatment.

4. Use of Reliable Disposal Contractors and Close Monitoring and Supervision of the Contractors

The BMA intends to extensively use contractors for hauling both the old waste and fresh waste, and for disposing of waste at remote places. The BMA is advised to:

1) Select reliable contractors judging from their experience, qualification as well as financial and managerial capacity.
2) Prepare the adequate specifications of sanitary landfill, and include them in the contract conditions.
3) Make it a contractual requirement for contractors to make an environmental assessment of a proposed site, and to submit an assessment report to the BMA. Such report should include some arrangements that must be made for neighboring residents and local authority of the area where there is a proposed site if the site is located outside the BMA area
4) Monitor and supervise closely contractor's performance

5. Selection of a Reliable and Cost-Effective Incinerator

Because the incineration system is very costly, it is important for the BMA to choose a reliable and cost-effective one. An incinerator equipped with a power generation system is not advisable due to at present the low calorific value of waste in Bangkok.

6. Remodeling of the Incinerator attached to the Existing Compost Plant at On Nut

In the case the BMA is unable to construct the proposed incineration plant (600 tons/day) due to financial constraints, but can afford to construct a smaller incineration plant, it may be advisable for the BMA to construct a smaller model incinerator (with capacity of about 100 tons/day for example). Such incinerator will help BMA/DPC to acquire experience and know-how that would be required when operating incineration plants of much larger scale in the future.

In the case the BMA will construct a smaller incinerator as explained above, it will have to execute a feasibility study, and prepare new specifications and design for the incinerator. It should be noted that the specifications and design prepared for the incineration plant of 600 tons/day (200 tons/day x 3 units) by the JICA Study Team cannot be applied to a smaller incineration plant.

7. More Thorough Application of Beneficiary Pay Principle with Respect to Waste Collection Fees

1) BMA should collect more fees through raising the fee rates and increasing number of the fee payers based upon the BPP because the future SWM costs will further increase due to higher costs for waste collection, haulage, treatment and disposal.

2) BMA, firstly, should raise fee rates for the business waste collection service to the same level as those for household waste collection which is 5 times higher the fee rates for the business waste collection service. Then, the BMA should apply the maximum fee rates stipulated in the 1985 regulation.

3) It is advisable for the BMA to consider the possibility for the shift of the responsibility for the business waste collection service from the BMA to the waste dischargers themselves. It is also advisable that the BMA will apply such shift only to dischargers of large waste amounts in the initial stage, then increase the number of dischargers to which the shift is applied.

8. Improvement on the Maintenance of Collection Vehicles

It is recommended that the BMA will:

1) Strengthen monthly maintenance system by using
   a. Remote workshops,
   b. Mobile workshop Units, and
   c. Mechanics of the districts

2) Enforce all the drivers to do practice daily maintenance check.

3) Reorganize the Central Workshop or privatize it in order to increase its efficiency.

9. Cost Control of the New Compost Plant

The DPC has spent over 100 million Baht every year for the operation and maintenance of the existing compost plants which brought about much smaller benefits.

It is strongly recommended that the BMA should execute a through control over the costs for operation/maintenance of the new plant in comparison to benefits.

10. Solid Waste Management with Long Term Views and Planning

It is recommended that BMA/DPC will plan strategic facilities such as sanitary landfill sites, transfer stations and incinerators from long term viewpoints. Land acquisition and facility construction should be planned giving due consideration to the the future benefits arising from these facilities and socio-economic conditions of Bangkok.

11. Future Options Regarding Solid Waste Management

The current Master Plan covers the period until 2000. It is advisable that the BMA/DPC would examine the following options which may be applied after 2000.

1) Waste haulage to and disposal at remote places by using railway or other means

2) Waste recycling facilities
3) Separate collection of waste
4) Shift of responsibility for waste management from the BMA to generators of large waste amounts

In any case, however, a future solid waste management plan after 2000 will have to be prepared based upon the results of the implementation of the current Master Plan.

Appendices

Appendix 1. The Scope of Work for the Study on Bangkok Solid Waste Management in the Kingdom of Thailand and the Meeting Minutes

SCOPE OF WORK
FOR
THE STUDY
ON
BANGKOK SOLID WASTE MANAGEMENT
IN
THE KINGDOM OF THAILAND

AGREED UPON BETWEEN
JAPAN INTERNATIONAL COOPERATION AGENCY
AND
BANGKOK METROPOLITAN ADMINISTRATION

BANGKOK, AUGUST 22, 1989

Wicha Kiwalai

Dr. Wicha JIWALAI
DEPUTY GOVERNOR
BANGKOK METROPOLITAN
ADMINISTRATION

Masaru Tanaka

Dr. Masaru TANAKA
LEADER OF PRELIMINARY SURVEY TEAM
JAPAN INTERNATIONAL COOPERATION
AGENCY

I. INTRODUCTION

In response to the request of the Government of the Kingdom of Thailand, the Government of Japan decided to implement the Study on Bangkok Solid Waste Management (hereinafter referred to as "the Study"), within the general framework of technical cooperation between Japan and Thailand, which is set forth in the Agreement on Technical Cooperation between the Government of Japan and the Government of the Kingdom of Thailand, signed on November 5, 1981.

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as "JICA"), the official agency responsible for the implementation of the technical cooperation programme of the Government of Japan, will undertake the Study, in accordance with the relevant laws and regulations in force in Japan, in close cooperation with the authorities of Thailand.

The Department of Public Cleansing of Bangkok Metropolitan Administration (hereinafter referred to as "DPC") shall act as counterpart agency to the Japanese Study Team (hereinafter referred to as "the Team"), and also as a coordinating body in relation with other relevant organizations for the smooth implementation of the Study.

