

**SOLID WASTE MANAGEMENT STUDY
FOR
PULAU PINANG AND SEBERANG PERAI MUNICIPALITIES**

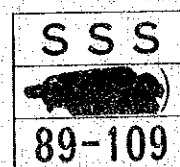
SUPPORTING REPORT

VOLUME I

PRESENT CONDITIONS AND MASTER PLAN

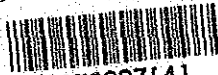
AUGUST 1989

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VOLUME I

PRESENT CONDITIONS AND MASTER PLAN

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CONTENTS

	<u>Page</u>
1. Present Situation and Future Conditions of the Study Area	1
1.1 Natural Condition	1
1.2 Administration	5
1.3 Population	8
1.4 Economic Conditions	13
1.5 Social Conditions	18
1.6 Land Use and Infrastructure	22
2. Present Situation of Solid Waste Management	35
2.1 Generation of Solid Waste	35
2.2 Storage and Discharge	49
2.3 Collection and Haulage	57
2.4 Cleansing Works	77
2.5 Intermediate Treatment and Recycling	97
2.6 Final Disposal	121
2.7 Organization and Management	151
2.8 Legislation and Enforcement	156
2.9 Privatization	178
2.10 Finance	188
3. Selection of Candidate Site	204
3.1 Site Selection Method	204
3.2 Selection of Potential Sites	226
3.3 Selection of Candidate Sites	233

	<u>Page</u>
4. Previous Study and Relevant Project	256
4.1 Master Plan on S.W.M. of MPPP	256
4.2 Structure Plan of MPPP	265
4.3 Development Plan (Structure Plan) of MPSP	270
4.4 Kang Valley Environmental Improvement Project	272
4.5 The Incineration Plant Kuala Terengganu	276
4.6 Technical Information on Waste Treatment and Disposal in Singapore	292
5. Estimation of Future Conditions	307
5.1 Priority Operational Area	307
5.2 Population Projection	310
5.3 Estimation of Future Solid Waste Amount	315
5.4 Estimation of Future Solid Waste Composition	323
5.5 Collection and Disposal Amount	326
5.6 Financial Conditions	330
6. Study on Sub-systems	332
6.1 Storage and Discharge of Solid Waste	332
6.2 Collection	342
6.3 Cleansing Work	349
6.4 Transfer Station	351
6.5 Intermediate Treatment	397
6.6 Final Disposal	529
6.7 Organization and Institution	557
7. Financial Evaluation	565
7.1 Financial Evaluation for MPPP	567
7.1 Financial Evaluation for MPSP	579

ABBREVIATION

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

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

1. Present Situation and Future Conditions of the Study Area

1.1 Natural Condition

(1) Topographic Conditions

There is a range of high mountains that forms the spine of Penang Island. Mountains with elevations higher than 1,300 feet run from north to south of the spine. However, mountains with elevations around 2,500 feet lie on the northern part. The highest mountain is Bukit Western having an elevation of 2,723 feet.

The Western part of the mountain range is characterized by a coastal plain and the eastern part of that is characterized by deltas along the valleys.

The Pantai Acheh area is situated in the northern part of this coastal plain and located between the Pantai Acheh fishing village and Sungai Pinang.

The shoreline of the area concerned is overgrown with mangrove swamp forests and the inland area consists mainly of flat terrained primary forests.

The bund set up by the Drainage and Irrigation Department serves as the borderline between the mangrove forests and the primary forests.

The western part of the Seberang Perai is characterized by a wide coastal plain and deltas along the valleys. The main rivers are Sungai Muda, Sungai Perai, Sungai Juru, Sungai Jawi, Sungai Tengah and Sungai Krian from north to south.

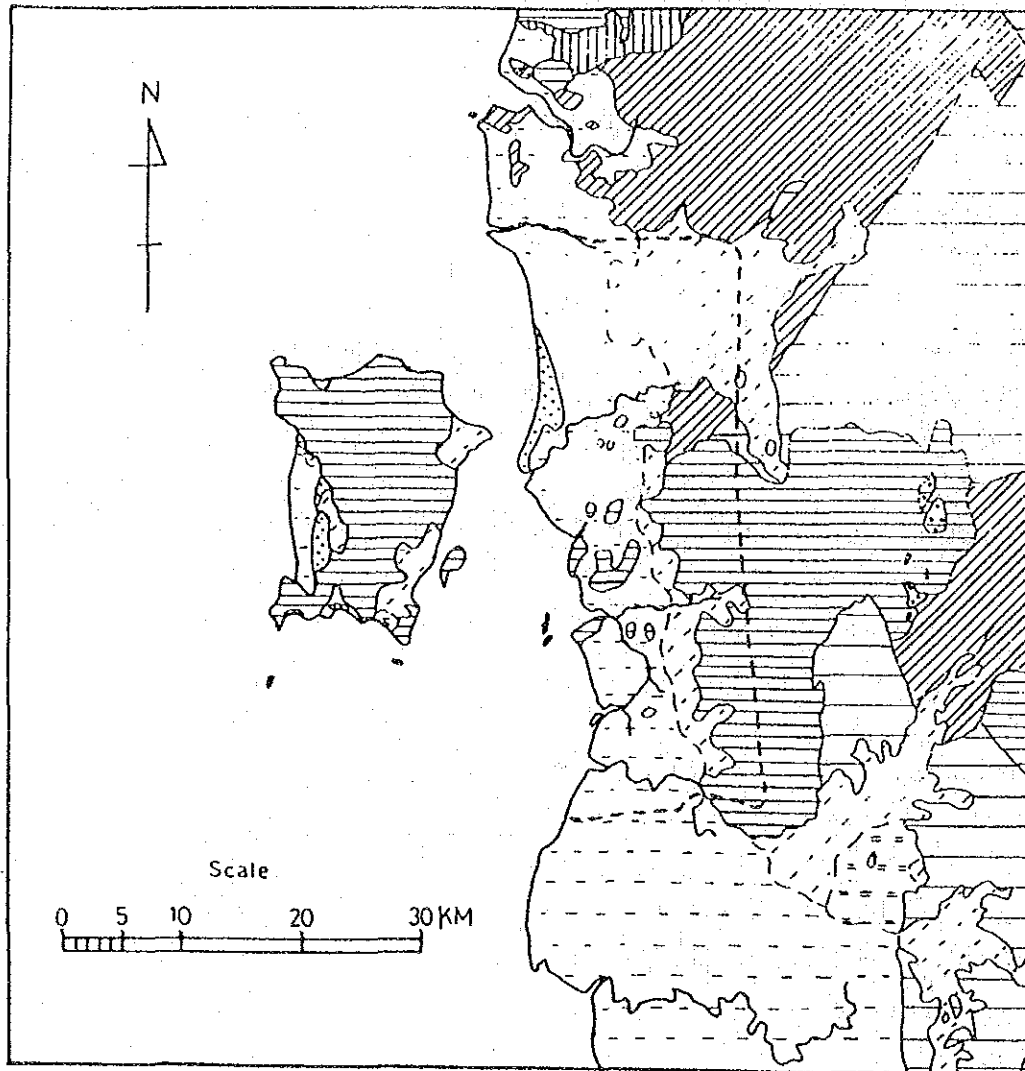
(2) Geological Conditions

The geological map of Penang State published by the Geological Survey is shown in Figure 1.1-1.

The geological setting in the coastal plain of Seberang Perai is mainly Alluvium deposits consisting of unconsolidated marine clay, sand and gravel.

Bukit Juru, Bukit Kangar and Bukit Batu Kawan are only studded with granite masses, whilst Pulau Aman consists of shale, chert and some sandstone.

The Kuala Muda and the Pulau Burong areas also consists of unconsolidated marine clay.



LEGEND

EXPLANATION		LITHOLOGY	
QUATERNARY	Marine and continental deposits: clay, silt, sand, peat with minor gravel. Basalt of Early Pleistocene age in the Kuantan area.	UNCONSOLIDATED DEPOSITS	Sand (mainly marine)
TRIASSIC	Interbedded sandstone, siltstone and shale; widespread volcanics, mainly tuffs of rhyolitic to dacitic composition in central peninsula. Limestone prominent in lower part of the succession. Conglomerate and chert locally prominent.	Clay and silt (marine)	Peat, humic clay and silt
SILURIAN-ORDOVICIAN	Schist, phyllite, slate and limestone. Minor intercalations of sandstone and volcanics.	Clay, silt, sand and gravel - undifferentiated (continental)	SEDIMENTARY AND METAMORPHIC ROCKS
CAMBRIAN	Sandstone/metasediment with subordinate siltstone, shale and minor conglomerate.	Sandstone/metasediment	INTRUSIVE ROCKS
		Acid intrusives (undifferentiated)	

Fig. 1.1-1 Geological Map of Penang State

(3) Marine Conditions

The shoreline of the Kuala Muda area is oriented in the direction of northwest - southeast. A natural sandbank stretches along the shoreline and the contour lines of water depth run almost parallel to the shoreline.

The zero meter contour line of the Admiralty Chart Datum, that equates approximately to the level of Lowest Astronomical Tide, lies about 600 meters away from the shoreline. The two and five meter contour lines lie about 2.1 km and 3.0 km away respectively from the shoreline, giving a mean sea-bed gradient of about 1/400 in the coastal areas.

On the other hand, the shoreline of the Pulau Burong area is oriented in the direction of north northeast - south southwest. The zero meter contour line is almost parallel to the shoreline and lies about 3 km away from the shoreline with a gradient of about 1/1,500. Just offshore Pulau Burong, there is a big mud flat called Great Kra Flat with water depths of less than five meters.

(4) Tides

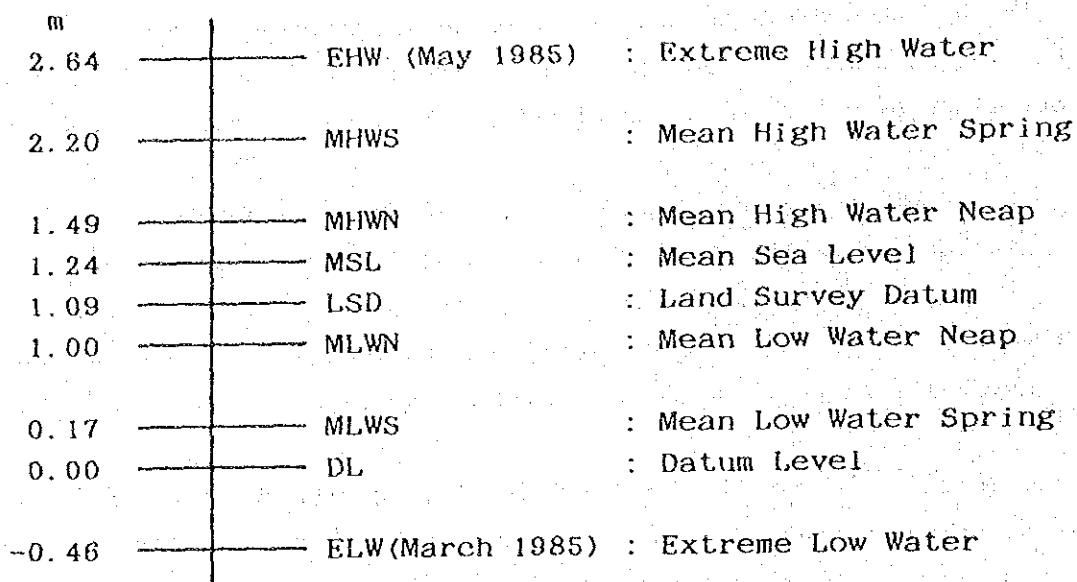
The tidal characteristics in the areas concerned obtained from the Penang Port data are as follows.

The tides are governed almost exclusively by the astronomical phenomena and semi-diurnal tides which means that both High Water and Low Water occur twice a day and inequality of tidal heights is observed at both of them.

The maximum tidal range is about 2.5 meters. The mean sea level is 1.24 meters above the Datum Level and 0.15 meters above the Land Survey Datum.

Figure 1.1-2 shows various datum relationships of tides at Penang Port.

Station: Penang Port



[Note] The Datum Level (DL) adopted is that of the Indian Low Water Springs. This shows approximately the level of Lowest Tides.

[Survey & Mapping Dept.]

Fig. 1.1-2 Various Datum Relationships of Tides

1.2 Administration

(1) Penang State

Penang State is one of the 13 states in Malaysia. Penang State comprises of 2 councils: Municipal council of Pulau Pinang (MPPP) and Municipal council of Seberang Perai (MPSP).

The head of the state government is Chief Minister, who is chosen, by prime minister, from 33 state assembly members. Governor who stays above Chief Minister in general sense is appointed by King of Malaysia. He serves constitutional head.

All the state assembly members are elected by the state citizens. Among 33 members, 8 members are called Executive councilors (EXCO), which constitute the highest decision-making body in the state government.

Under Chief Minister is State Secretary, who is appointed by Chief Minister. State Secretary is the head of the state secretariat office which has Administration and Development divisions. There are 12 departments in the state government as shown below.

- Finance Department
- Land & Minerals Department
- Public Works Department
- Penang Island State Spirit & Liquor Store Department
- State Agriculture Department
- Drainage & Irrigation Department
- Social & Welfare Department
- Urban & Rural Planning Department
- Forestry Department
- Park & Recreation Department
- State veterinary Department
- Islamic Welfare Department

In addition there exist the following statutory bodies in Penang State:

- Penang Development Corporation (PDC)
- Penang Water Authority
- Public Library Board
- State Museum & Art Gallery
- Hindu Benefit Board

Whole area of Penang State is divided to 5 Districts; North west and South east Districts in Pulau Pinang, North, Central and South Districts in Seberang Perai.

(2) MPPP and MPSP

The head of each Municipality is called "President" who is appointed by State Secretary. Under the President is Secretary who is appointed by the State Government. Under the secretary exists 10 departments in MPPP, while MPSP has 9 departments.

MPPP	MPSP
Secretariat	Secretariat
Town Planning	Town Planning
Valuation	Valuation
Legal Service	Legal Service
Treasury	Treasury
Building	Building
Health	Health
Engineering	Engineering
Transport	Transport
Veterinary	Veterinary

The highest decision making body in both MPPP and MPSP is council comprising of 24 members who are appointed by Chief Minister of the State Government. Following shows the list of committees in MPSP.

List of committees in MPSP council

1. Health, Licensing and Veterinary
2. Administrative and Finance
3. Tender
4. Appointments
5. Disciplinary Action
6. Town Planning and Building
7. Public Works
8. Traffic
9. Assessment Appeal (North District)
10. Assessment Appeal (Central District)
11. Assessment Appeal (South District)

1.3 Population

(1) Present Population Distribution

According to the Statistics Department of Penang State the population of Penang State is 1,049,282 in 1985, whereas MPPP is 539,558 and MPSP is 509,724. North East District of MPPP is 450,061, which includes 256,700 of Georgetown, and South West District in MPPP is 89,497. While North District of MPSP is 233,882, Central District is 191,420 and South District is 84,422.

The population distribution of MPPP by its Planning zone and of MPSP by Mukimu in 1985 is shown in Table 1.3-1. Fig. 1.3-1 shows the Planning zones of MPPP and Mukimus of MPSP.

The population of Penang State is concentrated in the towns and cities and their vicinities. In MPPP, the total population within the gazetted limits of towns and cities is 343,525 in 1980 which is about 69% of MPPP population. On the other hand in MPSP the population within the gazetted limits of towns and cities is 197,691 in 1985 which is only 39% of the population of MPSP. There have been a great deal of developments in the vicinities of existing town and cities. The agglomerations of those towns and cities are much larger than the existing gazetted limits. Fig. 1.3-2 shows the gazetted area of towns and cities and the urban expansions around them. The population including these vicinities covers 70% of the total population of MPSP in 1985 as shown in Table 1.3-2.

(2) Population Trend

Population of MPPP has increased 41,374 and Population of MPSP has increased 52,290 from 1980 to 1985. Yearly increase ratio of MPPP is 1.6% and one of MPSP is 2.2%

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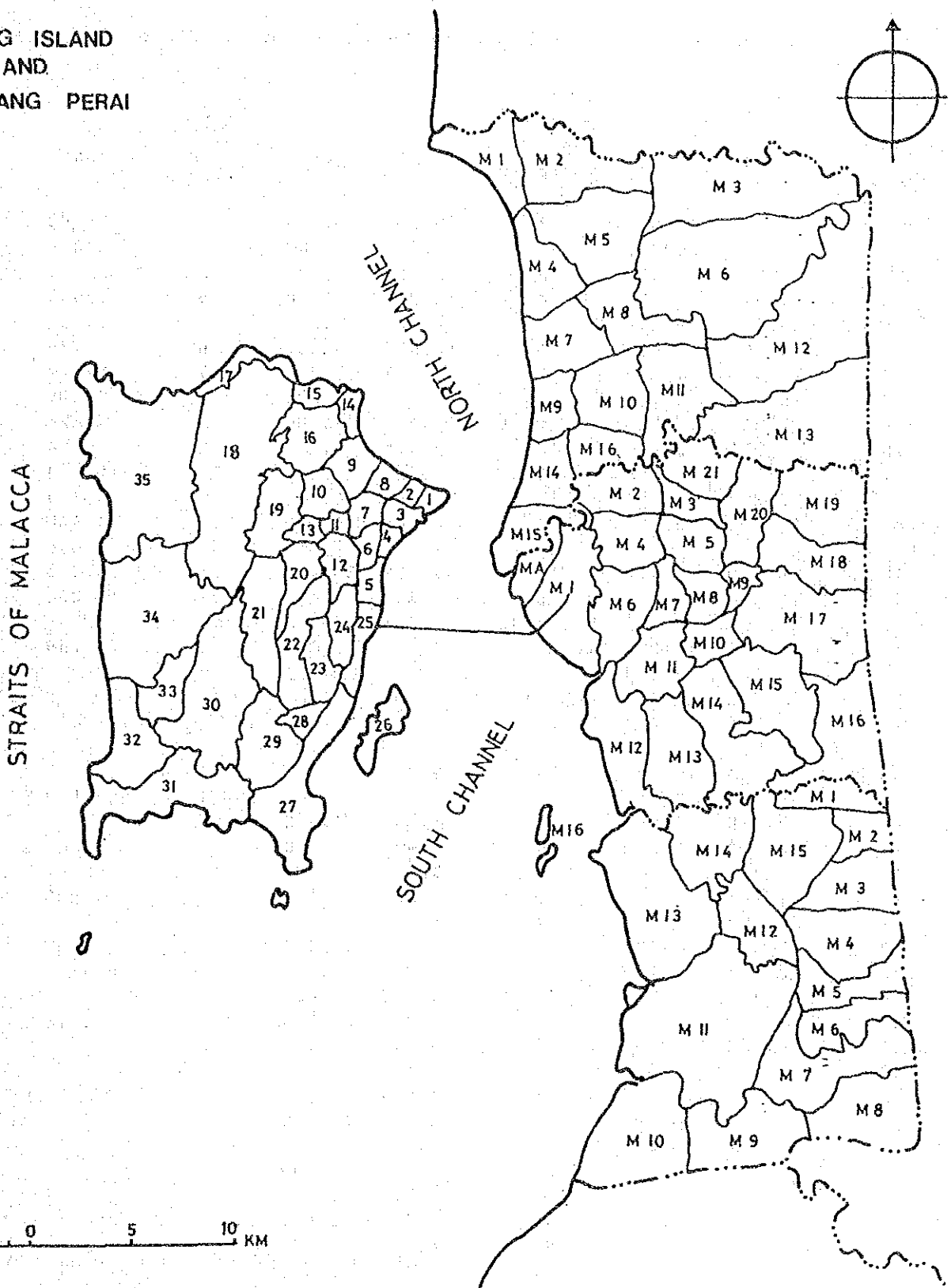


Fig. 1.3-1 Planning Zone of MPPP and Mukim of MPSP

Table 1.3-1 Population Distribution in Penang State

MPPP PLANNING ZONE	1980	1985	MPSF MUKIMU NORTH DISTRICT	1980	1985	MUKIMU SOUTH DISTRICT	1980	1985
1	40,568	40,600	1	6,293	6,600	1	2,492	2,600
2	16,686	16,700	2	5,994	6,100	2	1,224	1,300
3	47,034	49,400	3	8,238	8,500	3	534	600
4	34,311	33,600	4	5,932	6,400	4	3,093	4,000
5	19,919	18,000	5	7,029	7,200	5	4,895	5,600
6	36,501	35,000	6	13,522	14,000	6	579	572
7	13,975	14,000	7	12,012	13,000	7	5,099	6,600
8	15,018	14,700	8	7,672	7,800	8	2,594	2,700
9	12,306	12,200	9	11,491	13,100	9	7,426	9,250
10	2,399	2,400	10	3,916	4,100	10	8,494	8,700
11	8,656	7,300	11	8,356	8,500	11	19,303	20,800
12	12,827	12,800	12	16,085	16,200	12	3,119	3,800
Total	260,200	256,700	13	4,705	4,900	13	1,840	2,000
G'town			14	57,195	62,000	14	5,606	6,100
13	38,059	39,774	15	35,472	50,000	15	8,416	9,600
14	15,182	16,713	16	4,860	5,482	16	204	200
15	11,492	13,223	Wayfarer	1,538		Wayfarer	38	
16	10,754	12,059	Total	210,310	233,882	Total	75,766	84,422
17	4,322	5,077						
18	738	2,010	Central			MPSF		
19	1,898	1,904	District			TOTAL	457,434	509,724
20	23,299	31,100	1	20,238	39,000			
21	4,534	5,395	1A	9,303		PENANG		
22	2,846	3,385	2	4,562	4,700	STATE	955,618	1,049,282
23	9,489	19,569	3	4,354	4,400	TOTAL		
24	23,510	24,435	4	7,605	8,900			
25	7,485	8,145	5	3,529	3,600			
26	1,265	1,269	6	6,126	6,300			
27	20,664	22,531	7	2,211	2,300			
28	7,696	18,406	8	11,614	12,000			
29	12,335	13,752	9	11,954	12,600			
30	2,213	2,221	10	24,598	26,400			
31	11,596	12,271	11	9,054	10,900			
32	4,639	4,760	12	3,358	3,400			
33	4,322	4,654	13	3,505	5,200			
34	12,862	13,223	14	7,939	8,000			
35	6,747	6,982	15	16,532	18,000			
Total	237,948	282,858	16	6,645	6,800			
Rest PP			17	2,502	3,000			
			18	1,750	1,820			
MPPP	498,184	539,558	19	2,486	2,500			
			20	8,581	8,600			
			21	2,911	3,000			
			Total	171,357	191,420			

