Appendix 6.7 Cost for fertilizer application

Table Ap 6.9 Cost for application of chemical fertilizer and compost in Japan

Sort of fertilizer	Chemical fertilizer	Compost
Amount of supplied fertilizer	150 kg/0.1 ha	1,500 kg/0.1 ha
Necessary time for fertilizer application per 0.1 ha	0.5 d/0.1 ha	2.5 d/0.1 ha
Necessary time for fertilizer application per ton	27 h/t	13 h/t
Productivity of labor	557 yen/h	
Cost of fertilizer application per ton	15,039 yen/t	7,241 yen/t

Appendix 6.8 Necessary time for producing compost and income from agricultural products

Table Ap 6.10 Necessary time for producing compost in Japan

Material collection and conveyance	Collection area	0.1 ha
	Compost production volume (fully fermented compost)	1 t
	Necessary time	25 man.hour
Turn-over of compost		7 man.hour
Total		32 man.hour

Table Ap 6.11 Agricultural income and working hours in Japan

(Unit : Thousand yen)

Farm Household income	Agricultural sector			Other sector			Working hours (h)		
	Agricultural income	Agricultural receipt	Agricultural running expenses	Other income	Other receipt	Other expenses	Total hours	Family member	Employee
4,417.7	1,126.7	2,446.7	1,320.0	3,291.0	3,527.1	236.1	2,021	1,974	47

Source : The statistics of farm household economy in 1979, Ministry of Agriculture, Forestry and Fishery.

Table Ap 6.12 Average cash income from agricultural sector per agricultural household by type of income sources and regions, 1978/79

(Unit : Baht/farm)

Regions	Income from livestocks	Income from crops	Other income	Cash income from agricultural sector
Northeast	933.52 (12.25)	6,387.08 (83.69)	310.33 (4.06)	7,630.93 (100.00)
North	1,004.83 (6.43)	13,502.48 (86.25)	1,416.14 (7.32)	15,653.45 (100.00)
Central	4,109.99 (13.36)	24,711.96 (80.33)	1,940.59 (6.31)	30,762.54 (100.00)
South	1,297.41 (9.67)	11,218.71 (83.65)	894.68 (6.68)	13,410.80 (100.00)
Average Thailand	1,597.90 (10.72)	12,383.43 (83.10)	919.91 (6.18)	14,901.24 (100.00)

Remarks : The number in brackets is the percentage of cash income from agricultural sector by type of various income sources.

Source : Agricultual Statistics of Thailand, Crop Year 1979/80

Appendix 6.9 Indirect benefits

- Land value

In the without-project case, landfill at final disposal site is assumed to be executed by open dumping. This method will worsen the surrounding environmental condition in such way as water pollution by leachate, rank odour, dust and waste diffusion and overflow of solid waste during floods. If no measures are taken to prevent pollution, the land value will decrease.

In the with-project case, however, some countermeasures are planned to be taken according to the modernization of the solid waste treatment facilities and improvement of the sanitary standard; therefore, influences on the environment will not be tremendous so that the land value will not decrease so much but rather increase in some areas owing to the improvement of infrastructure such as expansion of road width and access road construction needed for the proposed solid waste treatment facilities at Bang Kapi and Phasi Charoen incineration plants.

- Utilization of the surplus heat generated in the incineration plant

Energy problems in Thailand will continue; therefore, it is very significant to utilize energy resources effectively. One of the effective means is to utilize the surplus heat from the incineration plant. In this study, the surplus heat is planned to be utilized for electricity generation. In addition, it can be utilized for hot water supply to public facilities, air conditioning, etc. when urbanization of the surrounding area progresses.

- Influence on related local enterprises

Operation of the proposed facilities may affect on environment of the employees and commercial enterprises nearby.

During the facilities construction stage, the project will favorably influence the local economic activity that contributes to rise of income level. In general, investment to a public project is considered to have the large influence especially on local enterprises since the investment is normally made with a large scale.

- Increase of employment opportunity

Employment opportunity in this sanitation project is summarized as follows:

	Case 9	Case 13	Case 19-(2)
Workers required during the construction period (million man·days)	1.10	4.60	3.20
New employees required for project operation, 1983-2010 (man.years)	7,700	6,300	6,500

This employment opportunity may not seem so large seeing from the viewpoint of the population of Bangkok city but, it is significant for each district.

The total number of employees required during the construction stage of the Yannawa incineration plant is 1.05 million man·days whereas the population in Yannawa district is only 375,000 (1979).

Ninety-eight additional employees will be needed for operation of the Yannawa plant when it starts operation.

This effect on laborers will be contributive to the local economic activity.

Appendix 6.10 Economic cost flow

Table Ap 6.13(A) Economic cost flow (Case No. 9)

(Unit: million Baht)

Year	Facilities construction cost	Land acquisition cost	Operation & maintenance cost	Collection & transport cost	Collection trucks purchase cost	General admin. cost	Total Cost	Total cost (Excluding land acquisition cost)
1983	121.4		84.9	117.7	21.8	33.3	379.1	379.1
1984			106.5	122.8	17.5	37.0	283.8	283.8
1985			120.0	128.8	17.0	39.9	305.7	305.7
1986	5.5	47.4	132.7	136.7	17.5	43.0	382.8	335.2
1987	48.0		112.9	144.4	19.7	41.6	366.6	366.6
1988	104.4		112.9	147.8	24.3	42.8	432.2	432.2
1989		14.6	112.9	153.9	29.2	44.4	355.0	340.4
1990	290.1	9.7	112.9	166.7	29.2	46.3	654.9	645.2
1991	109.4		112.9	174.1	39.3	48.9	484.6	484.6
1992	153.7	44.5	112.9	183.6	50.0	52.0	596.7	552.2
1993	230.9	99.3	124.1	190.7	50.0	54.7	749.7	650.4
1994	95.2		136.9	205.6	62.1	60.7	560.5	560.5
1995	131.3		136.9	216.9	62.8	62.5	610.4	610.4
1996	227.9	204.2	136.9	228.2	65.3	64.6	927.1	722.9
1997			144.9	232.3	61.4	65.8	504.4	504.4
1998	147.3		144.9	245.1	61.9	67.8	667.0	669.0
1999			144.9	258.0	60.2	69.5	532.6	532.6
2000	989.5		144.9	284.1	59.5	73.3	1,551.3	1,551.3
2001			144.9	293.4	52.9	73.7	564.9	564.9
2002			144.9	303.0	57.8	75.9	581.6	581.6
2003			144.9	313.0	58.5	77.5	593.9	593.9
2004			144.9	323.2	61.6	79.5	609.2	609.2
2005			144.9	333.8	61.6	81.0	621.3	621.3
2006			144.9	342.3	61.6	82.3	631.1	631.1
2007			144.9	351.0	81.0	86.5	663.4	663.4
2008			144.9	359.9	85.9	88.6	679.3	679.3
2009			144.9	369.0	85.9	90.0	689.8	689.8
2010	-612.4		144.9	378.4	85.9	91.4	88.2	88.2
Total	2,042.2	419.7	3,684.9	6,704.4	1,441.4	1,774.6	16,067.4	15,647.7

Table Ap 6.13(B) Economic cost flow (Case No. 13)

(Unit: million Baht)

Year	Facilities construction cost	Land acquisition cost	Operation & maintenance cost	Collection & transport cost	Collection trucks purchase cost	General admin. cost	Total cost	Total cost (Excluding land acquisition cost)
1983	161.5		82.8	117.7	21.8	33.3	417.1	417.1
1984			104.4	122.8	17.5	36.7	281.4	281.4
1985	4.5	44.4	117.8	128.8	17.0	39.5	352.0	307.6
1986	11.8	205.0	130.5	136.7	17.5	42.7	544.2	339.2
1987	260.2		110.7	144.4	19.7	41.2	576.2	576.2
1988	824.7		110.7	147.8	22.4	42.1	1,147.7	1,147.7
1989	688.1		110.7	153.9	22.4	43.1	1,018.2	1,018.2
1990	440.2		110.7	166.7	22.4	45.0	785.0	785.0
1991	11.0	117.3	129.3	159.2	21.3	46.5	484.6	367.7
1992	376.7		137.5	168.0	40.3	51.9	774.4	774.4
1993	1,351.9	14.5	142.9	177.2	50.0	55.5	1,792.0	1,777.5
1994	1,198.3		159.6	192.5	60.4	61.9	1,672.7	1,672.7
1995	315.3	14.5	162.4	204.0	50.7	62.6	809.5	795.0
1996	43.5	23.8	197.2	183.6	43.4	63.6	555.1	531.3
1997	326.3	47.9	202.2	195.3	51.7	67.4	890.8	842.9
1998	852.2		212.4	208.2	54.1	71.2	1,398.1	1,398.1
1999	726.5		231.2	216.7	51.7	74.9	1,301.0	1,301.0
2000	797.7		237.2	240.1	52.2	79.4	1,406.6	1,406.6
2001			278.8	227.7	31.6	80.7	618.8	618.8
2002			290.2	242.9	45.6	86.8	665.5	665.5
2003			298.0	250.8	48.0	89.5	686.3	686.3
2004			304.6	259.1	49.4	92.0	705.1	705.1
2005			309.8	267.6	49.4	94.0	720.8	720.8
2006			314.6	274.4	47.0	95.4	731.4	731.4
2007			318.9	281.4	66.2	100.0	766.5	766.5
2008			322.7	288.5	66.2	101.6	779.0	779.0
2009			326.7	295.8	66.2	103.3	792.0	792.0
2010	-2,196.8		329.3	303.4	66.9	104.9	-1,392.3	-1,392.3
Total	6,194.0	467.4	5,783.8	5,755.2	1,173.0	1,906.8	21,280.2	20,812.8

Table Ap 6.13(C) Economic cost flow (Case No. 19-(2))

(Unit: million Baht)

Year	Facilities construction cost	Land acquisition cost	Operation & maintenance cost	Collection & transport cost	Collection trucks purchase cost	General admin. cost	Total cost	Total cost (Excluding land acquisition cost)
1983	147.5		82.8	117.7	21.8	33.3	403.1	403.1
1984			104.4	122.8	17.5	36.7	281.4	281.4
1985	4.5	44.4	118.2	128.8	17.0	39.6	352.5	308.1
1986	12.5	210.0	130.5	136.7	17.5	42.7	549.9	339.9
1987	259.4		110.7	144.4	19.7	41.2	575.4	575.4
1988	807.1		110.7	147.8	22.4	42.1	1,130.1	1,130.1
1989	688.1		110.7	153.9	22.4	43.1	1,018.2	1,018.2
1990	435.7		110.7	166.7	22.4	45.0	780.5	780.5
1991	5.3	195.3	129.3	159.2	21.3	46.5	556.9	361.6
1992	212.3		137.5	168.0	40.3	51.9	610.0	610.0
1993	842.1	28.2	142.9	177.2	50.0	55.5	1,295.9	1,267.7
1994	687.4		159.6	192.5	60.4	61.9	1,161.8	1,161.8
1995	179.7	14.5	162.4	204.0	50.7	62.6	673.9	659.4
1996	36.5	9.6	182.8	190.2	50.7	63.6	533.4	523.8
1997	131.5	47.9	181.9	202.5	51.7	65.4	680.9	633.0
1998	281.4		188.5	215.3	56.6	69.1	810.9	810.9
1999	131.3		204.5	223.5	54.1	72.3	685.7	685.7
2000	873.1	53.9	208.5	247.2	52.2	76.2	1,511.1	1,457.2
2001			230.8	248.1	52.2	79.7	610.8	610.8
2002			234.0	264.6	48.0	82.6	628.6	628.6
2003			236.5	273.3	50.5	84.0	644.3	644.3
2004			239.3	282.3	51.9	86.0	659.5	659.5
2005			241.2	291.5	51.9	87.7	672.3	672.3
2006			243.5	298.9	51.9	89.1	683.4	683.4
2007			245.3	306.5	66.2	92.7	710.7	710.7
2008			247.1	314.3	68.6	94.5	724.5	724.5
2009			249.2	322.3	68.6	96.0	736.1	736.1
2010	-1,110.3		250.3	330.5	71.8	97.9	-359.8	-359.8
Total	4,625.1	603.8	4,993.8	6,030.7	1,230.3	1,838.2	19,321.9	18,718.1

Appendix 6.11 Cost for electricity generation by thermal-type power plant in Thailand

Outline of thermal type power generation plants in Thailand is described in Table Ap 6.14 next page.

An average cost of the generated power in heavy oil combustion plants is 0.98 Baht/kW·h in 1980 price.

Table Ap 6.14 Existing unit performance data

Plant	Mae Moh	N. Bangkok	N. Bangkok	S. Bangkok	S. Bangkok	Krabi	Surat Thani	Udon Thani	Nakhon Ratchasima	Phuket
Type*	ST	ST	ST	ST	ST	ST	ST	CT	CT	D
Unit No. (S)	1, 2 & 3	1 & 2	3	1 & 2	3, 4 & 5	1, 2 & 3	1	1	1	1 to 4
Nominal rating, MW (each)	75	75	87.5	200	300	20	30	15	15	2.65
Fuel	Lignite	Heavy oil	Heavy oil	Heavy oil	Heavy oil	Lignite	Heavy oil	Diesel oil	Diesel oil	Diesel oil
Gross station heat rate (Btu/kW-h)	11,500	10,238.4	10,011.7	10,246.5	10,046	12,076	12,076	20,401	20,405	10,175
Plant efficiency(%)	29.7	33.3	34.1	33.3	34.0	28.3	28.3	16.7	16.7	33.5
Unit cost of electricity (Baht/kW.h)	0.48	1.19	1.16	1.18	1.16	0.48	1.47	7.34	4.34	2.18
Plant	Hat Yai	Surat Thani	Chiang Mai	Mae Moh	Bang Pakong	Mea Moh	Mea Moh	Bang Pakong	Nakhon Si Thammarat	Khanom
Type*	CT	CT	D	D	CC	ST	ST	ST	D	ST
Unit No. (S)	1, 2 & 3	1 to 5	1 to 3	1 to 9	1 & 2	3	4 & 5	1 & 2	1 & 2	1
Nominal rating MW (each)	15	15	1	1	360	75	150	550	1	75
Fuel	Diesel oil	Diesel oil	Diesel oil	Diesel oil	Nat. Gas/ Diesel oil	Lignite	Lignite	Nat. Gas	Diesel oil	Heavy oil/ Nat. Gas
Gross station heat rate (Btu/kW-h)	18,588	18,728	13,628	11,191	11,588**/ 13,157**	11,500	10,168	9,087	12,081	10,125/ 10,599
Plant efficiency(%)	18.4	18.2	25.0	30.5	25.1**/ 25.9**	29.7	33.6	37.6	28.3	33.7/32.2
Unit cost of electricity (Baht/kW.h)	3.96	3.96	2.93	2.40	1.00/2.72	0.48	0.42	0.78	2.57	1.26/0.92

Note : * ST = Steam Turbine
CT = Combustion Turbine
CC = Combined Cycle
D = Diesel

** Combustion Turbine only

Appendix 6.12 Costs of a thermal-type power station

Table Ap 6.15 Percentage of annual expenses in the case of thermal-type power station

(Unit: percent)

Year	Book value	Rate of interest + Depreciation	Repair expenses	Personnel expenses	General management cost + Others	Total expenses
1	100.0	8.77	0.78	0.04	1.41	11.00
2	94.73	8.59	0.88	0.05	1.50	11.02
3	89.56	8.40	0.98	0.05	1.59	11.02
4	84.19	8.22	1.09	0.05	1.68	11.04
5	78.92	8.03	1.22	0.05	1.78	11.08
6	73.56	7.85	1.35	0.06	1.89	11.15
7	68.38	7.66	1.50	0.06	2.00	11.22
8	63.11	7.48	1.66	0.07	2.12	11.33
9	57.84	7.29	1.83	0.07	2.25	11.44
10	52.57	7.11	2.02	0.07	7.39	11.59
11	47.36	6.93	2.22	0.08	2.53	11.76
12	42.03	6.74	2.44	0.08	2.69	11.99
13	36.76	7.01	2.68	0.09	2.85	12.18
14	31.49	6.37	2.94	0.09	3.02	12.42
15	26.22	6.19	3.22	0.10	3.20	12.71
16	20.95	6.00	3.52	0.10	3.40	13.02
17	15.68	5.82	3.82	0.11	3.58	13.33
18	10.41	5.63	4.12	0.11	3.73	13.59
19	5.14	5.50	4.44	0.12	3.91	13.79
20	0.00	0.00	4.78	0.12	4.09	8.99

Appendix 6.13 Annual investment costs by facilities

Table Ap. 6.16(A) Appropriate Master Plan alternative No. 9

(Unit : million Baht)

	Compost plant		Landfill site			Parking lot	Major repair of the existing compost plant	Total
	Bang Khun Tian	Taling Chan	On-Nooch	Nong Khaem	Ram Intra			
1983			58.2	76.4				134.6
1984								
1985								
1986					81.7			81.7
1987					51.0			51.0
1988			52.3	65.4				117.7
1989	23.2							23.2
1990	53.1						284.6	337.7
1991	119.3							119.3
1992	97.3					140.0*1		237.3
1993		99.6	79.6	182.6	52.6			414.4
1994		100.1						100.1
1995		145.4						145.4
1996		183.6	292.2			99.2*2		575.0
1997								
1998			69.9	63.4	31.5			164.8
1999								
2000			349.3	287.7	95.9		284.6	1,017.5
Total	292.9	528.7	901.5	675.5	312.7	239.2	569.2	3,519.7

Note: *1 Yannawa parking lot
*2 Bangkok Noi parking lot

Table Ap 6.16(B) Appropriate Master Plan alternative No. 13

(Unit : million Baht)

	Incineration plant				Compost plant		Landfill site			Major repair of the existing compost plant	Total
	Yannawa	Bangkok Noi	Bang Kapi	Phasi Charoen	Bang Khun Tian	Taling Chan	On-Nooch	Nong Khaem	Ram Intra		
1983							76.5	93.9			170.4
1984											
1985	75.6										75.6
1986	293.6								47.3		340.9
1987	253.0								36.3		289.3
1988	797.4						61.3	83.2			941.9
1989	797.4										797.4
1990	204.8	4.6	4.6							284.6	498.6
1991		140.9	57.6								198.5
1992		209.0	217.1								426.1
1993		690.3	700.3				38.5	119.1	28.1		1,576.3
1994		690.3	700.3								1,390.6
1995		179.4	179.1	4.6	23.2						386.3
1996				30.0	53.1						83.1
1997				219.6	119.3	99.6					438.5
1998				691.0	97.3	100.1	22.8	39.9	15.0		966.1
1999				691.0		145.4					836.4
2000				177.0		183.6	114.5	74.6	48.9	284.6	883.2
Total	2,421.8	1,914.5	1,859.0	1,813.2	292.9	528.7	313.6	410.7	175.6	569.2	10,299.2

Table Ap 6.16(C) Appropriate Master Plan alternative No. 19-(2)

(Unit : million Baht)

	Incineration plant		Compost plant		Landfill site			Major repair of the existing compost plant	Total
	Yannawa	Dusit	Bang Khun Tian	Taling Chan	On-Nooch	Nong Khaem	Ram Intra		
1983					68.6	86.5			155.1
1984									
1985	75.6								75.6
1986	293.6						56.1		349.7
1987	253.0						35.3		288.3
1988	797.4				51.7	73.7			922.8
1989	797.4								797.4
1990	204.8	4.6						284.6	494.0
1991		317.7							317.7
1992		240.3							240.3
1993		796.5			39.2	140.9	28.3		1,004.9
1994		796.5							796.5
1995		206.8	23.2						230.0
1996			53.1						53.1
1997			119.3	99.6					218.9
1998			97.3	100.1	34.5	50.6	18.2		300.7
1999				145.4					145.4
2000				183.6	322.2	169.9	73.1	284.6	1,033.4
Total	2,421.8	2,362.4	292.9	528.7	516.2	521.6	211.0	569.2	7,423.8

Appendix 6.14 Budget of solid waste management

Table Ap 6.17(A) BMA budget during fiscal year 1977 ∿ 1981

Functions	Fiscal 1977		Fiscal 1978		Fiscal 1979		Fiscal 1980		Fiscal 1981	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
1. Public Works	507,548,910	23.71	835,728,505	28.69	881,647,882	26.72	1,102,077,035	28.18	900,284,398	22.76
2. Education	553,669,250	25.87	605,215,750	20.78	658,330,420	19.96	799,779,047	20.45	858,737,001	21.71
3. Central Fund	298,873,128	13.96	464,009,211	15.93	681,500,805	20.66	735,906,378	18.81	573,687,921	14.50
4. General Administration	157,855,707	7.37	251,353,682	8.63	292,769,385	8.87	354,870,879	9.07	528,772,220	13.36
5. Public Health	194,301,610	9.08	221,962,020	7.62	273,712,280	8.30	302,142,504	7.73	386,719,255	9.77
6. Sanitation	173,394,720	8.10	233,599,730	8.02	227,347,230	6.89	272,353,560	6.96	346,373,719	8.75
7. Drainage	114,991,350	5.37	187,830,780	6.45	135,074,231	4.09	154,485,510	3.96	147,668,575	3.73
8. Social Welfare	97,076,100	4.54	68,184,500	2.34	94,832,485	2.88	123,528,245	3.16	145,536,620	3.68
9. B.M.A. Enterprises	31,504,250	1.47	33,583,900	1.15	44,631,250	1.35	56,461,263	1.44	60,486,500	1.53
10. Loan Payments	11,303,982	0.53	11,303,982	0.39	9,303,982	0.28	9,303,983	0.24	8,143,991	0.21
11. Miscellaneous	-	-	-	-	-	-	-	-	-	-
Total	2,140,519,007	100.00	2,912,772,060	100.00	3,299,149,950	100.00	3,910,908,404	100.00	3,956,410,200	100.00

Note : 1. Fiscal year begins on 1 October and ends on 30 September.
2. The figures include subsidy from the government.