The present document sets forth the Scope of Work for the Study.

II. OBJECTIVE OF THE STUDY

To prepare the up-dated solid waste management plan for Bangkok Metropolitan Administration to suit the actual socio-economic condition.

III. STUDY AREA

The Study covers the area under the jurisdiction of Bangkok Metropolitan Administration.

IV. SCOPE OF THE STUDY

The Study will deal with municipal solid wastes in the Study Area and will be carried out in two (2) successive stages.

(1) Master Plan Study Stage

(2) Feasibility Study Stage

And each of them will be conducted with field surveys in Thailand and analysis works both in Thailand and in Japan. The Master Plan Study will cover the period from 1990 to 2000.

(I) Master Plan Study Stage

1. Analysis of the present conditions

1-1 Collection of data and existing documents

1-2 Comprehension of the present Solid Waste Management system and identification of problems

1-3 Review of the Bangkok Solid Waste Management Study

2. Presumption of solid waste generation and composition

3. Confirmation of the planning framework

   3-1 Determination of basic criteria for the design of the plan

   3-2 Determination of the future system components based on the comparative analysis of alternatives

4. Formulation of the Master Plan

   4-1 Solid waste generation and discharge control plan

   4-2 Collection and transportation plan

   4-3 Processing and final disposal plan

   4-4 Organization and management plan

   4-5 Financial Plan

(II) Feasibility Study Stage

1. Confirmation of the planning framework

   1-1 Target year

   1-2 Planning area

   1-3 Service level

   1-4 System components

2. Examination of combinations of the system components

   2-1 Preparation of system component alternatives

   2-2 Comparative study for the selection of the best combination

3. Preliminary design of facilities

   3-1 Transfer stations

   3-2 Disposal sites

4. Examination of material and equipment
5. Cost estimation
6. Consideration of institution and organization
7. Project evaluation
   7-1 Economic evaluation
   7-2 Financial evaluation
   7-3 Social and environmental evaluation
8. Project implementation plan
   8-1 Implementation schedule
   8-2 Financial plan

V. SCHEDULE OF THE STUDY

The Study will be executed in accordance with the tentative working schedule. (See ANNEX)

VI. REPORTS

JICA will prepare and submit the following reports in English to the Government of the Kingdom of Thailand.

1. Inception Report :
   Twenty (20) copies at the commencement of the field survey in Thailand.

2. Progress Report :

   Twenty (20) copies within four (4) months after the commencement of the Study.

3. Interim Report :

   Twenty (20) copies within seven (7) months after the commencement of the Study.

4. Draft Final Report :

   Twenty (20) copies within twelve (12) months after the commencement of the Study.

   The Government of the Kingdom of Thailand will provide JICA with its comments within one (1) month after its reception of the Draft Final Report.

5. Final Report :

   Fifty (50) copies within two (2) months after JICA's reception of the said comments on the Draft Final Report.

VII. UNDERTAKINGS OF THE GOVERNMENT OF THE KINGDOM OF THAILAND

1. In accordance with the Agreement on Technical Cooperation between the Government of Japan and the Government of the Kingdom of Thailand dated 5 November 1981, the Government of the Kingdom of Thailand shall accord benefits to the Team as follows:

   (1) To permit the members of the Team to enter, leave and sojourn in Thailand for the duration of their assignment therein, and exempt them from alien registration requirements and consular fees.

(2) To exempt the members of the Team from taxes, duties, and any other charges on equipment, machinery and other materials brought into Thailand for the conduct of the Study.

(3) To exempt the members of the Team from income taxes and charges of any kind imposed on or in connection with any emolument or allowance paid to the members of the Team for their services in connection with the implementation of the Study.

(4) To bear claims, if any arises against the members of the Team resulting from, occurring in the course of, or otherwise connected with the discharge of their duties in the implementation of the Study, except when such claims arise from gross negligence or willful misconduct on the part of the members of the Team.

2. To facilitate smooth conduct of the Study, DPC shall take necessary measures in cooperation with other relevant organizations :

(1) To secure permission for entry into private properties or restricted areas for the conduct of Study.

(2) To secure permission for the Team to take all data and documents related to the Study out of Thailand to Japan.

(3) To provide medical services as needed. Its expenses will be chargeable on the members of the Team.

(4) To ensure the safety of the member of the Team when and as it is required in the course of the Study.

3. DPC shall, at its own expense, provide the Team with the followings in cooperation with other relevant organizations concerned :

(1) Available data and information related to the Study.

(2) Counterpart personnel.

(3) Suitable office space with necessary equipment in Bangkok.

(4) Credentials or identification cards.

VIII. UNDERTAKING OF JICA

For the implementation of the Study, JICA shall take following measures :

1. To dispatch, at its own expense, the Team to Thailand.
2. To pursue technology transfer to the Thai counterpart personnel in the course of the Study.

IX. CONSULTATION

JICA and DPC will consult each other in respect of any matter that may arise from or in connection with the Study.

TENTATIVE SCHEDULE

MONTH / DESCRIPTION	1	2	3	4	5	6	7	8	9	10	11	12	13
WORK IN THAILAND		═══	═══	═══			═══	═══	═══			═══	
WORK IN JAPAN	═══				═══	═══				═══	═══		
REPORT		△ IC/R			△ P/R		△ IT/R					△ DF/R	◎ △ F/R

NOTE * IC/R : Inception Report　　P/R : Progress Report　　IT/R : Interim Report

DF/R : Draft Final Report　　◎ : Comments　　F/R : Final Report

MINUTES OF MEETINGS OF THE SCOPE OF WORK

FOR

THE STUDY ON BANGKOK SOLID WASTE MANAGEMENT

Bangkok, August 22, 1989

Wicha Jiwalai

Dr. Wicha JIWALAI
Deputy Governor
Bangkok Metropolitan Administration

Masaru Tanaka

Dr. Masaru TANAKA
Leader of Preliminary Survey Team,
Japan International Cooperation
Agency

At the request of the Government of the Kingdom of Thailand, the Preliminary Survey Team (the Team) of the Japan International Cooperation Agency (JICA) visited Thailand from August 15 to 23, 1989, to discuss the Scope of Work for the Study on Bangkok Solid Waste Management (the Study).