Source: MPPP, Structure Plant Unit
 MPSP, Malaysia Population Census 1980
 Technical Report for Structure Plan, MPSP
 Distribution to Mukimu by Study Team (1985)

Table 1.3-2 Population in Gazetted Towns and their Surrounding Areas MPSP 1985

	A	B	C	D	
	<u>WITHIN TOWN</u>	<u>SURROUNDING AGGLOMERATION</u>	<u>(A+B)</u>	<u>POPULATION OF DISTRICT</u>	<u>RATIO (%) C/D</u>
<u>NORTH DISTRICT</u>					
Kuara Muda	-	1,726	1,726		
2 Tasek Gelugor	843	2,351	3,194		
4 Sungai Dua	736	1,276	2,012		
6 Penaga	572	664	1,236		
7 Kepala Batas	2,089	13,964	16,053		
8 Butterworth	91,690	34,019	125,709		
Total	95,930	54,000	149,930	233,882	64%
<u>CENTRAL DISTRICT</u>					
9 Sungai Lembu	968	-	968		
11 Permatang Tinggi	2,727	5,998	8,725		
12 Perai	11,146	32,214	43,360		
13 Machang Bubok	2,726	538	3,264		
14 Kubang Semang	1,648	-	1,648		
16 Juru	2,336	3,521	5,857		
17 Bukit Tengah	724	7,694	8,418		
18 Bukit Mertajam	35,928	47,892	83,820		
20 Permatang Pauh	2,557	8,081	10,638		
Total	60,760	105,938	166,698	191,420	87%
<u>SOUTH DISTRICT</u>					
21 Sungai Bakap	1,909	14,626	16,535		
23 Permatang Tok Mahat	1,375	6,426	7,801		
24 Sungai Kecil	376	-	376		
25 Tasek	158	-	158		
28 Nibong Tebal	6,258	8,317	14,575		
29 Kampung Besar	231	-	231		
31 Changkat	157	-	157		
32 Bukit Tambun	775	-	775		
Total	11,239	29,369	40,608	84,422	48%
MPSP TOTAL	167,929	189,307	357,236	509,724	70%

Note:

Remark for No. 8 : Teluk Air Tawar (975), Sungai Puyu (963), Permatang Kencing (11,038)

Remark for No. 11: Simpang Empat (1,636)

Remark for No. 18: Simpang Empat (707), Berapit (4,760)

Remark for No. 20: Kampung Pkertama (999)

Remark for No. 21: Val Dor (4,497), Jawi (2,336)

Remark for No. 23: Permatang Keling (1,338)

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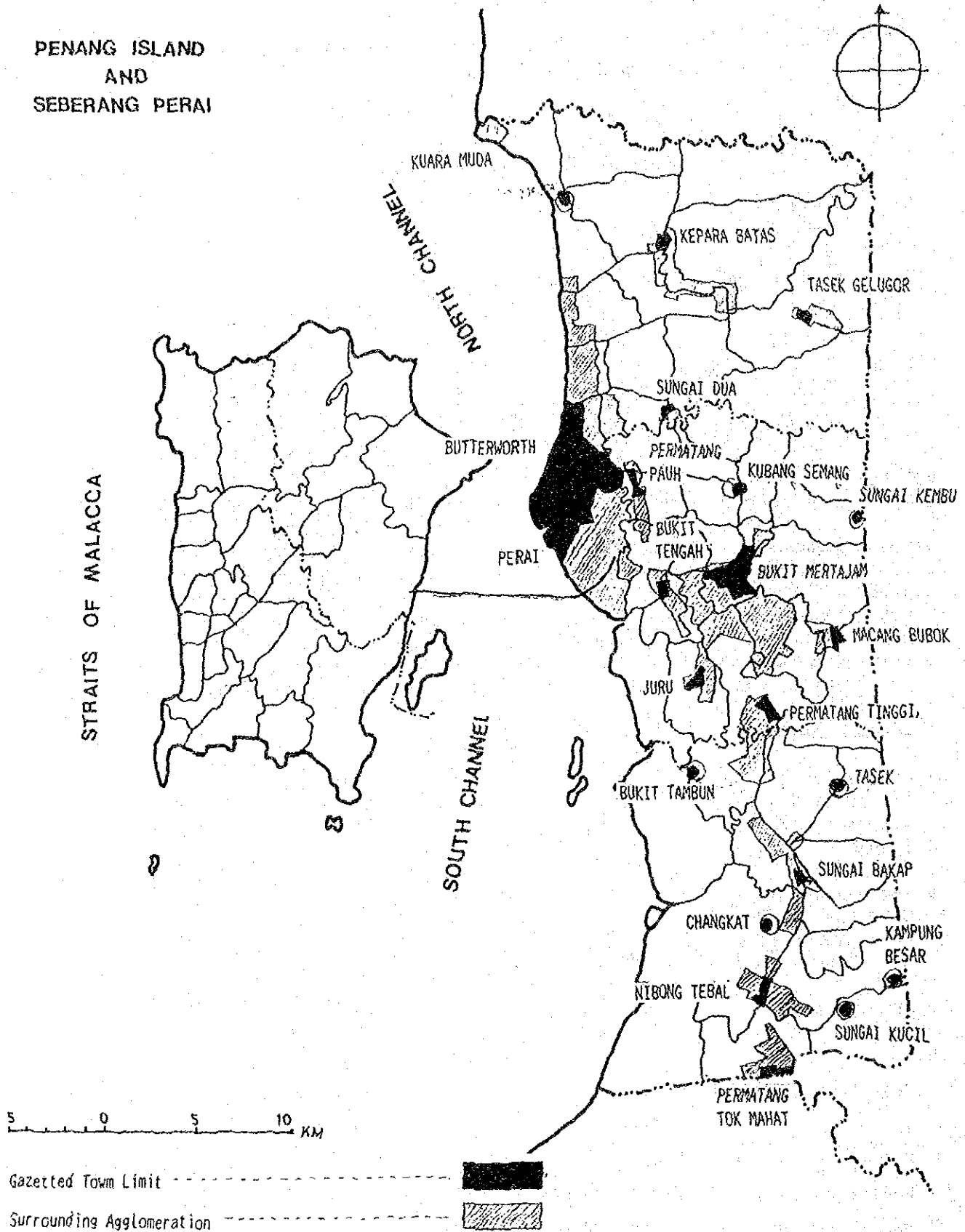


Fig. 1.3-2 Gazetted Town and Surrounding Agglomeration in MPSP

1.4 Economic Conditions

(1) Household Income

The distributions of monthly household income of MPPP and MPSP are shown in Table 1.4-1 and Table 1.4-2

In MPPP the average household income was \$1,355 per month in 1983, 43% - 55% household in MPPP earned less than \$800.

The average household income in MPSP was \$800 per month in 1985, 56% of households earned less than \$600 per month.

Projected household income of MPPP is shown in Table 1.4-3 and MPSP Table 1.4-4.

(2) Economy of Penang State

a. Economic Growth and Economic Structure

Although the economic growth of Penang was higher than that of Peninsula Malaysia from 1971 to 1980, The Fifth Malaysia Plan, (1986-1990) projected a growth as same as that of Peninsula Malaysia from 1985 to 1990. It is higher than the rate from 1980 to 1985, though almost all regions are projected to have declined after 1985.

Manufacturing is the major industry in Penang, and is the leading industry too. On the other hand, urban services have increased in recent years.

From 1980 to 1985, the growth rate of manufacturing sector has declined, which has caused recession and decline of property prices in Penang. But presently, some positive signs of improvements can be noted in the residential and industrial sectors.

Table 1.4-1 Estimated Household Income Distribution Pattern
Penang Island 1983

Monthly Household Income (\$)	% Household 1976 (Actual)	% Household 1983 (Estimated)	
		(a)	(b)
< 300	29.6	8	10
300 - 500	23.4	14	20
500 - 800	19.7	21	25
800 - 1000	7.1	11	7
1000 - 1500	8.6	18	12
1500 - 2000	4.7	9	5
2000 - 3000		7	7
3000 - 4000	6.9	5	6
4000+		7	8
ALL	100	100	100
Mean	744	1355	1355
Median	472	927	705

(a) assuming uniform income growth at all level at the mean income

Table 1.4-2 Seberang Perai: Household Income By District, 1985

Total Income Per Month	Center Seberang Perai	North Seberang Perai	South Seberang Perai	Total
Below 300	21.8%	26.1%	23.8%	24.3%
301 - 600	33.7%	29.7%	35.1%	31.9%
601 - 900	19.0%	16.6%	16.5%	17.4%
901 - 1200	11.2%	10.7%	9.4%	10.7%
1201 - 1500	4.8%	6.2%	5.5%	5.6%
1501 - 1800	3.5%	3.2%	3.0%	3.3%
1801 - 2100	2.4%	2.2%	2.5%	2.3%
2101 - 2400	1.0%	1.6%	0.7%	1.2%
2400+	2.6%	3.7%	3.5%	3.3%
Total	100.0%	100.0%	100.0%	100.0%

Source: MPSP-USM Socio Economic Study

Table 1.4-3 Projected Household Income Distribution,
Penang Island 1983-2000

Monthly Household Income %p.a.	a) uniform growth assumption					b) likely pattern	
	2.4% p.a.		4.4% p.a.			3.4% p.a.	
	1983	1990	2000	1990	2000	1990	2000
< \$500	30	22	13	20	10	22	12
\$ 500 - 1000	32	34	31	35	26	33	25
\$1000 - 1500	12	12	18	12	21	14	22
\$1500 - 2000	5	8	8	7	8	8	10
\$2000 - 3000	7	7	9	8	11	7	11
\$3000 - 4000	6	5	5	5	6	5	5
\$4000 +	8	12	16	13	18	11	15
All	100	100	100	100	100	100	100
Mean	1335	1443	1823	1590	2214		

Source: Report of Survey, MPPP

Table 1.4-4 Projection of Average Household Income Through Employment
MPSP, 1985-2000

1985			1990			2000		
Average Income(\$)	No. of Household	%	Average Income(\$)	No. of Household	%	Average Income(\$)	No. of Household	%
248	39,925	35.00	323	352,611	30.02	764	36,700	28.50
427	47,758	41.85	708	43,575	37.10	860	40,469	31.43
906	17,308	15.17	932	23,397	19.92	1,126	28,415	22.07
1,420	5,252	4.60	1,450	8,157	6.94	2,020	11,088	8.61
1,589	1,959	1.72	1,638	3,594	3.06	2,143	5,356	4.16
2,129	687	0.60	2,159	1,032	0.88	2,255	1,778	1.38
3,107	152	0.13	3,210	340	0.29	3,327	626	0.49
3,693	1,063	0.93	3,992	2,109	1.79	3,810	4,331	3.36

Source: Source: Report of Survey, MPSP

b. Future Perspectives

The Technical Report of the Structure Plan in MPSP has adopted 5.5% until 1990 and 7.2% during 1990 to 2000.

Considering the actual estimated growth rate from 1980 to 1985, and the tendency of world economy, the figures seems optimistic.

In this study, the growth rate after 1990 will be set in an average level of 4.8% from 1980 to 1990 as projected by the Fifth Malaysia Plan (FMP).

(3) Finance of MPPP

The MPPP budget consists of two parts, one is for the Transportation Department and the other for the rest of the Operating Departments. (General Rate Fund).

The Transportation Department shares only 6.5% of Total Revenue and 10.0% of Total Expenditure.

a. Revenue of MPPP

Consolidated rate and Contribution in lieu of rates (Assessment) is the principal source of revenue and contributed 55.5% of the Total Revenue collected in 1987.

But, in 1988, it will decline both the portion and the value because of the Revalued Variation List issued in 1987.

It is obvious that the recurrent revenue capacity of MPPP can no longer sustain the operational expenditures, and that non-recurrent sources of revenue are limited.

b. Expenditure of MPPP

The operational expenditure will touch \$68 million in 1988, an annual increase rate of 8.1%.

The expenditure of the Cleansing Section shares 43.4% of the total operational expenditure, and increases about 9.8% per annum. Engineering Department shows the decline, though Health Department has increased gradually. Other department shows an increase of 8.8% per annum.

Estimated expenditure by items points out as follows:-

- The annual recurrent expenditure shows an increase of 8.5% over the 1987 allocation
- Salaries and wages shares about half, the total expenditure, and shows an average of 6.9% over the 1987 figure
- Development expenditure only shares 2.8% of the total expenditure, and shows radical decline

Those factors required the improvement of the solid waste management and reduction of cost, and investigate new revenue resources for it.

1.5 Social Conditions

(1) Labor Conditions

Since Malaysian economy has entered the economic recession in early 1980, the employment demand has decreased, while the labor supply has been increasing slightly. As a result, labor wages in private sector has been depressed since then.

in 1984, both federal and local government stopped recruiting new employees unless it is essential. Another strong measure taken by the governments was to frozen promotions of government employees. During the past several years there has not been any major changes in the government employees wage rate.

In general the wage earned by a government sector employee is higher, at present, than that earned by a private sector employer with similar qualification and experience, although it was the other way round during the economic boom in 1970's.

Minimum legal wage is \$250/month at present, while the lowest wage paid to government laborers is \$300/month.

(2) Salary System in Government Sector

Rank and salary system for all the local government employees in Malaysia must be in accordance with that set by the federal government. All the ranks are coded. The amount of salary and educational qualification required are set according to rank as shown in the table below:

Overtime is paid only to senior overseers or lower ranks. Remuneration for work on sundays and national holidays are 50% and 100% higher than regular rates respectively. Maximum overtime is one third of regular monthly salary.

As can be seen from the above table, there exists great salary difference between higher ranks (health inspector or higher positions) and lower ranks (senior overseers or lower positions). For example, the start salary of an health inspector (\$745) is about 2.5 times higher than that (\$300) of an laborer. The difference in the maximum salary is as much as nearly 3.7 times. This big difference may reflect an excess supply of manual laborers over the demand for them.

(3) Working Days and Time

All the municipal employees work 6 days a week. Work time and hour of site workers i.e. senior overseers, overseers, mandors and drivers are different from those of office workers including health inspectors. Detailed schedule is shown below:

Table 1.5-1 Salary According to Rank

Unit: Malaysian dollar

CODE	POSITION	MONTHLY SALARY		MAX	ALLOW- ANCE
		START OF INCREASE	ANNUAL RATE		
A-10	Director	2,650	120	2,770	125
A-15	Assistant Director	1,360	60	1,840	125
B-1	Chief Health Inspector	1,685	60	1,865	75
B- ^{2,3} 4	Senior Health Inspector	1,305	60	1,505	75
B-9	Health Inspector	745	40-16y/60	1,505	75
C-3	Senior Clerk	1,055	40	1,255	45
C-11	Clerk	395	25-14Y/ 30-4Y/40	1,025	45
D-3	Senior Health Overseer	720	25-2y/30	920	35
D-10	Health Overseer	500	20-1y/25	720	35
D-11	Junior Clerk & Typist	350	15-10y/ 20-1y/25	720	35
D-28	Office Boy	300	10-4y/15	415	35
D-36	Senior Mandor	380	15	545	35
D-43-1	Car Driver	330	10-2y/15	515	35
D-46	Mandor	310	10	420	35
D-47	Laborer	300	10	410	35

Note: 40-16y/60 means that monthly salary increases by Rgt. 40 per year for the first 16 years, the rate of increase goes up to Rgt. 60 later on until the salary reaches to the ceiling.

Table 1.5-2 Working Time

	OFFICE WORKERS (Both MPPP & MPSP)	SITE WORKERS (MPPP)	SITE WORKERS (MPSP)
Monday - Thursday	8:00 - 12:45 14:00 - 16:15 (7 work hours)	6:30 - 10:30 11:30 - 14:30 (7 hours)	7:00 - 11:30 12:30 - 15:15 (7.25 hours)
Friday	8:00 - 12:15 14:45 - 16:15 (5.75 hours)	6:30 - 9:30 10:00 - 12:00 (5 hours)	7:00 - 12:00 (5 hours)
Saturday	8:00 - 12:45 (4.75 hours)	6:30 - 12:30 (6 hours)	7:00 - 11:30 12:30 - 14:00 (6 hours)
Total Weekly Working Hours	38.5 hours	39 hours	40 hours

1.6 Land Use and Infrastructure

1.6.1 Land Use and the Development Policy

1) Existing Land Use

a. Land Use in MPPP

- . In MPPP forest and agricultural land occupy 70% of the total land area.
- . Built-up area is 22% of the total land area.
- . Vacant and reclaimed land is approximately 1,800 ha, which is 6% of the total area.
- . Residential area is 3,900 ha, which covers 60% of the built-up area.

Table 1.6-1 shows land use distribution of MPPP.

b. Land Use in MPSP

- . Agricultural land and forest occupy 71% of the total land area.
- . Built-up area covers 22% of the total land area.
- . Vacant area occupies approximately 5,200 ha, is 7% of the total land area.
- . Residential area is approximately 8,600 ha, which covers 54% of the built-up area.

Table 1.6-2 shows land use distribution of MPSP.

- . Existing land use map is shown in Fig. 1.6-1.

Table 1.6-1 Land Use Distribution Pattern in Penang Island, 1985

<u>LAND USE</u>	<u>AREA (ha)</u>	<u>% OVER TOTAL PG. ISLAND</u>	<u>% OVER TOTAL BUILT-UP AREA</u>
Residential (permanent)	1,433	4.85	21.91
Indigenous Housing	2,458	8.33	37.58
Commercial	227	0.77	3.47
Educational	421	1.43	6.44
Government & Special Uses	806	2.73	12.32
Cemeteries	263	0.89	4.02
Other Built-up Areas	765	2.59	11.69
Open Spaces	303	1.03	
Forest & Scrub Forest	8,865	30.02	
Agriculture	12,023	40.72	
Vacant Land & Reclaimed Land	1,794	6.07	
Total Area of Penang Island	29,526	100%	100%

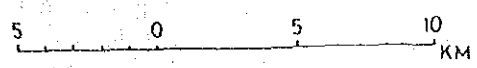
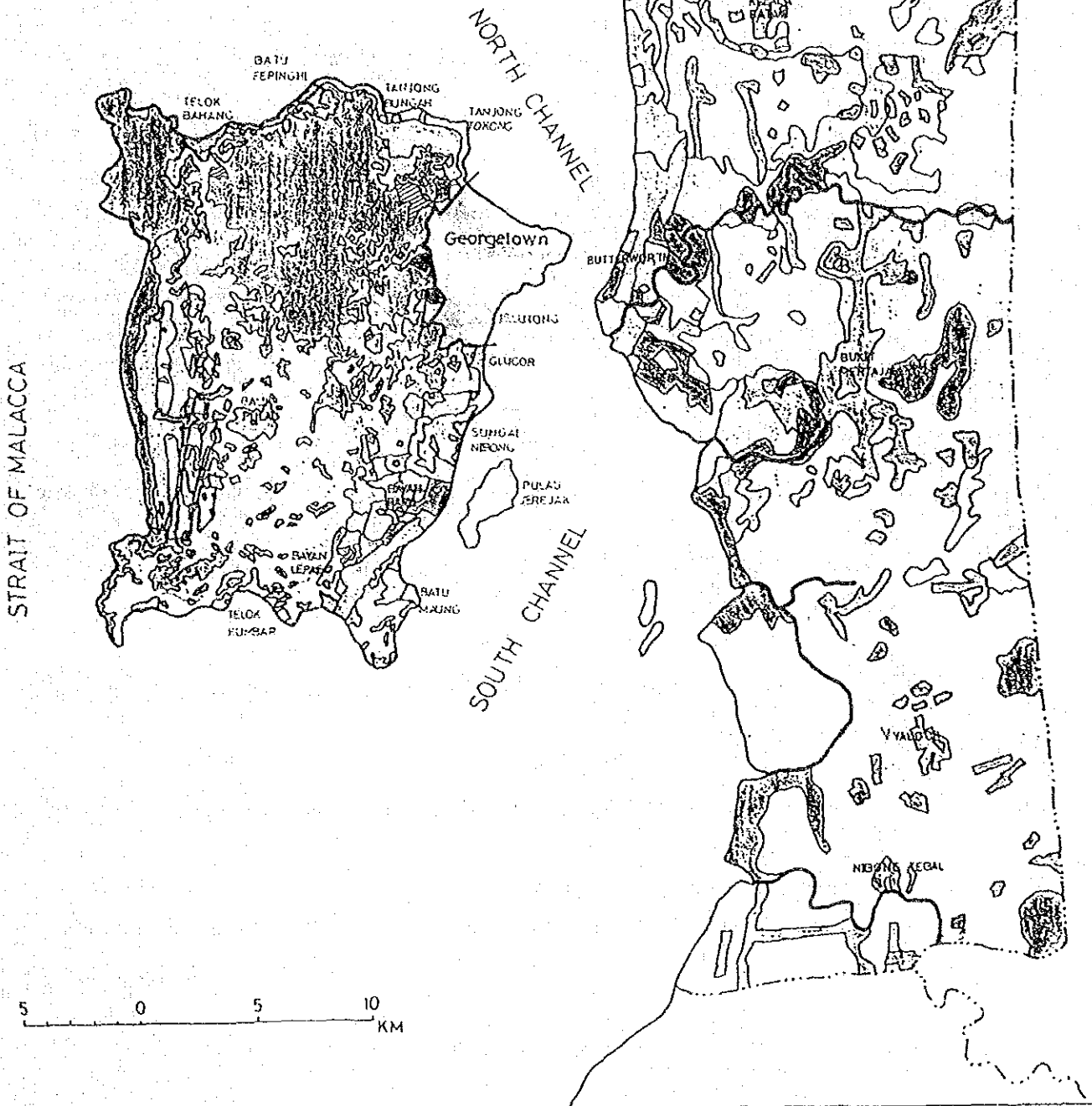
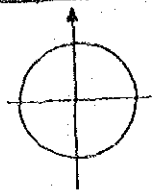
Source: Report of Survey

Table 1.6-2 Land Distribution in Seberang Perai, 1985

<u>LAND USED</u>	<u>NSP</u>	<u>CSP</u>	<u>SSP</u>	<u>TOTAL (HECTARE)</u>	<u>PERCENTAGE</u>
Housing	3582.15	3794.52	1209.97	8587.34	11.6
Commercial	116.36	67.72	33.62	217.70	0.3
Industry	240.70	533.20	449.05	1222.95	1.7
Institution	890.27	185.40	99.54	1175.21	1.6
Reserve	2041.68	1660.02	864.72	4566.42	6.2
Recreation & Unused Area	18.80	35.96	4.45	59.21	0.1
Forest & Catchment Area	47.35	973.38	847.21	1867.94	2.5
Agriculture	17416.51	14536.30	18991.36	50944.17	69.0
Vacant Area	1882.04	1688.41	1586.03	5156.48	7.0
Total:	26239.56	23474.91	24085.95	73797.42	100.00