Table Ap 6.17(B) Annual budget in 1980
(Bureau of Sanitation)

(Unit : Baht)

Fixed Expenditure		1. Salary			2. Permanent Wages			3.Temporary Wages	4.Remuneration	5. Expenses	6. Supply	7. Equipment			8. Land and Construction			9. Other Expenses					Total
		Former Rate	Promotion		Former Rate	Promotion						Vehicles	Other Equipment		Land	Construction		Reimburse Accrued Loan: Salary & wage	Reimburse Accrued Loan: Equipment	Refund borrowing from accrued fund	Contract for operation		
1. General service	1.1 General administrative work	911,600	35,700	947,300	914,900	52,800	557,700	21,600	200,000	317,000	247,000	55,000	15,000	111,000	-	4,050,000	4,050,000	223,140	-	-	-	223,140	7,836,740
	1.2 Technical section	675,360	28,740	704,100	99,360	5,940	105,300	38,000	18,000	10,000	153,000	-	510,750	510,750	-	-	-	-	-	-	-	-	1,539,150
2. Sanitation	2.1 Refuse collection	1,348,500	59,900	1,408,400	7,195,600	303,200	7,499,830	358,300	1,190,000	557,000	4,617,300	-	54,500	54,500	-	33,900	33,900	-	140,000	-	-	140,000	15,769,200
	2.2 Refuse disposal work	1,068,100	27,900	1,096,000	7,509,250	374,150	7,883,400	256,000	1,200,000	1,252,000	7,013,300	5,645,400	891,100	6,536,500	-	6,000,000	6,000,000	-	-	-	-	-	31,235,200
	2.3 Refuse disposal plant	3,121,420	82,680	3,204,100	6,875,550	367,260	7,173,200	702,100	2,000,000	4,164,600	10,085,700	350,000	21,786,000	22,136,000	-	18,140,700	18,140,700	-	-	1,742,960	13,202,270	14,945,230	82,551,430
Total - Baht		7,124,980	234,923	7,359,900	22,545,070	1,083,330	23,629,400	1,374,000	4,518,009	6,300,600	22,116,300	6,091,400	23,257,350	29,348,750	-	28,224,600	28,224,600	223,140	140,000	1,742,960	13,202,270	15,358,370	138,229,720

Table Ap 6.17(C) Budget for fiscal year 1980
(Fertilizer Production & Selling Administration)

(Unit : Baht)

Plan-Work-Project	Salary	Permanent Wage	Temporary Wage	Renumeration	Expenditure	Public Utility Expenditure	Supply	Equipments	Land & Construction	Other Expenses	Total
Fixed Expenditure	1,616,000	7,064,700	-	384,400	846,000	252,000	611,000	1,431,400	1,400,000	-	13,605,500
Special Expenditure (Subsidy from BMA)	-	-	-	-	-	-	-	-	10,360,000	5,755,000	16,115,000
Total	1,616,000	7,064,700	-	384,400	846,000	252,000	611,000	1,431,400	11,760,000	5,755,000	29,720,500

Table Ap 6.17(D) District budget by work in 1980

(Unit : Baht)

District Name	1 Governmental Work	2 Finance Work	3 Registration Work	4 Civil Work	5 Sanitary Work	6 Health Caring Affairs	7 Income Affairs	8 Education Affairs	Total
1. Phra Nakhon	3,776,197	-	1,033,300	2,916,300	11,591,600	420,800	656,700	346,100	20,740,997
2. Pom Prap	2,885,510	-	755,300	4,057,700	7,441,200	392,100	637,400	210,100	16,379,310
3. Pathum Wan	3,268,236	-	780,000	4,644,300	7,949,500	350,000	577,100	326,400	17,895,536
4. Sam Phan Thawong	1,964,780	-	516,100	3,507,400	5,410,500	336,500	606,800	234,300	12,576,380
5. Bang Rak	3,047,160	-	754,900	4,486,500	5,626,980	386,500	833,300	254,600	15,389,940
6. Yannawa	4,812,430	-	1,433,900	15,125,550	9,469,000	495,300	912,300	424,900	32,673,380
7. Dusit	4,519,631	-	1,549,150	11,363,050	11,257,660	410,100	700,600	404,800	30,204,991
8. Phayathai	5,613,610	-	2,083,500	10,766,600	11,986,300	488,500	943,300	348,100	32,229,910
9. Huai Khwang	2,178,239	-	709,700	16,661,400	5,159,100	200,300	414,800	193,700	25,517,239
10. Phra Khanong	5,842,718	-	1,813,200	28,288,000	12,262,700	540,900	1,319,800	786,100	50,853,418
11. Bang Khen	5,004,250	-	1,333,900	23,060,400	5,231,500	297,500	712,500	415,300	36,055,350
12. Bang Kapi	2,988,920	-	957,200	16,081,600	3,683,900	349,700	589,400	357,600	25,008,320
13. Nong Chok	3,536,970	-	237,700	16,299,500	537,400	151,200	449,300	401,800	21,613,870
14. Minburi	2,216,545	-	354,400	14,305,700	1,190,200	169,900	375,600	308,600	18,920,945
15. Lat Krabang	2,347,330	-	191,500	16,159,500	867,300	144,800	321,100	188,400	20,219,930
16. Thonburi	2,933,740	-	942,300	13,638,500	6,350,500	552,700	568,300	454,700	25,440,740
17. Khlong San	2,435,752	-	542,140	4,444,000	4,317,500	457,100	453,500	276,200	12,926,192
18. Bangkok Noi	3,467,637	-	1,057,600	14,856,800	6,086,700	456,800	787,500	439,500	27,152,537
19. Bangkok Yai	2,829,940	-	499,700	9,124,500	2,937,900	305,800	415,300	213,900	16,327,040
20. Bang Khun Tian	2,516,188	-	603,300	15,718,100	3,169,000	319,200	402,300	404,200	23,132,288
21. Phasi Charoen	3,308,340	-	626,200	16,854,200	3,682,300	340,000	1,495,100	390,800	26,696,940
22. Rat Burana	2,026,575	-	540,200	12,885,800	4,201,700	360,000	517,600	315,000	20,846,825
23. Taling Chan	3,044,686	-	298,700	10,724,700	1,190,300	162,050	346,500	253,700	16,020,636
24. Nong Khaem	1,881,250	-	240,100	8,986,800	802,100	178,000	358,600	180,500	12,627,350
Subtotal	78,446,584		19,853,990	294,956,900	132,402,840	8,265,750	15,394,700	8,129,300	557,450,064

Table Ap 6.17(E) Annual budget in 1980
(24 Districts)

(Unit : Baht)

Salary	6,094,500 (4.6)
.Former rate	5,813,540
.Promoting increase	277,160
.Special fund for the veteran	3,800
Permanent wage	64,441,660 (48.7)
.Former rate	61,328,795
.Wage increase	3,099,765
.Special fund for the veteran	13,100
Temporary wage	20,635,240 (15.6)
Compensation	25,384,000 (19.2)
Daily expenditure	55,200 (0.0)
Raw material expense	5,122,460 (3.9)
Durable assets expenditure	9,409,780 (7.1)
Land & construction	1,260,000 (1.0)
Total	132,402,840 (100.0%)

Appendix 6.15 Cash flow statement

Table Ap 6.18(A) Appropriate Master Plan alternative No. 9

(Unit: million Baht)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Sources of funds										
BMA's fund	26.9	-	-	50.1	-	-	23.2	320.0	-	28.0
Foreign loan								6.6	49.5	41.1
Local loan	107.7	-	-	31.6	51.0	117.7	-	11.1	69.8	168.2
Bank overdrafts	25.4	2.3	2.2	3.0	-	0.5	1.1	1.3	2.0	2.2
Operating revenue	30.2	33.2	38.0	45.9	53.4	58.6	64.6	71.4	79.4	88.2
Total sources	190.2	35.5	40.2	130.6	104.4	176.8	88.9	410.4	200.7	327.7
Applications of funds										
Capital expenditure	134.6	-	-	81.7	51.0	117.7	23.2	337.7	119.3	237.3
Current assets increase	25.4	2.3	2.2	3.0	-	0.5	1.1	1.3	2.0	2.2
Management cost	276.2	303.7	326.6	352.0	338.1	348.7	362.7	378.2	401.8	428.7
Total debt service	3.8	31.2	29.8	28.6	31.7	37.9	54.1	52.7	53.3	83.9
Amortization of principal	0.0	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	30.8
Payment of interest	3.8	20.4	19.0	17.8	20.9	27.1	43.3	41.9	42.5	53.1
Total applications	440.0	337.2	358.6	465.3	420.8	504.8	441.1	769.9	576.4	752.1
BMA's current financing burden	249.8	301.7	318.4	334.7	316.4	328.0	352.2	359.5	375.7	424.4

Table Ap 6.18(A) Appropriate Master Plan alternative No. 9 (cont'd)

(Unit: million Baht)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sources of funds										
BMA's fund	159.6	9.1	-	111.2	-	-	-	431.2		
Foreign loan	3.0	30.9	61.2	76.6	-	-	-			
Local loan	251.8	60.1	84.2	387.2	-	164.8	-	586.3		
Bank overdrafts	2.9	4.3	1.2	1.4	2.9	1.4	1.0	2.0	-	1.6
Operating revenue	102.1	113.8	127.3	142.7	168.4	188.6	211.5	237.9	241.1	244.1
Total sources	519.4	218.2	273.9	719.1	171.3	354.8	212.5	1,257.4	241.1	245.7
Applications of funds										
Capital expenditure	414.4	100.1	145.4	575.0	-	164.8	-	1,017.5	-	-
Current assets increase	2.9	4.3	1.2	1.4	2.9	1.4	1.0	2.0	-	1.6
Management cost	450.9	503.1	517.4	534.1	542.7	558.6	571.1	594.8	595.7	614.0
Total debt service	117.3	164.0	179.4	183.5	241.8	230.3	268.6	255.8	389.3	381.5
Amortization of principal	42.0	56.4	70.1	70.1	78.1	78.1	103.2	105.6	166.7	183.2
Payment of interest	75.3	107.6	109.3	113.4	163.7	152.2	165.4	150.2	222.6	198.3
Total applications	985.5	771.5	843.4	1,294.0	784.4	955.1	840.7	1,870.1	985.0	997.1
BMA's current financing burden	466.1	553.3	569.5	574.9	616.1	600.3	628.2	612.7	743.9	751.4

Table Ap 6.18(A) Appropriate Master Plan alternative No. 9 (cont'd)

(Unit: million Baht)

	2003	2004	2005	2006	2007	2008	2009	2010	Sulvage value	Total
Sources of funds										
BMA's fund										1,159.3
Foreign loan									-153.5	115.4
Local loan									-36.6	2,054.9
Bank overdrafts	1.0	1.4	1.0	0.8	3.2	1.5	0.9	0.9	-69.4	0.0
Operating revenue	247.6	250.8	262.7	265.6	268.5	271.1	274.1	287.0		4,467.8
Total sources	248.6	252.2	263.7	266.4	271.7	272.6	275.0	287.9	-259.5	7,797.4
Applications of funds										
Capital expenditure	-	-	-	-	-	-	-	-	-858.6	2,661.1
Current assets increase	1.0	1.4	1.0	0.8	3.2	1.5	0.9	0.9	-69.4	0.0
Management cost	626.5	643.0	655.2	664.9	703.7	721.2	731.7	742.6	-563.8	13,924.1
Total debt service	347.9	301.8	266.5	247.0	220.0	201.7	158.3	143.7		4,705.4
Amortization of principal	176.3	155.4	141.7	141.7	133.8	133.8	108.6	108.6		2,170.6
Payment of interest	171.6	146.4	124.8	105.3	86.2	67.9	49.7	35.1		2,534.8
Total applications	975.4	946.2	922.7	912.7	926.9	924.4	890.9	887.2	-1,491.8	21,290.6
BMA's current financing burden	726.8	694.0	659.0	646.3	655.2	651.8	615.9	599.3	-1,232.3	13,493.2

Table Ap 6.18(B) Appropriate Master Plan alternative No. 13

(Unit: million Baht)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Sources of funds										
BMA's fund	34.1	-	75.6	339.2	92.9	22.3	-	293.8	198.5	141.0
Foreign loan	-	-	-	-	160.1	576.3	576.3	144.0	-	285.1
Local loan	136.3	-	-	1.7	36.3	343.3	221.1	60.8	-	-
Bank overdrafts	25.2	2.3	2.2	3.0	-	0.2	0.6	1.3	1.0	4.0
Operating revenue	30.2	33.2	38.0	45.9	53.4	58.6	64.6	71.4	105.3	114.1
Total sources	225.8	35.5	115.8	389.8	342.7	1,000.7	862.6	571.3	304.8	544.2
Applications of funds										
Capital expenditure	170.4	-	75.6	340.9	289.3	941.9	797.4	498.6	198.5	426.1
Current assets increase	25.2	2.3	2.2	3.0	-	0.2	0.6	1.3	1.0	4.0
Management cost	273.8	301.3	324.1	349.5	335.6	343.4	350.2	365.7	377.2	424.9
Total debt service	3.8	38.1	36.5	34.9	33.1	41.3	108.1	156.7	216.4	226.0
Amortization of principal	0.0	13.6	13.6	13.6	13.6	13.6	13.6	13.6	61.7	79.9
Payment of interest	3.8	24.5	22.9	21.3	19.5	27.7	94.5	143.1	154.7	146.1
Total applications	473.2	341.7	438.4	728.3	658.0	1,326.8	1,256.3	1,022.3	793.1	1,081.0
BMA's current financing burden	247.4	306.2	322.6	338.5	315.3	326.1	393.7	451.0	488.3	536.8

Table Ap 6.18(B) Appropriate Master Plan alternative No. 13 (cont'd)

(Unit: million Baht)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sources of funds										
BMA's fund	393.2	49.9	27.8	65.4	173.9	202.0	73.3	332.3		
Foreign loan	1,028.4	1,028.4	256.9	6.6	194.8	585.6	574.8	204.8		
Local loan	154.7	312.3	101.6	11.1	69.8	178.5	188.3	346.1		
Bank overdrafts	2.6	4.6	0.2	0.9	2.8	2.6	3.5	2.7	2.9	3.8
Operating revenue	124.4	136.1	149.6	205.1	222.6	242.8	269.3	295.7	325.8	328.8
Total sources	1,703.3	1,531.3	536.1	289.1	663.9	1,211.5	1,109.2	1,181.6	328.7	332.6
Applications of funds										
Capital expenditure	1,576.3	1,390.6	386.3	83.1	438.5	966.1	836.4	883.2		
Current assets increase	2.6	4.6	0.2	0.9	2.8	2.6	3.5	2.7	2.9	3.8
Management cost	456.2	510.6	513.0	522.2	555.1	587.1	617.2	649.1	656.9	701.4
Total debt service	222.9	267.0	332.5	385.4	405.6	438.6	469.0	493.3	530.2	555.9
Amortization of principal	79.9	81.2	81.2	123.2	159.6	196.0	202.2	202.2	202.2	248.9
Payment of interest	143.0	185.8	251.3	262.2	246.0	242.6	266.8	291.1	328.0	307.0
Total applications	2,258.0	2,172.8	1,232.0	991.6	1,402.0	1,994.4	1,926.1	2,028.3	1,190.0	1,261.1
BMA's current financing burden	554.7	641.5	695.9	702.5	738.1	782.9	816.9	846.7	861.3	928.5

Table Ap 6.18(B) Appropriate Master Plan alternative No. 13 (cont'd)

(Unit: million Baht)

	2003	2004	2005	2006	2007	2008	2009	2010	Sulvage value	Total
Sources of funds										
BMA's fund										2,515.2
Foreign loan									-3,255.3	2,366.8
Local loan									-50.3	2,111.6
Bank overdrafts	1.9	2.4	1.4	0.9	3.5	1.1	1.1	1.1	-79.8	0.0
Operating revenue	332.3	335.5	347.4	350.3	353.2	355.8	358.8	371.7		5,719.9
Total sources	334.2	337.9	348.8	351.2	356.7	356.9	359.9	372.8	-3,385.4	12,713.5
Applications of funds										
Capital expenditure									-2,867.4	7,431.8
Current assets increase	1.9	2.4	1.4	0.9	3.5	1.1	1.1	1.1	-79.8	0.0
Management cost	724.3	753.9	770.5	781.0	822.8	836.1	850.1	862.8	-442.1	15,173.9
Total debt service	624.4	583.5	559.4	495.7	517.3	534.3	508.0	488.8		9,306.7
Amortization of principal	339.0	324.2	324.2	284.6	323.8	360.5	354.3	354.3		4,478.3
Payment of interest	285.4	259.3	235.2	211.1	193.5	173.8	153.7	134.5		4,828.4
Total applications	1,350.6	1,339.8	1,331.3	1,277.6	1,343.6	1,371.5	1,359.2	1,352.7	-3,389.3	31,912.4
BMA's current financing burden	1,016.4	1,001.9	982.5	926.4	986.9	1,014.6	999.3	979.9	-3.9	19,198.9

Table Ap 6.18(C) Appropriate Master Plan alternative No. 19-(2)

(Unit: million Baht)