The Team carried out field surveys of the study area and had a series of discussions with officials concerned of Bangkok Metropolitan Administration(BMA).

The meetings were held on August 17 and 21, 1989, at the conference room of Department of Public Cleansing (DPC). A list of those who attendedis shown in the attached sheet. The draft Scope of Work proposed by the Teamwas discussed in detail between the Team and BMA. Both sides agreed to adoptthe Scope of Work with the following understandings:

1. The future landfill site to be identified by BMA for the Feasibility Study shall be included in the Study Area together with its environs even though the site may be located outside of BMA jurisdiction.
2. The identification of the future landfill site should be completed by BMA by the time of submission of the progress report.
3. The municipal solid waste is the waste which the Department of Public Cleansing of BMA is responsible to manage. They may include household waste, commercial waste, hospital waste, canal waste and a part of industrial waste. Toxic and hazardous waste shall not be included for the Study. To carry out the Study with the limited resources, the priority among these wastes shall be discussed and decided at the time of the Inception Report consultation.
4. The candidate sites for the construction of transfer stations stated in Ⅳ (Ⅱ) 3-1 in the Scope of Work, are the existing dumping sites shown below

    1. ON NUT
    2. RAM INTRA
    3. NONG KHAEM

5. The disposal site stated in Ⅳ (Ⅱ) 3-2 in the Scope of Work, means the new site mentioned in the item 1 and 2 of these minutes and the existing sites in ON NUT and NONG KHAEM. As for the existing sites, the preliminary design shall be carried out for the closure of the open dumping sites and rehabilitation or reconstruction of composting plants and incinerators attached.
6. Serious efforts shall be made by JICA Study Team to assess the environmental impact to be caused by waste management facilities. Environmental evaluation stated in Ⅳ (Ⅱ) 7-3 in the Scope of Work will be carried out to cover the technical aspects required by the National Environmental Quality Act and its regulations as much as possible.
7. BMA will provide one car with a driver to JICA Study Team.
8. To pursue technology transfer as stated in Ⅷ.2 in the Scope of Work, BMA requested JICA to hold a seminar in conjunction with the submission of Draft Final Report.
9. BMA shall organize a steering committee by inviting all the relevant departments of BMA to facilitate the conduct of the Study as well as the implementation of Study's recommendations.
10. BMA also requested JICA the dispatch of an expert to facilitate the coordination between BMA and JICA Study Team not only in the conduct of the Study but also in the implementation of the Study's recommendations. The Team recommended BMA to submit the request through DTEC.

LIST OF THE ATTENDANTS

Japanese Side

Dr. Masaru	TANAKA	Leader of the Team
Dr. Kunitoshi	SAKURAI	Member of the Team
Mr. Kazuhiko	TODA	〃
Mr. Shigeo	KUREBAYASHI	〃
Mr. Seigo	MATSUMOTO	〃
Mr. Hideo	MIYAMOTO	JICA Thailand Office

Thai Side

Dr. Wicha	Jiwalai	Deputy Governor, BMA
Mr. Damri	Ratanawong	Director General of DPC
Mr. Boonchern	Suttapreyasri	Department Deputy Director General
Mrs. Prathuang	Thavisin	Department Deputy Director General
Mr. Somchitt	Trivichien	Director of Technical Division
Mr. Chalee	Thiramanus	Director of Public Cleansing Service Division
Mr. Nakorn	Sakornsinthu	Director of Garbage Disposal Division
Miss Parichat	Sanghiran	Acting Chief, Foreign Relations Section, BMA
Miss Pattamaporn	Saithongkhan	Foreign Relations Officer, BMA
Mr. Gecha	Chaechai	Program Officer, Japan Sub-division, DTEC
Miss Sarinporn	Leemaharoungrueng	Chief of Survey and Research Section Technical Division, DPC
Miss Chantana	Nivatapan	Planning and Project Section Technical Division, DPC
Miss Wullaya	Wattamasiritamawong	Planning and Project Section Technical Division, DPC

Appendix 2. The Study Organization and Members Involved

Appendix 2. The Study Organization and Members Involved

The Study organization is as shown below.

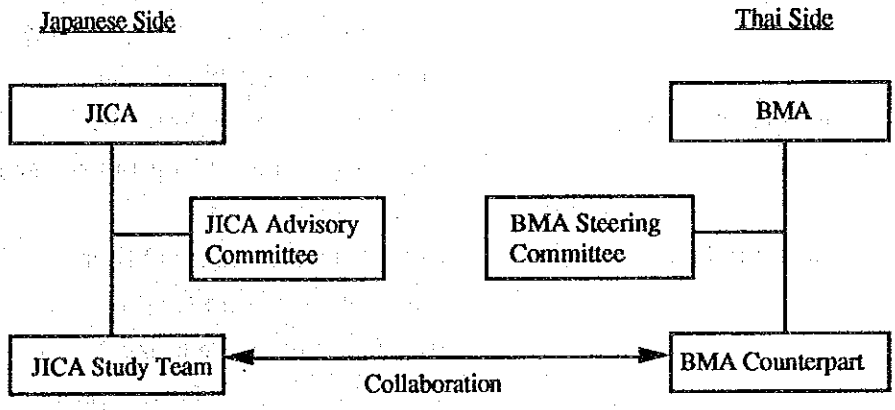


Fig. The Study Organization

Members involved in the Study are as follows:

1. Steering Committee Members

Ms. Pratuang Thaveesin	Director General of DPC, Chairman
Mr. Kanchai Nopakaew	Deputy Director General of DPC
Mr. Somchitt Trivichien	Director of Technical Division
Mr. Anati Sittipunt	Director of Garbage Disposal Division
Mr. Chalee Tiramanat	Director of Public Cleansing Service Division
Mr. Watana Luanratana	Chief of Nong Khaem Solid Waste Disposal Plant
Mr. Akedeck Haumsetthee	Chief of On Nut Solid Waste Disposal Plant
Mr. Phronarong Reablertron	Public Cleansing Service Division
Late Mr. Boonchern Suttapreyasri	Deputy Director of DPC

2. JICA Advisory Committee Members

Professor Dr. Sachiho Naito	President, Kanto Gakuin University Chairman of the Committee
Dr. Masaru Tanaka	Chief of Solid Waste Engineering Section Department of Sanitary Engineering The Institute of Public Health
Dr. Kunitoshi Sakurai	Senior Development Specialist Japan International Cooperation Agency (JICA)
Dr. Kazuo Fukui	Acting Chief Executive Officer (Technology Development) Bureau of Public Cleansing Tokyo Metropolitan Government
Mr. Minoru Sawachi	Assistant Manager Management Department, Facility Division Public Cleansing Bureau Osaka City Government

3. Counterparts

Mr. Thanoo Pholpunthin	Technical Division, DPC
Mr. Vitoonpan Vanachamrat	Technical Division, DPC
Mr. Manit Decrouthai	Garbage Disposal Division, DPC
Ms. Ratanaporn Kerdpakee	Technical Division, DPC
Ms. Vullaya Wattanasiritanawang	Technical Division, DPC
Mr. Paitool Sukpaibool	Technical Division, DPC
Mr. Suvit Suksin	Technical Division, DPC
Ms. Sompak Vudthithornnatirak	Technical Division, DPC

4. JICA Study Team Members

Mr. Kyoich Miyazaki	Team Leader
Mr. Kiichiro Sakaguchi	Economist
Mr. Masato Ohno	Waste Collection Planner
Mr. Toru Naito	Waste Collection Surveyor
Mr. Shinichi Suzuki	Waste Collection Surveyor

Mr. Shunsuke Aoyama	Intermediate Treatment Planner
Mr. Masao Takenaga	Equipment Maintenance Expert
Mr. Takashi Goto	Final Disposal Planner
Mr. Akinori Sato	Sanitation & Environment Expert
Mr. Atsushi Saito	Organization & Institution Analyst
Mr. Fuminori Tsurunaga	Facility Designer
Mr. Hideo Hattori	Incineration Expert

Appendix 3. Major Assumptions Used for the Cost Estimation of Disposal System Options shown in Chapter 8

Appendix 3. Major Assumptions Used for the Cost Estimation of Disposal System Options shown in Chapter 8

1. The costs of the sanitary landfill (as shown in Options 2 & 3) were estimated based upon the sanitary landfill (using a flat land in the east part of Bangkok) of which details are shown in Section 8.3.

2. The Costs of the incinerator (as shown in Option 6) were estimated based upon the incinerator (200 tons/day/unit x 3 units) of which details are shown in Section 8.4.

3. The costs of the seashore landfill (Option 4) were estimated based upon the study shown in Chapter 13 of Volume 4 Supporting Report. The costs breakdown is as shown below:

Table A3-1 Estimated Costs of the Seashore Landfill in Bang Khun Thian

1) Construction	
a. Civil and building works	194 B/t
b. Leachate treatment	45 B/t
2) Land Purchase	0 B/t
3) Operation/Maintenance	
a. Site operation	30 B/t
b. Leachate treatment	78 B/t
Total	347 B/t

4. The costs of the transfer stations (as shown in Option 3) and the compaction and binding system (as shown in Option 5) were estimated based upon the specifications shown in Tables A3-2 and A3-3. The costs breakdown is shown in Table A3-4.

Table A3-2 Specifications of the Transfer Station

- Capacity:	500 t/d
- Land required:	2 ha
- Type:	Push & fall
- Weigh bridge:	1 unit (40t)
- Reception yard	900 m2
- Guide hopper:	1 unit
- Housing:	with roofing
- Stock pit:	30 m2
- Trailer Dump:	6 units
- Capacity/volume:	20 t/40 m3
- Trip:	5 times/d
- Utilities required	
- Electricity:	60 kwh/d x 365 d/y = 21,900 kwh/y
- Fuel	230,000 Baht/year
- Douzer:	3 units (15 t/unit, 4 million Baht/unit)

Table A3-3 Specifications of the Compaction and Binding System

- Capacity:	300 t/d
	100 t/d x 3 line
- Weight/Volume (in):	0.3 t/m^3
- Weight/Volume (out):	0.9 t/m^3
- Reduction ratio	1/3
- Operation hours:	18 h/d
- Binding material:	Net wire
- Utilities required:	
- Electricity:	50 kw x 18 h/d x 365 d/y = 3,285,000 kwh/year
- Water:	10 m^3/d x 365 d/y = 3,650 m^3/y
- Lubricant	400,000 Baht/year

Table A3-4 Estimated Costs and Manpower Required for the Transfer Stations and Compaction and Binding System