Source: UPS, MPSP; Dec. 1985

PENANG ISLAND
AND
SEBERANG PERAI



LEGEND					
	Housing		Government Use/Institution		Open Recreation Area
	Commercial		Padi		Cemetery
	Industry		Other Crops		
	Forest Mangrove		Vacant Land		

Source: Structure Plan Exit MPT
 Planning Dept. of MPSP
 Existing Landuse
Fig. 1.6-1

The Solid Waste Management Study For Pulau Pinang And Seberang Perai

2) Development Policy and Future Land Use Plan

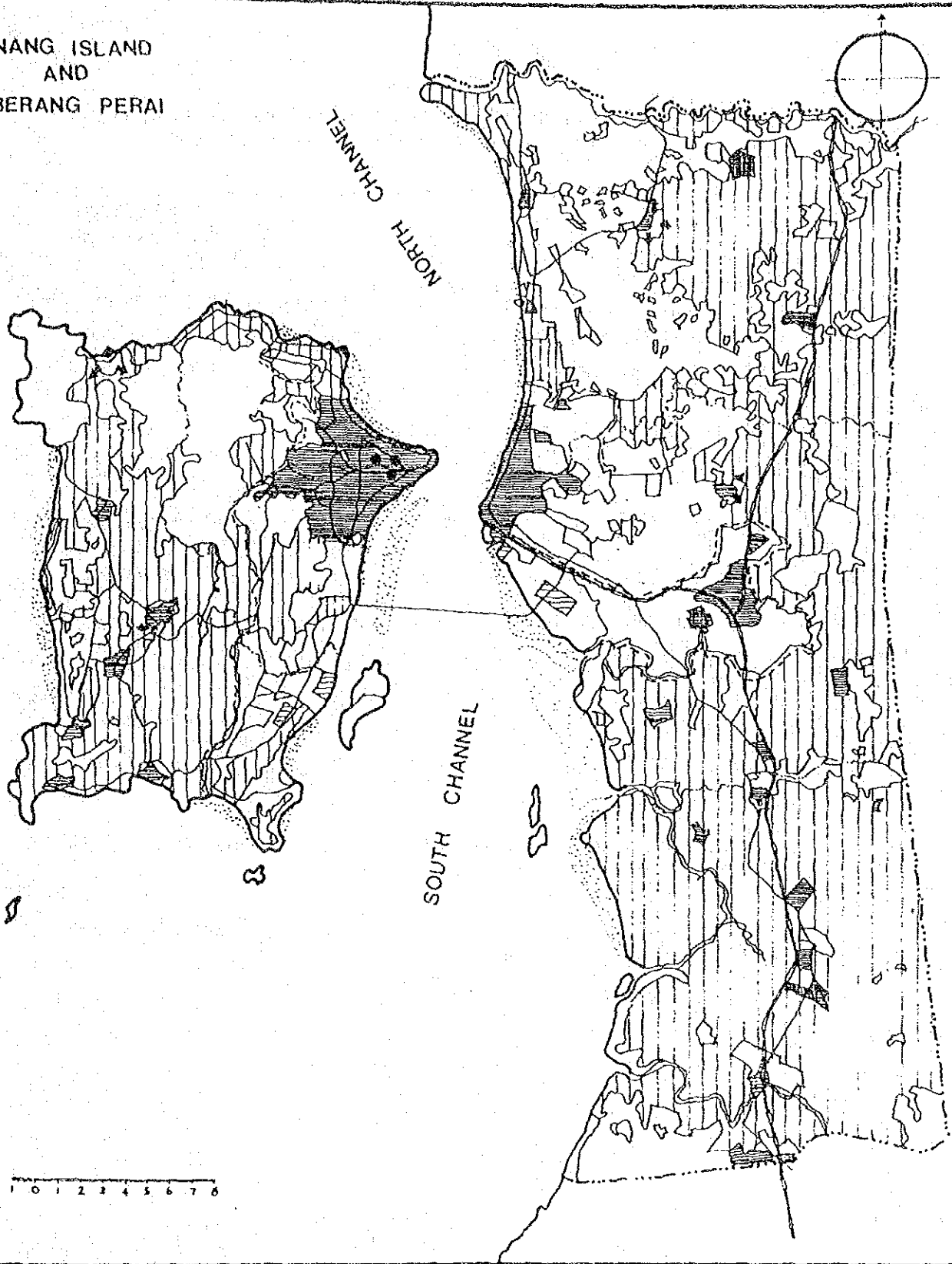
- . The Town and Country Planning Act was announced in 1976. Penang State enforced it in 1985. The Local Planning Authorities of MPPP are in a process of preparing structure plans as well as local plans.

a. Development Policy and Future Land Use of MPPP

- . The draft structure plan of MPPP was circulated in September 1987.
- . According to the draft structure plan most of the developments in Penang Island are Planned in the eastern half of the Island. Especially in Bayan Baru area and Ayer Item area. Batu Feringgi and the near part of it will be also developed.
- . Bayan Baru is planned as a sub-regional centre.
- . Western half of the Island is preserved from the urban development.
- . Georgetown will be the primary centre, but the population will remain at present level.
- . Future land use plan shown as a target plan in the report of survey is shown in Fig. 1.6-2.
- . Average number of housing needed for every year is approximately 3,300 units.
- . Land required for future development till 2000 is shown in Table 1.6-3.

b. Development Policy and Future Land Use of MPSP

PENANG ISLAND
AND
SEBERANG PERAI



LEGEND :-

- | | | |
|----------------------|----------------------|----------------------------------|
| TOWN/VILLAGE | WATER RETENTION AREA | MILITARY AREA |
| PADI AREA | URBAN RENEWAL AREA | INDUSTRIAL AREA |
| RECREATION AREA | SPECIAL USES AREA | NEW TOWN |
| FOREST RESERVE | OTHER CROPS | FREE TRADE ZONE |
| DISTRICT ADMN.CENTRE | | PROPOSED DEVELOPMENT GROWTH AREA |

Source: Structure Plan

Future Land Use Plan

Fig. 1.6-2

The Solid Waste Management Study For Pulau Pinang And Seberang Perai

Table 1.6-3 Projected Land Required for Future Development
in Penang Island Up to the Year 2000

<u>U S E S</u>	<u>APPROXIMATE AREA REQUIRED</u>
Housing (including local infrastructure & community facilities) (assuming 50 units/ha gross)	1,300 ha
Schools (primary & secondary)	80 ha
Parks (assuming 2/3 on land below 200')	540 ha
Other Community Facilities	50 ha
Industries	100 ha
Commercial (assuming plot ratio of 3)	40 ha
Public Utilities	30 ha
Sport Fields	30 ha
Cemeteries	40 ha
Total:	2,210 ha

Table 1.6-4 Projected Land Require for Future
Development in MPSP

1.6.2 Housing

According to 1980 Malaysia Population and Housing Census, there were 157,039 units of houses in Penang State, whereas 75,857 units (46%) in MPPP and 81,182 units (54%) in MPSP. Within MPPP there were 36% of detached house, 30% of Terrace house, 13.5% of semi detached house, 12.4% of flat, 3.0% of shop-house and 5.1% others. While in MPSP 64% were detached house, 20.5% Terrace house, 9.2% semi detached house, 2.5% flat 2.2% shop-house and 1.6% others.

During the Fourth Malaysian Plan 5,277 units of low cost public housing were completed, while in the fifth Malaysian Plan (1986-1990) 14,003 units of low cost housing have been proposed.

Table 1.6-5 and Table 1.6-6 shows the estimated demand for housing units in MPPP and MPSP. Both MPPP and MPSP require approximately 3,300 housing units every year.

Table 1.6-5 Estimated Demand for Housing Unit in MPPP

<u>HOUSING CATEGORY</u>	<u>1981-1985</u>	<u>1986-1990</u>	<u>1991-1995</u>	<u>1996-2000</u>	<u>TOTAL</u>
Shortage	1,869	1,868	-	-	3,737
Urgent Replacement	1,133	-	-	-	1,133
Ordinary Replacement	2,109	2,455	2,764	2,764	10,092
Additional Unit	10,545	12,273	13,818	13,818	50,454
Total Unit	15,656	16,596	16,582	16,582	65,416
Yearly average	3,131	3,319	3,316	3,316	3,271

Source: Technical Report for Structure Plan, MPPP

Table 1.6-6 Estimated Demand for Housing Unit in MPSP

<u>HOUSING CATEGORY</u>	<u>1985-1990</u>	<u>1991-1995</u>	<u>1996-2000</u>	<u>TOTAL</u>
Urgent Replacement	740	-	-	740
Ordinary Replacement	1,877	2,177	2,477	6,531
Additional Unit	14,981	14,991	13,480	43,452
Total Unit	17,598	17,168	15,957	50,723
Yearly Average	3,520	3,434	3,191	3,382

Source: Technical Report for Structure Plan, MPSP

1.6.3 Road

In terms of street sweeping the study directly concerns with road length and its condition, while the efficiency of collection and haulage of waste much depends on road conditions.

Road inventory is shown in Table 1.6-7. As it is shown in the table, roads are classified into 3 types in MPPP i.e. Federal road, State road and City road, and into 4 types in MPSP, i.e.. Federal road, State road, Rural road and Village road.

The condition of Federal Highway is among the best in the state. Federal Road Department is responsible for the maintenance and implementation of road projects. The width of the pavement of federal roads differs from place to place even on the same route. This causes bottle-neck, which might be the cause of traffic congestions and accidents, especially in town areas.

The State Highway Department is responsible for carrying out the maintenance of state roads. The conditions of state roads is not very good, especially in MPSP. There are patches and holes on the surface, which cause troubles in street sweeping activities. State roads have different grades from without shoulder. Roads within Georgetown is the city road which is maintained by MPPP, Engineering Department.

Rural roads are also state roads. the maintenance is carried out by JKR. Road surface of this type can be found either tar, gravel or red soil only.

The maintenance and project implementation of Village roads are responsibility of District Offices involved. This road is known as JKK road (Village Safe Committee). Village roads are either tarred or slabbed.

Total length of the road is 1,684.2 km in Penang State whereas 551.0 km in MPPP and 1,133.2 km in MPSP. Total length of Federal road is 130.4 km in penang state whereas 68.0 km in MPPP and 62.4 km in MPSP.

Table 1.6-7 Road Inventory (1985)

MPSP	MPPP (km)	MPSP			TOTAL (km)	REMARKS
		NORTH DIST(km)	CENTRAL DIST(km)	SOUTH DIST(km)		
Federal Road	68	26	16.6	19.8	62.4	W=66-100ft Pavement=24-29ft
State Road	277	258.6	281.6	72.5	685.3	
City Road	206	-	-	-	-	
Rural Road Tar, JKR	-	33.8	6.2	39.4	79.3	
Village Road	-	221.7 (216.7)	63.9 (55.0)	20.6 (12.8)	306.2 (284.5)	W=7ft, JKKK Tarred
Total	551	540.1 (48%)	368.2 (32%)	225 (20%)	1,133.2 (100%)	
AREA (km ²)	292	262	235	241	738	
Population	539,558	233,882	191,420	84,422	509,724	1985
Road Length/ Km ²	1.9	2.1 km	1.6	0.9	1.5	
Road length per 1000 persons	1.02	2.3 km	1.92	1.67	2.2	

Source: MPPP, Department of Engineering

MPSP, Technical Report for Structure Plan

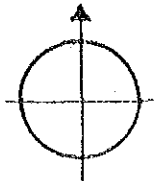
1.6.4 Other infrastructure

Drainage in Penang State is shown in Fig. 1.6-3. The total length of drainages is approximately measured by the length of roads. 1.5 to 2 times of the road length is likely to be the length of drainages. Where the drainage is affected by tides, flooding is still problem.

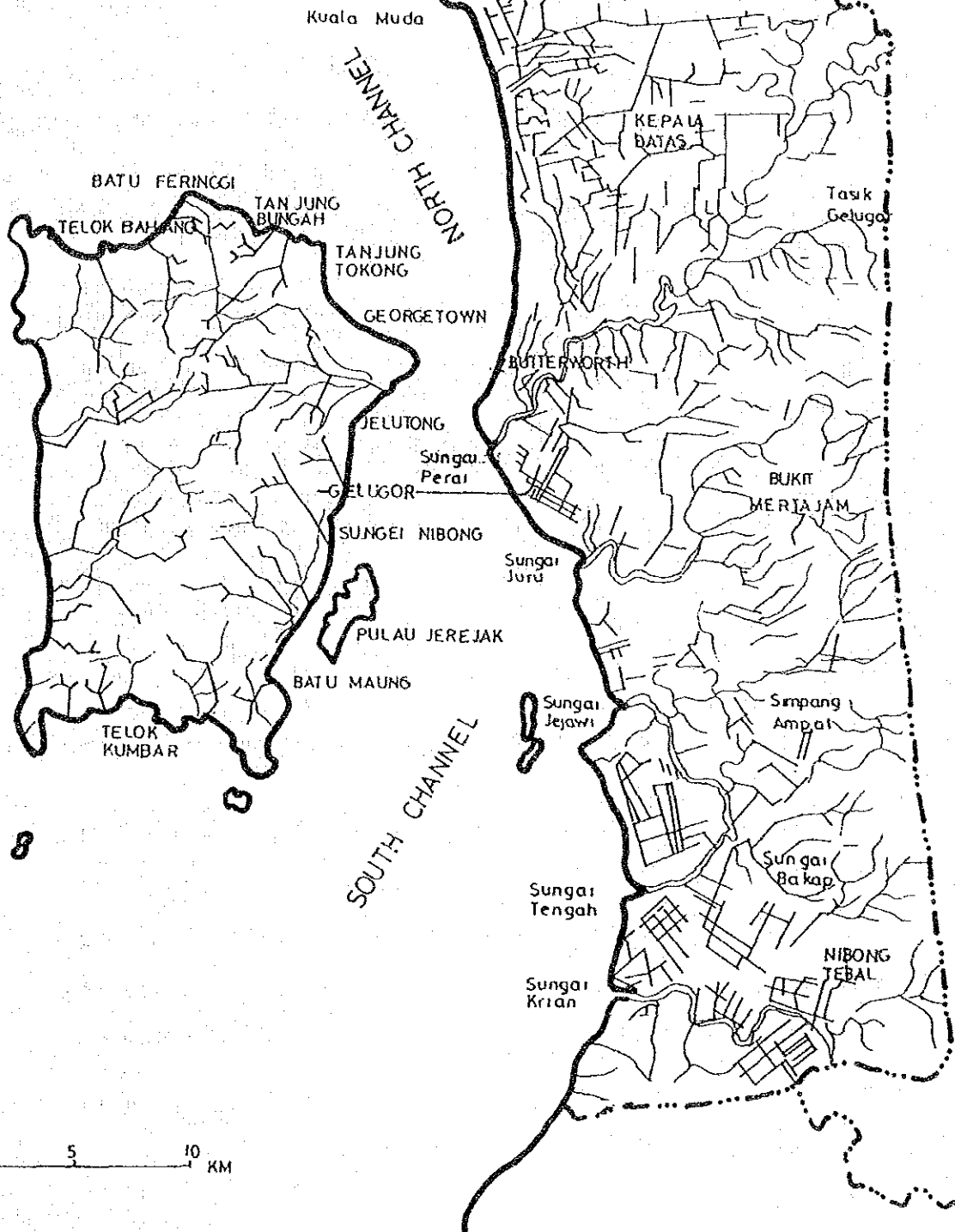
Park is classified into four categories i.e. Neighborhood park, Community park, Metropolitan park and Regional park. Neighbourhood park is about 0.2 ha to 2 ha in size and mainly for uses of children's play ground, open space for informal games and others. Community park is about 4 ha to 20 ha in size and mainly for picnic and jogging and walking besides other uses. A community park is expected to serve for 10,000 to 50,000 people. Metropolitan park is 10 ha to 40 ha in size and used for camping sties, walking trails and natural areas mainly. Regional park is more than 80 ha in size and serves for 200,000 people. It is mainly used for hiking trails and forest prservation areas besides other uses.

Existing parks and open spaces and projected requirement in MPPP is shown in Table 1.6-8. Existing recreational and open space area by district in MPSP is shown in Table 1.6-9.

PENANG ISLAND
AND
SEBERANG PERAI





STRAITS OF MALACCA



5 0 5 10 KM

LEGEND —

-  Drainage
-  River

Source: Structure Plan

Drainage Catchment Areas

Fig. 1.6.3

Table 1.6-8 MPPP: Existing Public Recreational parks and Open Spaces & Projected Future Requirement

<u>YEAR</u>	<u>POPULATION</u>	<u>TYPES OF PARKS AND OPEN SPACES</u>				<u>TOTAL</u>
		<u>NEIGHBOURHOOD OPEN SPACES</u>	<u>COMMUNITY PARK</u>	<u>METROPOLITAN PARK</u>	<u>REGIONAL PARK</u>	
1985 (existing)	524,100	35.3 ha (87.2 ac.)	21.7 ha (53.6 ac.)	58 ha (143 ac.)	116 ha (2,096 ac.)	848 ha (2,096 ac.)
1990	568,800	230 ha. (568 ac.)	230 ha. (568 ac.)	230 ha. (568 ac.)	230 ha. (568 ac.)	920 ha. (2,272 ac.)
1995	617,900	250 ha. (618 ac.)	250 ha. (618 ac.)	250 ha. (618 ac.)	250 ha. (618 ac.)	1,000 ha. (2,472 ac.)
2000	667,400	270 ha. (667 ac.)	270 ha. (667 ac.)	270 ha. (667 ac.)	270 ha. (667 ac.)	1,080 ha. (2,668 ac.)

Source: Penang Island Structure Plan Report of Survey, 1985

Table 1.6-9 Land Use Distribution in Seberang Perai (1985)

<u>LAND USE</u>	<u>NSP</u>	<u>CSP</u>	<u>SSP</u>	<u>TOTAL (ha)</u>	<u>PERCENTAGE</u>
Housing	3,582.15	3,794.52	1,209.97	8,578.34	11.6
Commercial	116.36	67.72	33.62	217.70	0.3
Industry	240.70	533.20	449.05	1,222.95	1.7
Institution	890.27	185.40	99.54	1,175.21	1.6
Reserve	2,041.68	1,660.02	864.72	4,566.42	6.2
Recreation & Unused Area	18.80	35.96	4.45	59.21	0.1
Forest & Catchment Area	47.35	973.38	847.21	1,867.94	2.5
Agriculture	17,416.51	14,536.30	18,991.36	50,944.17	69.0
Vacant Area	1,882.04	1,688.41	1,586.03	5,156.48	7.0
Total	26,239.56	23,474.91	24,085.95	73,797.42	100.0

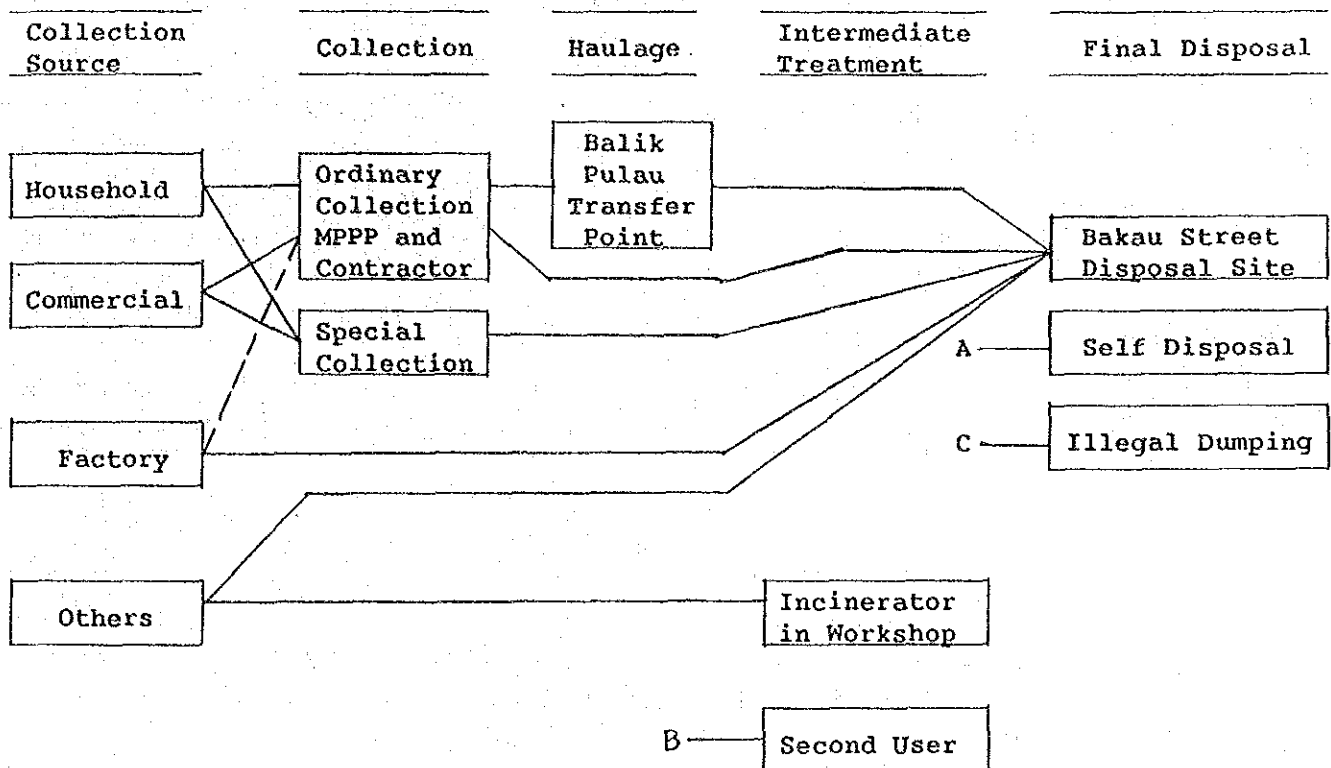
Source: USP, MPSP; Dec. 1985

2. Present Situation of Solid Waste Management

2.1 Generation of Solid Waste

2.1.1 Waste Flow

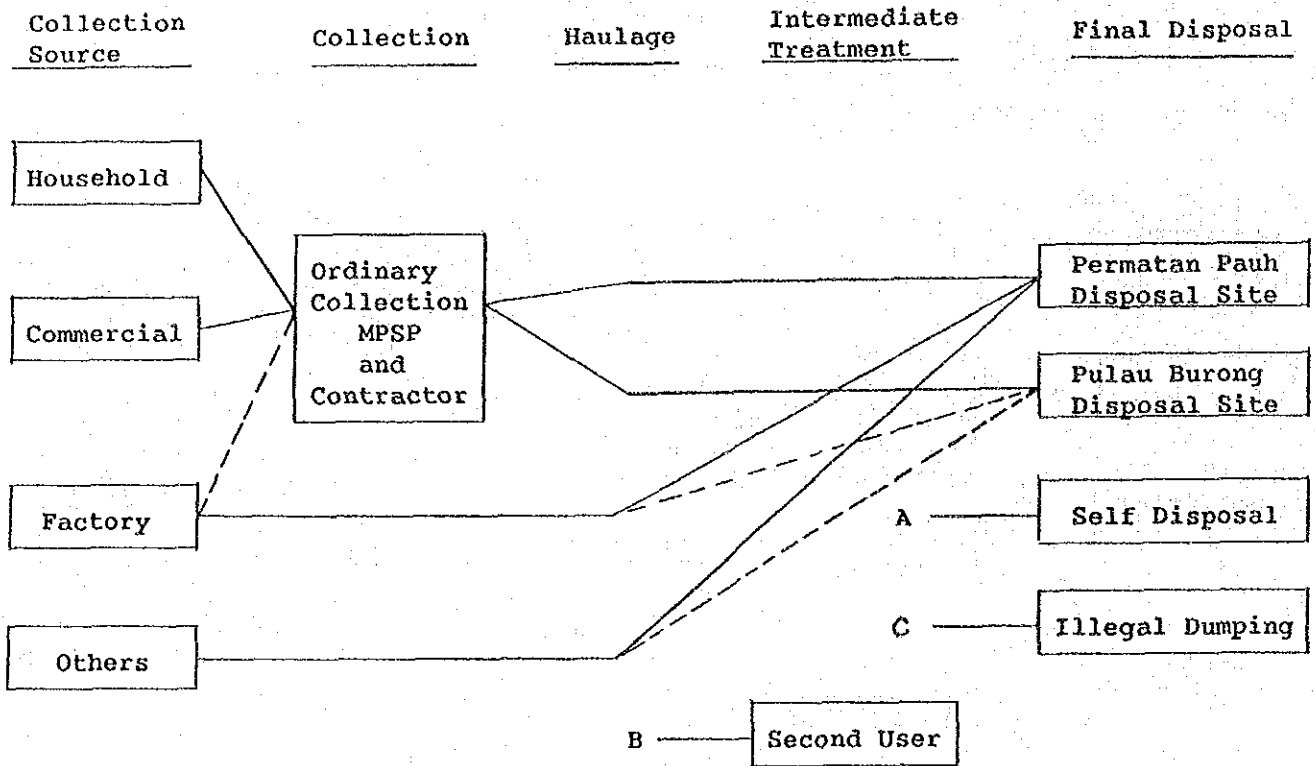
Amount all of waste generated in MPPP is collected and is disposed of at Bakau street dump site. Major waste flow is illustrated in Fig. 2.1-1.