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Sources of funds										
BMA's fund	31.0	-	75.6	337.0	92.9	22.3	-	289.2	317.7	80.2
Foreign loan	-	-	-	-	160.1	576.3	576.3	144.0	-	160.1
Local loan	124.1	-	-	12.7	35.3	324.2	221.1	60.8	-	-
Bank overdrafts	25.2	2.3	2.2	3.0	-	0.2	0.6	1.3	1.0	4.0
Operating revenue	30.2	33.2	38.0	45.9	53.4	58.6	64.6	71.4	105.3	114.1
Total sources	210.5	35.5	115.8	398.6	341.7	981.6	862.6	566.7	424.0	358.4
Applications of funds										
Capital expenditure	155.1	-	75.6	349.7	288.3	922.8	797.4	494.0	317.7	240.3
Current assets increase	25.2	2.3	2.2	3.0	-	0.2	0.6	1.3	1.0	4.0
Management cost	273.8	301.3	324.5	349.5	335.6	343.4	350.2	365.7	377.2	424.9
Total debt service	3.8	35.1	33.7	32.2	32.2	40.5	104.6	153.4	213.3	222.1
Amortization of principal	0.0	12.4	12.4	12.4	12.4	12.4	12.4	12.4	60.5	77.8
Payment of interest	3.8	22.7	21.3	19.8	19.8	28.1	92.2	141.0	152.8	144.3
Total applications	457.9	338.7	436.0	734.4	656.1	1,306.9	1,252.8	1,014.4	909.2	891.3
BMA's current financing burden	247.4	303.2	320.2	335.8	314.4	325.3	390.2	447.7	485.2	532.9

Table Ap 6.18(C) Appropriate Master Plan alternative No. 19-(2) (cont'd)

(Unit: million Baht)

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Sources of funds										
BMA's fund	111.7	-	23.2	35.4	96.6	29.8	-	397.5		
Foreign loan	576.3	576.3	144.0	6.6	52.5	72.0	61.2	76.6		
Local loan	316.9	220.2	62.8	11.1	69.8	198.9	84.2	559.3		
Bank overdrafts	2.6	4.6	0.2	0.8	1.3	2.5	3.2	2.1	4.6	1.5
Operating revenue	124.4	136.1	149.6	190.8	208.3	228.5	255.0	281.4	292.8	295.8
Total sources	1,131.9	937.2	379.8	244.7	428.5	531.7	403.6	1,316.9	297.4	297.3
Applications of funds										
Capital expenditure	1,004.9	796.5	230.0	53.1	218.9	300.7	145.4	1,033.4		
Current assets increase	2.6	4.6	0.2	0.8	1.3	2.5	3.2	2.1	4.6	1.5
Management cost	456.2	510.6	513.0	522.3	537.5	568.0	594.1	619.6	648.4	665.4
Total debt service	215.7	273.8	311.8	356.6	376.3	404.7	424.5	417.0	492.6	487.9
Amortization of principal	77.8	82.1	82.1	125.4	161.8	198.2	206.5	206.5	217.4	236.4
Payment of interest	137.9	191.7	229.7	231.2	214.5	206.5	218.0	210.5	275.2	251.5
Total applications	1,679.4	1,585.5	1,055.0	932.8	1,134.0	1,275.9	1,167.2	2,072.1	1,145.6	1,154.8
BMA's current financing burden	547.5	648.3	675.2	688.1	705.5	744.2	763.6	755.2	848.2	857.5

Table Ap 6.18(C) Appropriate Master Plan alternative No. 19-(2) (Cont'd)

(Unit: million Baht)

	2003	2004	2005	2006	2007	2008	2009	2010	Sulvage value	Total
Sources of funds										
BMA's fund										1,940.1
Foreign loan									-1,528.0	1,654.3
Local loan									-50.3	2,251.1
Bank overdrafts	1.4	1.3	1.1	0.9	2.7	1.3	0.9	1.3	-74.1	0.0
Operating revenue	299.3	302.5	314.4	317.3	320.2	322.8	325.8	338.7		5,318.4
Total sources	300.7	303.8	315.5	318.2	322.9	324.1	326.7	340.0	-1,652.4	11,163.9
Applications of funds										
Capital expenditure									-1,806.4	5,617.4
Current assets increase	1.4	1.3	1.1	0.9	2.7	1.3	0.9	1.3	-74.1	0.0
Management cost	682.4	698.2	711.4	722.5	754.7	769.8	781.4	797.0	-468.2	14,530.4
Total debt service	526.8	483.1	458.6	393.1	381.8	367.8	341.1	323.9		7,908.0
Amortization of principal	298.0	281.3	281.3	240.4	247.1	251.4	243.2	243.2		3,905.2
Payment of interest	228.8	201.8	177.3	152.7	134.7	116.4	97.9	80.7		4,002.8
Total applications	1,210.6	1,182.6	1,171.1	1,116.5	1,139.2	1,138.9	1,123.4	1,122.2	-2,348.7	28,055.8
BMA's current financing burden	909.9	878.8	855.6	798.3	816.3	814.8	796.7	782.2	-696.3	16,891.9

Appendix 6.16 Project cost by year

Table Ap 6.19(A) Appropriate Master Plan alternative No. 9

(Unit : million Baht)

		1983	1984	1985	1986	1987	1988	1989	1990	1980~90	1991	1992
Facilities construction cost	T	134.6			5.8	51.0	117.7		322.3	496.8	119.3	166.1
	F/C	6.2			-	3.3	7.0		193.3	203.6	49.5	44.2
	L/C	128.4			5.8	47.7	110.7		129.0	293.2	69.8	121.9
Plant*	T								37.7	37.7	119.3	166.1
	F/C								6.6	6.6	49.5	44.2
	L/C								31.1	31.1	69.8	121.9
Final disposal site	T	134.6			5.8	51.0	117.7			174.5		
	F/C	6.2			-	3.3	7.0			10.3		
	L/C	128.4			5.8	47.7	110.7			164.2		
Major repair of the existing compost plant	T								284.6	284.6		
	F/C								186.7	186.7		
	L/C								97.9	97.9		
Land aquisition cost	T.L/				75.9			23.2	15.4	114.5		71.2
Plant*	T.L/				-			23.2	15.4	38.6		71.2
Final disposal site	T.L/				75.9			-	-	75.9		-
Management cost	T	276.2	303.7	326.6	352.0	338.1	348.7	362.7	378.2	1,779.7	401.8	428.7
	F/C	66.6	77.1	80.6	84.0	75.0	81.4	88.5	90.6	419.5	104.6	119.8
	L/C	209.6	226.6	246.0	268.0	263.1	267.3	274.2	287.6	1,360.2	297.2	308.9
Total project cost	T	410.8	303.7	326.6	433.7	389.1	466.4	385.9	715.9	2,391.0	521.1	666.0
	F/C	72.8	77.1	80.6	84.0	78.3	88.4	88.5	283.9	623.1	154.1	164.0
	L/C	338.0	226.6	246.0	349.7	310.8	378.0	297.4	432.0	1,767.9	367.0	502.0
W.P.P	T	270.7	298.2	321.4	423.1	332.5	343.0	357.1	657.2	2,112.9	396.2	423.1
A.S.P	T	140.1	5.5	5.2	10.6	56.6	123.4	28.8	58.7	278.1	124.9	242.9

Note: *Parking lots are included.
T: Total F/C: Foreign currency L/C: Local currency
W.P.P: Without-project case portion
A.S.P: Additional system portion

Table Ap 6.19(A) Appropriate Master Plan alternative No. 9

(Unit : million Baht)

		1993	1994	1995	1991~95	1996	1997	1998	1999	2000	1996~2000	Total
Facilities construction cost	T	255.4	100.1	145.4	786.3	248.5		164.8		1,017.5	1,430.8	2,848.5
	F/C	17.2	30.9	61.2	203.0	79.7		10.0		230.3	320.0	732.8
	L/C	238.2	69.2	84.2	583.3	168.8		154.8		787.2	1,110.8	2,115.7
Plant*	T	22.8	100.1	145.4	553.7	248.5					248.5	839.9
	F/C	3.0	30.9	61.2	188.8	79.7					79.7	275.1
	L/C	19.8	69.2	84.2	364.9	168.8					168.8	564.8
Final disposal site	T	232.6			232.6			164.8		732.9	897.7	1,439.4
	F/C	14.2			14.2			10.0		43.6	53.6	84.3
	L/C	218.4			218.4			154.8		689.3	844.1	1,355.1
Major repair of the existing compost plant	T									284.6	284.6	569.2
	F/C									186.7	186.7	373.4
	L/C									97.9	97.9	195.8
Land aquisition cost	T.L/C	159.0			230.2	326.5					326.5	671.2
Plant*	T.L/C	76.8			148.0	34.3					34.3	220.9
Final disposal site	T.L/C	82.2			82.2	292.2					292.2	450.3
Management cost	T	450.9	503.1	517.4	2,301.9	534.1	542.7	558.6	571.1	594.8	2,801.3	7,789.4
	F/C	123.8	155.3	158.0	661.5	161.5	149.4	152.1	151.8	154.2	769.0	2,074.3
	L/C	327.1	347.8	359.4	1,640.4	372.6	393.3	406.5	419.3	440.6	2,032.3	5,715.1
Total project cost	T	865.3	603.2	662.8	3,318.4	1,109.1	542.7	723.4	571.1	1,612.3	4,558.6	11,309.1
	F/C	141.0	186.2	219.2	864.5	241.2	149.4	162.1	151.8	384.5	1,089.0	2,807.1
	L/C	724.3	417.0	443.6	2,453.9	867.9	393.3	561.3	419.3	1,227.8	3,469.6	8,502.0
W.P.P	T	517.3	488.8	502.1	2,327.5	820.0	521.0	531.8	543.4	849.4	3,265.6	8,596.3
A.S.P	T	348.0	114.4	160.7	990.9	289.1	21.7	191.6	27.7	762.9	1,293.0	2,712.8

Note: *Parking lots are included.
T: Total F/C: Foreign currency L/C: Local currency
W.P.P: Without-project case portion
A.S.P: Additional system portion

Table AP 6.19(B). Appropriate Master Plan alternative No. 13

(Unit : million Baht)

		1983	1984	1985	1986	1987	1988	1989	1990	1986∿90	1991	1992
Facilities construction cost	T	170.4		4.6	13.0	289.3	941.9	797.4	498.6	2,540.2	11.0	426.1
	F/C	9.7		3.7	-	162.6	585.4	576.3	338.1	1,662.4	-	285.1
	L/C	160.7		0.9	13.0	126.7	356.5	221.1	160.5	877.8	11.0	141.0
Plant	T			4.6	9.8	253.0	797.4	797.4	214.0	2,071.6	11.0	426.1
	F/C			3.7	-	160.1	576.3	576.3	151.4	1,464.1	-	285.1
	L/C			0.9	9.8	92.9	221.1	221.1	62.6	607.5	11.0	141.0
Final disposal site	T	170.4			3.2	36.3	144.5			184.0		
	F/C	9.7			-	2.5	9.1			11.6		
	L/C	160.7			3.2	33.8	135.4			172.4		
Major repair of the existing compost plant	T								284.6	284.6		
	F/C								186.7	186.7		
	L/C								97.9	97.9		
Land aquisition cost	T.L/C			71.0	327.9					327.9	187.5	
Plant	T.L/C			71.0	283.8					283.8	187.5	
Final disposal site	T.L/C			-	44.1					44.1	-	
Management cost	T	273.8	301.3	324.1	349.5	335.6	343.4	350.2	365.7	1,744.4	377.2	424.9
	F/C	66.6	77.1	80.6	84.0	75.0	79.0	79.8	81.9	399.7	91.3	125.1
	L/C	207.2	224.2	243.5	265.5	260.6	264.4	270.4	283.8	1,344.7	285.9	299.8
Total project cost	T	444.2	301.3	399.7	690.4	624.9	1,285.3	1,147.6	864.3	4,612.5	575.7	851.0
	F/C	76.3	77.1	84.3	84.0	237.6	664.4	656.1	420.0	2,062.1	91.3	410.2
	L/C	367.9	224.2	315.4	606.4	387.3	620.9	491.5	444.3	2,550.4	484.4	440.8
W.P.P	T	270.7	298.2	321.4	423.1	332.5	343.0	357.1	657.2	2,112.9	396.2	423.1
A.S.P	T	173.5	3.1	78.3	267.3	292.4	942.3	790.5	207.1	2,499.6	179.5	427.9

Note: T: Total F/C: Foreign currency L/C: Local currency
W.P.P: Without-project case portion
A.S.P: Additional system portion

Table Ap 6.19(B) Appropriate Master Plan alternative No. 13

(Unit : million Baht)

		1993	1994	1995	1991~95	1996	1997	1998	1999	2000	1996 ~ 2000	Total
Facilities construction cost	T	1,552.9	1,390.6	363.1	3,743.7	45.0	361.7	966.1	836.4	883.2	3,092.4	9,551.3
	F/C	1,038.8	1,028.4	260.6	2,612.9	6.6	194.8	590.6	574.8	407.1	1,773.9	6,062.6
	L/C	514.1	362.2	102.5	1,130.8	38.4	166.9	375.5	261.6	476.1	1,318.5	3,488.7
Plant	T	1,390.6	1,390.6	363.1	3,581.4	45.0	361.7	888.4	836.4	360.6	2,492.1	8,149.7
	F/C	1,028.4	1,028.4	260.6	2,602.5	6.6	194.8	585.6	574.8	204.8	1,566.6	5,636.9
	L/C	362.2	362.2	102.5	978.9	38.4	166.9	302.8	261.6	155.8	925.5	2,512.8
Final disposal site	T	162.3			162.3			77.7		238.0	315.7	832.4
	F/C	10.4			10.4			5.0		15.6	20.6	52.3
	L/C	151.9			151.9			72.7		222.4	295.1	780.1
Major repair of the existing compost plant	T									284.6	284.6	569.2
	F/C									186.7	186.7	373.4
	L/C									97.9	97.9	195.8
Land aquisition cost	T.L/C	23.4		23.2	234.1	38.1	76.8				114.9	747.9
Plant	T.L/C	-		23.2	210.7	38.1	76.8				114.9	680.4
Final disposal site	T.L/C	23.4		-	23.4	-	-				-	67.5
Management cost	T	456.2	510.6	513.0	2,281.9	522.2	555.1	587.1	617.2	649.1	2,930.7	7,856.2
	F/C	144.0	176.8	168.7	705.9	179.8	199.2	215.7	225.2	235.5	1,055.4	2,385.3
	L/C	312.2	333.8	344.3	1,576.0	342.4	355.9	371.4	392.0	413.6	1,875.3	5,470.9
Total project cost	T	2,032.5	1,901.2	899.3	6,259.7	605.3	993.6	1,553.2	1,453.6	1,532.3	6,138.0	18,155.4
	F/C	1,182.8	1,205.2	429.3	3,318.8	186.4	394.0	806.3	800.0	642.6	2,829.3	8,447.9
	L/C	849.7	696.0	470.0	2,940.9	418.9	599.6	746.9	653.6	889.7	3,308.7	9,707.5
W.P.P	T	517.3	488.8	502.1	2,327.5	820.0	521.0	531.8	543.4	849.4	3,265.6	8,596.3
A.S.P	T	1,515.2	1,412.4	397.2	3,932.2	-214.7	472.6	1,021.4	910.2	682.9	2,872.4	9,559.1

Note: T: Total F/C: Foreign currency L/C: Local currency
W.P.P: Without-project case portion
A.S.P: Additional system portion

Table AP 6.19(C) Appropriate Master Plan alternative No. 19-(2)

(Unit : million Baht)

			1993	1994	1995	1991~95	1996	1997	1998	1999	2000	1996 ~ 2000	Total
Facilities construction cost		T	959.9	796.5	206.8	2,208.7	37.7	142.1	300.7	145.4	947.1	1,573.0	6,457.6
		F/C	586.6	576.3	144.0	1,467.0	6.6	52.5	78.6	61.2	293.3	492.2	3,628.3
		L/C	373.3	220.2	62.8	741.7	31.1	89.6	222.1	84.2	653.8	1,080.8	2,829.3
	Plant	T	796.5	796.5	206.8	2,045.3	37.7	142.1	197.4	145.4	183.6	706.2	4,823.1
		F/C	576.3	576.3	144.0	1,456.7	6.6	52.5	72.0	61.2	76.6	268.9	3,189.7
		L/C	220.2	220.2	62.8	588.6	31.1	89.6	125.4	84.2	107.0	437.3	1,633.4
	Final disposal site	T	163.4			163.4			103.3		478.9	582.2	1,065.3
		F/C	10.3			10.3			6.6		30.0	36.6	65.2
		L/C	153.1			153.1			96.7		448.9	545.6	1,000.1
	Major repair of the existing compost plant	T									284.6	284.6	569.2
		F/C									186.7	186.7	373.4
		L/C									97.9	97.9	195.8
Land aquisition cost		T.L/C	45.0		23.2	380.7	15.4	76.8			86.3	178.5	966.2
	Plant	T.L/C	-		23.2	335.7	15.4	76.8			-	92.2	782.7
	Final disposal site	T.L/C	45.0		-	45.0	-	-			86.3	86.3	183.5
Management cost		T	456.2	510.6	513.0	2,281.9	522.3	537.5	568.0	594.1	619.6	2,841.5	7,767.4
		F/C	144.0	176.8	168.7	705.9	180.3	183.4	198.7	205.1	210.0	977.5	2,307.4
		L/C	312.2	333.8	344.3	1,576.0	342.0	354.1	369.3	389.0	409.6	1,864.0	5,460.0
Total project cost		T	1,461.1	1,307.1	743.0	4,871.3	575.4	756.4	868.7	739.5	1,653.0	4,593.0	15,191.2
		F/C	730.6	753.1	312.7	2,172.9	186.9	235.9	277.3	266.3	503.3	1,469.7	5,935.7
		L/C	730.5	554.0	430.3	2,698.4	388.5	520.5	591.4	473.2	1,149.7	3,123.3	9,255.5
	W.P.P	T	517.3	488.8	502.1	2,327.5	820.0	521.0	531.8	543.4	849.4	3,265.6	8,596.3
	A.S.P	T	943.8	818.3	240.9	2,543.8	-244.6	235.4	336.9	196.1	803.6	1,327.4	6,594.9

Note: T: Total F/C: Foreign currency L/C: Local currency
W.P.P: Without-project case portion
A.S.P: Additional system portion

Table Ap 6.19(C) Appropriate Master Plan alternative No. 19-(2)

(Unit : million Baht)

		1983	1984	1985	1986	1987	1988	1989	1990	1986~90	1991	1992
Facilities construction cost	T	155.1		4.6	13.7	288.3	922.8	797.4	494.0	2,516.2	5.2	240.3
	F/C	8.2		3.7	-	162.5	584.0	576.3	334.4	1,657.2	-	160.1
	L/C	146.9		0.9	13.7	125.8	338.8	221.1	159.6	859.0	5.2	80.2
Plant	T			4.6	9.8	253.0	797.4	797.4	209.4	2,067.0	5.2	240.3
	F/C			3.7	-	160.1	576.3	576.3	147.7	1,460.4	-	160.1
	L/C			0.9	9.8	92.9	221.1	221.1	61.7	606.6	5.2	80.2
Final disposal site	T	155.1			3.9	35.3	125.4			164.6		
	F/C	8.2			-	2.4	7.7			10.1		
	L/C	146.9			3.9	32.9	117.7			154.5		
Major repair of the existing compost plant	T								284.6	284.6		
	F/C								186.7	186.7		
	L/C								97.9	97.9		
Land aquisition cost	T.L/C			71.0	336.0					336.0	312.5	
Plant	T.L/C			71.0	283.8					283.8	312.5	
Final disposal site	T.L/C			-	52.2					52.2	-	
Management cost	T	273.8	301.3	324.5	349.5	335.6	343.4	350.2	365.7	1,744.4	377.2	424.9
	F/C	66.6	77.1	80.6	84.0	75.0	79.0	79.8	81.9	399.7	91.3	125.1
	L/C	207.2	224.2	243.9	265.5	260.6	264.4	270.4	283.8	1,344.7	285.9	299.8
Total project cost	T	428.9	301.3	400.1	699.2	623.9	1,266.2	1,147.6	859.7	4,596.6	694.9	665.2
	F/C	74.8	77.1	84.3	84.0	237.5	663.0	656.1	416.3	2,056.9	91.3	285.2
	L/C	354.1	224.2	315.8	615.2	386.4	603.2	491.5	443.4	2,539.7	603.6	380.0
W.P.P	T	270.7	298.2	321.4	423.1	332.5	343.0	357.1	657.2	2,112.9	396.2	423.1
A.S.P	T	158.2	3.1	78.7	276.1	291.4	923.2	790.5	202.5	2,483.7	298.7	242.1

Note: T: Total F/C: Foreign currency L/C: Local currency
W.P.P: Without-project case portion
A.S.P: Additional system portion

Chapter 7 ENVIRONMENTAL IMPACT ASSESSMENT

Appendix 7.1 Present state of the compost plant

Researches of the solid waste composition and emission gas component were made on the attached incinerator of Nong Khaem compost plant in June and July, 1981.