Unite: Million Baht unless indicated otherwise

	Transfer Stations (500 t/d)	Compaction & Binding (100 t/d x 3 units = 300 t/d)
1. Construction & Land Purchase	72	216
- Mechanical works		130
- Electrical works	17	20
- Civil & building works	6	9
- Others	2	10
- Land purchase	47	47
2. Operation & Maintenance	133	323
- Repair (Overhaul)	23	166
- Utilities & maintenance	59	126
- Emolument	51	31
3. Total (1 = 2)	205	539
4. Physical, Price & Exchange Rates Contingency (7% of Item 3)	14	38
5. Grand Total (3 + 4)	219	577
Unit cost (Baht/ton)	50	394
a. Plant duration	25 years	15 years
b. Required Personnel	(Persons)	
- Qualified	2 persons	12 persons
- Skilled	8 persons	36 persons
- Worker	8 persons	36 persons
- Clerk	2 persons	6 persons
Total	20 persons	90 persons
c. Required land	1.5 ha	1.5 ha

5. Costs of emolument and utilities were estimated using the assumptions shown in Table A3-5.

Table A3-5 Assumptions on the Rates of Emoluments and Utility Costs

1) Emolument (including all the benefits, allowance & social securities)

a. Qualified: 180,000 Baht/year

b. Skilled: 120,000 Baht/year

c. Worker: 60,000 Baht/year

d. Clerk: 120,000 Baht/year

2) Utilities

e. Electricity: 2.33 Baht/kwh

f. Water: 4.00 Baht/m^3

g. Diesel oil: 6.40 Baht/litter

Appendix 4. Technical Guidelines for the Construction and Operation of the Sanitary Landfill

Appendix 4. Technical Guidelines for the Construction and Operation of the Sanitary Landfill

Technical guidelines aim at standardizing the sanitary landfill method with keeping adequate sanitary condition for both the BMA and the private contractor, and at being easy to supervise and manage the sanitary landfill works. Anyone who wants to undertake the sanitary landfill must follow the technical guidelines.

The guidelines comprise of the following four components:

1. Technical guidelines regarding location of the sanitary landfill site,
2. Technical guidelines regarding structure of the sanitary landfill site,
3. Technical guidelines regarding operation and maintenance of the sanitary landfill, and
4. Technical guidelines regarding environmental survey for the sanitary landfill site.

This guideline also contains application forms to be filled by tenderers who wish to submit disposal proposals. Those forms may be useful for the BMA as they would ease the evaluation of proposals.

1. Technical Guidelines Regarding Location of the Sanitary Landfill Site

1.1 Suitable and Unsuitable Places for Sanitary Landfill

1.1.1 Suitable Places

The sanitary landfill site should be located in:

1) the area where it will not affect the daily life of neighbor residents by contaminating public water basins such as rivers, canals, lakes and groundwater,
2) the area where it will not affect the living environment of nearby area by creating air pollution, noise, vibration and odor,
3) the area where it will not cause landslides,
4) the area where it will not affect public water supply sources, and
5) the area where it will not affect public facilities such as road and canal.

1.1.2 Unsuitable Places

1) Sanitary landfill sites should be located more than 50m away from the property lines of premises such as residences and stores.
2) The sanitary landfill site should not be located in future housing development areas and the areas within 50m from there.
3) The sanitary landfill site should be located at least 50m away from rivers, sea, or lakes.
4) The sanitary landfill site should not include the areas of environment preservation, disaster prevention and historical interests.
5) The distance from the existing final disposal site should be more than 1.0km.

1.2 Procedures Regarding the Location of Sanitary Landfill

1.2.1 Land Owner's Agreement to be Obtained (in the case of land lease)

The right of using land for a final disposal site and the land owner's agreement concerning the conditions and other necessary matters such as types of solid waste to be filled, method of landfill and re-use of land should be obtained.

1.2.2 Agreement of Land Owners who have a land around the Site

An agreement should be obtained from the lands' owners who have a land around the site as to the types of solid waste to be filled and the filling method.

1.2.3 Agreement of neighbor Residents

An agreement should be obtained from neighbor residents as to the location of the final disposal site, the types of solid waste to be filled, and the filling method.

1.2.4 Pollution Prevention Agreement with the Heads of Related Local Authorities

If the neighbor residents or the heads of concerned local authorities request to submit a pollution prevention agreement, the responsible body for the final disposal site should accept it.

1.2.5 Covenant and Joint Liabilities for Closure the Final Disposal Site

The responsible body for the final disposal should enter into a covenant with neighbor residents for taking positive and necessary measures to close the final disposal site. If the final disposal site is located on leased land, the land owner should be jointly responsible and liable for it.

1.2.6 Assurance after Closing the Final Disposal Site

The responsible agency and the land owner (if the disposal site is located on leased land) should jointly/severally pledge and assure taking the necessary measures (including compensation or reparation) against all complaints pertaining to the closure of the final disposal site.

2. Technical Guidelines Regarding Structure of the sanitary Landfill

2.1 Major Structures

2.1.1 Retaining Walls and Embankments

Retaining walls and embankments are structured for preventing filled waste materials from flowing out the sanitary landfill site. They must meet the following requirements:

1) Structural safety against their own weights, earth pressure, hydraulic pressure, wave forces, and seismic forces
2) Appropriate anti-errosion measures to be taken considering the types of solid waste to be filled, the quality of surface and groundwater, and the characteristics of the soil
3) Appropriated measures to avoid the pollution of water basins and groundwater waste leachate

2.1.2 Waterproofing (lining) Work

Except for the entrance part and leachate treatment facility area, the sanitary landfill shall be provided with waterproofing work to prevent the leakage of water contained in the disposed materials and rainwater.

2.1.3 Leachate Collection Facility

Strong and durable pipes and related equipment shall be installed to effectively collect leachate.

