社会開発調査部報告書

No. 12

SOLID WASTE MANAGEMENT STUDY FOR PULAU PINANG AND SEBERANG PERAI MUNICIPALITIES

SUMMARY

AUGUST 1989

JAPAN INTERNATIONAL COOPERATION AGENCY

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FOR
PULAU PINANG AND SEBERANG PERAI MUNICIPALITIES

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PREFACE

In response to a request from the Government of Malaysia, the Japanese Government decided to conduct a study of Solid Waste Management for Pulau Pinang and Seberang Perai Municipalities and entrusted the study to Japan International Cooperation Agency (JICA).

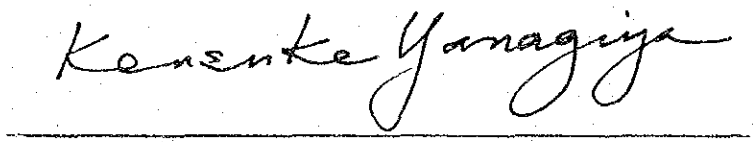
JICA sent to Malaysia a survey team headed by Mr. MITO Kango, Yachiyo Engineering Co., Ltd., and composed of members from Kokusai Kogyo Co, Ltd., from January to March, from June to August, and from November to December 1988.

The team held discussions with concerned officials of the Government of Malaysia, and conducted field surveys. After the team returned to Japan, further studies were made and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincerest appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the team.

August 1989



Kensuke YANAGIYA
President,
Japan International Cooperation Agency (JICA)

Solid Waste Management Study for
Pulau Pinang and Seberang Perai Municipalities

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for
Summary

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II. First Phase Project Plan for MPPP

III. First Phase Project Plan for MPSP

ABBREVIATION

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

PADS	:	Pantai Acheh Disposal Site
PBDS	:	Plau 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

Conclusion

The following conclusion are meant for both MPPP and MPSP unless otherwise indicated.

1. Major Problems Identified are as follows:

    1) Low operational efficiency in waste collection and haulage as well as street/draing cleansing
    2) Inadequate disposal standard
    3) Weak management
    4) Inadequate citizens' cooperation
    5) Weak revenue basis

2. Major improvement targets and measures proposed in the Master Plan are:

    1) Improvement on waste collection efficiency through:
        - Introduction of a 3 times/week collection system in residential area
        - Use of plastic bags for waste storage and discharge
        - Replacement of side-loaders with compactor vehicles (10 m^3) for waste collection
        - Introduction, in future, of a station collection system in which a collection point is provided for every 20 households or so in principle.

    2) Cost reduction in street/drain cleansing by applying weekly cleansing in residential area, and team work system.

    Note:
    Through the improvements as mentioned in the above items 1) and 2), MPPP and MPSP would be able to reduce the size of labor force by about 35% and 25% by 1995.

3) Improvement on disposal standard through the introduction of sanitary landfill system. A stepwise improvement is proposed as shown below:

	MPPP	MPSP
- Construction of sanitary landfills with leachate circulation and monitoring facilities (Level 3):	1991	1991
- Construction of sanitary landfills with leachate treatment facilities and a monitoring system (Level 4) which satisfies effluent standards as stipulated by Department of Environment (DOE):	1996	2001

4) Strengthening of the managerial capacity through
   - Establishment of an independent department resonsible for solid waste management
   - Specialization of management staff (departmental head and public health inspectors) in solid waste management
   - Use of political influence in more constructive way (Reduction of political interference in the Councils' daily administrative affairs)

5) Strengthening of the revenue basis through:
   - Increasing assessment rates and reducing arrears
   - Increasing commercial waste collection fee and disposal tipping fee (MPPP)
   - Introducing commercial waste collection fee and disposal tipping fee (MPSP)

3. Both MPPP and MPSP have implemented some of the immediate improvement projects and a pilot project which have been proposed by JICA. Through the implementation of those projects, the following has been proved:

(1) 3-times/week collection system with plastic bag is cost-effective and workable even in Penang in view of the results of the pilot collection project executed by MPPP in Bayan Baru area.

(2) The weigh-bridge system is essential in analyzing, planning and managing waste collection and haulage in view of MPSP's experience.

(3) Both MPPP and MPSP are capable of improving disposal standards; MPPP has upgraded its existing disposal site from controlled tipping system (Level 1) to sanitary landfill with a bund and daily soil covering (Level 2), while MPSP has upgraded its existing disposal site from open dumping to controlled tipping system (Level 1).

4. Level 3 sanitary disposal system is most realistic as an improvement target of the first phase which starts 1991 as a result of overall evaluation of technical, environmental and financial aspects.

5. It has been found that the environmental impacts of Level 3 disposal system at three future disposal sites are minimal as the result of Pre-EIA which has been executed by University Sains Malaysia (USM) under a contract with the Ministry of Housing and Local Government. The Pre-EIA report incorporated all the results of the environmental study on air, water and noise conducted by JICA Study Team.