The results are summarized as follows.

(1) Phisical composition of the solid waste

The objective solid waste was the compost residue separated by trommel. This residue was composed of moisture (64%), ash (8%), and combustibles (28%). Eighty percent of the combustibles were trees and grass, textile and plastics, and had an average ignition calorie of 1,145 kcal/kg.

(2) Characteristics of the leachate from the reception pit

The leachate from the reception pit was the condensed organic water which had characteristics of pH 6.5, 23,600 ppm of BOD, 45,800 ppm of residue after evaporation and 24,000 ppm of ignition loss after evaporation.

(3) Characteristics of emission gas

Concentration of NOx of the emitted gas from stack ranged from 30 to 59 ppm (average: 42 ppm), CO was widely ranging from 0.093 to 0.17% (average: 0.14%), but SO_2 was not distinguished.

(4) Characteristics of ash cooling waste water

Ash cooling waste water had a wide range and high contents of pH(10 - 11), BOD (215 - 1,150 ppm), and COD (53 - 334 ppm).

The residue after evaporation showed a high concentration ranging from 5,700 to 1,300 ppm since the applied system was such type that does not discharge waste water outside the facility. This water contained heavy metal extracted from solid waste.

(5) Characteristics of ash

Ignition loss of ash was high (average value was 20.2% including non-combustibles), which indicated that incineration of solid waste was incomplete.

Concentration of alkyl mercury (0.028 mg/kg), cyanide (52 ppm) and organic phosphorus (0.018 mg/L) were relatively high compared to the ordinarily controlled incinerator.

Source: The Bangkok solid waste management study in Thailand, Field investigation report 1981, JICA

Appendix 7.2 Environmental laws and regulations in Thailand

Table AP 7.1 Environmental laws and regulations in Thailand

Laws in Thailand	Environmental factor										Responsible Ministry
	Living env.						Natural env.		Socio-economic env.		
	Air pollution	Water pollution	Noise	Rank odour	Vibration	Waste treatment	Wild life preservation	Aquatic life preservation	Land use	Historical place	
Public Health Act B.E. 2484 (1941)	×	×	×			×			×		MOPH
Factory Act B.E. 2512 (1969)	×	×	×	×	×				×		MOI
Motor Vehicle Act B.E. 2522 (1979)	×		×								MOPH
Act for Land Transport B.E. 2522 (1979)	×										MOC
Act for Medicine B.E. 2510 (1978)	×										MOPH
Notification of the Revolution Party No. 16	×		×								MOInt
Notification of Traffic officials in the Kingdom	×		×								MOInt
Act for Local Administration B.E. 2457 (1914)		×									MOInt
Municipal Act B.E. 2496 (1953)		×									MOInt
Sanitary Act B.E. 2495 (1952)		×									MOInt
Commercial Codes		×					×				MOJ
Criminal Codes		×	×								MOInt/MOJ
Act for the Cleanliness and Orderliness of the Country B.E. 2503 (1960)		×							×		MOInt
Irrigation Act B.E. 2482 (1939)		×							×		MOA/CO
Royal Irrigation Act B.E. 2485 (1942)		×							×		MOA/CO
Act for Water Supply Canal B.E. 2446 (1903)		×							×		MOA/CO
Act for Navigation in Thai Territorial Waters B.E. 2456 (1913)/Amendment B.E. 2522 (1979)		×	×					×	×		MOC
Mining Act B.E. 2461 (1918)		×							×		MOA/CO/MOI
Canal Maintenance Act Ratanakosin Era 121		×									MOA/CO
Communicable Disease Act B.E. 2477 (1934)		×									MOInt/MOPH
Act for Petroleum of Thailand B.E. 2521 (1978)		×						×			MOI
National Parks Act B.E. 2404 (1951)		×					×				MOA/CO
Fishery Act B.E. 2490 (1947)		×						×			MOA
Act for Land Traffic B.E. 2521 (1978)			×								MOPH
Notification of the Harbour Department Dated 21, Feb. 1971			×								MOC
Act for Wild Life Conservation and Protection B.E. 2503 (1960)							×				MOA/CO
Act for Animal Breed Nourishment B.E. 2509 (1966)							×				MOA/CO
Act for Wild Elephant Conservation B.E. 2464 (1921)							×				MOInt
Act for Animal Epidemic B.E. 2499 (1956)							×				MOA/CO
Swallow's Nest Act B.E. 2482 (1939)							×				MOF
Royal Decree Specifying Buildings where Swallow Naturally Builts its Nest as Restricted Area B.E. 2454 (1911)							×				MOA/CO
Act for Ancient Remain, Antique, Art Works, and National Museum B.E. 2504 (1961)										×	MOE
Town and Country Planning Act B.E. 2518 (1975)									×		MOInt
Act for Land Reform for Agriculture B.E. 2518 (1975)									×		MOA/CO
Act for Land Management for Agriculture B.E. 2517 (1974)									×		MOA/CO
Land Code B.E. 2497 (1954)									×		MOInt
Building Control Act B.E. 2522									×		MOI
Act for Industrial Estates of Thailand B.E. 2522 (1979)									×		MOI
Mineral Act B.E. 2510 (1967)									×		MOI
Notification of the Revolution Party No. 655									×		MOC/MOInt

Note :

Abbreviation	Full name
MOPH	Ministry of Public Health
MOInt	Ministry of Interior
MOC	Ministry of Communications
MOJ	Ministry of Justice
MOA/CO	Ministry of Agriculture and Co-operatives
MOF	Ministry of Finance
MOE	Ministry of Education
MOI	Ministry of Industry

7.3 Screening of environmental factors and indicators

Table AP 7.2 Screening of environmental factors and indicators (1)

Legend
× Study was needed.
– Study was not needed.

Environmental phenomena	Environmental factor	Environmental indicator		Facility: Compost plant	Incineration plant	Final disposal site	Collection trucks	Study items (marked with ×): Forecast study	Outline study
Living environment	Air pollution	Ambient air quality	Average concentration (NOx, SOx, dust, HCl, CO)	×	×	×	×	Diffusion of emission gas	
			Occurence of high concentration	×	×	×	–	Maximum concentration & location	
			Conformity to standards	–	–	–	–		×
		Emission volume	Fixed source	×	×	×	–	Emission volume	
			Mobile source	–	–	–	×	-do-	
	Water pollution	Water quality							
		River bed quality – toxic substances		–	–	–	–		×
		Discharge	Discharge source	×	×	×	–	Discharge volume	
			Discharge volume	×	×	×	–		
	Noise, vibration	Fixed source		×	×	×	–	Influence of main sources	
		Mobile source		–	–	–	×	Noise level caused by trucks	
	Low frequency air vibration	Sound pressure level		×	×	–	–	Vibration caused by operation of facility	
	Rank odour	Concentration of odour substances		×	×	×	–	Diffusion of substances	
	Soil contamination	Concentration of substances		×	×	×	–	Influence of leachate	
		Source		–	–	–	–		
	Land subsidence	Amount of subsidence		–	–	×	–	Subsidence on the boundary	
		Movement of standard leveling point		–	–	–	–		
	Obstruction against sunshine	Shadow		×	×	–	–	Duration of shadow	
	Electric wave obstruction	TV electric wave obstruction		×	×	×	–	Obstruction by buildings	
	Wind damage	Change of wind velocity caused by building		×	×	×	–	Influence by buildings	
	Hot effluent	Hot water effluent		–	–	–	–		
	People's complaint	Complaint raised by resident		–	–	–	–		×
	Health	Health indicator	Death rate	–	–	–	–		
			Baby death rate	–	–	–	–		
			Pupil's health	–	–	–	–		
		Level of health	Disease rate of respiratory organs	–	–	–	–		
			Heavy metal accumulated in body	–	–	–	–		
			Number of patient	–	–	–	–		
	Traffic	Road traffic safety facilities		–	–	–	×		×
		Traffic volume		–	–	–	×	Volume of collection trucks	
		Public transportation		–	–	–	–		
		Traffic accident		–	–	–	–		
	Disaster	Earthquake		–	–	–	–		
		Fire		–	–	×	–	Natural fire	
	Treatment refuse Sanitation	Secondary influence		×	×	×	–	Decomposition and vector	
		Scattering of solid waste		–	–	–	–		
	Water usage	Fishery		–	–	–	–		
		Consumption	Fresh water	–	–	–	–		
			Industry	–	–	–	–		
		Irrigation		–	–	–	–		
	Severage	Severage system		–	–	–	–		
		Discharge volume	Resident	–	–	–	–		
			Industry	–	–	–	–		
Natural environment	Geology	Topography	Surface feature	×	×	×	–	Change of ground surface	
		Geology	Stratum	–	–	–	–		×
		Ground	Permiability	–	–	×	–	Time length to permiate	
			N value, landslide	–	–	–	–		
		Soil		–	–	–	–		×
	Hydrology	River	Basin feature	–	–	–	–		×
			Flow volume, water quality	–	–	–	–		×
			Bank structure	–	–	–	–		
			Water usage	–	–	–	–		×
			Water disaster	–	–	–	–		×
		Pond	Water volume, surface area	–	–	–	–		
			Water usage	–	–	–	–		×
		Ground water	Water level, quality	–	–	–	–	Pollution by leachate	×
			Water usage	–	–	–	–		
	Sea	Seashore, seabed		–	–	–	–		
		Tide		–	–	–	–		
		Disaster		–	–	–	–		

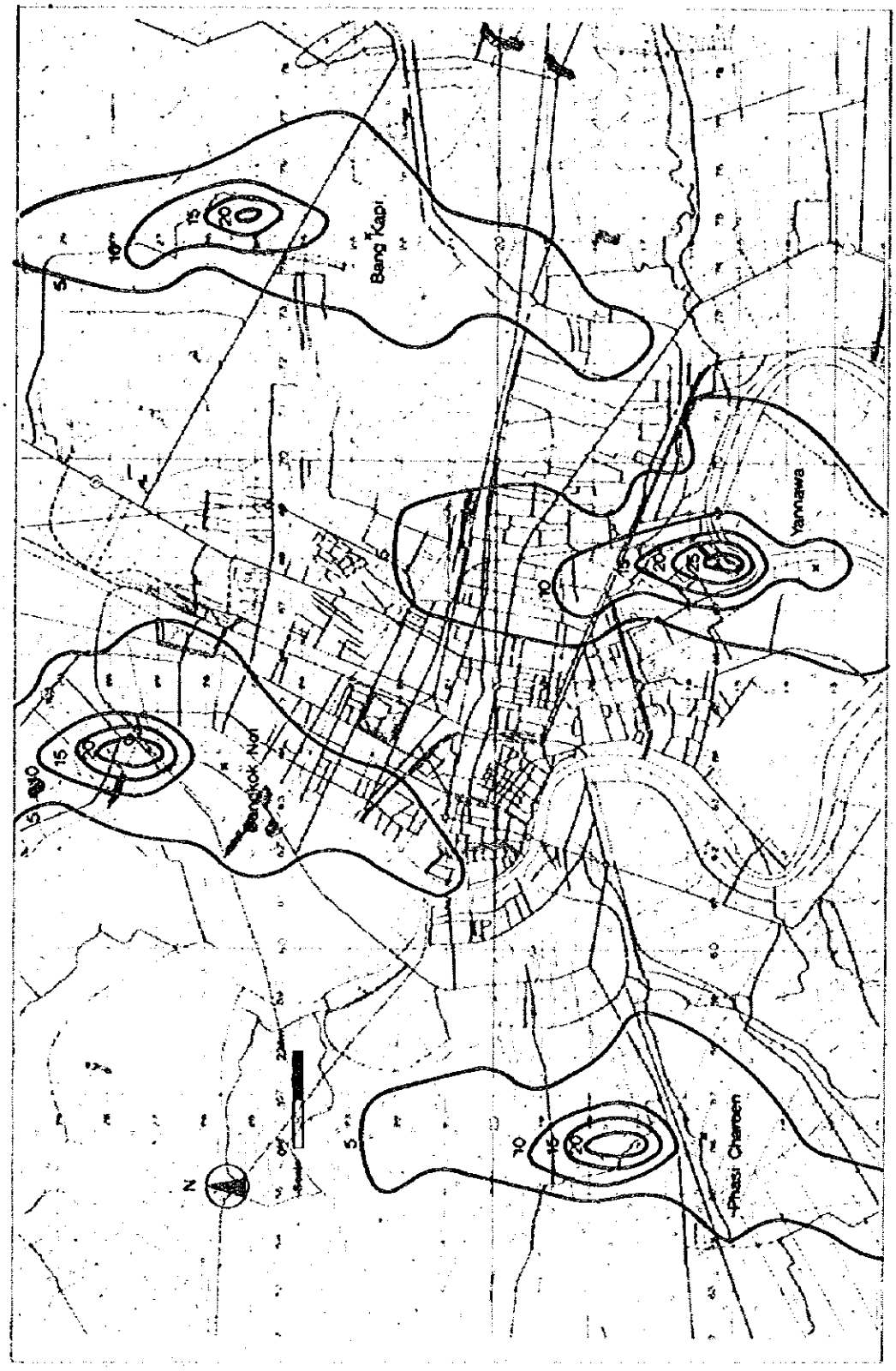
Table AP 7.2 Screening of environmental factors and indicators (2)

Environmental phenomena	Environmental factor	Environmental indicator		Facility: Compost plant	Facility: Incineration plant	Facility: Final disposal site	Facility: Collection trucks	Study items: Forecast study	Study items: Outline study
Natural environment	Climate	Wind direction & speed, temperature, humidity		-	-	-	-		x
		Rainfall		-	-	-	-		x
		Number of fine days and cloudy days per year		-	-	-	-		
		Sunshine		-	-	-	-		
		Stability		-	-	-	-		
		Typhoon		-	-	-	-		
	Ecology	Flora	Important species	x	x	x	-	Loss of plants	
			Existing grass and tree	x	x	x	-	Identification of plants	
			Potential vegetation	-	-	-	-		
			Plant coverage	-	-	-	-		
		Fauna	Important species	x	x	x	-	Loss of wild animal	
			Existing birds and wild animal	x	x	x	-	Identification of kinds	
		Aquatic life	Economic fish	-	-	-	-	Fishery	
			Aquatic life	-	-	-	-	Damage on aquatic life	
	Important nature	Special land feature and geology		-	-	-	-		x
		Historical place		-	-	-	-		x
		Bird sanctuary		-	-	-	-		
	Aesthetics	Landscape		x	x	x	-	Existing and future state	
Socio-economic industry	History & culture	Historical place, buried treasures		x	x	x	-		x
		Historical building		x	x	x	-		x
		Cultural assets		-	-	-	-		
	Crime	Occurence of crime		-	-	-	-		
	Employment	Employment opportunity		x	x	x	x	Influence on employment	
	Life consciousness	life consciousness		-	-	-	-		
	Land use	Restriction on land use, land value		x	x	x	-	Change of land use and value	
		Land use planning		x	x	x	-	Identify existing planning	
	Population	Distribution and density		x	x	x	-		
		Population change in daytime and night		-	-	-	-		
	Community	Community facility (hospital, school, etc.)		x	x	x	-		x
		Community structure		-	-	-	+		
	Industry	Primary	Number of farmers	-	-	-	-		
			Farm area	-	-	-	-		x
			Livestock	-	-	-	-		
		Secondary	Industrial area, location, employee	-	-	-	-		x
			Product	-	-	-	-		x
			Energy consumption	-	-	-	-		
		Tertiary	Business area, location	-	-	-	-		
			Trade	-	-	-	-		
		Industrial structure		x	x	x	x	Influence on structure	

Appendix 7.4 Dispersion of pollutant

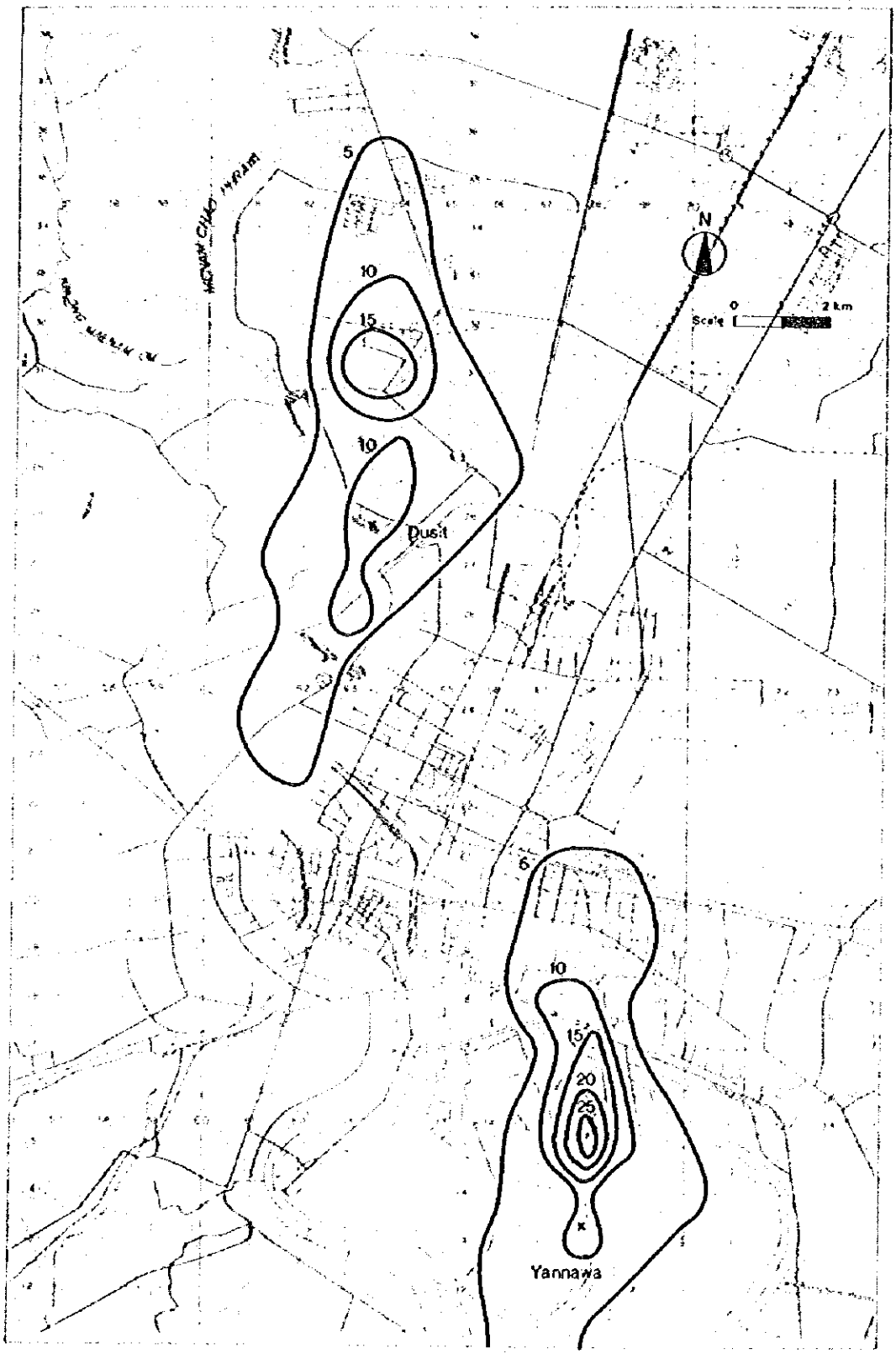
(1) Case No. 13 (Stack height 60 m)