2.1.4 Leachate Treatment Facility

Leachate treatment Facility shall be installed to treat the collected leachate before discharging it into a public drainage system in order to meet relevant waste water standards.

2.1.5 Rainwater Drainage Facility

Drainage facility shall be constructed around the sanitary landfill site to prevent rainwater from flowing into the site.

2.2 Other Facilities

2.2.1 Monitoring Equipment

In order to monitor groundwater conditions, more than two water quality monitoring wells should be constructed.

1) Well Location
One well should be provided on the downstream side of the groundwater flow. Another well should be provided at an appropriate place.

2) Well Depth
Deep enough to reach into the first aquifer.

3) Well Size
The well diameter shall be 100mm or more. A strainer shall be installed in the first aquifer section.

2.2.2 Gas Releasing Facility

An appropriate gas releasing facility shall be provided, if necessary. The facility structure should be, as a general principle, of a pipe type and it should be attached to the water collection facility in the sanitary landfill site.

2.2.3 Operation Office

It will be necessary to construct an office for operation and management of the sanitary landfill.

2.2.4 Road

Access roads to the sites should have width of 4 m or more. The road should be paved with crushed stone. On-site roads should be at least 3.0m wide (sufficient for vehicle traffic).

2.2.5 Fence

Fence shall be provided around the sanitary landfill site to prevent people from entering the site.

2.2.6 Bulletin Board

A bulletin board should be prepared at the most visible place for the purpose of displaying information such as name of responsible body, landfill operation period, type of incoming waste.

2.3 Others

2.3.1 Prevention of Landslide and Land Subsidence

Landslide or land subsidence prevention facilities shall be provided, if necessary.

2.3.2 Slope Failure Prevention Work

The slope of the original ground cut should be in the range of 1:0.8 to 1:1.2. The slope of the embarkment should be in the range of 1:1.5 to 1:2. The step of both the cut and the embarkment should be less than 5.0m. A horizontal berm with 1.0m or more width shall be made for both the cut and the embankment.

The cut and the embankment work at the other area of the sanitary landfill site should be provided with appropriate slope, if necessary.

2.3.3 Measures for Water Seepage

If water seepage exists, water collection and drainage facilities should be installed under the waterproof sheet (lining).

3. Technical Guidelines regarding Operation and Maintenance of the Sanitary Landfill Facility

3.1 Guidelines for the Operation and Maintenance of Major Facilities

3.1.1 Maintenance of Retaining Walls and Embankments

The retaining walls and embankments (for preventing the filled waste from flowing out) should be inspected at least once a month for a preventive maintenance.

3.1.2 Maintenance of Waterproofing Sheets (lining)

The waterproofing sheets (for preventing leachate from flowing out the sanitary landfill site) should be inspected at least once a month. If any portion of the waterproofing has an unsatisfactory condition, repair work should be made immediately.

3.1.3 Operation and Maintenance of Leachate Treatment Facility

The leachate treatment facility should be operated and maintained as follows:

1) The facility must be properly operated and maintained so that the discharged water should meet relevant drain water quality standards.
2) A water quality test should made at least once a month for the purpose of checking the quality of the discharged water.

3.1.4 Maintenance of Rainwater Drainage Facility

The rainwater drainage facility to prevent rainwater from flowing into the site should be properly maintained. The sludge accumulated at the open ditches (which are provided to prevent rainwater from flowing into the site) should be completely removed in order to maintain the function of the ditches.

3.2 Guidelines for Operation and Maintenance of Other Facilities

3.2.1 Monitoring Equipment

Groundwater quality should be monitored at least once a month. Inspection items include pH, BOD, COD, Suspended Solid (SS), Color, etc.

3.2.2 Gas releasing Facility

A ventilating facility should be inspected at least once a month.

3.2.3 Road

Access roads to the sanitary landfill site should be kept clean and must be repaired, if necessary.

3.2.4 Fence

The fence around the sanitary landfill site should be properly maintained to prevent people from entering the site.

3.2.5 Bulletin Board

Bulletin board should be kept in good condition at all times. The content of notice should be revised as often as necessary.

3.3 Others

3.3.1 Preventing Scattering and Flowing out of the Waste

Necessary precautions must be taken to prevent the waste from scattering and flowing out the sanitary landfill site.

3.3.2 Offense of Odors

Necessary precautions for preventing odors emanating from the sanitary landfill site must be taken.

3.3.3 Fire Prevention

Appropriate fire prevention measures should be provided. The fire fighting equipment must be provided.

3.3.4 Insect and Rodent Prevention

Chemical sprays and the other necessary measures must be provided to prevent infestation by rodents and insects such as files and mosquitoes.

3.3.5 Noise, Vibration and Dust Prevention

Appropriate measures should be taken against noise, vibration and dust which may be caused by waste collection vehicles and landfilling equipments.

3.3.6 Management of Seepage Water

Seepage water should be frequently inspected. When any abnormality is observed on the seepage water, the cause of seepage should be investigated and appropriate measures must be taken to rectify.

3.3.7 Intermediate Soil Covering

A layer of the waste should be less than 2.0m thick. Each layer must be covered by more than 50cm thick layer of covering soil.

3.3.8 Final Covering

After completing the sanitary landfill, surface of the waste must be covered with more than 1.0m of covering Soil.

3.3.9 Measures for the Site Closing

Prior to close the final disposal site, confirmation must be made to verify whether measures have been taken for preventing the scattering and flowing out of the waste, the contamination of public water basins and groundwater with leachate, and spontaneous combustion.

3.3.10 Record Keeping

The records of inspections and tests conducted in connection with operating and maintaining the sanitary landfill should be kept for approximately five years.