- A: Self disposal at generation source mainly by burning
 B: Collected at generation source and at disposal site
 C: Disposal at road side in rural area

Fig. 2.1-1 Water Flow in MPPP

MPSP has two disposal sites; Permatan Pauh and Pulau Burong disposal sites. Waste collected in North and central districts is disposed of at Permatan Pauh disposal site and waste in south district is disposed of at Pulau Burong Disposal site. Waste flow in MPSP is shown in Fig. 2.1-2.



- A: Self disposal at generation source mainly by burning etc.
- B: Collected at generation source and at disposal site
- C: Disposal at road side in rural area

Fig. 2.1-2 Waste flow in MPSP

2.1.2 Solid Waste Amount in MPPP

(1) Collection Amount

Solid waste amount collected by MPPP is 358.1 t/day in average during July 1987 to June 1988 as shown in the Table 2.1-1 and 2.1-2. Solid waste amount is larger in June and July, and it is smaller in February. July has 1.14 times of solid waste.

Bulk bin system and Multi lift system collect 76.3 t/day of solid waste mainly from business establishment such as markets and hotels, and flats. Commercial waste generated in small shops is collected through side loader system together with domestic waste.

Maximum waste amount collected in a day is 463 ton which is 1.29 times of average document.

Fig. 2.1-3 shows change of coefficient to the ranking of daily solid waste amount. This shows that only 13 days in a year exceed 1.15 in coefficient.

(2) disposal Amount

At Bakau Dumpsite, 148,959 ton of solid waste is disposed of during July 1987 to June 1988. Daily disposed amount is 407.6 ton in average is shown in Table 2.1-3.

Some of waste is hauled to an incinerator installed in the Workshop. 0.9 t/day of waste is burned in average.

At the Bakau street disposal site 270 t/day of red earth and 37 t/day quarry remains are used for covering material which is 75% of waste in weight.

Table 2.1-1 Waste Amount in MPPP

(July 1987 - June 1988)

TYPE OF WASTE	TOTAL (TON)	AVERAGE (T/DAY)	RATIO %
Collected Waste			
By Contractor			
Side Loader	90,688	247.8	60.8
Bulk Bin System	16,227	44.3	10.0
Multi Lift	11,704	32.0	7.8
Sub Total	118,619	324.1	79.5
By Council	12,441	34.0	8.3
Total	131,060	358.1	87.8
Waste Hauled Directly			
Factory Waste	5,532	15.1	3.7
Building Debris	852	2.3	0.6
Grass and Tree	1,247	3.4	0.8
Domestic Waste	966	2.6	0.6
Others	9,282	25.4	6.2
Total	17,879	48.8	12.0
Incineration	(198)	0.9	0.2
Grand Total	148,939	407.8	100.0
Covering Material			
Red Earth	(57,965)	306.9	
Quarry Remain	(8,013)	269.6	
Total	(65,978)	37.3	

Note: Figure () is the amount from July 1987 to Jan. 1988

Table 2.1-2 Solid Waste Amount Collected in MPPP (July 1987 - June 1988)

AWS	DOMESTIC WASTE						COMMERCIAL WASTE							
	HY	WD	OM	IH	EKB	DS	AK	MPPP	SUBTOTAL	BULK BIN	MULTI	SUBTOTAL	TOTAL	
7	2,170	1,215	1,481	1,209	1,335	663	836	479	10,160	1,566	739	2,305	12,465	
8	2,159	1,110	1,366	976	1,142	592	734	428	9,130	1,338	980	2,318	11,448	
9	2,008	1,121	1,225	927	1,007	571	622	444	8,512	1,304	1,017	2,321	10,833	
10	1,967	1,115	1,138	1,011	1,207	73	751	843	8,729	1,332	1,124	2,456	11,185	
11	1,865	1,062	1,109	1,029	1,206	-	132	1,176	8,134	1,283	1,071	2,354	10,538	
12	1,901	1,197	1,120	1,010	1,217	-	647	-	8,306	1,378	1,009	2,387	10,693	
1	1,954	1,163	1,082	915	1,205	-	612	-	8,025	1,385	1,057	2,442	10,467	
2	1,661	1,140	1,034	820	1,242	-	703	-	7,878	1,181	811	1,992	9,870	
3	1,859	1,130	981	743	1,293	-	607	-	7,873	1,245	960	2,205	10,078	
4	1,966	1,175	997	754	1,354	-	620	-	8,153	1,288	960	2,248	10,401	
5	2,111	1,288	1,135	865	1,397	-	725	-	8,976	1,421	1,017	2,438	11,414	
6	2,003	1,315	1,209	947	1,441	-	795	-	9,203	1,506	959	2,465	11,668	
Total	23,634	14,031	13,877	11,206	15,046	1,899	7,920	3,075	12,441	103,129	16,227	11,704	27,931	131,060
Ave. Mth.	1,969.5	1,169	1,156	934	1,254	158	660	256	1,037	8,594	1,352	975	2,328	10,922
Daily	64.6	38	38	31	41	5	22	8	34	282	44	32	76	358
Max. Days	88t	54	57	45	60	25	62	32	65	379	56	42	93	463
	1.36	1.91	1.50	1.47	1.46	-	2.87	-	1.34	1.26	1.31	1.22	1.29	

Table 2.1-3 Solid Waste Amount Disposed of at Bakau Street Disposal Site in MPPP July 1987 - June 1988

COLLECTION	COMMERCIAL			BUILDING			DOMESTIC			DIRECT HAULAGE			SUBTOTAL	TOTAL
	DOMESTIC	COMMERCIAL	SUBTOTAL	DOMESTIC	BUILDING	SUBTOTAL	FACTORY	OTHERS	FACTORY	OTHERS	TREE			
7.0	10,160.0	2,305.0	12,465.0	62.0	55.0	117.0	484.0	1,725.0	131.0	2,457.0	14,922.0	14,922.0		
8.0	9,130.0	2,318.0	11,448.0	20.0	39.0	59.0	517.0	882.0	132.0	1,589.0	13,037.0	13,037.0		
9.0	8,512.0	2,321.0	10,833.0	-	50.0	50.0	431.0	821.0	124.0	1,426.0	12,259.0	12,259.0		
10.0	8,729.0	2,456.0	11,185.0	-	41.0	41.0	427.0	845.0	91.0	1,404.0	12,589.0	12,589.0		
11.0	8,184.0	2,354.0	10,538.0	-	58.0	58.0	366.0	833.0	66.0	1,323.0	11,861.0	11,861.0		
12.0	8,306.0	2,387.0	10,693.0	-	108.0	108.0	372.0	614.0	52.0	1,146.0	11,839.0	11,839.0		
1.0	8,025.0	2,442.0	10,467.0	29.0	155.0	184.0	279.0	584.0	45.0	1,092.0	11,559.0	11,559.0		
2.0	7,878.0	1,992.0	9,870.0	-	157.0	157.0	309.0	309.0	81.0	856.0	10,726.0	10,726.0		
3.0	7,873.0	2,205.0	10,078.0	228.0	76.0	304.0	549.0	660.0	110.0	1,623.0	11,701.0	11,701.0		
4.0	8,153.0	2,248.0	10,401.0	279.0	165.0	444.0	569.0	1,055.0	157.0	2,225.0	12,626.0	12,626.0		
5.0	8,976.0	2,438.0	11,414.0	148.0	21.0	169.0	590.0	554.0	122.0	1,435.0	12,849.0	12,849.0		
6.0	9,203.0	2,465.0	11,668.0	86.0	41.0	127.0	640.0	400.0	136.0	1,303.0	12,971.0	12,971.0		
Total	103,129.0	27,931.0	131,060.0	852.0	966.0	1,818.0	5,532.0	9,282.0	1,247.0	17,879.0	148,939.0	148,939.0		
Ratio %	69.2%	18.8%	88.0%	0.6%	0.6%	1.2%	3.7%	6.2%	0.8%	12.0%	100.0%	100.0%		
Ave. Mth	8,594.1	2,327.6	10,921.7	71.0	80.5	151.5	461.0	773.5	103.9	1,489.9	12,411.6	12,411.6		
Ave. Daily	282.5	76.5	359.1	2.3	2.6	4.7	15.2	25.4	3.4	49.0	408.1	408.1		

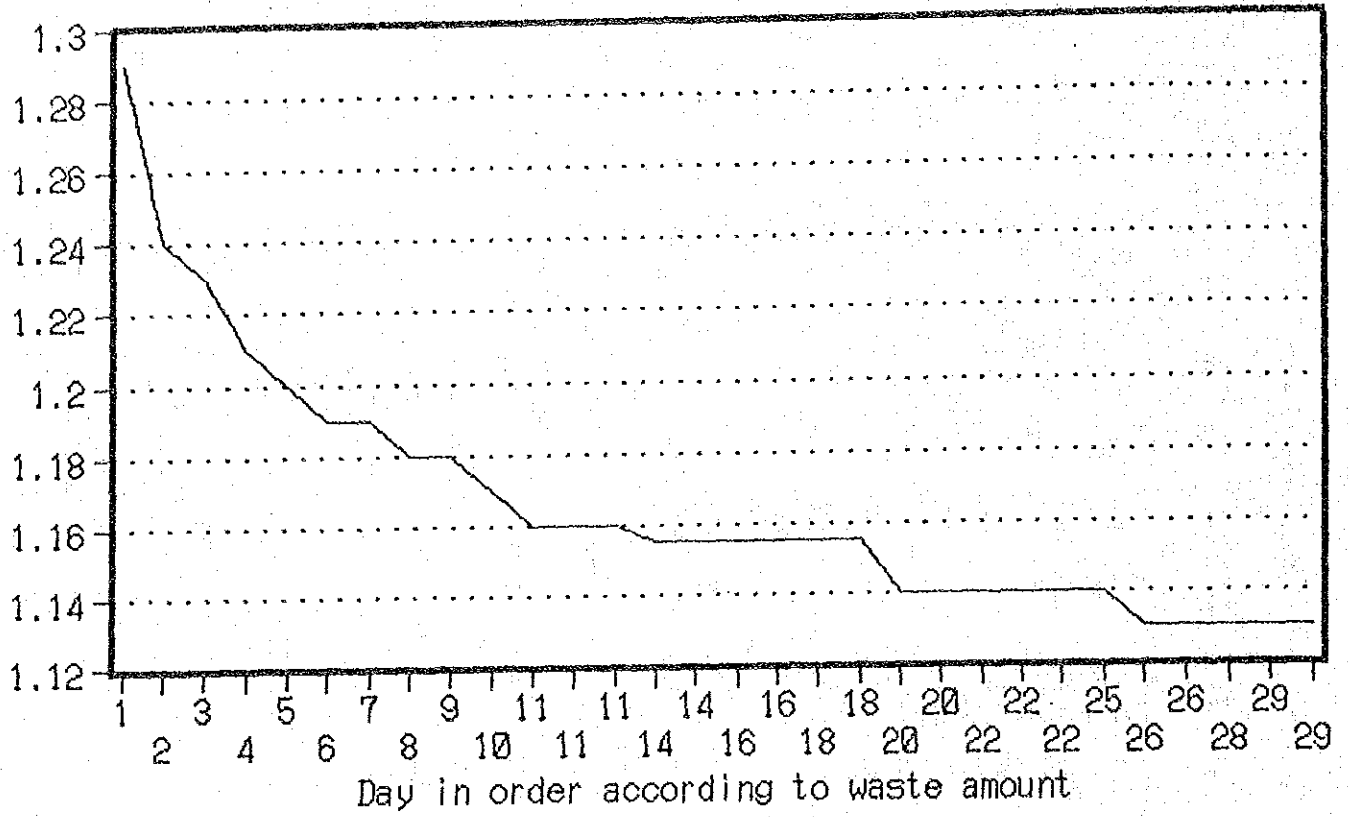


Fig. 2.1-3 Waste Amount of the Day

(2) Change of Yearly Waste Amount in MPPP

Yearly waste amount collected in MPPP is available from 1971 as shown in Table 2.1-4 including some changes of basic condition.

In 1974, City Council of Georgetown and District Council of Rural were integrated to MPPP. Waste amount until 1973 shown in the table is only for Georgetown. In 1979, MPPP started the privatization on refuse storage and transportation. Until 1985, front loader vehicles which were employed by Conwaste Sdn. Bhd. did not measure the weight because of out of weighbridge capability. At end of 1983, MPPP contracted out to 3 other private companies for waste collection and haulage.

Change of yearly waste amount collected from 1974 is shown in Fig. 2.1-4 which shows drastic increase of waste amount after 1984. Also show a decrease of waste amount between 1986 and 1987, maybe because of strict checks at disposal site carried out from June 1986.

Anyway, it may be right, considering that the drastical increase of waste amount reflects improvement of collection service in spite of numerous cheating incidence found at disposal site.

(3) Monthly Waste Amount

Table 2.1-5 shows the monthly waste amount collected and transported by each-contractor and the council from 1984. Fig. 2.1-5 shows the change of monthly waste amount by each contractor.

Record in 1987, indicates after carrying out strict check, the monthly waste amount of each contractor was more from June to August maybe due to fruits season compared to other months, also it is easily noticeable that month of February, which has chinese new year is minimum waste amount.

(4) Weekly Fluctuation of Waste Amount

One example from 9 to 15, November, 1987 is shown in Fig. 2.1-6. Basically, weekly fluctuation is not big because of daily collection.

Table 2.1-4 Yearly Waste Amount Collected in MPPP (ton)

YEAR	ORDINARY CONTRACTOR	COLLECTION MPPP	BULK BIN	MULTI LIFT	SUBTOTAL	OTHERS	TOTAL
1971		53,165			53,165		
1972		53,266			52,266		
1973		53,496			53,496		
1974		71,325			71,325		
1975		73,619			73,619		
1976		74,355			74,355		
1977		72,556			72,556		
1978		79,249			79,249		
1979					74,157		
1980					76,446		
1981					69,887		
1982					80,640		
1983					76,309		
1984	71,804	29,384	-	704	102,851		
1985	92,133	22,699	825	10,706	126,363		
1986	103,930	6,946	11,609	13,551	135,036		
1987	96,903	7,459	9,446	15,962	129,770		
1988							

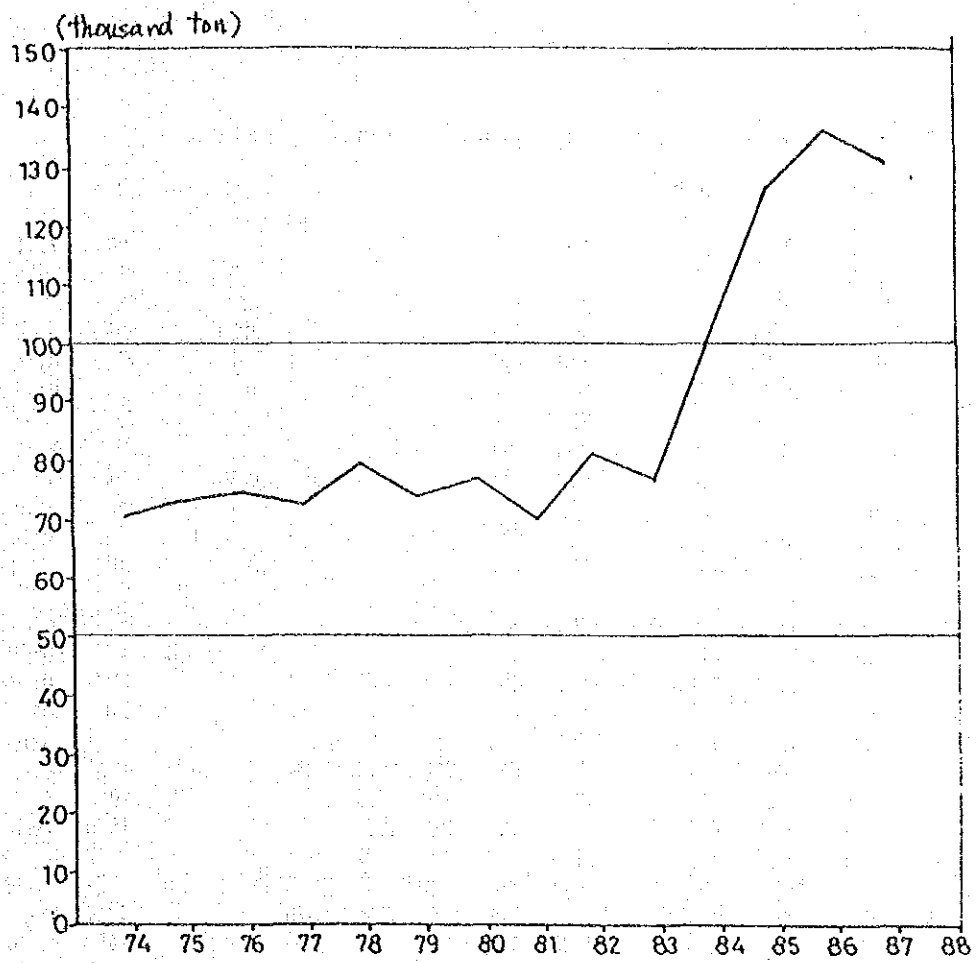


Fig. 2.1-4 Change of Yearly Waste Amount

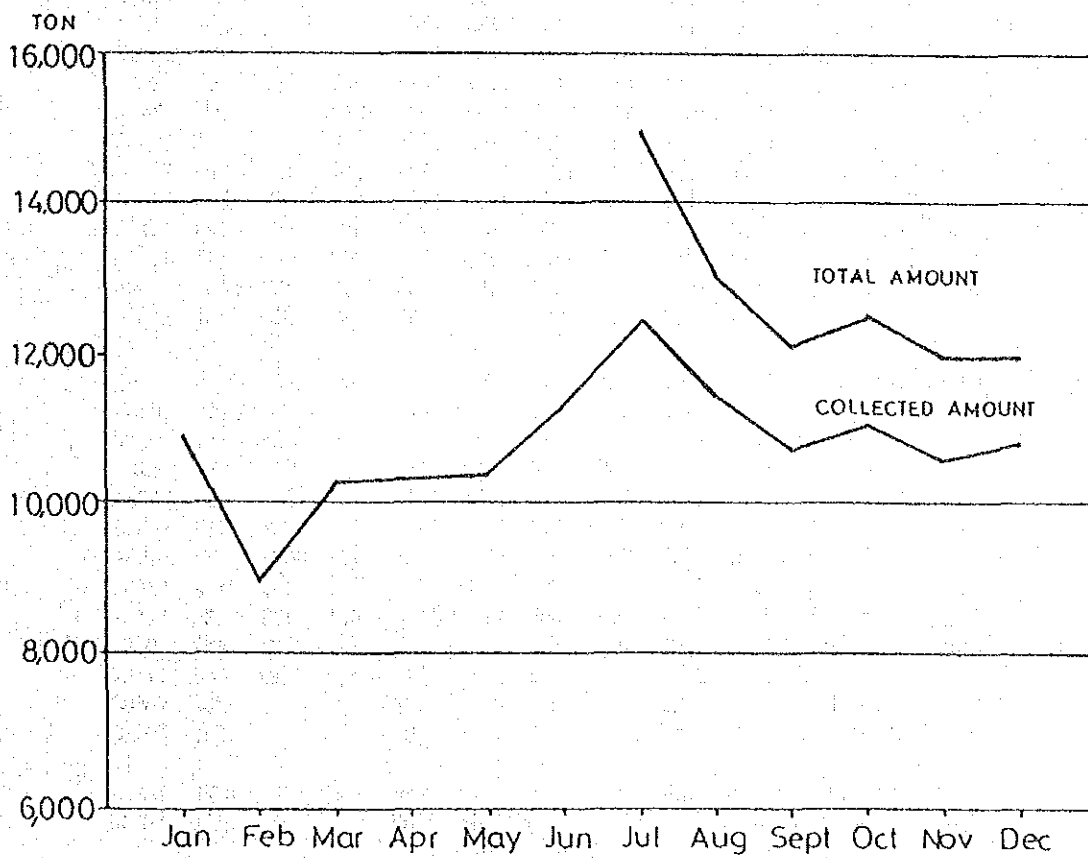


Fig. 2.1-5 Monthly Waste Amount in MPPP 1987

Table 2.1-5 Monthly Waste Amount in MPPP

1984	AMS	AW-H	IHT	BKB	Conwaste D/master	Skip	MPPP	Total
Jan	1376		854	195	3062		1984	7471
Feb	1145		606	433	2955		2438	7577
Mar	1653		788	743	1979	1258	2553	8984
Apr	1368		869	718	1365	1823	2399	8540
May	1439		869	809	3247		2390	8754
June	1381		869	732	2861		2634	8477
July	1401		720	587	3392		2377	8477
Aug	1445		746	550	3362		2516	8619
Sept	1296	94	642	486	3059		2343	7920
Oct	1439	317	803	588	1825	1450	2583	9005
Nov	1528	557	763	631	1759	1357	2528	9119
Dec	1757	695	812	647	1833	1523	2641	9908