Fig. AP 7.1 Concentration of HCl (ppb)



(2) Case No. 19-(2) (Stack height = 60 m)

Fig. AP 7.2 Concentration of HCl (ppb)



(3) Case No. 19-(2) (Stack height 100 m)

i) Air pollution on the ground

Air pollution caused by the 100 m high stacks of the incineration plants were forecast with respect to the Case No. 19-(2). The concentration of the pollutants were almost half of those calculated with the 60 m high stack. (Ref. Table Ap 7.3)

Table AP 7.3 Comparison of air pollution

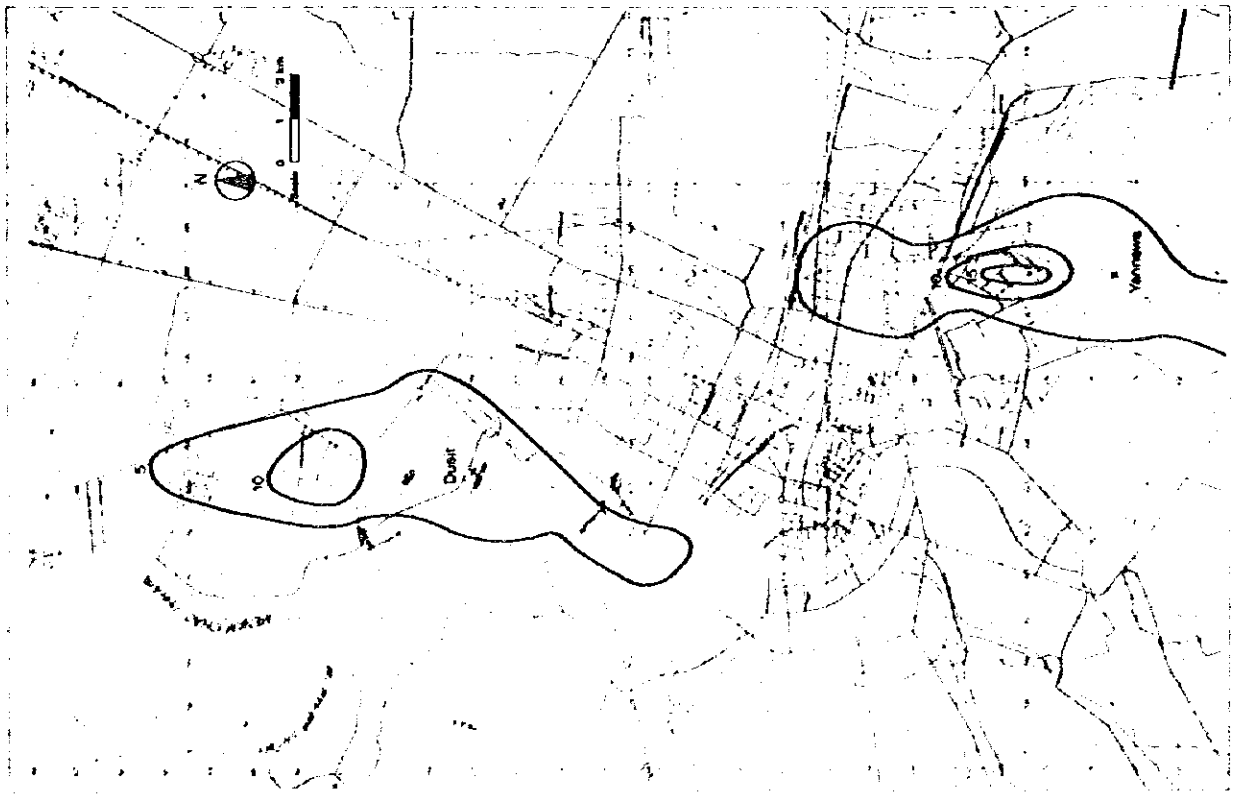
Height of stacks(m)	Pollutants				
	HCl(ppm)	SOx(ppm)	NOx(ppm)	CO(ppm)	Dust(mg/m^3)
100	0.017	0.001	0.003	0.001	0.002
60	0.029	0.002	0.006	0.002	0.004

The maximum concentration was estimated to occur 2 km north of Yannawa for both cases.

ii) Map of air pollution

The contour lines of air pollution (HCl) were shown in Fig. Ap 7.3.

Fig. AP 7.3 Concentration of HCl



Appendix 7.5 Restriction of land use around the solid waste treatment facilities

(1) Incinaration plant

i) Environmental impact caused by the incineration plant was assessed not remarkable under normal condition of climate and operation. However, under some specific condition such as strong wind, the residents in a building which is as high as the stack would be influenced by emitted gas if it is placed near the plant. Therefore, construction of tall buildings should be restricted near the plant. Similarly, the plant cannot be built near the buildings which are as tall as the stack.

ii) Construction of facilities which attract vehicles such as truck and bus terminals and wholesale markets should be restricted near the plant because these vehicles and the collection trucks may cause traffic congestion.

When the plant is built facing a narrow road without footpath, construction of kindergartens and schools near the plant should also be restricted for children's safety.

iii) High class residential areas should not be developed near the plant. Medium and tall residences and offices, or business districts will neither be developed around the site.

(2) Compost plant

i) Rank odour from the compost plant will be the outstanding item of environmental influence, especially when the compost product or compost residue is piled up on the ground, or when the landfill site of compost reject and a compost plant are constructed nearby. Therefore, construction of compost plant in the city areas should be restricted.

ii) Traffic conditions will be the same as mentioned in ii) of the incineration plant above.

(3) Landfill site

i) Rank odour from the landfill site is not completely avoidable even landfill is covered with soil: when the wind is strong, light solid waste pieces, dust, soil and pesticide may be diffused. Occurrence of spontaneous fire is possible at the landfill site; so, landfill site should not be constructed in the city area.

ii) Traffic conditions will be the same as ii) of the incineration plant above.

Appendix 7.6 Regional development in the areas around the solid waste treatment facilities

Construction of the incineration plants of Yannawa, Dusit and Bangkok Noi are proposed in the city areas along the main roads; Rujjadapi Seag Rd., Piboon Song Karm Rd., and Charansanit Wong Rd. respectively. Therefore, their new road network is expected to contribute to regional development somewhat.

Bang Kapi incineration plant will be located between Lat Prao Rd. and Phrakanong Bangkapi Rd., from 1 to 2 km away from them. Construction of the plant will contribute to regional development through provision of convenience if the access road from the main roads to the site is expanded. Construction of the incineration plant of Phasi Charoen will help promote development of the surrounding areas provided Petch Kasen Rd. (located to the north of Khlong Phasi Charoen) is connected to Talard Poo Rd. (located to the south of the same Khlong).

Taling Chan compost plant will be constructed in the agricultural area. The number of workers of this plant was estimated to be about 300. Restaurants and small retail shops which serve the workers are expected to be built, that will help development of the surrounding areas.

Compost plant of Bang Khun Tian will be small in size and the number of the workers is estimated to be only 130. The plant will be located close to the city areas and new town. Accordingly, contribution to regional development by this plant is not expectable.

Appendix 7.7 Share of the university graduate engineers in solid waste management

According to the Labor Force Survey (1977), share of employees in a whole population was 41.2%; 6.7% of which were the professional, technical and the related workers. The number of workers of these categories were estimated to be 1,866,000. From these figures the Study team estimated population in the year 2000 to be 67,600,000. Assuming that 10% of these categories are the mechanics, electricians and chemists, their number is estimated 187,000. The number of engineers who will be engaged in solid waste management was calculated to be 43 to 85 or 0.02 to 0.05% of these engineers. The number of university graduates who are engaged in engineering was 2,089 in 1978. The graduates of the same major in the future is forecast from the following equation.

$$y = -4,389 + 0.1408x \quad (r = 0.8188)$$

(Based on the data from 1975 to 1978)

where, y = Number of university graduates who are engaged in engineering

x = Population of Thailand (1,000 persons)

The result of the forecast indicates that the total number of 78,000 will graduate from engineering course of university during the period from 1975 to the year 2000. (Ref. Table Ap 7.4)

Table AP 7.4 University graduate from engineering course

Year	University graduate from engineering course
1980	2,220
1985	2,960
1990	3,680
1995	4,410
2000	5,130
Total (1975-2000)	78,000

Estimated by the Study team

Provided that 40% of the total graduate (78,000) are from mechanical, electric and chemical courses, the number of engineers of these fields was estimated to be 31,000. The estimated share of the engineers employed in the solid waste management in the number of the university graduates is shown in Table AP 7.5.

Table AP 7.5 University graduate engineers in solid waste management

Case No.	9	13	19-(2)
Required number of university graduate engineers in the solid waste management in the year 2000. [person]	43	85	63
Share in the total number of university graduate engineers in the period of 1975 to 2000. [%]	0.13	0.27	0.20

Estimated by the Study team.

Appendix 7.8 Evaluation of environmental factor

Table AP 7.6 Evaluation table (Case No. 9)

Environmental factor		New compost plant						Final disposal site & Existing compost plant						Collection trucks		
		Plant			Landfill site			Final disposal site			Exist. compost plant			Traffic		
		Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade
		E4	W2	E3	E4	W2	E3	E4	W2	E3	E4	W2	E3	E4	W2	E3
Living environment	Air pollution	0	0.2	0	0	0.2	0	0	0.2	0	0.36	0.2	1.8	0.2	0.2	1.0
	Water pollution	0	0.2	0	0.3	0.2	1.5	0.4	0.2	2.0	0	0.2	0	0	0.2	0
	Noise	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.2	0.1	2.0
	Vibration	0	0.05	0	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0.1	0.05	2.0
	Rank odour	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.2	0.1	2.0
	Soil contamination	0	0.05	0	0.05	0.05	1.0	0.05	0.05	1.0	0	0.05	0	0	0.05	0
	Land subsidence	0	0.05	0	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0	0.05	0
	Low frequency air vibration	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0
	Obstruction against sunshine	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0
	Wind damage	0.03	0.03	1.0	0	0.03	0	0.03	0.03	1.0	0.03	0.03	1.0	0	0.03	0
	Electric wave obstruction	0.03	0.03	1.0	0	0.03	0	0	0.03	0	0.03	0.03	1.0	0	0.03	0
	Treatment residue	0.03	0.03	1.0	0.03	0.03	1.0	0.06	0.03	2.0	0.03	0.03	1.0	0	0.03	0
	Traffic	0	0.05	0	0	0.05	0	0	0.05	0	0	0.05	0	0.1	0.05	2.0
	Fire	0	0.05	0	0.05	0.05	1.0	0.1	0.05	2.0	0	0.05	0	0	0.05	0
Natural environment	Topography and geology	0	0.2	0	0.2	0.2	1.0	0.4	0.2	2.0	0	0.2	0	0	0.2	0
	Groundwater	0	0.1	0	0.1	0.1	1.0	0.2	0.1	2.0	0	0.1	0	0	0.1	0
	Aesthetics	0.2	0.1	2.0	0.2	0.1	2.0	0.2	0.1	2.0	0.1	0.1	1.0	0	0.1	0
	Flora	0.2	0.2	1.0	0.2	0.2	1.0	0.2	0.2	1.0	0	0.2	0	0	0.2	0
	Fauna	0.2	0.2	1.0	0.2	0.2	1.0	0.2	0.2	1.0	0	0.2	0	0	0.2	0
	Aquatic life	0.2	0.2	1.0	0.2	0.2	1.0	0.2	0.2	1.0	0	0.2	0	0	0.2	0
Socio-economic environment	Historic peace & cultural assets	0	0.2	0	(Included in plant)			0	0.2	0	(Included in Final disposal site)			0	0.2	0
	Land use	0.4	0.4	1.0				0.8	0.4	2.0				0	0.4	0
	Industry	0.2	0.2	1.0				0.2	0.2	1.0				0.2	0.2	1.0
	Employment	0	0.2	0				0	0.2	0				0	0.2	0

Table AP 7.7 Evaluation table (Case No. 13)

Environmental factor		New compost plant						Incineration plant						Final disposal site & Existing compost plant						Collection trucks		
		Plant			Landfill site			Plant			Landfill site			Final disposal site			Exist. compost plant			Traffic		
		Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade
		E4	W2	E3	E4	W2	E3	E4	E2	E3	E4	W2	E3	E4	W2	E3	E4	W2	E3	E4	W2	E3
Living environment	Air pollution	0	0.2	0	0	0.2	0	0.2	0.2	1.0	0	0.2	0	0	0.2	0	0.36	0.2	1.8	0.2	0.2	1.0
	Water pollution	0	0.2	0	0.3	0.2	1.5	0.3	0.2	1.5	0	0.2	0	0.4	0.2	2.0	0	0.2	0	0	0.2	0
	Noise	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0
	Vibration	0	0.05	0	0	0.05	0	0	0.05	0	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0.05	0.05	1.0
	Rank odour	0.1	0.1	1.0	0.1	0.1	1.0	0	0.1	0	0	0.1	0	0.1	0.1	1.0	0.1	0.1	1.0	0.2	0.1	2.0
	Soil contamination	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0	0.05	0
	Land subsidence	0	0.05	0	0	0.05	0	0	0.05	0	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0	0.05	0
	Low frequency air vibration	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0
	Obstruction against sunshine	0	0.03	0	0	0.03	0	0.03	0.03	1.0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0
	Wind damage	0.03	0.03	1.0	0	0.03	0	0.03	0.03	1.0	0	0.03	0	0.03	0.03	1.0	0.03	0.03	1.0	0	0.03	0
	Electric wave obstruction	0.03	0.03	1.0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0	0.03	0.03	1.0	0	0.03	0
	Treatment residue	0.03	0.03	1.0	0.03	0.03	1.0	0.03	0.03	1.0	0	0.03	0	0.06	0.03	2.0	0.03	0.03	1.0	0	0.03	0
	Traffic	0	0.05	0	0	0.05	0	0	0.05	0	0	0.05	0	0	0.05	0	0	0.05	0	0.1	0.05	2.0
	Fire	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0	0.05	0
Natural environment	Topography and geology	0	0.2	0	0.2	0.2	1.0	0	0.2	0	0	0.2	0	0.2	0.2	1.0	0	0.2	0	0	0.2	0
	Groundwater	0	0.1	0	0.1	0.1	1.0	0	0.1	0	0	0.1	0	0.2	0.1	2.0	0	0.1	0	0	0.1	0
	Aesthetics	0.2	0.1	2.0	0.2	0.1	2.0	0.1	0.1	1.0	0.1	0.1	1.0	0.2	0.1	2.0	0.1	0.1	1.0	0	0.1	0
	Flora	0.2	0.2	1.0	0.2	0.2	1.0	0.2	0.2	1.0	0	0.2	0	0.2	0.2	1.0	0	0.2	0	0	0.2	0
	Fauna	0.2	0.2	1.0	0.2	0.2	1.0	0.2	0.2	1.0	0	0.2	0	0.2	0.2	1.0	0	0.2	0	0	0.2	0
	Aquatic life	0.2	0.2	1.0	0.2	0.2	1.0	0.2	0.2	1.0	0	0.2	0	0.2	0.2	1.0	0	0.2	0	0	0.2	0
Socio-economic environment	Historic peace & cultural assets	0	0.2	0	Included in plant			0	0.2	0	Included in plant			0	0.2	0	Included in Final disposal site			0	0.2	0
	Land use	0.4	0.4	1.0				0.4	0.4	1.0				0.8	0.4	2.0				0	0.4	0
	Industry	0.2	0.2	1.0				0.2	0.2	1.0				0.2	0.2	1.0				0.2	0.2	1.0
	Employment	0	0.2	0				0	0.2	0				0	0.2	0				0	0.2	0

Table AP 7.8 Evaluation table (Case No. (9-(2))

Environmental factor		New compost plant						Incineration plant						Final disposal site & Existing compost plant						Collection trucks		
		Plant			Landfill site			Plant			Landfill site			Final disposal site			Exist. compost plant			Traffic		
		Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade
		E4	W2	E3	E4	W2	E3	E4	E2	E3	E4	W2	E3	E4	W2	E3	E4	W2	E3	E4	W2	E3
Living environment	Air pollution	0	0.2	0	0	0.2	0	0.2	0.2	1.0	0	0.2	0	0	0.2	0	0.36	0.2	1.8	0.2	0.2	1.0
	Water pollution	0	0.2	0	0.3	0.2	1.5	0.3	0.2	1.5	0	0.2	0	0.4	0.2	2.0	0	0.2	0	0	0.2	0
	Noise	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0	0.2	0.1	2.0
	Vibration	0	0.05	0	0	0.05	0	0	0.05	0	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0.1	0.05	2.0
	Rank odour	0.1	0.1	1.0	0.1	0.1	1.0	0	0.1	0	0	0.1	0	0.1	0.1	1.0	0.1	0.1	1.0	0.2	0.1	2.0
	Soil contamination	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0	0.05	0
	Land subsidence	0	0.05	0	0	0.05	0	0	0.05	0	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0	0.05	0
	Low frequency air vibration	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0
	Obstruction against sunshine	0	0.03	0	0	0.03	0	0.03	0.03	1.0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0
	Wind damage	0.03	0.03	1.0	0	0.03	0	0.03	0.03	1.0	0	0.03	0	0.03	0.03	1.0	0.03	0.03	1.0	0	0.03	0
	Electric wave obstruction	0.03	0.03	1.0	0	0.03	0	0	0.03	0	0	0.03	0	0	0.03	0	0.03	0.03	1.0	0	0.03	0
	Treatment residue	0.03	0.03	1.0	0.03	0.03	1.0	0.03	0.03	1.0	0	0.03	0	0.06	0.03	2.0	0.03	0.03	1.0	0	0.03	0
	Traffic	0	0.05	0	0	0.05	0	0	0.05	0	0	0.05	0	0	0.05	0	0	0.05	0	0.1	0.05	2.0
	Fire	0	0.05	0	0.05	0.05	1.0	0	0.05	0	0	0.05	0	0.1	0.05	2.0	0	0.05	0	0	0.05	0
Natural environment	Topography and geology	0	0.2	0	0.2	0.2	1.0	0	0.2	0	0	0.2	0	0.4	0.2	2.0	0	0.2	0	0	0.2	0
	Groundwater	0	0.1	0	0.1	0.1	1.0	0	0.1	0	0	0.1	0	0.2	0.1	2.0	0	0.1	0	0	0.1	0
	Aesthetics	0.2	0.1	2.0	0.2	0.1	2.0	0.1	0.1	1.0	0.1	0.1	1.0	0.2	0.1	2.0	0.1	0.1	1.0	0	0.1	0
	Flora	0.2	0.2	1.0	0.2	0.2	1.0	0.2	0.2	1.0	0	0.2	0	0.2	0.2	1.0	0	0.2	0	0	0.2	0
	Fauna	0.2	0.2	1.0	0.2	0.2	1.0	0.2	0.2	1.0	0	0.2	0	0.2	0.2	1.0	0	0.2	0	0	0.2	0
	Aquatic life	0.2	0.2	1.0	0.2	0.2	1.0	0.2	0.2	1.0	0	0.2	0	0.2	0.2	1.0	0	0.2	0	0	0.2	0
Socio-economic environment	Historic peace & cultural assets	0	0.2	0	(Included in plant)			0	0.2	0	(Included in plant)			0	0.2	0	(Included in Final disposal site)			0	0.2	0
	Land use	0.4	0.4	1.0				0.4	0.4	1.0				0.8	0.4	2.0				0	0.4	0
	Industry	0.2	0.2	1.0				0.2	0.2	1.0				0.2	0.2	1.0				0.2	0.2	1.0
	Employment	0	0.2	0				0	0.2	0				0	0.2	0				0	0.2	0

Table AP 7.9 Evaluation table (without-project case)

Environmental factor		Final disposal site & Existing compost plant						Collection trucks		
		Final disposal site			Exist. compost plant			Traffic		
		Point	Weight	Grade	Point	Weight	Grade	Point	Weight	Grade
		E4	W2	F3	E4	W2	E3	E4	W2	E3
Living environment	Air pollution	0	0.2	0	0.36	0.2	1.8	0.2	0.2	1.0
	Water pollution	0.6	0.2	3.0	0.6	0.2	3.0	0	0.2	0
	Noise	0.1	0.1	1.0	0.1	0.1	1.0	0.1	0.1	1.0
	Vibration	0.05	0.05	1.0	0	0.05	0	0.05	0.05	1.0
	Rank odour	0.1	0.1	1.0	0.1	0.1	1.0	0.2	0.1	2.0
	Soil contamination	0.05	0.05	1.0	0.05	0.05	1.0	0	0.05	0
	Land subsidence	0.05	0.05	1.0	0	0.05	0	0	0.05	0
	Low frequency air vibration	0	0.03	0	0	0.03	0	0	0.03	0
	Obstruction against sunshine	0	0.03	0	0	0.03	0	0	0.03	0
	Wind damage	0.03	0.03	1.0	0.03	0.03	1.0	0	0.03	0
	Electric wave obstruction	0	0.03	0	0.03	0.03	1.0	0	0.03	0
	Treatment residue	0.09	0.03	3.0	0.09	0.03	3.0	0	0.03	0
	Traffic	0	0.05	0	0	0.05	0	0.1	0.05	2.0
	Fire	0.15	0.05	3.0	0	0.05	0	0	0.05	0
Natural environment	Topography and geology	0.2	0.2	1.0	0	0.2	0	0	0.2	0
	Groundwater	0.3	0.1	3.0	0	0.1	0	0	0.1	0
	Aesthetics	0.3	0.1	3.0	0.1	0.1	1.0	0	0.1	0
	Flora	0.2	0.2	1.0	0	0.2	0	0	0.2	0
	Fauna	0.2	0.2	1.0	0	0.2	0	0	0.2	0
	Aquatic life	0.2	0.2	1.0	0	0.2	0	0	0.2	0
Socio-economic environment	Historic peace & cultural assets	0	0.2	0	(Included in Final disposal site)			0	0.2	0
	Land use	0.8	0.4	2.0				0	0.4	0
	Industry	0.2	0.2	1.0				0.2	0.2	1.0
	Employment	0	0.2	0				0	0.2	0

Chapter 8 OPTIMUM MASTER PLAN AND ITS IMPLEMENTATION SCHEDULE

Appendix 8.1 Evaluation from technological viewpoint

(1) Grade of technical advancement

Individual disposal method was evaluated through the scoring method concerning the grade of technical advancement, which means viewpoints such as treatment effect, environmental protection, operation efficiency and sanitation control.