4. Technical Guidelines Regarding Environmental Survey for the Sanitary Landfill

4.1 Environmental Assessment (Preliminary)

The topography and land use condition of a planned sanitary landfill site and its surrounding area should be studied to obtain the basic data necessary for assessing the suitability of the site and designing sanitary landfill facilities.

4.1.1 Study Method

The existing data should be basically used. However, a field survey should be conducted if necessary.

4.1.2 Study Items

1) Topography
2) Geology
3) Disaster
4) Weather conditions
5) Fauna and flora
6) Surface water
   (1) Public water basins
   (2) Rainwater and seepage water
7) Public assets
8) Land use conditions
   (1) Urban planning
   (2) Land use
   (3) Roads
   (4) Housing areas
   (5) Existing buildings
   (6) Planned land development areas
9) Water use conditions
   (1) Groundwater
   (2) Surface water
10) Cultural assets and historic remains

11) Restrictions of related regulations

4.2 Environmental Studies with Boring

Water level, geology, and soil conditions of the planned sanitary landfill site and its surrounding area should be studied to obtain the basic data necessary for designing an appropriate sanitary landfill facilities.

4.2.1 Study Method

A Boring test should be conducted to examine the water level, soil conditions, and geological conditions if necessary.

4.2.2 Study Items

1) Groundwater
2) Water qualities
3) Topography, geology and soil conditions

4.2.3 Study of Impacts on Public Water Systems

If there is any discharged water from the sanitary landfill site, the future effects on the water qualities of public water basins should be studied.

4.2.4 Monitoring Plan

A monitoring plan should be established to periodically examine the qualities of the groundwater and the discharge water after the commencement of operation of the sanitary landfill.

Application Form to be Filled by Tenderers (Sheet 1)

PAPERS OF PRESENTATION								
Applicant	Adress							
	Name							
Main items of the company	Capital		No.of members					
	Main business							
The persons in caharge for procedure	Position	Name	TEL.NO.					
Chief engineer								
Master plan	Purposes of construction							
	Type of waste							
	The site structure							
	The site location	detail information is shown as attachment						
	Scale of the site	Site area	Landfill area	Capasity of the site				
	Landfill period							
	Landuse of the old site							

Landfill amount		
	Waste	
	Covering material	
	Total	

Attachment			
	Environmental survey	According to the Standard	Attachment 1
	Location map	Scale=1:25,000	〃 2
	Ditail Location map	Scale=1:25,000	〃 3
	Main drawings of the site	1) Topgraphical map	〃 4
		2) Planimetric drawing	
		3) Profile section	
		4) Cross sections	
		5) Structure drawing	
		6) etc.	
	Land owners and area map	Scale=1:500	〃 5
	Another datas	City planning map	〃 6
		Landuse map	〃 7

Application Form to be Filled by Tenderers (Sheet 2)

Main Items of the site land								Facilities of the site	
		Adress	Landowner	User	Area	Landuse of present	Remark	Net fence	
The site area	1							Sign board	
	2								
	3							Landslide safety work	
	4							Safety distance from neigberland	
	5							Rainfall water drainage ditch	
	6								
	7							Set up a reference point and area points	
	8								
	9							Access road and insite road	
	10							Stock yard for covering material	
Neigber land	1								
	2							Car washing facility	
	3								
	4							Fire fighting facility	
	5							Controll office	
	6								
	7							Monitaring well	
	8								
	9								

Application Form to be Filled by Tenderers (Sheet 3)

Facilities of the site			Daily works				
Structure of embankment			Landfill work	Waste volume (t/d)		Thickness of waste of covering material	(m) (m)
Unpervious work				Covering material volum (t/d)		Number of transportation virchle	
Leachate collection facility			Confirmation method of waste				
Countermeasure of groundwater			Fly and flow out protection				
Structure of out-let gus pipe			Bad smell protection				
Leachate tretment facility	Flow of system		Noise and ribration protection				
	Structure of discharge point		Vermin appearance protection				
	Target ralue of treatment water quality		Working hour				
			Access road				
			Record				

Application Form to be Filled by Tenderers (Sheet 4)

Maintenance		Monitaring		
Protection method of the site slope		Groundwater	Sampling method	
Protection method of the bank			Items of analysis	
Protection method of unpervious zone			Times of analysis (time/year)	
Leachate treatment facility		Leachate	Sampling method	
			Items of analysis	
			Times of analysis (time/year)	
		Discharge water		
Landuse of old site				

Application Form to be Filled by Tenderers (Sheet 5)

Environmental Survey		Surface Water	Distribution of rever, kholng, pond and so on. (be attached map, photograph) How to use river, khlong, pond and so on ?
Condition of Topography	How is location ? a.Hole (naturaly or artificialy) b.Flatness c.Sloop d.Hill e.Swamp f.Other Explanation (be attached photograph)		
Condition of Geology	Explanation	Climate Data of more than 5 years	Temperature·····each monthly average Humidity·····each monthly average Wind·····wind rose, most frequent wind direction maximum wind speed, each monthly average wind speed

Application Form to be Filled by Tenderers (Sheet 6)

Surrounding Aquatic Biology	Existing of valuable species	Condition of Land Use	Distribution of residential area, commercial area, industry area, agriculture area etc. (be attached map) Location of public facilityies (be attached map) notice: recreation facility, hospital, school, temple, mosque, cultural assets, historic site etc.
Surrounding Terrestrial Animals and Plants	Existing of valuable species	Condition of Transportation	Transportation network map notice: railway, main road etc.

Application Form to be Filled by Tenderers (Sheet 7)

Condition of Natural Calamity	Explanation		

Appendix 5. A Study on a Simplified Sanitary Landfill in Ram Intra

Appendix 5. A Study on a Simplified Sanitary Landfill in Ram Intra

In the Master Plan report, a complete type (Case 1) landfill is proposed as a future final disposal system. However, its implementation depends greatly on the financial capacity of the BMA as its construction and management are costly. This Appendix presents a less costly alternative plan (Case 2) for both Ram Intra site (Site 1) and a place in the east part of Bangkok (Site 2).