1985	AMS	AW-H	AW-C	IHT	BKB	SOM	VD	SH	Conwaste D/master	Skip	MPPP	Total
Jan	1769	704		701	647				1796	1833	3409	10859
Feb	2010	624		946	491	753	932	1157			2178	9091
Mar	2132	623		946	584	790	1074	1281			1795	9225
Apr	2226	676		946	613	845	1092	1227			1757	9182
May	2408	832		1176	640	755	1214	1328			1934	10287
June	2520	913		1214	747	1102	1426	1448			2026	11396
July	2412	847		1113	700	919	1370	1290			1879	10530
Aug	2422	877		1176	683	900	1509	1221			1542	10330
Sept	2207	980		1047	652	706	1316	1288			1582	9778
Oct	2380	1124		1264	702	1063	1525	1525			1687	11270
Nov	2370	1154		1220	715	1174	1456	1710			1653	11452
Dec	2470	1352	825	1413	745	1167	1681	2053			1257	12963

1986	AMS	AW-H	AW-C	IHT	BKB	SOM	VD	SH	DS	AK	MPPP	Total
Jan	2320	1174	766	1311	663	1054	1460	1734			1020	11502
Feb	1919	1055	783	1140	633	907	1155	1267			858	8717
Mar	2206	963	1141	1281	637	938	1250	1166	656		969	11207
Apr	1943	1095	1189	1413	616	1157	1444	1450	913	330	488	12038
May	2035	1052	1323	1582	719	1320	1589	1583	988	894	387	13472
June	1816	1065	1185	924	637	861	1162	1071	691	714	429	10555
July	2120	1092	1241	1151	682	1109	1394	1289	627	810	511	12026
Aug	2003	958	1232	1128	654	1009	1419	1231	541	905	503	11583
Sept	2031	995	1316	1232	627	1150	1399	1273	471	857	423	11684
Oct	1989	865	1188	1341	656	1104	1395	1245	579	916	541	11819
Nov	1694	722	1024	1020	580	823	1171	995	611	786	480	9906
Dec	1892	663	1163	1097	616	995	1213	1115	667	769	337	10527

1987	AMS	AW-H	AW-C	IHT	BKB	SOM	VD	SH	DS	AK	MPPP	Total
Jan	1832	1206	663	1262	637	1057	1144	1179	706	809	444	10939
Feb	1280	489	1076	1136	541	932	840	976	649	648	450	9017
Mar	1529	559	1295	1091	597	986	1019	1139	765	773	536	10289
Apr	1531	573	1310	1223	596	974	1121	1101	685	796	480	10390
May	1588	585	1367	1169	604	817	1225	1090	755	759	416	10375
June	1879	630	1506	1308	677	1014	1353	1195	809	867	453	11691
July	2172	741	1566	1335	661	1209	1480	1213	775	831	479	12462
Aug	2158	983	1335	1139	597	985	1369	1108	624	733	426	11457
Sept	2007	1018	1305	1000	571	929	1222	1125	447	623	447	10692
Oct	1966	1126	1330	1207		1013	1135	1113	621	750	843	11104
Nov	1865	1069	1291	1205		1030	1107	1072	614	131	1202	10586
Dec	1903	1010	1377	1216		1010	1122	1201	646		1283	10768

1988	AMS	AW-H	AW-C	IHT	BKB	SOM	VD	SH	DS	AK	MPPP	Total
Jan	1954	1057	1382	1206		913	1085	1159			1170	10540

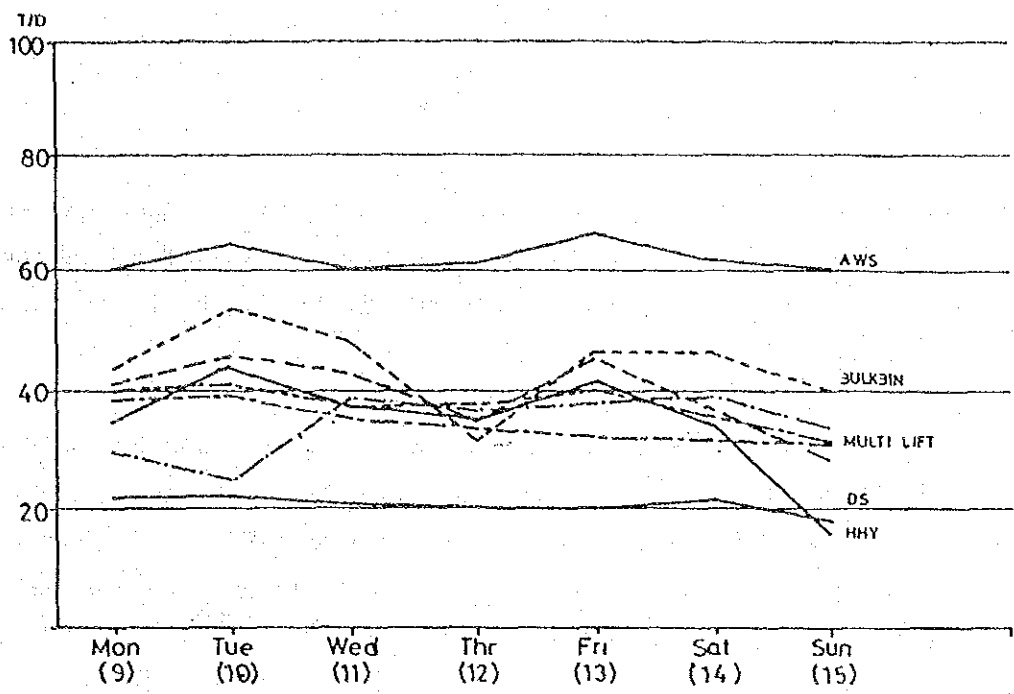


Fig. 2.1-6 Weekly Change of Waste Amount in MPPP

2.1.1.3 Solid Waste Amount in MPSP

(1) Collected Amount

MPSP has two disposal sites, the main one is of Permatang Pauh disposal site, where the waste of North and Central District is hauled, weighed at weighbridge from 12 Feb., 1988 then disposed of, the other is at Pulau Burong disposal site for South district.

MPSP collects solid waste by itself and by contractor which was newly employed from May 1988. 175.1 ton/day of solid waste was collected in June 1988, 133.3 ton by MPSP 41.8 ton by Contractor excluding solid waste collected in South District and disposed of at Pulau Burong disposal site as shown in Table 2.1-6.

According to estimation based on the data surveyed at Pulau Burong disposal site during 8th to 10th of August (3 days) in 1988, MPSP collected 11.7 ton/day and contractor collected 4.3 ton/day. Therefore, total waste of amount collected estimated as 191 ton/day.

(2) Disposal Amount

According to the record in June, 6,687 ton (223 ton/day in average) of solid waste was disposed of at Permatang Pauh disposal site. 48 ton/day of waste is hauled directly Permatang Pauh disposal site mainly by factories themselves. It is 21% of total waste.

At Pulau Burong Disposal site 16.1 ton/day of solid waste including 0.1 ton/day of waste hauled are directly disposed of. Therefore, amount of total waste disposed of at MPSP Dump Sites is 238.9 ton/day.

(3) Daily Waste Amount

Fig. 2.1-7 shows daily waste amount disposed at Permatang Pauh disposal sites and number of trips. MPSP collects the waste basically 6 days a week except in town areas which are provided daily services. As a result, waste amount of Sunday is less than half of other days.

Table 2.1-6 Solid Waste Amount in MPSP

NUMBER OF DAYS	NORTH	CENTRAL	COLLECTION			SUBTOTAL	DIRECT HAUL FACTORY & OTHER	TOTAL
			SOUTH*4	CONTRACTOR	TON			
Feb. 18 days*1	955 53.1	998 55.4	- -	850 47.2	2,803 155.7	729 40.5	3,532 196.2	
Mar.								
Apr. 30 days	1,526 50.9	2,099 70	17 0.6	*3 -	3,642 121.5	2,451 81.7	6,093 203.2	
May 21 days*2	1,128 53.7	1,198 57	6 0.3	*3 -	2,332 111	1,116 53.1	3,448 164.1	
June 30 days	2,124 70.8	1,866 62.2	10 0.3	1,255 41.8	5,255 175.1	1,432 47.7	6,687 222.8	

- *1 Start from 12th
 - *2 Breakdown of weighbridge 10 days
 - *3 Amount collected by contractor are included in direct haul
 - *4 Most of waste collected in South District is hauled to another disposal site
 - *5 Waste amount disposed of at Pulau Burong disposal site during 8th to 10th August 1988.
- MPSP 11.7 ton/day
Contractor 4.3 ton/day
Direct Haul 0.1 ton/day

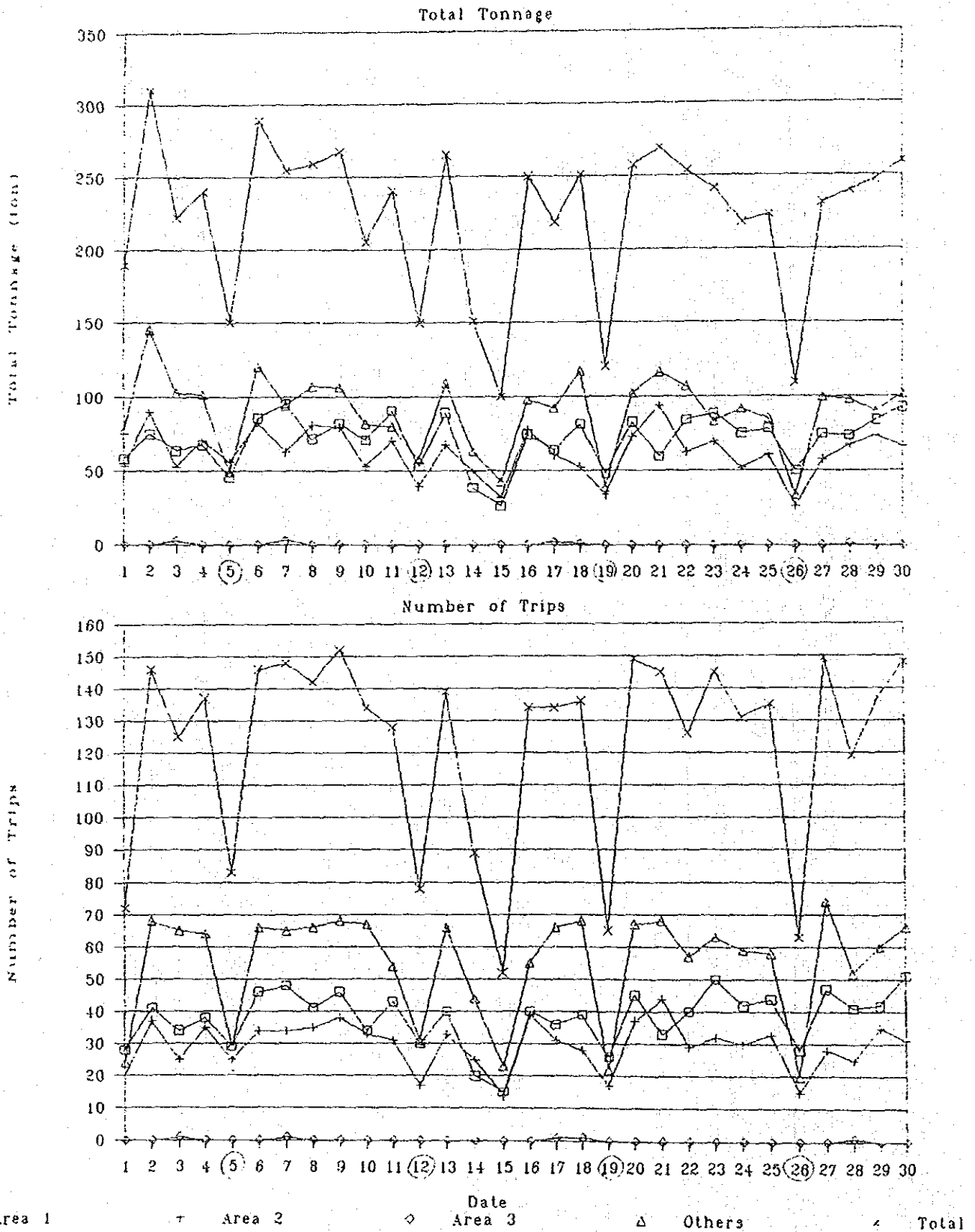


Fig. 2.1-7 Daily Waste Amount Disposed of at Permatang Pauh

2.2 Storage and Discharge

According to "A Guideline on Storage, Collection, Transport and Disposal of Solid Waste in Malaysia", the following containers are recommended.

- a. Litter bin Type A 3/4 cubic feet litter bin (21.2 l)
 Type B Fibreglass litter bin

- b. Household bin Standard bin (86.7 l)

- c. Communal bin (Mechanically loaded onto compactor vehicle)
 Type A container 1.73 m³ (Rectangular type)
 Type B container 0.96 m³ (Cylinder type)

2.2.1 Household Bin

Fig. 2.2-1 shows some example of present situation of waste storage and discharge in MPPP. Fig. 2.2-2 shows the household bin recommended by MPSP in housing estate.

Standard bin recommended in the guideline is only used in certain part of housing estates in MPPP and MPSP. Even if such areas are provided with standard storage bins, the percentage of household using standard bins is still low.

Litter bins used in MPPP are rectangular type, typically seen along Gurney road beach. Number of these litter bins are 668 including 65 units for bus stops - (1986).

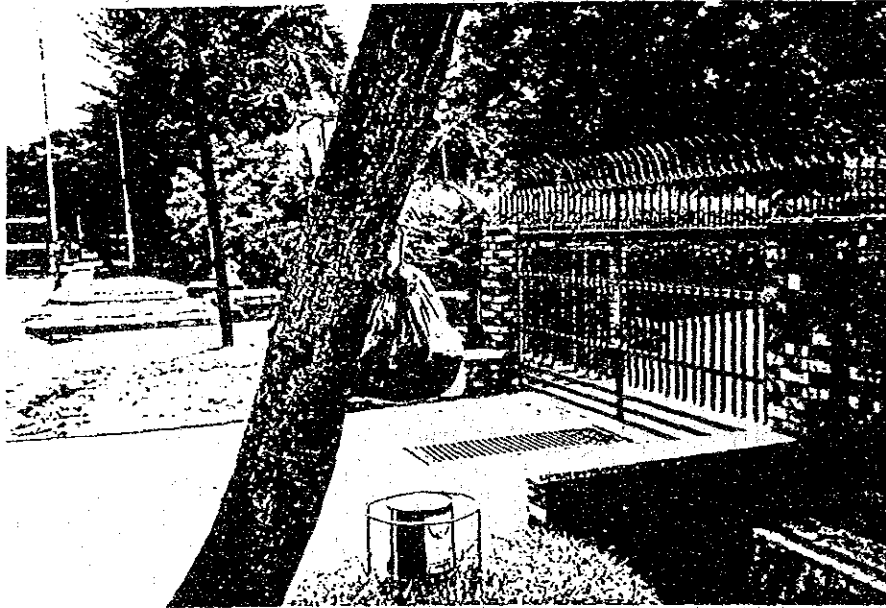
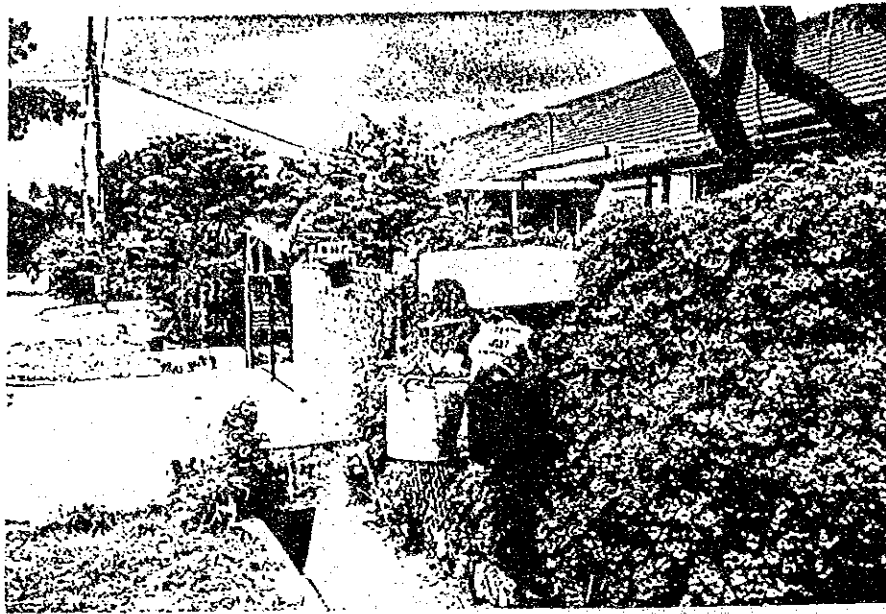


Fig. 2-1-1 Present Situation

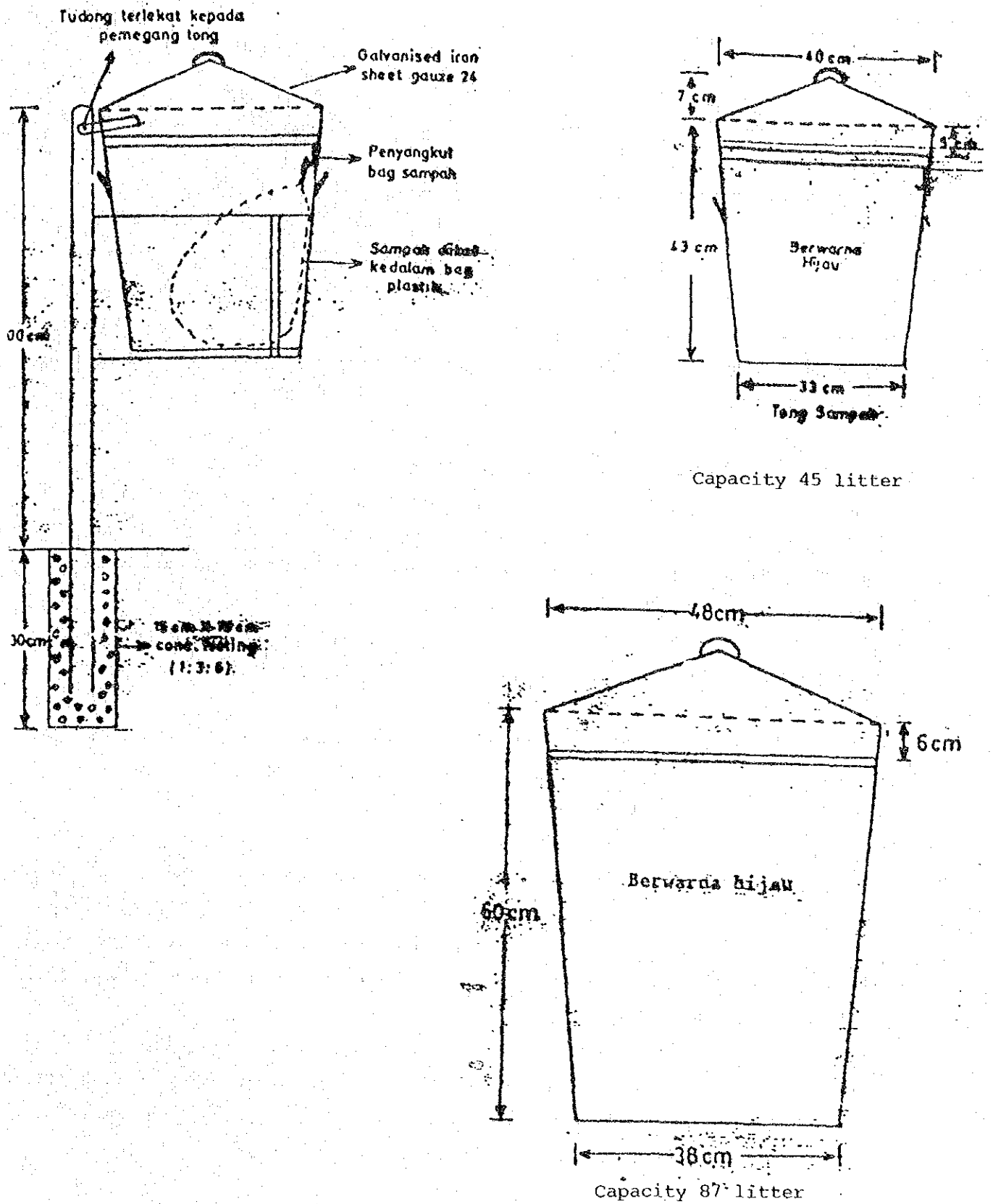


Fig. 2.2-2 Household Bin Recommended in MPSP

2.2.2 Communal Bin

(1) Communal Bin in MPPP

MPPP uses 3 types of communal bins as following:

a. Hauled container (37 units)

Hauled containers are provided for markets, kampongs and housing estates mainly for high rise flats. This container is hauled to disposal site by roll-on vehicle.

b. Bulk bin (Type B container 629 units)

Bulk bins are provided for supermarkets and shopping complex, hotels, kampongs and housing estates. Bulk bin wastes are collected using compactor vehicle with lifters.

c. Rectangular bin (Manual loading type 0.68 m^3 , 291 units)

Rectangular bins are provided mainly in rural areas and placed along side of main roads. From these bins, wastes are collected by side-loader vehicle or compactor vehicle.