The result of evaluation is shown in the following table with the rating of four grades. (The highest value is the best one.)

Disposal method (k)	Rating (A_k)
Slag incineration, Pyrolysis, RDF, Methane production by anaerobic fermentation, Pulp recovery, Pipeline collection and transport system, Incineration (electric power recovery type), Aerobic landfill	3
Incineration (without electric power recovery), Composting, Materials recovery	2
Sanitary landfill	1
Open dump	0

The score of the appropriate masterplan alternative regarding the grade of technical advancement was calculated through weighted arithmetic mean of the scores of individual disposal methods contained in the alternative applying the rate of the volume of individual disposal methods to the total disposal volume.

$$C = \Sigma P_k A_k$$

where, C = Score of the appropriate Master Plan alternative

P_k = Rate of the volume of individual disposal methods (k) to the total volume (in the year 2000)

A_k = Rating of an individual disposal method (k) (shown in the aforementioned table)

Table of P_k value (in the year 2000)

Case No.	Disposal method				
	Open dump	Sanitary landfill	Existing compost plant	New compost plant	Incineration plant (electric power recovery)
9	-	0.654	0.202	0.144	-
13	-	-	0.202	0.144	0.654
19-(2)	-	0.112	0.202	0.144	0.542
W/O	0.798	-	0.202	-	-

C is determined as following table.

Case No.	9	13	19-(2)	W/O
C	1.346	2.654	2.430	0.202

On the basis of the score C, the relative score S compared with the score of the without-project (W/O) case was given as shown in the following table, giving the rating of 3 to the score C of the W/O case, 1 to the lowest C and 5 to the highest C.

Case No.	9	13	19-(2)
S	4	5	5

(2) Reliability of solid waste disposal method

i) Reliability of disposal method

Considering the operation rate, use of the method in the past and ease of operation and maintenance, the reliability of individual disposal methods was evaluated. The result of the evaluation is shown through the scoring method in the following table.

Disposal method (k)	Evaluation parameter						Basic score (D_k) weighted arithmetic mean
	Operation rate		Use in the past		Ease of operation and maintenance		
	%	Rating		Rating		Rating	
Incineration (electric power recovery type)	80	3	lots	5	fair	3	3.7
Incineration (without electric power recovery)	85	4	lots	5	easy	4	4.3
Compost	85	4	lots	5	easy	4	4.3
Sanitary landfill	100	5	lots	5	very easy	5	5
Open dump	100	5	lots	5	very easy	5	5
Pyrolysis	80	3	a few	4	difficult	2	3
Slag incineration	80	3	a few	4	difficult	2	3
Other new technics	80	3	few	3	difficult	2	2.7
Pulverization and classification	80	3	a few	4	easy	4	3.7
Weight	1/3		1/3		1/3		-

Note: Rating is composed of 1, 2, 3, 4 and 5.

The score of the appropriate Master Plan alternatives (C_1) was calculated through the following equation.

$$C_1 = \Sigma P_k D_k$$

C_1s are determined as shown in the following table and the relative scores (S_1) compared with the score of the without-project case calculated through the same procedure as shown in the paragraph (1) are also shown in the table.

Case No.	9	13	19-(2)	W/O
C_1	4.76	3.91	4.05	4.86
S_1	3	3	3	3

ii) Number and capacity of facilities

Capacities of intermediate treatment facilities were properly determined in every masterplan alternative (no extremely large plant).

When a unit (or furnace) is not in use for some reason, the solid waste volume of its capacity has to be hauled to other destination such as a landfill site.

From this viewpoint, the appropriate Master Plan alternative was examined about the appropriateness of distribution of number and capacity.

Mean capacities of units in the facilities by Master Plan alternative are shown in the following table.

Case No.	9	13	19-(2)	W/O
Mean unit capacity (t/d)	320	390	410	280

Considering the impact of destination change on the solid waste collection operation, mean unit capacity is disired to be within 20% of total collection volume. Relative scores (S_2) of the appropriateness of capacity was calculated based on the criteria that rating 1 is given to the alternative with the mean capacity of around 1,100 tons per day and the rating 3 to the without-project case. The scores are shown in the following table.

Case No.	9	13	19-(2)	W/O
S_2	3	3	3	3

iii) Final evaluation

Both evaluation items {i) and ii)} are equally important. Therefore, final relative scores (S) of the appropriate Master Plan alternatives were calculated by simply averaging the scores of S_1 and S_2.

Final relative scores are shown in the following table.

Case No.	9	13	19-(2)	W/O
S	3	3	3	3

(3) Variety of disposal method

i) Number of kinds of disposal methods

Although it is preferable to have more kinds of disposal methods, to use too many kinds of disposal methods doesn't produce much more resultant effect composing the advantages of each disposal method.

Therefore, five is the maximum number of kinds. Score as shown in the following table is given to the number of kinds of disposal methods.

Number of kinds of disposal methods	1	2	3	4	5	6 or more
Rating	1	2	3	4	5	5

Note: Range of rating is 1 to 5 and the best gets the highest rating.

Score of each alternative (A) is shown in the following table.

Case No.	9	13	19-(2)	W/O
Number of kinds of disposal methods	2	2	3	2
A	2	2	3	2

ii) Appropriatness of disposal volume by each disposal method

Although the number of kinds of disposal methods is the same, the effect produced by the variety of the disposal methods is reduced. For instance, suppose the case where the number of kinds of the disposal methods is two and the collected volume of solid waste is equally allocated to both kinds of means and the other case where the number of kinds of disposal methods is the same two but 95% of collected volume is allocated to one method and the rest 5% to the other method, the difference between the two cases is considerably different. In the latter case, the number two is, in reality, close to the number one.

In order to evaluate these differences, the score obtained in the paragraph i) should be adjusted by the following equation.

$$C = A + V$$

$$V = 1 - \text{Max.}\left(\frac{|M - G/n|}{G - G/n} \right)$$

where, C = Score of the alternative concerning the variety

M = Maximum disposal volume by method (t/d)

G = Collected volume (t/d)

n = Number of kinds of disposal methods

A = Score obtained in i)

V = Additional score for the adjustment (range: (0, 1))

Scores (C) are shown in the following table.

Case No.	9	13	19-(2)	W/O
C	2.693	2.693	3.667	2.404

iii) Final evaluation

Relative scores (S) compared with the without-project case were calculated in the manner similar to the preceding section (1) and the results are shown in the following table.

Case No.	9	13	19-(2)	W/O
S	3	3	4	3

(4) Inactivation

From the viewpoint of inactivation of solid waste, individual methods were evaluated and the results were expressed in scores as shown in the following table.

Process residue	Rating (B_k)	Disposal method (k)
Slag	5	Slag incineration
Incineration residue	4	Incineration
Compost residue	3	Compost
Crushed materials	2	Pulverization and classification
Solid waste (covered with soil)		Sanitary landfill
Solidified materials by cement	1	Hazardous substance treatment
Solid waste		Open dump
Char	0	Halfprocessed residue by pyrolysis

Scores (C) of the appropriate Master Plan alternatives expressing the effect of inactivation were calculated as the weighted arithmetic mean of the scores of individual disposal methods contained in the alternative applying the rate of the volume of the individual disposal methods to the total disposal volume in the manner similar to the section (1). Relative scores (S) are also shown in the same table in the manner similar to the section (1).

Case No.	9	13	19-(2)	W/O
C	2.35	4.00	3.43	1.40
S	3	5	4	3

(5) Volume reduction

Reduction percentage is defined by the following equation.

$$\varepsilon = 100 \cdot \frac{V_a}{V_c}$$

where, ε = Volume reduction [%]

V_a = Volume of residue after processing one ton solid waste as disposed-of basis [m^3]

V_c = Volume of one ton solid waste as collection-site basis [m^3]

Values of ε are shown in the following table.

Disposal method (k)	Reduction percentage (ε_k) [%]
Existing compost	5.2
Aerobic compost	11.2
Incineration	5.8
Sanitary landfill	25.5
Open dump	23.2
Slag incineration	4.4

Volume reduction (E) achieved by each appropriate Master Plan alternative was calculated as the weighted arithmetic mean applying the rate of disposal volume of individual disposal methods to the total disposal volume by the following equation.

$$E = \Sigma P_k \varepsilon_k$$

Case No.	9	13	19-(2)	W/O
Volume reduction percentage (E) [%]	19.3	6.5	8.7	19.6

Relative scores (S) determined by adjusting E in the manner similar to the section (1) are shown in the following table.

Case No.	9	13	19-(2)	W/O
S	3	5	5	3

(6) Resource recovery

Resource recovery of individual disposal methods was evaluated and the results were shown with the rating of score method in the following table.

Disposal method (k)	Recovered resource	Rating (A_k)
Incineration (water wall type)	electricity, steam, hot water	2
Pyrolysis	electricity, fuel gas, fuel oil	2
Slag incineration	electricity, fuel gas, stone and sand, pig iron	2
RDF	solid fuel	1
Compost	compost	1
Materials recovery by pulverization and classification	materials such as iron scrap, plastic film and so on.	1
Materials recovery by hand-sorting	materials such as iron scrap, plastic film, glass bottles, and so on.	1
Methane production by anaerobic fermentation	methane gas (fuel)	1
Landfill	nothing	0
Incineration (without heat recovery)	nothing (or incineration residue)	0

Scores (C) of the Master Plan alternatives concerning the resource recovery were calculated as the weighted arithmetic mean of the scores of an individual disposal method included in the alternative applying the rate of the disposal volume of the individual disposal methods to the total disposal volume.

$$C = \Sigma P_k A_k$$

Case No.	9	13	19-(2)	W/O
C	0.346	1.654	1.430	0.202

Relative scores (S) determined by adjusting C in the manner similar to the section (1) are shown in the following table.

Case No.	9	13	19-(2)	W/O
S	3	5	5	3

Appendix 8.2 Detailed project cost

Table AP 8.1 Annual investment cost for Yannawa Incineration Plant

(Unit: million Baht)

Cost item		Year						Total
		1985	1986	1987	1988	1989	1990	
Land acquisition	T, L/C	71.0	283.8					354.8
Study and design	T	4.6	9.8	19.8				34.2
	F/C	3.7	-	15.9				19.6
	L/C	0.9	9.8	3.9				14.6
Land reclamation and access road construction	T			33.8			5.8	39.6
	F/C			0.2			-	0.2
	L/C			33.6			5.8	39.4
Main facilities construction	T			166.1	664.3	664.3	166.0	1,660.7
	F/C			138.5	554.1	554.1	138.5	1,385.2
	L/C			27.6	110.2	110.2	27.5	275.5
Duty, tax and other expenses	T, L/C			26.9	107.5	107.5	26.8	268.7
Supervision	T			6.4	25.6	25.6	6.2	63.8
	F/C			5.5	22.2	22.2	5.5	55.4
	L/C			0.9	3.4	3.4	0.7	8.4
Total	T	75.6	293.6	253.0	797.4	797.4	204.8	2,421.8
	F/C	3.7	-	160.1	576.3	576.3	144.0	1,460.4
	L/C	71.9	293.6	92.9	221.1	221.1	60.8	961.4

Note: T: Total F/C: Foreign currency L/C: Local currency

Table AP 8.2 Annual investment cost for Dusit Incineration Plant

(Unit: million Baht)

Cost item		Year						Total
		1990	1991	1992	1993	1994	1995	
Land acquisition	T, L/C		312.5					312.5
Study and design	T	4.6		19.7				24.3
	F/C	3.7		15.9				19.6
	L/C	0.9		3.8				4.7
Land reclamation and access road construction	T		5.2	21.4			7.8	34.4
	F/C		-	0.2			-	0.2
	L/C		5.2	21.2			7.8	34.2
Main facilities construction	T			166.1	664.3	664.3	166.0	1,660.7
	F/C			138.5	554.1	554.1	138.5	1,385.2
	L/C			27.6	110.2	110.2	27.5	275.5
Duty, tax and other expenses	T, L/C			26.7	106.6	106.6	26.7	266.6
Supervision	T			6.4	25.6	25.6	6.3	63.9
	F/C			5.5	22.2	22.2	5.5	55.4
	L/C			0.9	3.4	3.4	0.8	8.5
Total	T	4.6	317.7	240.3	796.5	796.5	206.8	2,362.4
	F/C	3.7	-	160.1	576.3	576.3	144.0	1,460.4
	L/C	0.9	317.7	80.2	220.2	220.2	62.8	902.0

Note: T: Total F/C: Foreign currency L/C: Local currency

Table AP 8.3 Annual investment cost for Bang Khun Tian Compost Plant

(Unit: million Baht)

Cost item		Year				Total
		1995	1996	1997	1998	
Land acquisition	T, L/C	23.2	15.4			38.6
Study and design	T			6.9		6.9
	F/C			5.5		5.5
	L/C			1.4		1.4
Land reclamation and access road construction	T		37.7	16.0	1.2	54.9
	F/C		6.6	2.8	-	9.4
	L/C		31.1	13.2	1.2	45.5
Main facilities construction	T			71.5	71.3	142.8
	F/C			34.1	33.9	68.0
	L/C			37.4	37.4	74.8
Duty, tax and other expenses	T, L/C			15.5	15.4	30.9
Supervision	T			9.4	9.4	18.8
	F/C			7.1	7.2	14.3
	L/C			2.3	2.2	4.5
Total	T	23.2	53.1	119.3	97.3	292.9
	F/C	-	6.6	49.5	41.1	97.2
	L/C	23.2	46.5	69.8	56.2	195.7

Note: T: Total F/C: Foreign currency L/C: Local currency

Table AP 8.4 Annual investment cost for Taling Chan Compost Plant

(Unit: million Baht)

Cost item		Year				Total
		1997	1998	1999	2000	
Land acquisition	T, L/C	76.8				76.8
Study and design	T		10.9			10.9
	F/C		8.6			8.6
	L/C		2.3			2.3
Land reclamation and access road construction	T	22.8	53.0		2.0	77.8
	F/C	3.0	7.0		-	10.0
	L/C	19.8	46.0		2.0	67.8
Main facilities construction	T		28.4	113.6	142.1	284.1
	F/C		13.6	54.3	68.0	135.9
	L/C		14.8	59.3	74.1	148.2
Duty, tax and other expenses	T, L/C		5.6	22.8	28.4	56.8
Supervision	T		2.2	9.0	11.1	22.3
	F/C		1.7	6.9	8.6	17.2
	L/C		0.5	2.1	2.5	5.1
Total	T	99.6	100.1	145.4	183.6	528.7
	F/C	3.0	30.9	61.2	76.6	171.7
	L/C	96.6	69.2	84.2	107.0	357.0

Note: T: Total F/C: Foreign currency L/C: Local currency

Table AP 8.5 Annual investment costs for final disposal sites

(Unit: million Baht)

Site name	Cost item	Year							Total
		1983	1986	1987	1988	1993	1998	2000	
On-Nooch	FC	68.6			51.7	39.2	34.5	235.9	429.9
	LA	-			-	-	-	86.3	86.3
	T	68.6			51.7	39.2	34.5	322.2	516.2
Ram Intra	FC		3.9	35.3		28.3	18.2	73.1	158.8
	LA		52.2	-		-	-	-	52.2
	T		56.1	35.3		28.3	18.2	73.1	211.0
Nong Khaem	FC	86.5			73.7	95.9	50.6	169.9	476.6
	LA	-			-	45.0	-	-	45.0
	T	86.5			73.7	140.9	50.6	169.9	521.6
Total	FC	155.1	3.9	35.3	125.4	163.4	103.3	478.9	1,065.3
	LA	-	52.2	-	-	45.0	-	86.3	183.5
	T	155.1	56.1	35.3	125.4	208.4	103.3	565.2	1,248.8

Note: No expenditure in the years which are not shown in the table.
FC: Facilities construction cost LA: Land acquisition cost T: Total

Table AP 8.6 Annual management cost by item

(Unit: million Baht)

Cost item		Year								
		1983	1984	1985	1986	1987	1988	1989	1990	1991
General management	T, L/C	35.7	39.3	42.3	45.6	43.8	44.8	45.7	47.7	49.2
Collection and transport	T	120.6	125.7	131.9	140.0	147.7	151.0	156.9	170.4	162.6
	F/C	18.1	18.9	19.8	21.0	22.2	22.7	23.5	25.6	24.4
	L/C	102.5	106.8	112.1	119.0	125.5	128.3	133.4	144.8	138.2
Collection trucks purchase	T, F/C	27.9	22.4	21.8	22.4	25.2	28.7	28.7	28.7	27.3
Operation and maintenance										
existing compost plant	T	84.8	109.1	124.0	137.4	115.1	115.1	115.1	115.1	115.1
	F/C	20.6	35.8	39.0	40.6	27.6	27.6	27.6	27.6	27.6
	L/C	64.2	73.3	85.0	96.8	87.5	87.5	87.5	87.5	87.5
additional compost plant	T									
	F/C									
	L/C									
incineration plant	T									21.6
	F/C									12.0
	L/C									9.6
final disposal site	T. L/C	4.8	4.8	4.5	4.1	3.8	3.8	3.8	3.8	1.4
Total	T	273.8	301.3	324.5	349.5	335.6	343.4	350.2	365.7	377.2
	F/C	66.6	77.1	80.6	84.0	75.0	79.0	79.8	81.9	91.3
	L/C	207.2	224.2	243.9	265.5	260.6	264.4	270.4	283.8	285.9