1. Outlines of the Major Facilities

1.1 Site 1 in Ram Intra

Major differences between the two cases exist in the following two aspects:

1. Leachate Treatment: Case 2 will employ only biological treatment, while Case 1 will have both biological and chemical treatment.

2. Lining: Case 2 will have a permeable layer made of crash stone, over which there will be an artificial lining with 0.2 mm thickness, while Case 1 will have an artificial lining with 1.2 mm thickness, which is much more costly.

Table A5-1 shows the outlines of the Case 2 facilities in comparison with Case 1.

Table A5-1 Outline of Major Facilities for Both Cases 1 and 2 for the Site 1 Planned in Ram Intra

MAJOR FACILITY	FUNCTION	SPECIFICATIONS	
		CASE 1	CASE 2
Embankment	To prevent garbage from flowing out of the site and rainfall water from flowing in	Soil band of one meter height around the site	Same as Case 1
Lining	To avoid seepage of leachate and contamination of ground water	Artificial liner Thickness = 1.2mm	Construction of permeability layer (with crash stone) higher than the existing bottom level & Artificial liner thickness = 0.2mm
Leachate Collection Facility	To collect leachate quickly	Ø 200 to Ø 300mm PVC porous pipe covered with crash stone	Crash stone only
Rainfall Water Drain Facility	To prevent water from flowing into the site	Concrete drain ditch (width = Depth = 300 mm) are constructed around the site	Same as Case 1
Leachate Treatment Facility	To treat leachate and improve quality of water to be discharged outside the site	Chemical and biological treatment	Biological treatment
Gas Exhaust Facility	To collect and release the gas generated from decomposed waste	Ø 200 to Ø 300mm PVC porous pipe covered with crash stone	Crash stone with PVC pipe (only at the top part)

Case 1: Complete sanitary final disposal system

Case 2: Simplified sanitary final disposal system

1.2 Site 2 in the East Part of Bangkok

Major difference between the proposed Case 1 and a simplified Case 2 is that the former will employ both biological and chemical treatment, while the latter will employ only biological treatment. Both cases will not employ an artificial lining as natural clay will be available in the Site 2 (a flat land) for the lining. Table A5-2 shows the outline of Case 2 facilities in comparison with Case 1.

Table A5-2 Outlines of Major Facilities for Both Cases 1 and 2 for the Site 2 Planned in the East Part of Bangkok

MAJOR FACILITY	FUNCTION	SPECIFICATIONS	
		CASE 1	CASE 2
Leachate Treatment Facility	To treat leachate and improve quality of water to be discharged outside the site	Chemical and biological treatment	Biological treatment
Leachate Collection Facility	To collect leachate quickly	Ø 200 to Ø 300mm PVC porous pipe covered with crash stone	Crash stone only
Gas Exhaust Facility	To collect and release the gas generated from decomposed waste	Ø 200 to Ø 300mm PVC porous pipe covered with crash stone	Crash stone with PVC pipe (only at the top part)
Lining	To avoid seepage of leachate and contamination of groundwater	Natural clay lining	Natural clay lining

2. Environmental Impacts

It is anticipated that Case 2 (simplified case) will cause much greater environmental impacts than Case 1 will.

Leachate will seep into the ground water under Case 2 when there is a heavy rainfall while such seepage will not occur under Case 1 as it is provided with a thick artificial lining.

The quality of effluent to be discharged after treatment of leachate under Case 2 will not satisfy the Industrial Emission Standards proposed by the Ministry of Industry as shown in Table A5-3.

Table A5-3 Estimated Quality and Volume of Effluent to be Discharged under Cases 1 and 2

ITEM		CASE 1	CASE 2	PROPOSED INDUSTRIAL EMISSION STANDARDS
BOD (mg/l)		60 (Max)	180 (Max)	60 (Max)
SS (mg/l)		30 (Max)	300 (Max)	30
Color (Pt-Co unit)		250	500	250
pH		5-9	5-9	5-9
Heavy metal		N.D.	N.D.	N.D.
Effluent Amount (tons/day)	Site 1	160 Constant through the year	160 on average (Max. 300 in rainy season)	Not Specified
	Site 2	1,000 constant through the year	1,000 on average (Max 1,500 in rainy season)	

3. Costs of Construction and Operation

3.1 Site 1 in Ram Intra

It is estimated that Case 1 will require 362 Baht per ton of waste to be disposed, about 35 % higher than Case 2 which requires 268 Baht/ton . Major cost differences arise from the differences in the leachate treatment systems and lining methods between the two cases.

Table A5-4 shows costs estimated for both cases.

Table A5-4 Costs Sanitary Landfill for Cases 1 and 2 Planned in Ram Intra

	CASE 1		CASE 2	
	TOTAL (Baht)	UNIT COST (Baht/ton)	TOTAL (Baht)	UNIT COST (Baht/ton)
1. Civil Work	304,500,000	167	167,500,000	92
2. Leachate Treatment Facility	52,000,000	28	60,000,000	33
3. Sub-Total (1 + 2)	356,500,000	195	227,500,000	125
4. Land Purchase	95,200,000 (85 rai)	52	95,200,000 (85 rai)	52
5. Total (3 + 4)	451,700,000	247	322,700,000	177
6. Operation/Maintenance	210,370,000	115	182,440,000	91
7. Grand Total	662,070,000	362	505,140,000	268
Total Waste Disposal Amount	1,825,000 tons		2,000,000 tons	