Collection service from household to the communal bins provided in kampongs or housing estates are done by contractors or council workers using mainly pushcarts. Also, it has found that residents of remote kampongs were required to bring their waste to communal bin by themselves.

In the case of side-loader system, which is the main collection system in MPPP, collection workers (crew of vehicle) collect waste from households and bring it to the road side, mainly using bamboo baskets, and later loading the waste onto collection vehicle by themselves.

(2) MPSP

MPSP use the following communal bins

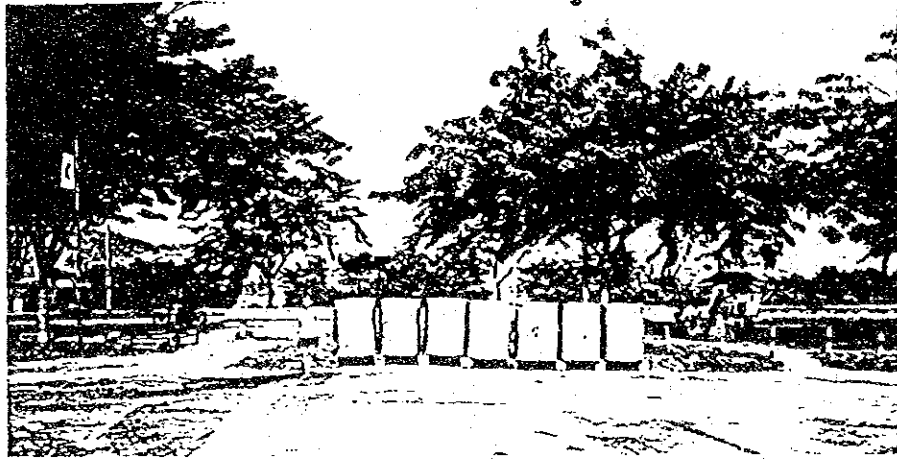
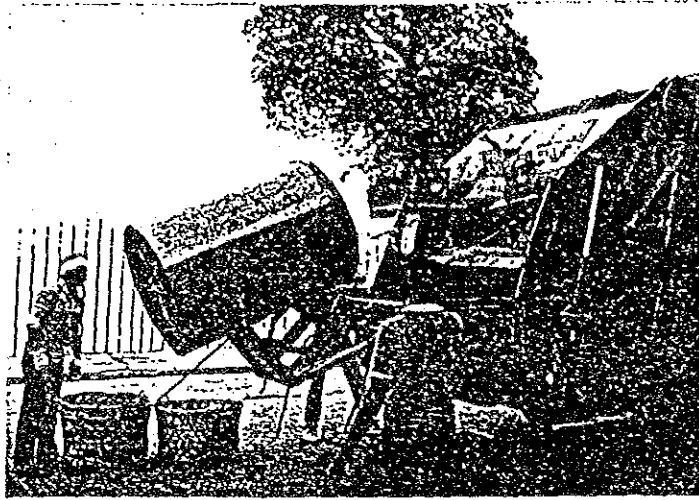
a. Hauled container

Almost all the hauled containers are placed at the markets and are hauled by contractors.

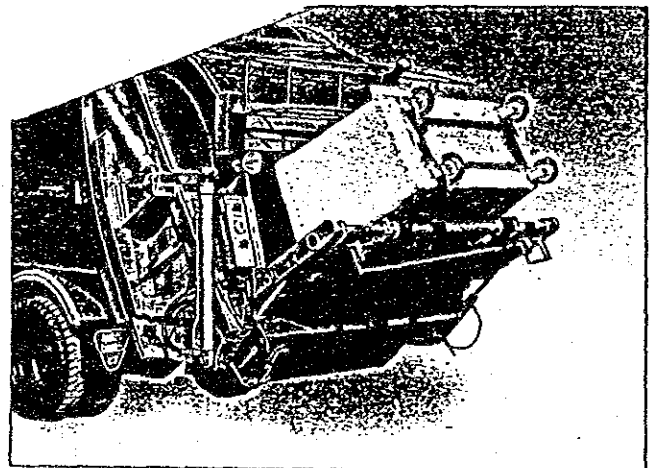
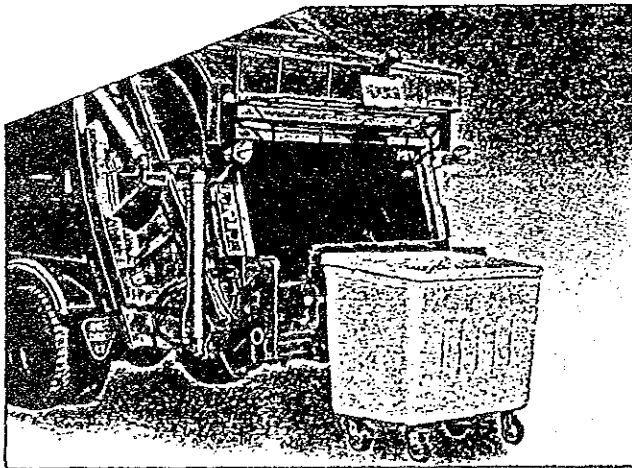
b. Standard container (Type A capacity about 1 m³)

Communal container are provided for markets, housing estates, town areas and main roads in rural areas. Mainly council workers collect the waste from each household and premises to these bins. Compactor vehicles with lift haul waste to disposal site.

In kampongs of MPSP, waste is collected from waste station located beside the wider roads in kampongs using open trucks. Residents in kampongs are required to bring their waste to the communal bin or waste station.



(a) Bulk-bin



(b) Standard container

Fig. 2.2-3 Stationary Containers

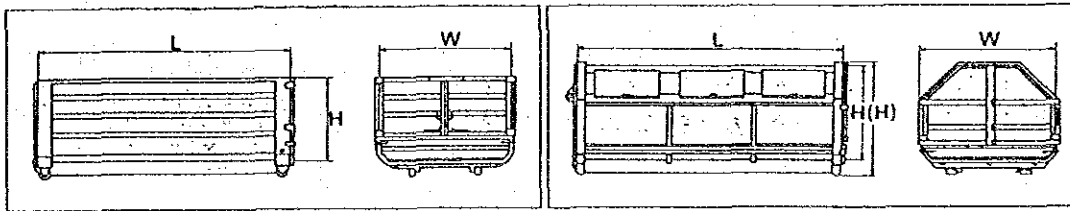
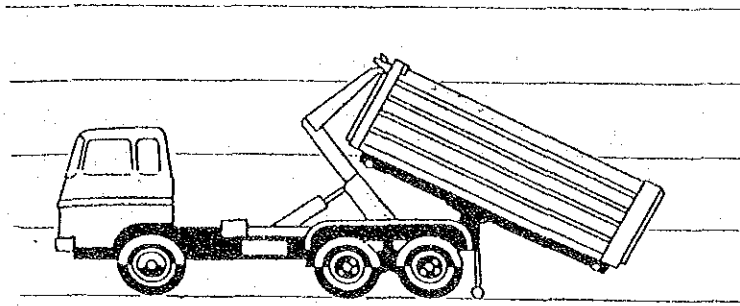


Fig. 2.2-4 Hauled Container

2.2.3 Problems on Storage and Discharge

(1) MPPP

MPPP employs the daily door-to-door collection system without separation of waste. This system requires only a little cooperation on the part of residents such as discharging their solid waste in front of houses with proper containers. Even in these situation, following problems are found.

- a. Various type of household bins are used to discharge solid waste. Standard bin are recommended to use, but the use of such bins has not been generalized. This is partly because the instruction to residents at the time of renewal is not sufficient.

- b. Standard bins are not used in Kampongs since standard bins fixed to a post do not suit to the conditions of Kampongs where access to each house is not easy and residents should place their waste at collection points by themselves. More examination of standard bins is necessary to suit to conditions of Kampongs.
- c. Daily collection is not necessary in residential area. Petaling Jaya employs alternate day collection (3 times a week). Since the daily collection service is more than enough in residential area, it is recommended to reduce service frequency with having more residents' cooperation.
- d. Access to dust chutes used in many high-rise buildings is not easy. It should be improved. Also it is desirable to prohibit the use of dust chutes system to keep the buildings clean. In stead of using the dust chute system, it is expected that residents should take their waste collection points by themselves.
- e. Building owners are responsible for the maintenance of bulk bins used in high-rise building. The maintenance is not sufficient.

(2) MPSP

MPSP employs the container collection system. The collection is daily except Sunday in the urban areas. Collection workers collect solid waste from each house then take it to a container. In Kampong area, solid waste is collected twice or three times a week from station instead of each house. The following problems are found in MPSP.

- a. MPSP has the same problems as mentioned in the above a, b, c, and d.
- b. The maintenance of containers for which MPSP is responsible is not sufficient. The equipment renewal system should be examined.
- c. In Kampong, solid waste is discharged to collection points without using any containers. MPSP should give instructions to residents for discharging their waste properly.

2.3 Collection and Haulage

2.3.1 Outline of Waste Collection

(1) Collection System

MPPP is contracting out 90% of refuse collection to 6 contractors at present. Each contractor has their own contract zone. Collection system of each contractor need to be approved by the Health Department based on the contract conditions.

MPPP and contractors provide basically a "door-to-door service" including kampongs Collection systems employed by MPPP are classified as follows:

- Side loader system using side loader vehicle

Collection workers (crew), collect waste from each household and haul to main road side using bamboo basket and etc., and later loaded on to collection vehicle.

- Bulk bin system using compactor vehicle with lifting equipment

Bulk bins are provided to large buildings, kampongs and housing estates. In the kampongs and certain housing estate heapers collects the waste from each household and haul to bulk bins using hand carts.

- Multi lift bin system using roll-on vehicle

Hauled containers are provided to markets, large buildings, some of the kampongs and housing estates. Collection works in the kampongs and housing estates are same as bulk bin system.

For some kampongs, and rural area, communal bins are provided only at main road side and residents of kampongs are required to bring their waste to these bins.

PENANG ISLAND
AND
SEBERANG PERAI

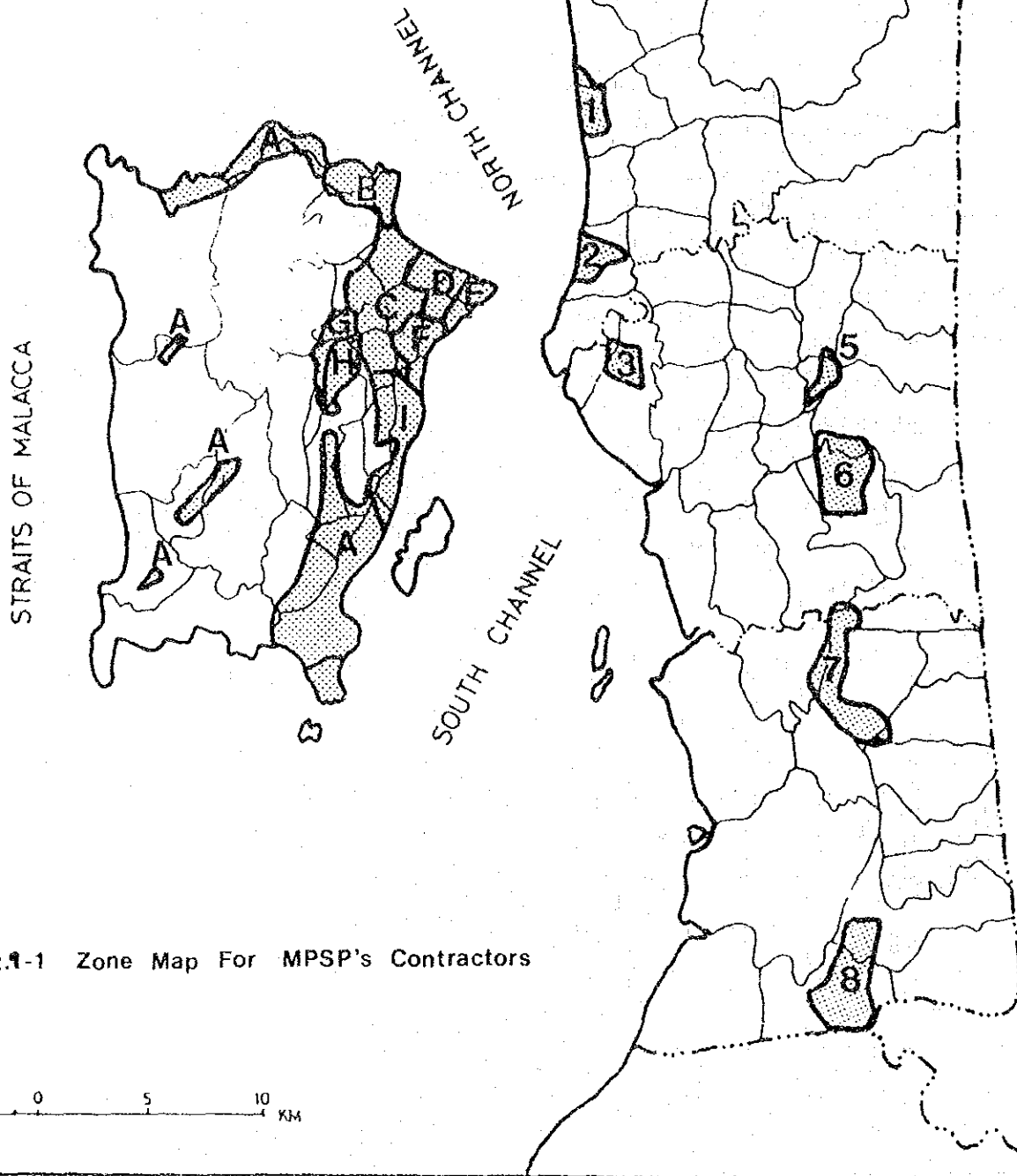
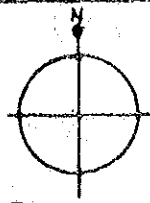


Fig.2.1-1 Zone Map For MPSP's Contractors

LEGEND

- 1 PERUMAHAN SISTEMATIK SDN. BHD.
- 2 KEJURUTERAAN KOMBINAKOM SDN. BHD.
- 3 FADASON HOLDING SDN. BHD.
- 5 SYKT. HJ. ABD. RAHMAN & GOEY.
- 6 HJ. ZAIN MUSTAFA IB. ISMAIL
- 7 BUMI ENTERPRISE
- 8 JURUNIAGA SDN. BHD.

- A. MPPP
- B. MPPP
- C. SYARIKAT OMAR MERICAN
- D. SYARIKAT HASHIM HJ. YUSOF
- E. AWS JAYA SDN. BHD.
- F. WASTE DISPOSAL SDN. BHD.
- G. DELIMA SURIA SDN. BHD.
- H. MPPP
- I SYARIKAT IBRAHIM HASHIM TRANSPORT

Source MPPP and MPSP HEALTH

DEPT

Contract Zone

Fig.2.3-1

MPSP has contracted out 30% of refuse collection to 7 contractors mainly housing estates.

MPSP and contractors provide a "door-to-door service" in the Town areas. In the kampongs both inside Town and in rural areas, MPSP has provided a "station service" system.

Compactors vehicle, dump truck and minicompactor are used for refuse collection in MPSP. At Jetty Lama area which has a compactor truck and an open truck, type A bins are provided along main roadsides and not inside of kampongs area.

In main parts of areas, each worker is assigned to a small area of waste collection. These workers collect waste from each household bring them to Type A bins. Kampong areas which do not have any workers, residents are required to bring their waste to Type A bins or waste station provided along roads in kampongs. Also there are small housing estates, without Type A bins but workers providing "door-to-door service". Compactor truck service is for Type A bin only. Open truck service is for all areas including waste overflowed from Type A bins and kampongs.

Collection system employed at MPSP can be classified as follows:

- Type A bin system, using compactor

In the town area and housing estate heaper collects waste from households and brings it to Type A bin. In kampongs, residents are required to bring their waste to the Type A bin.

- Open truck system and small compactor system

Open truck and small compactor cover the same area which is served by Type A bin system. Open truck collects waste overflowed from bins, areas served by door-to-door service and waste stations in kampongs.

a. Frequency of waste collection

In MPPP, the collection of solid waste is done daily including sundays and national holidays.

In MPSP, the collection of solid wastes in commercial areas, of Butterworth and Bukit Mertajam is done daily while in residential areas, it is collected 6 times a week. The industrial wastes are either collected by the respective owners or contractors hired by the owners, and are disposed of at one of the municipal landfills.

c. Service area

MPPP and its contractors provide the daily waste collection service to almost whole of the island including Batu Feringghi, Balik Pulau and Penang Hill. But in rural areas, communal bins are provided, only beside the main roads and residents of kampongs dispose their refuse into these bins.

MPSP and its contractor covers mainly the gazetted area.

(2) Work Assignment

a. MPPP

Health Department of MPPP has a cleansing section which is responsible for all cleansing works refuse collection, street sweeping, drain cleansing and night soil collection. The island is divided into 24 Health zone which have one Health Inspector in each individual zone. Each Health zone in Georgetown has one overseer and one to three in rural areas. These overseers supervise daily cleansing activities including refuse collection, street sweeping and drain cleansing. Overseer has mandors and workers and assign their daily works. The collection vehicle and its driver belongs to Engineering Department.

Where the area is contracted out, refuse collection is done by the contractor workers. But there are areas where refuse collection from household to communal bin are done by council workers. Also, there are some rural areas where refuse collection and haulage done by council workers.

At these areas, crew of collection vehicle deployed from workers controlled by the overseer.

In general, mandors and workers are assigned to areas and carry out functions, such as refuse collection, drain cleansing or street sweeping. However, each worker have own assigned area and does all the cleansing works individually.

b. MPSP

Health Department of MPSP has 4 branch zones which are controlled by a Senior Health Inspector at each zone. Each branch zone is divided to 2 or 4 Health zones which have a Health Inspector in each of the sub-zone too. The Health Inspector is responsible for functions of the Health Department in his Health zone. Each Health zone is again divided into 3 or 4 zone for cleansing activities. Each zone has an overseer who carries out daily cleansing activities with mandors and workers. The overseer assigns the work to each mandor and workers. Basically, each worker has their own territory and have to do all the cleansing works, including refuse collection, street sweeping and drain cleansing in his territory.

In MPSP, collection vehicles and drivers belongs to Health Department. Therefore, overseer provides the drivers and crew for the collection vehicles.

2.3.2 Vehicle Distribution in MPSP

The following table shows the present distribution of collection vehicles in MPSP. There are vehicle assignments by area. Each area is very small. This makes difficult to have stand-by vehicle.

Work load in each area differs from 1.5 to 7.0 ton per vehicle per day. A reason for this large variation is partly because MPSP has not adjusted number of vehicles in some area which has been partially contracted out. Area which is far from present disposal site and also area in rural area have more work load.

Therefore it is necessary to make the work load even between the areas through the changes in vehicle assignment.

Table 2.3-1 Distribution of Collection Vehicle in MPSP

<u>ZONE CODE</u>	<u>NUMBER OF VEHICLES</u>	<u>POPULATION</u>	<u>WASTE AMOUNT</u>	<u>WORK-LOAD PER VEHICLE</u>	<u>GENERATION RATE (G/DAY)</u>
<u>North</u>					
110	4(2)	63,800	604.8 (686.3)	5.04 ton	358
120	2(0)	64,700	113.4	1.89 ton	58
130	2(2)	63,800	329.8	5.50 ton	449
140 & 150	9(1)	52,000	1,075.5	3.98 ton	689
Sub-Total	17(5)		2,123.5 (2,735.3)	4.16 ton	
<u>Central</u>					
210	3(0)	41,000	202.2 (423.8)	2.25 ton	345
220	4(1)	20,600	534.7	4.45	865
230	3(3)	50,500	408.9 (502.8)	4.54	332
240	2(0)	30,900	87.4 (415.5)	1.46	448
250	3(0)	56,900	632.4	7.03	
Sub-Total	15(4)		(1,865.6) (2,509.2)	4.15	

Note: Data are not available for South District.

2.3.3 Collection Vehicle Crew

Number of vehicle and laborers deployed by MPPP for its own collection operation are summarized as follows:

A. Manpower (persons)

- Heapers	127
- Vehicle crew excluding drivers	58
Total	185

B. Collection Vehicle in Use

- Compactors	3
- Side loaders	9
Total	12

Note:

According to an official of Health Dept., some heapers are working in some area where contractors undertake haulage service. Details of this situation have not been made clear yet.

Average number of heapers and vehicle crew are calculated as follows:

- Heaper: $58 \div 12 \text{ vehicle} = 4.8/\text{vehicle}$ (3.5/vehicle)
- Crew : $127 \div 12 \text{ vehicles} = 10.6/\text{vehicle}$ (7.7/vehicle)

The figures shown in the parentheses are the number of laborers per vehicle adjusted based upon the fact that the average number of working days for a laborer is 265 days per year which is 72.6% of 365 days.

On the other hand, the contractors have the following corresponding figures.

a. Contractor A

Waste Disposal has 6 vehicles, of which 5 are currently used. There are 7 drivers and 44 laborers (heapers and vehicle crew). Numbers of drivers and laborers per vehicle are calculated as follows:

- Drivers: 7 drivers E 5 vehicles = 1.4 drivers/vehicle (1.0)
- Heapers and vehicle crew: 44 laborers E 5 vehicles =
8.8/vehicle (6.4)

b. Contractor B

AWS has 10 side loaders, of which 8 are in operation. There are 64 vehicle crew including drivers, and 8 heapers.

- Drivers and crew: 64 E 8 vehicles = 8/vehicle (5.8)
- Heapers: 8 laborers E 8 vehicles = 1 laborer/vehicle (0.7)

In addition, AWS has 5 compactors and 4 multilift, of which 4 and 3 are currently used respectively. There are 42 crews including drivers.

- Drivers and crew for Compactor: 34 E 4 vehicles =
8.3/vehicle (6.0)
- Drivers and crew for Multilift: 9 E 3 vehicles =
3/vehicle (2.2)

As for MPSP, correct number of crew and drivers and vehicles in operation have not been made available yet. Types of vehicles according to area have not been known either.