Note: T: Total F/C: Foreign currency L/C: Local currency

Table AP 8.6 Annual management cost by item

(cont'd)

(Unit: million Baht)

Cost item		Year									Total
		1992	1993	1994	1995	1996	1997	1998	1999	2000	
General management	T, L/C	55.4	59.5	66.6	66.9	68.1	70.1	74.1	77.5	80.8	1,013.1
Collection and transport	T	171.6	181.0	196.6	208.4	194.1	206.7	219.8	228.3	248.3	3,161.4
	F/C	25.7	27.2	29.5	31.3	29.1	31.0	33.0	34.2	37.2	474.4
	L/C	145.9	153.8	167.1	177.1	165.0	175.7	186.8	193.9	211.1	2,687.0
Collection trucks purchase	T, F/C	51.6	64.1	77.4	65.0	65.0	66.3	72.5	69.4	66.9	831.3
Operation and maintenance											
existing compost plant	T	115.1	115.1	129.6	129.6	128.1	115.1	115.1	115.1	115.1	2,108.7
	F/C	27.6	27.6	41.3	41.3	39.9	27.6	27.6	27.6	27.6	562.1
	L/C	87.5	87.5	88.3	88.2	88.2	87.5	87.5	87.5	87.5	1,546.6
additional compost plant	T								12.1	12.1	24.2
	F/C								2.9	2.9	5.8
	L/C								9.2	9.2	18.4
incineration plant	T	29.6	34.5	38.1	40.6	65.4	77.5	84.6	90.1	94.5	576.5
	F/C	20.2	25.1	28.6	31.1	46.3	58.5	65.6	71.0	75.4	433.8
	L/C	9.4	9.4	9.5	9.5	19.1	19.0	19.0	19.1	19.1	142.7
final disposal site	T, L/C	1.6	2.0	2.3	2.5	1.6	1.8	1.9	1.8	1.9	52.2
Total	T	424.9	456.2	510.6	513.0	522.3	537.5	568.0	594.1	619.6	7,767.4
	F/C	125.1	144.0	176.8	168.7	180.3	183.4	198.7	205.1	210.0	2,307.4
	L/C	299.8	312.2	333.8	344.3	342.0	354.1	369.3	389.0	409.6	5,460.0

Note: T: Total F/C: Foreign currency L/C: Local currency

Table AP 8.7 Planned annual revenue by source

(Unit: million Baht)

Source of revenue	Year										
	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Solid waste collection fee	21.2	24.2	27.8	31.8	36.4	41.6	47.6	54.4	62.4	71.2	81.5
Compost sales	7.7	7.7	8.9	12.8	15.7	15.7	15.7	15.7	15.7	15.7	15.7
Recovered ferrous metal sales	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Electricity sales	-	-	-	-	-	-	-	-	25.9	25.9	25.9
Total	30.2	33.2	38.0	45.9	53.4	58.6	64.6	71.4	105.3	114.1	124.4

Source of revenue	Year							Total
	1994	1995	1996	1997	1998	1999	2000	
Solid waste collection fee	93.2	106.7	122.1	139.6	159.8	182.7	209.1	1,513.3
Compost sales	15.7	15.7	15.7	15.7	15.7	19.2	19.2	263.9
Recovered ferrous metal sales	1.3	1.3	1.3	1.3	1.3	1.4	1.4	23.6
Electricity sales	25.9	25.9	51.7	51.7	51.7	51.7	51.7	388.0
Total	136.1	149.6	190.8	208.3	228.5	255.0	281.4	2,188.8

Appendix 8.3 Destinations for collected solid waste (the year 2000)

Table AP8.8 Operation schedule in a year

Name of site		Kind of operation situation				
	Abbre-viation	A	B	C	D	E
On-Nooch C.P. & L.	O/N	op.	op.	op.	op.	op.
Nong Khaem C.P. & L.	N/K	op.	op.	op.	op.	op.
Ram Intra C.P. & L.	R/I	op.	op.	op.	op.	op.
Yannawa I.P.	Y	op.	op.	stop	op.	op.
Dusit I.P.	D	op	stop	op.	op.	op.
Taling Chan C.P.	T	op.	op.	op.	stop	op.
Bang Khun Tian C.P.	B	stop	op.	op.	op.	op.
Days in a year		55	73	73	55	109

Note : C.P. means a compost plant.
L. means a landfill site.
I.P. means an incineration plant.
O.P. means 'in operation'.

Table AP8.9 Destination of solid waste

District name	Solid waste except market waste					Market waste
	Kind of operation situation					
	A	B	C	D	E	
Phra Nakhon	D	Y, N/K	D	Y, (D)	D	T
Pom Prap	D	Y	D	Y	D	T
Phathum Wan	Y	Y	D, O/N	Y	Y	T
Sam Phan Thawong	Y	Y	N/K	Y	Y	T
Bang Rak	Y	Y	O/N	Y	Y	B
Yannawa	Y	Y	O/N	Y	Y	B
Dusit	D	R/I, N/K	D	D	D	T
Phayathai	D	O/N	D	D	D	T
Huai Khwang	R/I, (D)	O/N	R/I, (O/N)	R/I, O/N	R/I, (D)	R/I
Phra Khanong	O/N, (Y)	O/N	O/N	O/N, (Y)	O/N, (Y)	O/N
Bang Khen	R/I, (D)	R/I	R/I	R/I	R/I, (D)	R/I
Bang Kapi	O/N	O/N	O/N	O/N	O/N	O/N
Nong Chok	O/N	O/N	O/N	O/N	O/N	O/N
Minburi	O/N	O/N	O/N	O/N	O/N	O/N
Lat Krabang	O/N	O/N	O/N	O/N	O/N	O/N
Thonburi	N/K	N/K	N/K	N/K	N/K	B
Khlong San	N/K	N/K	N/K	N/K	N/K	B
Bangkok Noi	T, (D)	T, (N/K)	T, (D)	D	T, (D)	T
Bangkok Yai	N/K	N/K	N/K	N/K	N/K	N/K
Bang Khun Thian	N/K	B	B	B	B	B
Phasi Charoen	N/K	N/K	N/K	N/K	N/K	N/K
Rat Burana	N/K	N/K, (B)	N/K, (B)	N/K, (B)	N/K, (B)	B
Taling Chan	T	T	T	N/K	T	T
Nong Khaem	N/K	N/K	N/K	N/K	N/K	N/K

Note : Name in a parenthesis means a destination for a small part of collected solid waste, in other words, the secondary destination.

Chapter 9 RECOMMENDATIONS FOR IMPLEMENTATION OF ADMINISTRATIVE ORGANIZATION AND SERVICES

Appendix 9.1 List of laws and regulations providing solid waste management

Table AP 9.1 List of laws and regulations providing solid waste management

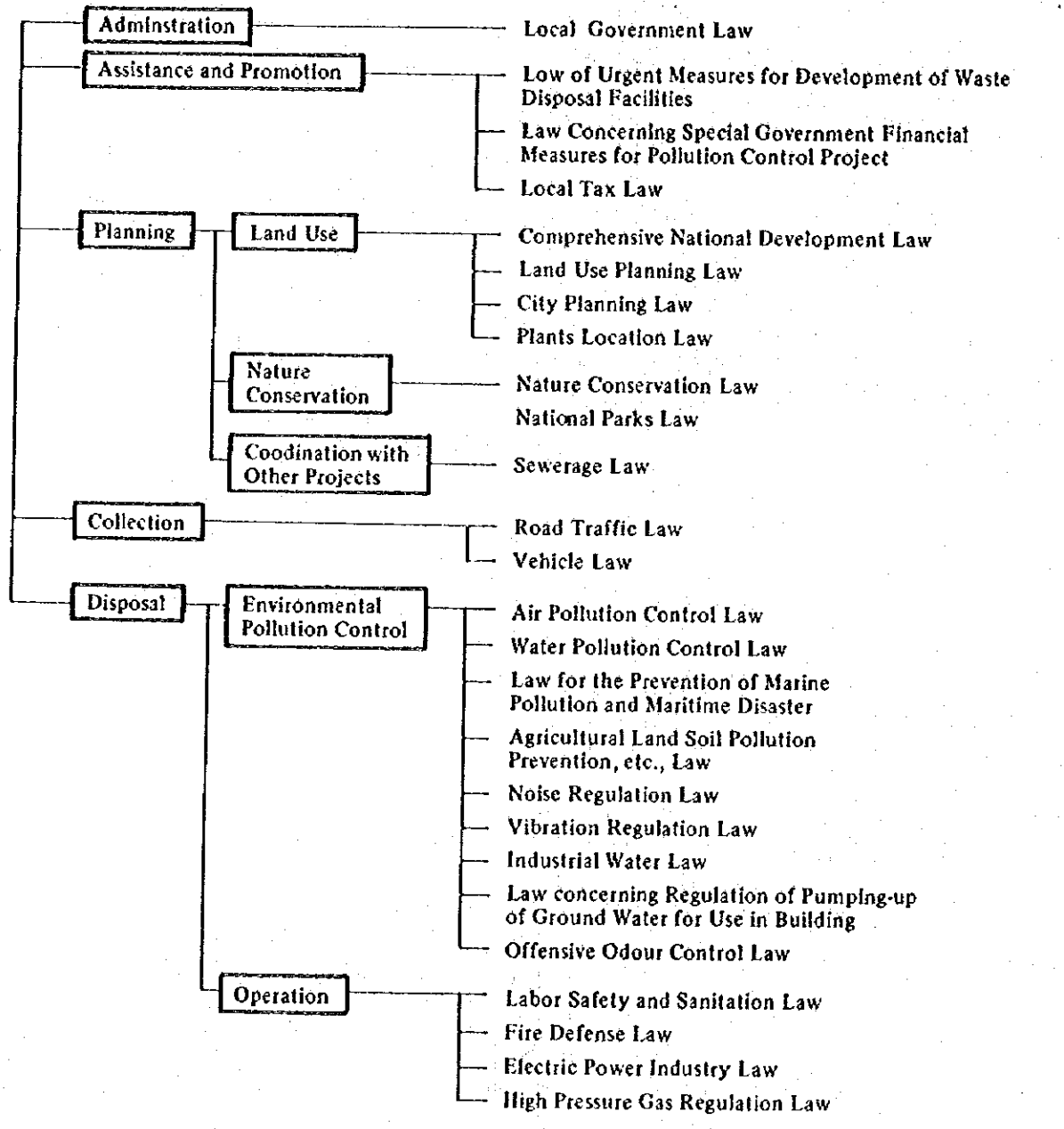
	Name of Related Laws	Year of Enactment	Contents
Laws Related to Solid Waste Management	1. Public Health Act	1941 (BE2484)	Article 6 specifies the collection fee and the items to be performed for improvement of public health.
	2. Act for the cleanliness and Orderliness of the Country	1960 (BE2503)	Article 4 stipulates householders obligation for maintaining cleanliness of dwellings; Article 18 prohibits illegal disposal of solid waste.
	3. BMA Ordinance R: The disposal of refuse, waiste and fifth	1978 (BE2521)	Article 17 stipulates householder's responsibility for house fronts, designates solid waste containers, prohibits illegal disposal, prohibits retrieval of utilizable materials and authorizes BMA to carry out private solid waste disposal.
	4. Fines and Penalty in accordance with the BMA Ordinance for Sanitation and Orderliness in Bangkok Metropolis	1980 (BE2523)	In accordance with the extent of the illegal disposal, fines are prescribed from 500 Baht to 5,000 Baht.
	5. Act for controlling the use of Excrements as fertilizer	1937 (BE2480)	
Laws Related to Control of Environmental Pollution	1. Factory Act	1969 (BE2512)	Article 4 provides that the law shall not be applied to factories engaged in public works. Stipulates standards for industrial wastewater, noise, working conditions, odor, etc.
Laws Related to Environmental Protection	1. National Environment Promotion and Preservation Act	1975 (BE2518)	Provides measures for promoting environmental protection and improvement.
	2. Environmental Quality Standard in Thailand	1980 (BE2523)	Provides the standard (target) for air quality, noise and waste water quality.
Other Related Laws	1. Control of the Construction of Building	1974 (BE2517)	Article 91 provides that buildings with 2000 m^2 or more shall provide solid waste storage facilities for their exclusive use.
	2. City Planning Act	1975 (BE2518)	Enforcement of comprehensive planning.

Appendix 9.2-(1) Laws relating to waste disposal (Japan)

(1) The Law regulating principal waste disposal
Waste disposal (and Public Cleaning Law (1970))

(2) Other regulations relating to domestic waste disposal

Fig. AP 9.1 List of laws and regulations relevant to waste disposal



Appendix 9.2–(2) Regulations and contents of stipulation required for the control of waste disposal (Draft example)

Regulation	Contents of stipulation required
A. Regulation on waste storage	• Stipulate that for storing of waste in large quantity the owner of the relevant building or the relevant enterprise is required to maintain proper means of storage or other measures necessary from the following considerations so as to avoid inflicting adverse effects on the environment quality. 1. Waste of large quantity should be stored in proper storing facility such that the waste will not likely scatter, flow out or penetrate underground and also that no offensive odour will likely be emitted. 2. The structure of the storage facility should be such that not resting of rats or propagation of flies or mosquitoes will be allowed to take place in it.
B. Regulation on collecting and transportation of waste	• Stipulate that collection and transportation of waste should be done with care taken to the following points so as not to inflict any adverse effect on the environment. 1. In collecting and transporting the waste, care should be taken such that the waste will not scatter or flow out. 2. Vehicle and container for the use in collecting and transpoting waste should be of such structure that the waste will not likely scatter or flow out, and that no offensive odour should will likely spread out from it.
C. Structural requirements for intermediate treatment facilities	• Throughout the waste disposal process, intermediate treatment is technically the most demanding stage. In order that intermediate treatment of waste be properly performed, regulation on the facility structure is essentially required. Items to be stipulated include the follows for example: 1. Scope of application (existing and new facilities) 2. System of intermediate treatment 3. Performance of intermediate treatment facility 4. Performance in prevention of secondary pollution 1) Exhaust gas standard (particulates, HCl, NOx, SOx) 2) Liquid effluent standard (BOD, COD, S.S., pH, heavy metals, and other harmful substances, temperature) 3) Noise 4) Vibration 5) Odour 5.
D. Standards for maintenance and control of intermediate treatment facilities	• Urban intermediate waste treatment facilities can be divided largely into two categories, namely, solid waste intermediate treatment facilities and human waste intermediate treatment facilities. The following are items of standards for the maintenance and control of garbage incinerators, as an example, required for the control of environmental pollution. 1. The volume of waste fed into the incinerator should not surpass the capacity of the equipment. 2. Where a pit crane is used to feed the waste into the incinerator, the waste should alway be thoroughly mixed to maintain homogeneity. 3. Proper measures should be taken to prevent scattering of the waste and emission of offensive odour. 4. Effort should be made to prevent generation of flies and mosquitoes, and the facility should always be maintened clean. 5. Proper measure should be taken to avoid deterioration of the environment incurred by the generation of excessive noise and vibration. 6. Where drainage water from the facility is discharged into public water, the quality of such water should comply with the requirements of relevant environmental standards. 7. The combusting temporature at the main opening of the incinerator should be maintained at about 700 ∿ 1,000°C. 8. The exhaust gas discharged from the chimney of the incinerator should be of such quality that will not have adverse effect against conservation of the living environment. 9. Proper measures should be taken to maintain satisfactory functional performance of the equipment, including the implementation of regular inspection and investigation of qualities of the exhaust gas and drainage discharge. 10. A maintenance and control log should be maintained, for the recording or relevant events including inspection, examination, repair and other measures taken. Such records should be kept for 5 years.

Regulation	Contents of stipulation required
E. Standards for landfilling of solid waste	The remnants of waste after recovery of material resources, and the residues of intermediate treatment will ultimately be discharged into the environment in the form of final disposal. In the final disposal, the waste should in principle be returned to nature to form part of the natural cycle, without disturbing the existing ecology. Those substances which cannot form part of the natural cycle, as well as harmful substances should be segregated from the natural environment as far as practicable. Based on the above considerations, disposal of waste as fill material for reclamation should be regulated in the following aspects:- 1 Public water area and ground water should be prevented from being polluted by water percolated from the reclamation fill material. 2 Disposed waste should be reduced in quantity and stabilized. 3 The incuring of sanitary problems incidental to the reclamation treatment should be prevented.
F. Structural requirements for landfill site	In order that all reclamation treatment of waste be properly implemented without incurring any undesirable effect on the environment, it is necessary that structural standards including the following items be established for the field of final disposal. 1 Scope of application (existing and newly implemented reclamation areas) 2 Landuse plan of the reclaimed area 3 Facility operation and management policy 4 Facility size 5 Reclamation structure 1) Method of construction 2) Impervious structure works 3) Water collecting facilities 4) Drainage works 5) Percolated water treatment system 6 Environment protection standards 1) Quality standard for effluent discharged from percolated water treatment facility 2) Circumferencial environment control standard.
G. Maintenance and control standards for final waste treatment facilities	In order that waste treatment facilities be properly maintenanced and controlled without incurring any adverse effect on the environment, regulation including the following items as required. 1. Proper measures should be taken to prevent scattering and flowing out of the waste. 2. Proper measures should be taken to prevent spreading of odour from the final treatment facility as far as practicable. 3. Proper measures should be taken to prevent the outbreak of fire. Fire extinction equipment should also be provided. 4. Proper measures such as spreading of insecticides etc. to prevent the propagation of flies mosquitoes etc., as well as resting of rats. 5. Fencing should be provided to prevent the entrance of unauthorized person. 6. All equipment in the final treatment facility should be periodically inspected, and proper measures should be taken to maintain the equipments in good functioning condition. 7. Ground water quality in the peripheral areas should be regularly checked. 8. Proper measures should be taken to prevent the influx of storm water and flood. 9. The percolated water treatment facility should be regularly inspected including testing of quality of the discharged water, and be properly maintained to ensure that the discharged water complies with the requirement of the relevant standard. 10. The percolated water treatment facility should be provided with ventilation device for the discharge of undersirable gas. 11. On completion of the reclamation work, the filled waste should be covered with a soil layer of 1 m thick, and the gates of the fencing should be closed and locked. 12. Prior to closing of the final disposal facility, proper measures should be taken to prevent the scattering and flowing out of the waste, pollution of the surrounding environment by the percolated water, and the break out of fire due to spontaneous ignition. 13. The maintenance and control record should be kept in file for 5 years.