The following table shows the average numbers of crew including driver per vehicle which have been obtained through Time & Motion Study.

		<u>MPPP</u>	<u>MPSP</u>
	<u>CONTRACTORS</u>	<u>COUNCIL ITSELF</u>	
- Compactor	-	6 crew (4.5)	5 crew
- Side Loader	5 crew	6 crew (4.5)	6 crew
- Multilift	2 crew	-	-

The following can be said when the above table is compared to the previous figures.

- Contractors:

The figure (number of crew per vehicle) shown in the above table is less than the previous figure.

- MPPP's own operation:

The number of crew per vehicle shown in the above table is greater than the previous figure. This may be because that the council's heapers occasionally work as vehicle crew.

- MPSP:

The number of crew per vehicle shown in the above table is about same as the previous figure. This may be because MPSP has heapers responsible only for heaping.

Manpower Used for Collection

	(1) <u>DRIVER</u>	(2) <u>CREW</u>	(1)+(2)	(3) <u>HEAPER</u>	(1)+(2)+(3) <u>TOTAL</u>
MPPP	19	58	77	127	204
AWS - Side Loader	-	-	64	8	72
- Compactor	-	-	42	-	42
Total	-	-	106	8	114
Waste Disposal	7	44	51	-	51

2.3.4 Efficiency of Refuse Collection

(1) Waste Loading Efficiency

The following results have been obtained as a result of the Time and Motion Study.

Average Loading Efficiency

- Side Loader	1.6 t/hour	(Workers including driver: 5-6)
- Compactor	3.0 t/hour	(Workers including driver: 5-6)

The average loading efficiency differs according to amount of waste at collection point (station). The relationship between waste amount and loading time is shown in Fig. 2.3-2. The relationship is expressed by the following equations:-

$$t = 0.83 + 0.0252w \text{ for Side loader}$$

$$t = 1.84 + 0.0082w \text{ for Side loader = Compactor}$$

where t = Loading time at waste station

w = Amount of waste loaded

The loading efficiency is a function of waste amount. The relationship is approximated as follows:-

$$L = w/t = 0.64 + 0.0166w$$

where L is loading efficiency (w/t)

Note: The following is a Japanese example:

$$\text{Compactor with crew: } t = 0.42 + 0.0067w$$

The efficiency is approximated as follows:

$$L = 3.93 + 0.0158w$$

As shown above, the loading efficiency drops as waste amount decreases.

The average waste amounts at a collection station in Penang State are 70 Kg for side loader and 140 Kg for compactor. The waste amount at a collection station is not a factor explaining a low efficiency. In Penang, side loaders collect waste daily. The waste amount of a side loader is equivalent to the amount of 20 households. This follows that there is much work required to collect waste from households to waste stations.

There are four major factors which cause relatively low loading efficiency.

- 1) Collection vehicle
- 2) Bags or containers used at waste discharge
- 3) Discharge point
- 4) A laborer' dual role system (heaping from house to waste station and loading from stations to vehicles)

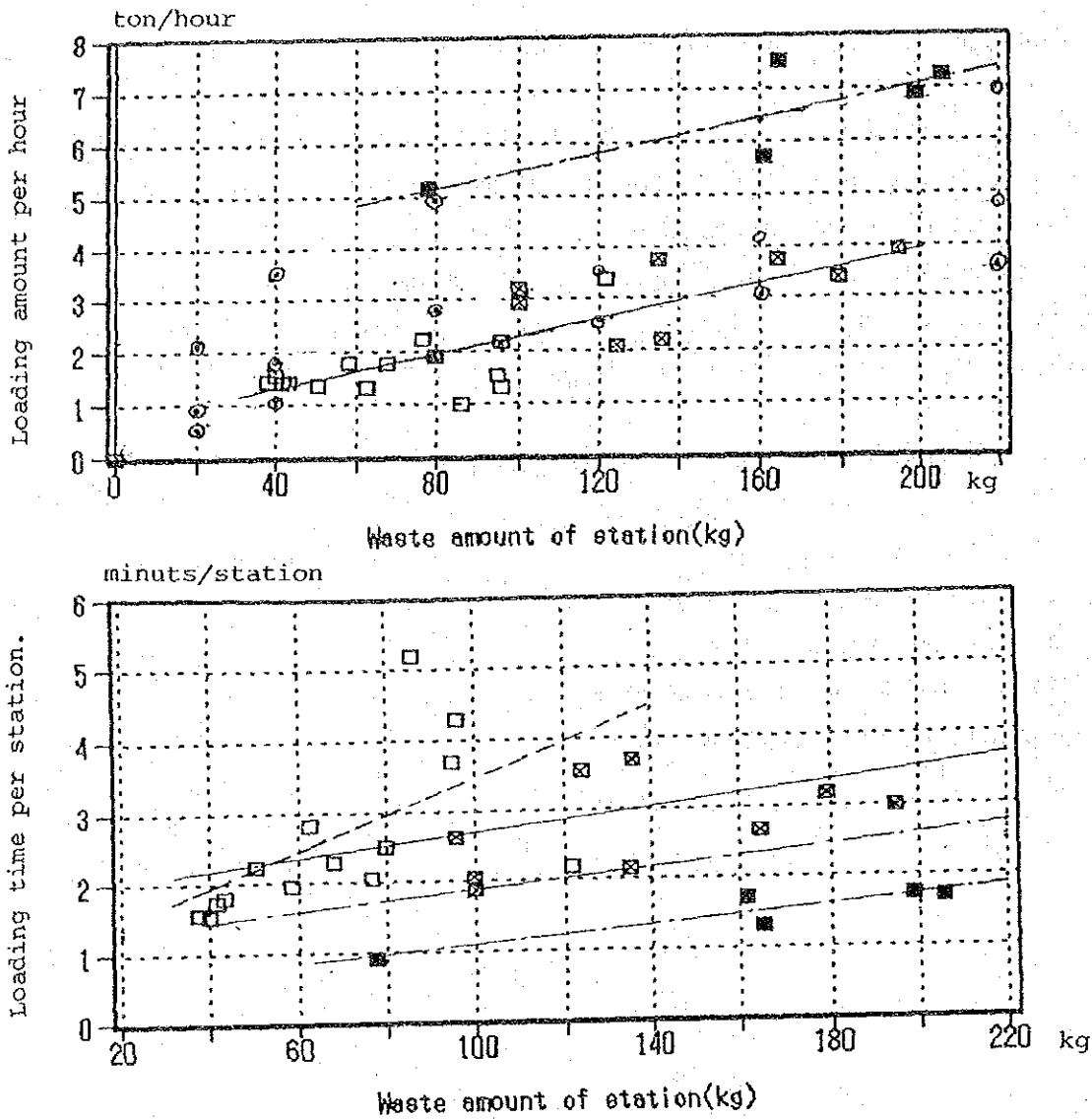


Fig. 2.3-1 Loading Time and Waste Amount

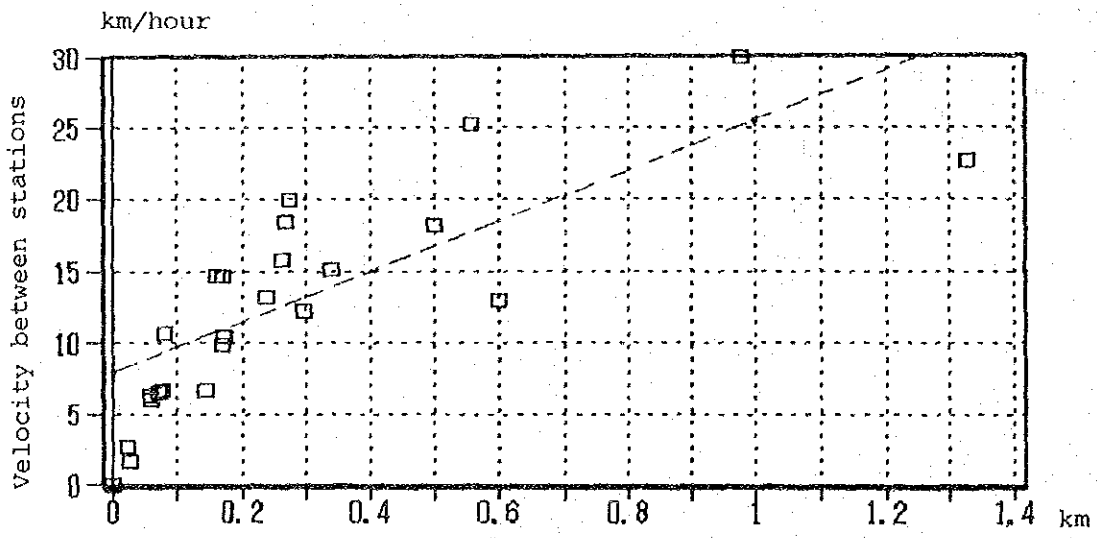


Fig. 2.3-2 Station Distance and Velocity

(2) Relationship between Vehicle Speed and Distance between the Station

Fig. 2.3-3 shows the relationship between the distance between the stations and vehicle speed, which has been obtained through Time and Motion Study. The relationship can be expressed by the following equation:-

$$V = 7.8 \text{ Km/hour} + 0.0175L$$

where V = Speed of vehicle between stations

L = Distance between stations (unit is meter)

(3) Waste Collection Amount per Vehicle

The waste collection amounts per vehicle are shown in the table below.

	SIDE LOADER		COMPACTOR		MULTILIFT
	<u>MPPP</u>	<u>CONTRACTOR</u>	<u>MPPP</u>	<u>CONTRACTOR</u>	<u>CONTRACTOR</u>
- Average Daily Trip (Number)	2.3	3.1	1.2	1.6	7.1
- Average Collection per trip (t)	1.5	2.1	4.6	5.2	1.5
- Average Daily Collection per Vehicle (t)	3.4	6.6	5.7	8.5	10.8

Waste collection amount per vehicle differs according to collection area characteristics and haulage distance. Considering this factor collection amount has been estimated (adjusted). Fig. 2.3-4 shows the relationship between such estimated amount and actual amount. Such estimation has been made assuming the actual working hours of a laborer is 7 hours per day. The points are summarized as follows:

- a. MPPP (council's own operation) collects about 80% of the estimated amount. This may be attributable to such factors as 1) the council laborer's actual working hours is 6 hours per day, and 2) waste amount loaded is a little.

- b. Contractors, on the other hand, collect 114% of the estimated amount. This is attributable to the fact that waste amount loaded per trip is much.
- c. In view of the above Contractors collect 1.4 times as much as MPPP! itself does.

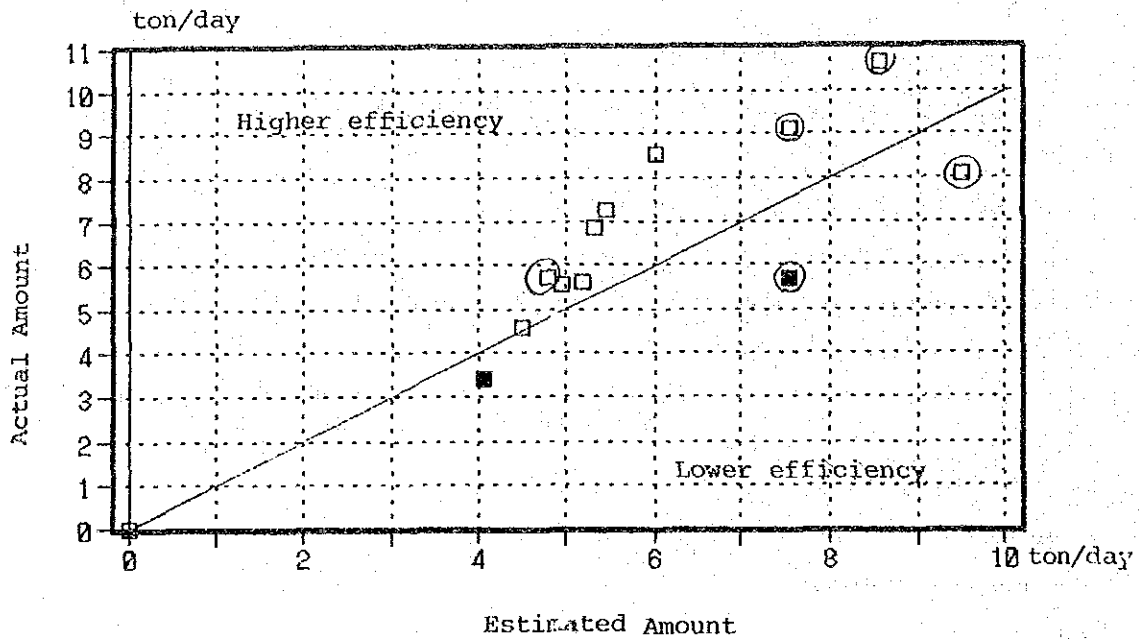


Fig. 2.3-4 Estimation of Haulage Amount

Table 2.3-2 Waste Amount Hauled in MPPP

SIDE LOADER	AMOUNT ESTIMATED (1)	ACTUAL AMOUNT (2)	RATIO (2)/(1)
AWS	6.00	8.51	1.42
HY	5.30	6.85	1.29
WD	5.44	7.28	1.34
OM	5.18	5.59	1.08
IH	4.95	5.57	1.13
DS	4.51	4.58	1.01
MPPP	4.07	3.43	0.84
AWS City	8.56	10.62	1.24
DS	4.81	5.71	1.19
AWS City	9.52	8.08	0.85
AWS rural	7.53	9.14	1.21
MPPP	7.53	5.70	0.76
	0	0	
Total	73.395	81.065	1.10

(4) Factors Causing Low Loading Efficiency and Measures for Improvement

The low lading efficiency is attributable to the following four major factors:-

- Vehicle
- Bags or containers used for waste discharge Discharge points
- Discharge points
- Heaping

SIDE LOADER

COMPACTOR

Vehicle

- Loading height is high.
- 3 to 4 laborers are required for loading.

Bags or Containers

Used for Discharge

- Appropriate containers are not used.
- Bamboo baskets re used for heaping.
- Dust chutes which need waste scraping out are still used.
- Waste scraping out from rectangular bins are needed.
- Waste is discharged without using containers or bags.

Discharge Points

- It is necessary to carry waste discharged at back-lane to the frontage of houses.
- Domestic waste is not discharged on curve side.

Heaping

- In appropriate/occasions of discharged points necessitate heaping.
- Daily door-to-door collection necessitates heaping from houses to stations.

- MPSP's containers' are broken.
- It is necessary to collect waste discharged outside containers.
- There are some places where waste scraping out is needed.

- Containers are placed at places which provide poor access to vehicles.
- So, it takes much time to pull out containers and to put them back.
- Containers have to pulled out due to inappropriate location of containers.

The following measures are proposed to improve the loading efficiency.

(1) Measures for Improvement on Collection by Side Loaders

- a. Replace side loaders by Compactors
- b. Place waste at curve sides which are accessible by collection vehicles
- c. Residents should use either plastic bag or plastic bins
- d. Usage of dust chutes without bulk bins has to be stopped. Either plastic bags or plastic bins should be used instead.
- e. Replace rectangular bins with bulk bins. In places which are not accessible by compact vehicles, rectangular bins need to be replaced by station system with the usage of plastic bags or plastic bins.

It is advised to implement the above measures one by one.

(2) Measures for Improvement on Collection by Compactors

- a. Repair containers thoroughly.
- b. Provide sufficient number of containers
- c. Ask residents to use either plastic bags or plastic bins
- d. Improve on location of containers

The improvement on location of containers is easy in some places, while it is difficult in some other places such as hotels and high-rise buildings. For high-rise buildings, appropriate location of containers should be chosen based upon residents' cooperation for bringing out waste to the containers. The thorough improvement on locations of containers may be difficult. It is necessary to implement other improvement measures one by one.

If the improvement on the side loader collection is thoroughly achieved, the loading efficiency will improve 100%, and will reach to a same level as that in Japan. It may be however difficult to achieve it in short time. So, it is recommended that the short-term target be an increase of the efficiency by 50% keeping the same number (4) of crew per vehicle. The efficiency is expected to improve as follows:

$$L = 2.2 + 0.016w \quad t = 1.1 + 0.0075w$$

If $W = 70 \text{ Kg}$, $L = 3.3 \text{ t/hour}$

If $W = 140 \text{ Kg}$, $L = 4.4 \text{ t/hour}$

2.3.5 Problems Collection and Haulage

All of solid waste discharged at collection points should be collected more than once a week regularly. The provision of regular collection service requires the following.

- a. Sufficient capacity (manpower and equipment) to collect solid waste allowing for the daily fluctuation of solid waste quantity and quality.
- b. Stand-by equipment and manpower for maintenance, repair and accident.
- c. To fix collection points, date and time in order to get residents, confidence in the collection service.
- d. Overall control with inspection and supervision of collection work.

(1) MPPP

The collection service in MPPP covers more than 95% of the population. The quality of the collection service is relatively good at present. The following problems are found.

- a. MPPP relies too much on private contractors. They collect 90% of waste.

- b. The daily collection and door-to-door service is more than enough in residential area. The service level including frequency should be examined according to area conditions.
- c. Average amount of waste collected by one vehicle of MPPP is lower than that of contractors. This difference can be partly explained by the fact that MPPP provides collection service mainly in rural area where collection efficiency is lower than in town.
- d. There are no independent collection system for bulky waste and garden waste. Some bulky waste and garden waste is illegally left along roadsides.

(2) MPSP

MPSP collects solid waste daily except Sunday. With the combined collection system. In Kampongs and rural areas, solid waste is collected once or twice or three times a week from waste stations or containers provided along major roads. Since population density is very low in rural area, residents are apt to dispose of their waste at the back yard of their houses. Therefore, the collection service seems to cover only 60% of the population. Problems in MPSP are as follows.

- a. In terms of waste amount, 30% of the collection service is contracted out to 9 private companies. The scale of each contract (5.2 t/d in average) is too small to have stand-by vehicles.
- b. Door-to-door collection service is provided daily in Butterworth and Bukit Mertajang. Kampongs around those towns are provided with irregular service with the frequency of a few times week. The difference in the service level between towns and Kampongs including rural areas is very big.
- c. There are no stand-by vehicles except for a few in Central District.

- d. A laborer is responsible for few different types of services, i.e. waste collection from houses to containers, street sweeping and drain cleansing. Further study is required to see whether or not such mixed work system is efficient considering the point that frequency and type of equipment differ according to type of the services.
- e. Independent collection systems for large amount dischargers and for garden waste and bulky waste has not been established./

2.4 Cleansing Work

2.4.1 Distribution of Laborers and Equipment

(1) Laborer Distribution in MPPP

Data on distribution of laborers in MPPP have been obtained from the reports submitted by PHI and through interview with overseers. The results indicate the difference of work load by area. Results of these survey shown in Table 2.4-2 and are summarized as follows.

- a. According to the data of PHI, total number of laborers is 1,349 persons excluding 77 mandors and 34 Overseers.
- b. Total overtime of laborers is 594 hours per day which means 0.42 hours per person in a day in average.
- c. Total length of drain is 925 km and total length of street is 680 km.
- d. According to the data obtained through PHI, average of work assignment is as shown in Table 2.4-1.

Table 2.4-1 work Assignment (except Mandor)

	NUMBER OF LABORER	WORK LOAD	
		AVERAGE	RANGE
Van Laborer	58 person	-	
Heaper	127 person	140 house/laborer	
Drain Cleansing	835 person	1,100 m/person	200-3,698 m
Street Sweeping	296 person	2,300 m/person	366-6,673 m
Grass Cutting	-	-	
Beach Cleansing	26 person	1,100 m/person	
Others	7 person	(working at Penang Hill)	
Total	1,349 person		

Note; Data based on PHIs report which include estimated figures.

- e. Table 2.4-2 shows work load differs greatly by area.

Table 2.4-2 Distribution on of Laborers

Division	Length (m)		Number of worker (person)		Drain		Road	
	Drain	Road	Drain	Street	*1 DL/La	Rank	*2 RL/La	Rank
1	22875	25010	13	17	1760	31	1471	9
2	24400	24400	20	8	1220	21	3050	24
3	14640	7320	28	20	523	5	366	1
4	15281	14640	20	10	764	13	1464	8
5	9501	9007	22	9	432	4	1001	2
6	25458	16000	21	10	1212	20	1600	11
7	38125	13725	24	8	1589	29	1716	13
8	32996	31442	22	11	1500	25	2858	21
8a	40675	35975	11	14	3698	34	2570	20
9	16352	15746	22	15	743	11	1050	3
9a	25568	24540	16	11	1598	30	2231	16
10	47618	28940	30	10	1587	28	2894	22
11	40640	44450	41	7	991	17	6350	29
12	41385	18040	20	4	2069	33	4510	27
13	63667	40000	32	18	1990	32	2222	15
14	29151	15708	19	11	1534	27	1428	6
14a	20928	7625	28	3	747	12	2542	19
15a	43960	17629	29	10	1516	26	1763	14
15b	31163	20254	47	9	663	8	2250	17
16	64630	42472	48	13	1346	22	3267	25
17	58767	33434	42	7	1399	23	4776	28
18a	19800	8000	20	2	990	16	4000	26
18b	10980	2440	17	-	646	7	-	31
19a	14780	12281	14	9	1056	19	1356	4
19b	7869	3050	15	2	525	6	1525	10
20a	18640	40040	27	6	690	9	6673	30
20b	27583	14624	30	9	919	15	1625	12
21	27848	27000	27	19	1031	18	1421	5
22a	3000	10000	15	7	200	1	1429	7
22b	8600	8850	11	3	782	14	2950	23
22c	2940	5400	14	-	210	2	-	32
23a	27500	19000	39	-	705	10	-	34
23b	7808	7808	23	-	339	3	-	33
24	40001	34281	28	14	1429	24	2449	18
Total	925128	679130	835	296	1108	-	2294	-

Note: *1 Drain length per laborer (m/person)

*2 Road length per laborer (m/person)

*3 Street length and drain length is given by PHIs. It seems to include estimated figures.

2.4.2 Efficiency of Cleansing Work

Table 2.4-3 shows the efficiency data obtained through the time and motion study and average length assigned to a laborer in MPPP.

Table 2.4-3 Efficiency of Cleansing Work

	<u>WORK EFFICIENCY ACCORDING TO THE TIME & MOTION STUDY</u>	<u>AVERAGE LENGTH ASSIGNED TO A LABORER</u>
Street Sweeping	200 m/hour	2,300 m/laborer/day
Drain Cleansing	200 m/hour	1,100 m/laborer/day
Grass Cutting	50 m/hour	-
Beach Cleansing	500 m/hour	1,100 m/hour/day

Table 2.4-3 shows necessity of proper assignment including decrease of frequency because street sweepers are assigned more than 10 hours work in average.