Appendix 9.3 Examples of waste classification

Table AP 9.2 Examples of waste classification

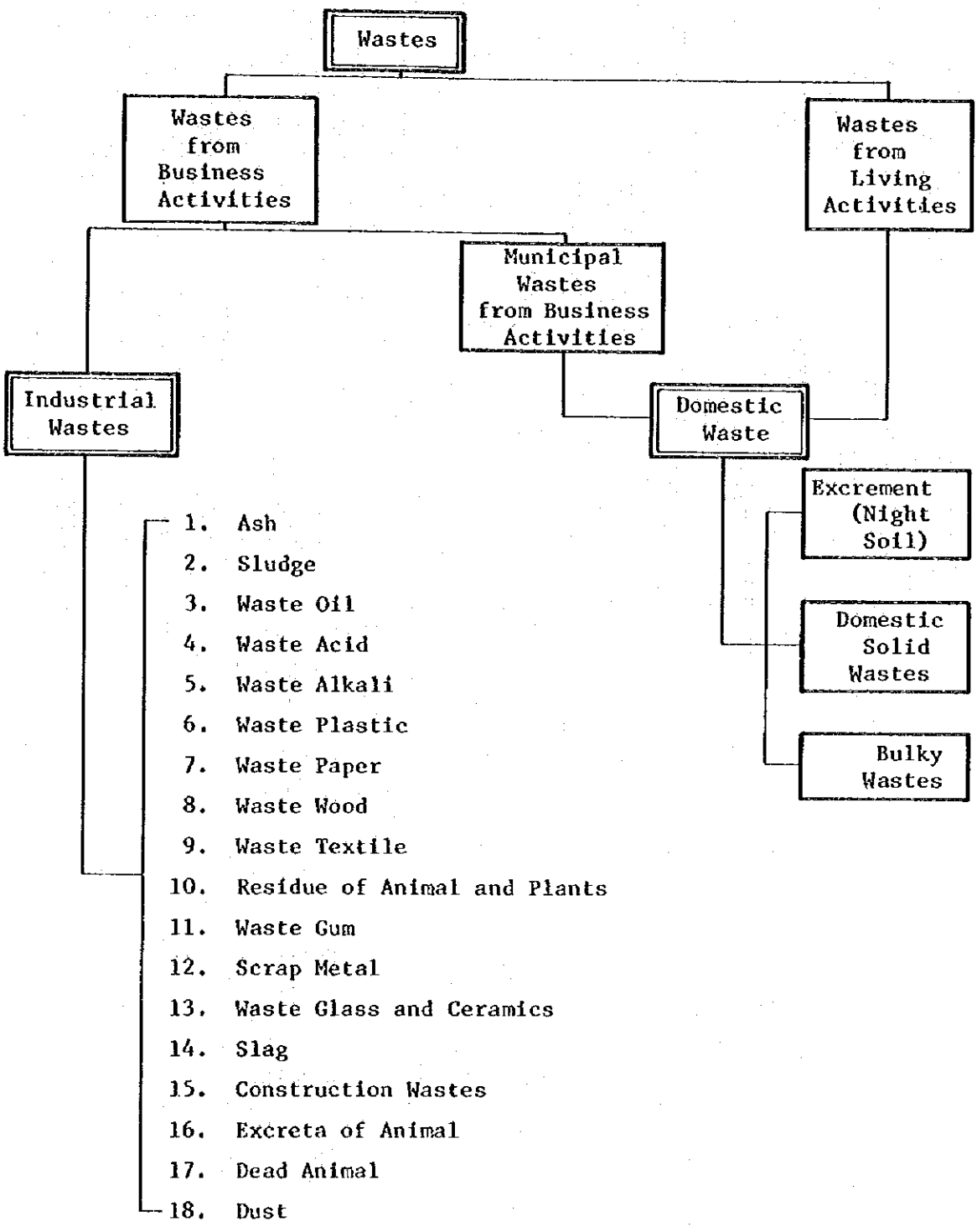
Basic classification (Discrimination by the sense)	Discharge source			Properties		Incineration and reuse
	I	II	III	I	II	
① Waste paper ② Waste plastics ③ Waste textile ④ Waste wood and bamboo ⑤ Waste straw ⑥ Waste rubber ⑦ Waste leather ⑧ Foodwaste (vegetables, fruit) ⑨ Foodwaste (meat and fish) ⑩ Chaff ⑪ Grass leaves ⑫ Scrap metal ⑬ Waste glass ⑭ Waste ceramics ⑮ Waste shell ⑯ Waste egg shell ⑰ Earth and sand ⑱ Demolition wastes ⑲ Cinders ⑳ Ash ㉑ Tar pitch ㉒ Waste oil ㉓ Waste acid ㉔ Waste alkali ㉕ Waste chemicals ㉖ Waste carbide ㉗ Sludge ㉘ Slag ㉙ Dead animals ㉚ Night soil ㉛ Residue of septic tank ㉜ Excreta of livestocks ㉝ Soot and dust ㉞ Others	1. General wastes (solid waste other than industrial solid waste) 2. Industrial wastes (wastes from business activities) which is designated by laws and regulations Designated wastes ⑲, ㉗, ㉒, ㉓, ㉔ and ② (from all business activities) Solid waste designated by government ordinances ⑥, ⑫, ⑬·⑭, ㉙, ㉝, ⑱ (from all business activities) ①, ④, ③, ⑧-⑨, ㉜ and ㉙ (from designated facilities)	1. Household waste: general wastes from living activities of general wastes (I-1) 2. Business general waste: general wastes from business activities of general wastes (I-1) 3. Industrial waste: Same as I-2.	1. Municipal solid waste (a) Solid wastes from living activities (b) Solid wastes from urban facilities: Solid waste discharged from sewage treatment plant, solid waste incineration plant and public undertaking. (c) General business wastes: Same as II-2 2. Industrial waste: Same as I-2.	1. Gaseous waste: Exhaust gas discharged from automobiles and factories etc. 2. Liquid waste: ㉒, ㉓, ㉔, ㉗, ㉚ and ㉛ 3. Slurry waste: ㉒, ㉗, ㉛ and ㉜ 4. Solid waste	1. Garbage: ⑧ & ⑨ 2. Miscellaneous waste 3. Mixed waste	1. Waste easy to burn: ①, ③, ④, ⑤ and ⑩ 2. Waste which can be burnt to some degree but discharge some pollutants in exhaust gas: ②, ⑥, ⑦, ⑧, ⑨ and ㉑ 3. Sludge or liquid waste which is in combustible: ㉓, ㉔, ㉕, ㉖ and ㉗ 4. Solid waste which is combustible: ⑬ to ⑳ (a) Waste which can be reused: ⑫, ⑬ and ㉘ (b) Solid waste which can be disposed of at landfill sites as it is: ⑰ to ⑳ 5. Others
Classification adopted in survey of actual condition of solid waste discharge in various cities in Japan.	Classification provided in Japanese laws 'Law of waste disposal and cleaning'	Classification provided in Tokyo Metropolitan ordinance, Re: Disposal of Solid Waste.	Classification used in study of countermeasures against solid waste (landfill countermeasures) in Tokyo Metropolis	Physical classification	Past classification used in Tokyo Metropolis	Classification adopted in the report "Survey and study report on waste" by the study team for countermeasures against municipal solid waste treatment and disposal in Osaka Metropolis

(cont'd)

Incineration, transport, landfill and reutilization	Compost, incineration and reutilization				Pulverization, compaction, incineration and landfill	Work plan	
	I	II	III	IV		I	II
1. Waste which is easy to burn 2. Waste which requires special treatment prior to incineration, transport and final disposal: ②, ⑧, ⑨ and ㉑ thru ㉗ 3. Waste which can be reused: ⑫, ⑬ and ㉘ 4. Waste which can be used for landfill as it is: ⑰ to ⑳	1. Garbage 2. Combustible miscellaneous waste 3. Incombustible miscellaneous waste	1. Utilizable materials: ①, ③ and ⑫ 2. Materials usable for composting: ⑤, ⑧ and ⑨ 3. Combustible materials 4. Incombustible materials	1. Materials usable for composting: ①, ⑤, ⑧ and ⑨ 2. Materials which are not suitable for composting nor difficult to be composted: ⑫ thru ⑱, ③, ④, ⑥ and ⑦	1. Materials usable for composting: ③, ⑤, ⑧ and ⑨ 2. Materials usable for mixing in compost: ⑰ 3. Combustible materials: ① 4. Materials which require selection: ④, ⑫ and ⑬	1. Materials which can be pulverized: ⑬ Tiles and pebbles, and empty cans 2. Materials which can be compacted: ⑫ bulky waste 3. Materials usable for landfill: ⑰, ⑱ and ⑲ 4. Materials which can be incinerated 5. Combustible materials	1. Waste collected by the Bureau (a) Container-collection waste (b) Collection-fee-charged waste (c) Bulky waste (d) Incombustible and unsuitable-for-collection waste 2. Carried-in waste (a) General waste i. Carried-in waste by the Corporation ii. General carried-in waste iii. Residue from incineration plant iv. Waste collected from road cleaning v. Waste collected from public roads and parks vi. Waste collected from rivers (b) Waste from the urban facilities (c) Industrial waste	1. Collection of garbage and others 2. Collection of incombustible wastes and bulky wastes 3. Collection of utilizable solid wastes (a) Waste papers (b) Empty bottles (c) Empty cans
Classification adopted in the report "Survey of actual condition of industrial waste in cities of Aichi Prefecture"	Classification adopted in the report "General view points of sanitation engineering"	Classification adopted in some report prepared by Tokyo Metropolis.	Classification adopted in some report prepared by Yokohama city	Classification adopted in some report prepared by Kanagawa Prefecture	Classification adopted in some report prepared by Saitama Prefecture	Classification adopted by Tokyo Metropolitan Government for Collection work	Classification adopted in the work plan prepared by Numazu City

Appendix 9.4-(1) Classification of wastes (Japan)

Fig. AP 9.2 Classification of wastes (Japan)



Appendix 9.4-(2) Allotment of duty for cleaning undertaking
(A standard for establishment of laws and regulations)

Division	General waste	Special waste
Contents and discharge sources	. Waste which can be treated and disposed of by the local authorities (the items of waste specified by the existing laws and regulations, and items of waste to be added by revision of laws and regulation).	. Waste which should be carefully treated or disposed of, for protection of environment or waste which cannot be treated of disposed of, by the local authorities. (Waste containing harmful substance at a level more than specified, or waste which is difficult to be treated and disposed of.)
Citizens (residents)	. Obligation to keep lands and buildings clean as occupant or manager . Obligation to cooperate with the cleaning work by the local authorities . Obligation to clean the spots in front of their houses, when the waste containers are put . Obligation to conduct self-management, and weight reduction of waste as much as possible . Obligation to pay the collection fee	
Enterprisers	. Obligation to reduce weight of waste and use utilizable materials again . Obligation to cooperate with the local authorities for business waste (a large volume of waste discharge and so on) Obligation to pay the fee (treatment and disposal expense)	. Responsibility to visually sort out the waste containing harmful substances at a level more than specified . Obligation to control manufacturing, processing and marketing of products which are difficult to be treated and disposed of, and recover them under their responsibility . Responsibility to set their business toward right direction in accordance with the regulations of laws and ordinances

Division	General waste	Special waste
Private contractors or the solid waste management (authorized contractors)	. The contractors carry out a part of cleaning work upon receiving the approval of local authorities (on a contract basis) . Upon receiving the approval of the authorities, the contractors handle the business waste on a contract basis . The contractors carry out the work under the guidance and surveillance of local authorities	. The contractors should have the qualification, ability and facilities stipulated in laws and regulations . Special approval is necessary . Upon receiving the approval, they are authorized to be engaged in handling of special waste . They are supposed to carry out their business under the control of laws and regulations . They are subject guidance and surveillance of state and local authorities
Local authorities BMA (BOS, districts)	. Establishment and notification of work plan . Right to establish ordinances and regulations . Obligation to carry out sanitary and efficient waste management . Responsibility to grasp the actual condition of discharge, treatment and disposal . Guidance and surveillance of citizens, enterprisers and private contractors for waste handling, including witness inspection . Control of illegal disposal of waste and education and training of authorized contractors	. Investigation and grasp of discharge and treatment condition of special waste . Control and guidance of contractors concerned in accordance with laws and regulations (in cooperation with the state authorities)
State authorities	. Determination of fundamental policy of waste management administration . Actions for legislation . Technical and financial assistance to local authorities	. Establishment of control standard for harmful substances . Designation of materials which are difficult to be treated and disposed of, and the right of order for recovery of these materials

Appendix 9.5 Standards for collection, transportation and disposal of domestic wastes (Japan)

(1) The collection, transport, and disposal of domestic waste shall be made in a manner that said waste does not scatter or flow out.

(2) The construction of a treatment facility of domestic waste shall be carried out in a manner that preservation of the living environment may not be hindered.

(3) Vehicles, containers, and pipelines for transport of domestic waste shall be those which keep said waste from scattering, flowing out, and emitting rank odour.

(4) The landfill of domestic waste (including the method of disposal using underground spaces which shall apply hereunder) shall be conducted as follows:

a. The place for landfill disposal (hereinafter referred to as "disposal site") shall be enclosed by an enclosure, and be indicated that said place is a disposal site.

b. Necessary measures shall be taken to prevent leachate from the disposal site from polluting public water and underground water.

c. The landfill (excluding reclamation on water surface of sludge (only sludge related to septic tanks for human waste which shall apply to this Subparagraph and Subparagraph (6)) shall be made after such sludge has been treated in a sanitation plant (excluding septic tanks for human waste which shall apply to this Subparagraph), incinerated in an incineration facility, or mixed with 0.5% or more slaked lime.

d. The reclamation on water surface of sludge shall be made after such sludge has been treated in a human waste treatment plant, or incinerated in an incineration facility.

e. The landfill of human waste (excluding reclamation on water surface) shall be made after such waste has been treated in a human waste treatment plant, or mixed with 0.5% or more slaked ime.

f. The reclamation on water surface of human waste shall be made after such waste has been treated in a human waste treatment plant.

g. Necessary measures shall be taken to prevent leaking of rank odour out of the disposal site.

h. The thickness of one layer of domestic waste (excluding those of which ignition loss was reduced to 15% or less) shall be approximately 3 meters or less, and each layer shall be covered with approximately 50 cm of soil or sand, except when the area of the disposal site is 10,000 m^2 or less, or when the volume of waste is 50,000 m^3 or less (hereinafter referred to as "small-scale landfill"), or when landfill is conducted using an underground space.

i. In a disposal site, means of ventilation shall be built to remove gas generating from said site, and necessary measures shall be

taken to prevent fires at said site, except in the case of small-scale landfill.

j. Necessary measures shall be taken to prevent the growth of rats, mosquitoes, flies, or other vermin at disposal sites.

(5) Parts made using PCB which are incorporated in air conditioners, TV sets, or electronic ovens shall not be buried in the disposal site.

(6) The ocean dumping of domestic waste (excluding parts made using PCB which are incorporated in air conditioners, TV sets, or electronic ovens) shall be allowed only when the following domestic waste is dumped from a ship:

a. Waste explosives (explosives provided in Article 2, Paragraph 1 of the Explosives Control Law (Law No. 140 of 1950) which have become unnecessary).

b. Combustible domestic waste (excluding waste explosives) of which ignition loss was reduced to 15% or less by incineration.

c. Sludge or human waste in which 0.1% or more ferrous sulfate or ferric chloride is mixed, or which are crushed.

d. Noncombustible domestic waste (excluding sludge and human waste).

(7) Even in the case of domestic waste provided in the preceding Sub-paragraph, when it is considered that such waste is able to be disposed of by means of landfill, ocean dumping shall be avoided.

Appendix 9.6 Present state of solid waste management enterprises in Japan

Table AP 9.3 Type of collection management of general solid waste in Japan

(Unit: %)

Type of collection management		Year					
		1974	1975	1976	1977	1978	1979
By regional government	Direct	71.0	70.9	69.6	57.4	65.9	65.6
	By commissioning to private agencies	20.5	22.2	22.8	23.2	23.8	25.4
By licensed private agencies		8.5	6.9	7.6	9.3	10.3	9.0
Index of total collected volume (Year 1974 = 100)		100	105	107	113	118	122

Table AP 9.4 Number of vehicles and boats by type of management (1979, Japan)

Type of collection management	Vehicle			Boat		
	Share in number (%)	Share in capacity (%)	Average capacity (t/unit)	Share in number (%)	Share in capacity (%)	Average capacity (t/unit)
Direct	54.4	53.8	2.35	83.3	81.6	116.4
Commissioned private agencies	20.1	19.1	2.25	7.8	18.2	276.7
Licensed private agencies	25.5	27.1	2.54	8.9	0.2	2.8

Appendix 9.7 Example of solid waste management cost by type of management

Table AP 9.5 Example of solid waste management cost by type of management

City	Area	Population	Collected volume			Collection & transport cost	Unit cost of collection and transport (Baht/t)			Level of service Upper: Frequency (times/week) Lower: Collection type*			Responsible agency d: Direct c: Commission			Total unit cost
			Total	Share by type of agency (%)			Total	By type of agency		Combustible waste	Incombustible waste	Bulky waste	Combustible waste	Incombustible waste	Bulky waste	
				Commission	Direct			Commission	Direct							
	(km²)	(thousand persons)	(t)			(thousand Baht)										(Baht/t)
A	17	118	26,590	0	100	47,064	1,770	–	1,770	3 s	2 s	2 h	d	d	d	2,678
B	11	89	22,420	17	83	27,721	1,236	949	1,295	3 s	1 s	2 h	d	d c	d	2,197
C	188	372	87,620	21	79	175,423	2,002	1,089	2,238	2∿3 s	2/month s	On occasion	d	d c	d	3,018
D	17	89	23,370	30	70	20,512	878	779	935	3 s	1 s	On occasion h	d c	d c	d	1,862
E	104	96	26,150	75	25	29,817	1,140	942	1,720	3 b	1 b	1 s	d c	d c	c	1,866
F	17	162	35,510	83	17	37,846	1,066	699	2,884	3 h	2/month h	On occasion h	c	d	d c	2,397
G	15	57	13,740	100	0	9,239	673	670	–	3 b	1 b	On occasion h	c	c	c	1,277
H	18	47	12,470	100	0	9,243	741	741	–	3 b	1 b	1 h	c	c	c	1,739
Average	48	129	30,980	42	58	44,608	1,188	838	1,807	–	–	–	–	–	–	2,129

Note * s: Station collection, h: House-to-house collection, b: Stationary container (small box) system

Table AP 9.6 Comparison of efficiency of management types

City	Type of management	Unit cost of collection and transport (Baht/t)			Values per truck per day				Unit cost per work
		Labor cost [G]	Equipment cost [H]	Total [G+H]	Haul frequency [J]	Collected volume [K] (t)	Mileage [L] (km)	Cost of collection and transport [M] (Baht)	[N] (Baht/t·km)
Cities in Tokyo	Direct [A]	1,084	723	1,807	3.1	3.7	44	6,686	127
	Commission [B]	419	419	838	4.0	4.8	53	4,022	63
	C=B/A (%)	38.7	58.0	46.4	129.0	129.7	120.5	60.2	49.6
BMA[1]	Direct [D]	79	96	175	2.3	6.8	90	1,190	4.5
	Efficiency[2] [E] (%)	69.4	79.0	–	114.5	114.9	110.3	–	–
	Commission [D·E/100]	55	76	131	2.6	7.8	99	1,022	3.4

Note: 1) Figures for BMA are estimated values by the Study team.

2) Calculation was made using the following equation on assumption that the efficiency is increased to a half of that in the case of Tokyo.
E = 100 + (C - 100)/2

3) Unit cost per work is determined by the cost spent for the transport of one ton load along the distance of one kilometer.
Calculation equation: N = J·M/(K·L)

Appendix 9.9 Study calculation of effect of change-over from direct management to commissioning

"Conditions of Study Calculation"

(1) BMA waste collection and transport cost (1980 fiscal): 175 Baht/t

(2) BMA waste disposal cost (1980 fiscal): 313 Baht/t

(3) Assumed part of collection to be changed from direct management to commissioning: 25%

(4) Estimated effect by changing collection work from direct management to commissioning: Assumed to be improved by one half of effect in the case of Japan

(5) Saving of collection and transportation cost associated with change-over from BMA direct management to commissioning: Assumed to be 25.4%

(6) Unit cost of collection and transport of BMA (direct management): 4.5 Baht/t.km (estimated by the Study team)

(7) Increased rate of cost saving associated with change-over from BMA direct management to commissioning: 24.4%

(8) Daily waste collection volume of BMA (1980 fiscal assumption): 1,966 t/d

"Measurement of Effect"

(1) Estimated amount of collection and transport cost saving
175 Baht/t x 0.254 x 0.25 = 11.1 Baht/t ≒ 11 Baht/t

(2) Estimated amount of annual expense saving
11 Baht/t x 1.966 t/d x 365 days = 7,893,000 Baht/year

(3) Cost saving effect on waste treatment cost
11/313 x 100 = 3.5%

(4) Effect on improvement of collection and transport unit cost

4.5 Baht/t·km x 0.244 x 0.25 = 0.27 Baht/t·km

{ (4.5 - 0.27) x 0.25} + { (4.5 x 0.75)} = 4.4 Baht/t·km

$$\frac{4.5 - 4.4}{4.5} \times 100 = 1.5\%$$