2.4.3 Grass and Tree Cutting

(1) Related Authorities

Grass and tree cutting at public premises such as parks, gardens and roads is a part of maintenance and beautification efforts that include the following services:

Maintenance and Beautification Services for Parks, Gardens and Roads

a. For Parks and Gardens

- Grass & tree cutting
- Nursery
- Landscaping and its maintenance
- Provision and maintenance of children's play facilities

b. For Roads

- Resurfacing
- Road line painting
- Patching pot holes
- Fixing road furnitures such as delinators, chevrons and bridge panels
- Fixing directional sign board
- Grass and tree cutting

In principle, it is a public premise owner who is responsible for grass & tree cutting and other maintenance and beautification services for the premises.

MPPP and MPSP are responsible for the maintenance and beautification of parks, gardens and municipal roads as they are owned by the municipalities, while JIR (Public Works Dept.) of Penang State Government is responsible for the maintenance of any roads constructed by JKR. All state and federal roads have been constructed by JKR as shown in the Table 2.4-3.

In Penang island, however, maintenance of city roads within George town is carried out by MPPP, while in Seberang Perai, maintenance of the state road called "Protocol" which consists of 7 continuous streets is carried out by MPSP Secretariat Dept. Park and Garden Section. In both cases, JKR pays some money to the municipalities for their maintenance service; \$15,000/month to MPPP and \$2,400/month to MPSP.

Table 2.4-3 Organizations Executing Grass Cutting & Other Maintenance Services

PREMISE	EXECUTING ORGANIZATION	
	PENANG ISLAND	SEBERANG PERAI
Municipal Parks and Gardens	MPPP Secretariat Dept. Park & Garden Section	MPSP Secretariat Dept. Park & Garden Section
Municipal Roads	MPPP Engineering Dept.	Same as above
State & Federal Roads within Town Area	MPPP Engineering Dept., and Secretariat Dept. Park & Garden Section (a highway only)	JKR except for Protocol street where Park & Garden Section provides grass cutting service
State & Federal Roads Out- side Town area	JKR Penang Island Branch	JKR Seberang Perai Branch
Along Drains	MPPP Health Dept.	MPSP Health Dept.

(4) Number of Personnel Involved

Number of personnel involved in grass/tree cutting are 154 in Penang island and over 200 in Seberang Perai. In addition there are many workers employed by contractors. Those numbers however have not been available. Number of personnel involved in grass/tree cutting according to salary code and organization in the government sector is shown Table 2.4-4.

Table 2.4-4 Penang Island

SALARY CODE	POSITION	MPPP SECRETARIAT DEPT. P & G SECTION	MPPD ENG. DEPT. ROAD SECTION	JKR PENANG ISLAND BRANCH	TOTAL
A-11	Principal Engineer	0	1	0	1
A-18	Road Engineer	0	1	0	1
B-8	Technical Assistant	0	1	0	2
C-3	Senior Site Overseer	0	1	0	1
C-4	Assistant Site Overseer	0	1	0	1
C-10	Technician	2	0	3	5
D-10	Junior Technician	2	1	2	5
D-43	Driver	1	0	0	1
D-46	Mandor	6	1	0	7
D-47	Laborer	90	40	0	130
Total		102	47	5	154

Note:

- 1) P & G Section stands for Park and Garden Section.
- 2) MPPP Secretariat Dept. P & G Section has the following breakdown:

	GRASS CUTTING UNIT (A)	TREE CUTTING UNIT (B)	(A)+(B)	NURSERY UNIT (C)	LANDSCAPE & VIP DECORATION UNIT (D)	(A)+(B)+ (C)+(D)
B-8 Horticulture Assistant	1	0	1	0	0	1
C-10 Technician	1	1	2	0	1	3
D-10 Junior Technician	2	0	2	1	0	3
D-43 Handy Man	1	0	1	0	0	1
D-46 Mandor	1	5	6	1	2	9
D-47 Laborer	50	40	90	26	35	151
Total	56	46	102	28	38	168

Table 2.4-5 Seberang Perai

SALARY CODE	POSITION	MPSP SECRETARIAT DEPT. P & G SECTION	JKR SEBERANG PERAI BRANCH	TOTAL
A-11	Principal Engineer	0		
A-18	Road Engineer	0		
B-8	Technical Assistant	0		
C-3	Senior Site Overseer	0		
C-4	Assistant Site Overseer	0		
C-10	Technician	5		
D-10	Junior Technician	6		
D-43	Driver	8		
D-46	Mandor	1		
D-47	Laborer	97		
Total		111	100	211

Note:

- 1) MPSP Secretariat Dept. P & G Section comprises of 3 branches: North, Central and South. Breakdown according to branch is as shown below:

	<u>TOTAL</u>	<u>NORTH</u>	<u>CENTRAL</u>	<u>SOUTH</u>
C-10 Technician	5	3	1	1
D-43 Driver	8	5	2	1
D-46 Mandor	1	1	0	0
D-47 Laborer	97	57	24	16
Total	111	66	27	18

The Personnel number of MPSP P & G Section include number of personnel involved in plant nursery as well. The separate number of those who are in the grass/tree cutting unit is not available.

- 2) The personnel number, 100 of JKR Seberang Perai Branch is a rough estimation.

(5) Equipment Used

Number and type equipment, used in grass/tree cutting according to organization is as shown Table 2.4-6.

Table 2.4-6 Equipments Used for Grass Cutting

EQUIPMENT TYPE	APPROX. PRICE	PENANG ISLAND			SEBERANG PERAI	
		MPPP TARIAT P & G SECTION	MPPP ENG. DEPT. ROAD SECTION	JKR PENANG ISLAND BRANCH	MPSP SECRE- TARIAT P & G SECTION	JKR SEBERANG PERAI BRANCH
1. Street Washer Vehicle	\$124,000	2	0	0	0	0
2. Truck with Platform	\$90,000	1	0	0	0	0
3. Truck with Crane (8t)	\$80,000	0	0	0	1	0
4. Tractor	\$80,000	0	0	0	3	0
5. Truck with Crane (6t)	\$70,000	4	0	0	0	0
6. Truck (6t)	\$60,000	0	1	0	0	0
7. Service Cutter	\$60,000	1	0	0	0	0
8. Van with Jack	\$35,000	0	0	0	5	0
9. Agriculture Tractor	\$5,000	0	0	0	0	1
10. Chainsaw (Big)	\$1,000	1	0	0	0	0
11. Chainsaw (Small)	\$700	4	0	0	0	0
12. Lawnmower	\$500-800	30	14	0		15
13. Cutter	\$400-800	20	5	0	68	11

Note:

- 1) As shown in the above, JKR Penang Island branch does not have any equipment because they contract out 100% of grass/tree cutting services.
- 2) Number and type of equipment used by contractors are not available.
- 3) In addition to the equipment listed above, the following tools are used:

<u>TYPE</u>	<u>PLANT</u>
Axe	\$22
Cutter	\$20
Trimming Scissor	\$15
Changkul	\$8
Plant Support	\$4.5
Bamboo Rake	\$2
Coconut Broom	\$1

Quantity of the tools used are not available.

(6) Expenditure

a. Summary

Total expenditures for grass and tree cutting service are estimated at \$1,821,900 for Penang Island, and \$3,184,200 for Seberang Perai, of which breakdown is shown Table 2.4-7.

Table 2.4-7 Expenditure for Grass and Tree Cutting Services

	(A)+(B)+(C)+(D) <u>TOTAL</u>	(B) <u>PERSONNEL</u>	(C) <u>AMOUNT PAID TO CONTRACTORS</u>	(D) <u>OTHERS</u>
1) Penang Island				
a. MPPP Secretariat				
Dept. P & G Section	\$1,196,000	\$698,500	\$110,000	\$387,500
b. MPPP Engineering				
Dept. Road Section	\$532,200	\$388,700	\$80,000	\$63,500
c. JKR	\$93,700	\$13,700	\$80,000	\$0
Total	1,821,900	\$1,100,900	\$270,000	\$451,000
2) Seberang Perai				
d. MPSP Secretariat				
Dept. P & G Section	\$661,100	\$537,900	\$7,500	\$115,700
e. JKR	\$2,354,200	Not available	\$0	Not available
Total	\$3,015,300	Not available	\$7,500	Not available

Note:

As shown above, expenditure are classified into 3 times; personnel cost, amount paid to contractors and other expenditures. The amounts of the last two items have been obtained through the interview with relevant departments and organizations. On the other hand, personnel costs have been estimated on some assumptions. Personnel costs comprises of employee's salary and other items as shown below:

(7) Use of Contractors

In Penang island, as great as approximately 95% of grass cutting in terms of area is contracted out, while no contractors have been used in Seberang Perai. JKR Seberang Perai branch, however, intends to start using contractors in the near future. Extent of contracting out in terms of area is shown in the Table 2.4-8.

In both Penang island and Seberang Perai, cutting of big trees which need a crane are contracted out at the rate of about \$1,500 per tree. Several big trees are cut per year. Expenditures for tree cutting are small relative to the expenditures for grass cutting service.

Table 2.4-8 Grass Cutting Area

RESPONSIBLE ORGANIZATION	TYPE OF AREA	GRASS CUTTING AREA	CONTRACT AREA	NUMBER OF CONTRACTOR USED
organization MPPP Secretariat Dept. P & G Section	f. play ground & open space	178.84 ha.	178.84 km (100.5%)	of con-
	a. Play ground & Open space in George Town	109.4 ha.	109.4 ha. (100%)	1
	b. Play ground & Open space outside George Town	8.8 ha.	7 ha. (20%)	1
	Total (a + b)	118.2 ha.	116.4 ha. (98.5%)	2
MPPP Eng. Dept. Road Section	c. Highway side		(60%)	1
	d. Side of Roads in George Town	5.2 ha.	1.35 ha. (26%)	1
	Total (a + b + d)	123.4 ha.	117.8 ha. (95.5%)	3
JKR Penang Island	e. Side of Roads outside George Town	178.84 Km	178.84 Km (100%)	5
MPSP Secretariat Dept. P & G Section	f. Play ground & Open space		0 ha. (0%)	0
	g. Road side	19.2 Km*1	0 Km (0%)	0
JKR Seberang Perai Branch	h. Road side		*2 0 Km (0%)	0

*1: 19.2 Km between Simpang Ampot (in Central district) and Titi Mukim (in North district). This section of road is called "Protocol", which comprises of 7 parts. Each part has its own name.

*2: Total length of roads are as shown below:

	(A) FEDERAL ROAD	(B) STATE ROAD	(A)+(B)	(C) LOCAL COUNCIL ROAD	(A)+(B)+(C)
1) Penang Island	68.03 Km	279.96 Km	344.99 Km	205.90 Km	550.89 Km
2) Seberang Perai					
North District	25.76 Km	339.24 Km	365.00 Km		
Central District	16.50 Km	342.09 Km	358.59 Km		
South District	20.47 Km	203.12 Km	223.59 Km		
Total of					
Seberang Perai	62.73 Km	884.45 Km	947.18 Km		

All the federal and state roads have been constructed by JKR. The roads area classified into the following 5 types. The road length according to type is available only for Central District of Seberang Perai as shown below.

ROAD LENGTH IN CENTRAL DISTRICT

A1: concrete surface	16.50 Km
A2: Bituminous metalled surface	28.83 Km
C : Hard surface bituminous sealed	0.00 Km
D : Hard surface waterbound	5.76 Km
E : Earth road	0.32 Km

Grass cutting is provided actually for A1 and A2 type roads only.

The following table 2.4-9 shows how much the grass cutting contractors receive out of the Employer's total expenditures.

Table 2.4-9 Percentage & Amount Paid to Contractors

	(A)/(B)	AMOUNT PAID TO CONTRACTORS (A)	EMPLOYER'S TOTAL EXPENDITURES (B)
1) MPPP & G Section	9.2%	\$110,000	\$1,196,000
2) MPPP Eng. Dept.	15.0%	\$80,000	\$532,200
3) JKR Penang Island Branch	85.4%	\$80,000	\$93,700
Total of 1), 2) & 3)	14.8%	\$270,000	\$1,821,900
4) MPSP P & G Section	1.1%	\$7,500 ^{*1}	\$661,100
5) JKR Seberang Perai Branch	0.0%	\$0	\$2,354,200
Total of 4) & 5)	0.2%	\$7,500	\$3,015,300

*1 This amount (\$7,500) was paid to tree cutting contractors.

The following table has been prepared based upon the preceding two tables. This table shows great difference in the cost-effectiveness between contractors and their employers.

Cost Effectiveness of Grass Cutting Contractors and their Employers

	RATIO OF CONTRACT AREA TO TOTAL GRASS CUTTING AREA (A)	RATIO OF CONTRACT AMOUNT TO EMPLOYER'S TOTAL EXPENDITURE (B)	CONTRACTOR'S AVERAGE COST- EFFECTIVE- NESS: (A)/(B) (C)	EMPLOYERS' AVERAGE COST- EFFECTIVE- NESS: [100-(A)]/ [100-(B)] (D)	CONTRACTORS' COST- EFFECTIVE- NESS INDEX: EMPLOYER=1.0 (C)/(D) (E)
1 MPPP Eng. Dept.	26%	15%	1.7333	0.8706	2
2. MPPP P & G Section	60%-98.5%	9.2%	10.7065	0.0165	15-648

The table shows that the contractors of MPPP Engineering Dept. is twice as cost-effective as their employer, while the cost-effectiveness of the contractors MPPP P & G Section is 15-648 times as great as their employer.

Contract area of play ground and open space of MPPP P & G Section is 98.5% while contract area of highway is 60%. The weighted average percentage which has not been directly available may be estimated somewhere between 60% and 98.5%. If we take 60%, the contractors' average cost effectiveness is 15 times as great as that of their employer, while is 98.5% is taken, the corresponding index is as great as 648.

(8) Frequency of Grass Cutting

It takes about a month to make a complete cycle of grass cutting on average, while tree cutting service is provided on ad-hoc base.

Table 2.4-10 Grass Cutting Frequency

a. MPPP Secretariat Dept. P & G Section	Once a month
b. MPPP Engineering Dept. Road Section	Once a month except for the road from the airport to George town where the frequency is once in 2 weeks.
c. JKR Penang Island Branch	Once in 3 weeks (It takes two weeks to make a complete cycle. No grass cutting is done in the following week.)
d. MPSP Secretariat Dept. P & G	Once a month for road sides. Less frequent in parks and gardens.
e. JKR Seberang Perai Branch	Once in 6 weeks

(9) Amount of Grass Cut

The following data have been made available.

Table 2.4-11

	<u>AVAILABLE INFORMATION</u>	<u>GRASS AMOUNT ESTIMATED BY THE STUDY TEAM</u>
MPPP P & G Section	5 full trucks (6 ton capacity) per day	7.5 ton/day 187.5 ton/month 2,250 ton/year
MPPP Eng. Dept.	2 trips per day	3.0 ton/day 900.0 ton/year
JKR Penang Island	Not available	
MPSP P & G Section	Not available	
JKR Seberang Perai	Not available	

Note:

- 1) The above shown amounts do not include grass cut by contractors.
- 2) The following assumptions have been used to estimate the grass amounts:
 - a. 1.5 ton of grass is hauled by a trip.
 - b. There are 25 working days in a month.
- 3) Both MPPP Engineering Dept. and JKR Penang Island Branch haul cut grass to Bakau Street Dump Site, while JKR Seberang Perai Branch leaves cut grass on sites.
- 4) MPPP P & G Section uses 30% of cut grass as fertilizer while the rest is hauled to Bakau Street Dump Site.

(10) Major Conditions of Contracts

The following common contract conditions have been found.

- 1) Method of Selection: Usually tenderers that offered lowest prices are selected.
- 2) The contract period is two years in KL. District engineer of JKR Penang Island branch said that two-years contract period is desirable because contractors are encouraged to invest in the equipments if the contract period is longer.
- 3) Contract amount: Contract amount is paid monthly on a fixed lump sum basis. Contractors estimate their offer prices based on grass area or length informed by employers.

MPPP Engineering Dept. estimates grass cutting cost at \$3 per 100 m³ or \$300/ha., while JKR Seberang Perai Branch is going to use \$130/acre or \$321/ha. as a guideline price.

JKR Seberang Perai Branch intends to employ contractors in the near future due to the following reasons:

- Shortage of machinery
- Low productivity in their own work

- 4) Minimum equipment and laborer: Usually minimum number of equipments and laborers to be used for grass cutting service are specified. For example, MPPP Engineer Dept. requires a contractor to keep at least 10 laborers, 1 lorry and 8 mowers at any time.
- 5) Number of tenderers: Usually, 10-25 tenderers participate in each tender.

2.4.4 Drain Cleansing

(1) Drain Cleansing by Anti-Mosquito Section of Health Dept. in MPPP

a. Function of the section concerning drain cleansing

The following three agencies are responsible for cleansing drains including river:

- Health Dept. Cleansing section
Drains in Georgetown and housing estates in Rural area
- Health Dept. Anti-Mosquito section
Ditch in Kampongs
River not used for irrigation
- Drainage and Irrigation Dept. of Penang State Government
River used for irrigation, mainly located in west part of island

Functions of Anti-Mosquito section is as follows:

- Spraying, construction of ditch, rodent control, anti-pest and ditch cleansing
- Aids mosquito (Hepatitis)

Ditch cleansing service includes the following:

- | | |
|---|----------|
| - Ditch cleansing (Cemented drain in
Kampongs called A.M. drain) | 44.9 Km |
| - Ditch cleansing (earth drain in Kampongs) | 140.1 Km |
| - Steam cleansing | 262.4 Km |
| - Ditch repair | 1.2 Km |

They removes solid waste accumulated in drains and leaves it beside the drain. Collection workers employed by a contractor collect these waste and haul to the disposal site.

b. Manpower of Anti-mosquito section concerning drain cleansing

Table 2.4-12 Number of Personnel in Anti-Mosquito Section in MPPP

<u>WORK ITEMS</u>	(person)		
	<u>GEORGETOWN</u>	<u>RURAL</u>	<u>TOTAL</u>
Ditch cleansing			
Mandor	6	-	6
Labor	69	31	100
Sub Total	75	31	106
Other Work			
PHI	-	1	1
Inspector	-	3	3
Overseer	-	17	17
Mandor	2	-	2
Labor	59	40	99
Sub Total	61	61	122
Total			

(Detail)

	<u>MANDOR</u>	<u>LABOR</u>	
Georgetown			
Spraying	1	15	
Construction of Drain	1	6	
Rodent Control	-	12	
Anti-pest	-	2	
Sub Total	2	35	
	<u>MANDOR</u>	<u>LABOR</u>	<u>SPRAY OILER</u>
Ditch Cleansing			
Team a	2	13	4
b	2	27	12
c	1	13	4
d	1	16	4
Sub Total	6	69	24
	<u>LABOR</u>		
Rural Area			
Rodent Control			
Tanjung Tokon	(5)		
Ayer Itam	(4)		
Sungai Gelugor	(4)		
Sub Total	13		
	<u>LABOR</u>		
Ditch Cleansing			
Tanjung Tokon	(4)		
Ayer Itam	(5)		
Sungai Gelugor	(12)		
Bayan Lepas	(10)		
Sub Total	31		

Aids mosquito gang (Hepatitis)	20 laborers
Senior Health Inspector	1
Senior Anti-mosquito inspector	3 (as senior overseer)
Anti-mosquito inspector	17 (as overseer)
Larvae collector	4 laborers
Rodent catcher	3 laborers

(2) Drain Cleansing Done by Drainage and Irrigation Dept. (DID) of Penang State Government

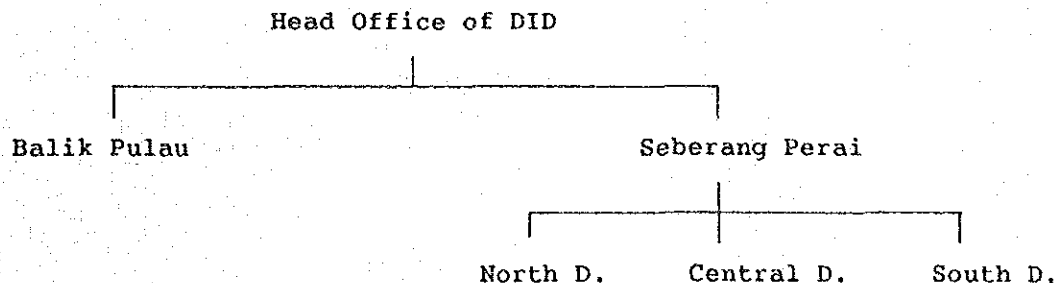
a. Extent of drain Cleansing Done by DID

DID manages and controls drainage and irrigation channel in agriculture area, while the Municipal Council manages drainage of urban area including town and development area. Most of drains managed by DID are in Seberang Perai. In Pulau Pinang DID's cleansing service is limited to the west part.

Main cleansing work done by DID consists of desettling (dredging) and clearing. Frequency of desettling is once in three to six years. Frequency of clearing is twice to three times in a year.

b. Organization of DID

DID has branch offices in each district as shown in Fig. 2.4- . River conservancy section of each branch office is responsible in above works.



c. Manpower of River Clearing Work

	<u>JUNIOR TECHNICIAN</u>	<u>TIME TAKER (OVERSEER)</u>	<u>MANDOR</u>	<u>LABOR</u>	<u>TOTAL</u>
Balik Pulau	1	-	-	7	8
Gang a	1	-	-	7	8
b	-	-	-	5	5
Seberang Perai					
North D.		1	-	8	9
Central D.		1	-	5	6
South D.		1	-	5	6
Total	2	3	-	37	42

d. Equipment

Drag Line	10 units
Chain Saw	6 units (1 unit/gang)
Slashing Knife	37 units (1 unit/labor)
Monkey Winch	
Hammer	6 units (1 unit/gang)

e. Contracting out

Contractors are made every year. In 1987, clearing service for 58 rivers (23 in North, 14 in Central and 11 in South) has been contracted out, which represents 70% of the total river clearing work. The remaining 30% was executed by DID itself.

Almost all of dredging is done by DID itself. Dredging work at 5 places were contracted out in 1987.

f. Budget

Budget of dredging and clearing work is as follows:

Contract amount	\$202,000
(clearing and river conservation)	
Dredging and river improvement work	\$638,000*

* 10% of this amount is used for maintenance of machine and fuel.