6. The Steering Committee has decided that the following three sites should be used as future disposal sites:

- Pantai Acheh (Pulau Pinang)
- Kuala Muda (Seberang Perai)
- Pulau Burong (Seberang Perai)

7. Feasibility of Major Facilities

Incinerator, transfer station, inter-municipal disposal system as well as compost plant have been found infeasible due to the reasons shown below:

(1) Incinerator

Like the cases in other developing countries, an incinerator has been found financially infeasible in this study because SWM system with an incinerator is much more expensive than the system without it. It is estimated that M$

100 million at least is needed to construct an incinerator with the capacity of 700 t/day of waste, which is equivalent to the capacity required by MPPP in 2005. On the other hand, it is estimated that M$ 22 million is sufficient for constructing a sanitary disposal system with the sufficient capacity of meeting the disposal demand up to 2005 at Pantai Acheh as proposed in the Master Plan.

It is important to note that an incinerator may prove to be feasible in the future if the acquision of land for disposal would be extremely costly or price of incinerator would decrease owing to some technological innovations in the future.

(2) Transfer Station

Transfer station has been found financially infeasible even considering the location of the future disposal sites and assuming the use of compactor vehicles of 10 m3. The advantage of having transfer stations is to reduce operation costs of haulage when the haulage distance is long. It has been found, however, that the expected reduction of the operation cost is negligiably small. As a matter fact, it is estimated that the haulage system with transfer stations is about 14 % more expensive than the system without it even in the long term.

(3) Inter-municipal Disposal System

Inter-municipal disposal system with either sea or land transport system has been found neither feasible nor necessary because:

- This system is more costly than the separately administered systems and
- A future disposal site to be used by MPPP has been found at Pantai Acheh. The site is large enough to absorb all waste till 2005.

(4) Compost Plant

Compost plant has been found infeasible in view of a very little demand for waste compost.

8. The present and future population, service coverage, waste amount and Council's revenue have been estimated as follows: (The future population and revenue of MPPP and MPSP were projected based upon the Structure Plan.)

(1) MPPP

	1987	1995	2005
Population:			
- Total population (Persons)	559,300	615,700	718,000
- Target Collection Service Coverage	93 %	95 %	97 %
Daily Waste Amount:			
- Per-capita Generation Amount	0.78 Kg.	0.91 Kg.	1.11 Kg.
- Total Generation Amount	432 t	556 t	784 t
- Target Collection Amount	360 t	470 t	670 t
- Target Disposal Amount	410 t	539 t	770 t

Note: 1. It is estimated that per-capita waste generation amount will increase by 2 percent per year.
2. The above-shown per-capita generation amounts include not only household waste but also commercial and industrial waste as well.

Council's Revenue:

	1987	1995	2005
- Total Revenue (million)	M$68.9	M$113.5	M$210.4

Note: An annual inflation of 1.5% is assumed in estimating the future revenue.

(2) MPSP

	1987	1995	2005
Population:			
- Total population (Persons)	531,300	627,100	754,100
- Target Collection Service Coverage	70 %	77 %	85 %
Daily Waste Amount:			
- Per-capita Generation Amount	0.70 Kg.	0.82 Kg.	1.00 Kg.
- Total Generation Amount	372 t	514 t	754 t
- Target Collection Amount	191 t	342 t	540 t
- Target Disposal Amount	239 t	437 t	679 t

Note: 1. It is estimated that per-capita waste generation amount will increase by 2 percent per year.
2. The above-shown per-capita generation amounts include not only household waste but also commercial and industrial waste as well.

Council's Revenue:

	1987	1995	2005
- Total Revenue (million)	M$31.4	M$51.7	M$95.9

Note: An annual inflation of 1.5% is assumed in estimating the future revenue.

9. Estimated Investment and Target Annual Costs

(1) MPPP

a. Estimated Required Investment

Unit: Million Malaysian Dollar

	Construction of Sanitary Landfill	Collection Vehicle Purchase	Street/Drain Cleansing Equipment	Total
1990 - 1995	6.2	1.9	1.5	9.6
1996 - 2000	20.3	2.7	1.6	24.6
2001 - 2005	0.7	2.4	0.8	3.8
Total	27.2	6.9	3.9	38.0

Note:

1) Yearly breakdown of the sanitary landfill construction cost is as follows: M$0.2 million in 1990, M$6.0 million in 1991, M$20.3 million in 1996 and M$0.7 million in 2001.

2) The sanitary landfill construction cost, M$6.2 during 1990 - 1995 includes design preparation cost.

3) Differences between the totals and sums of the respective amounts arise due to rounding errors.

4) An annual inflation of 1.5% is assumed in estimating the above costs.

b. Target Annual Costs and Fee Revenue

Unit: Million Malaysian Dollar

	1987	1990	1995	2000	2005
1) Operation and Maintenance & Interest Payment:	18.7	18.5	20.8	25.3	29.8
2) 1) plus Allowance for Depreciation:	18.7	18.5	22.2	28.2	33.1
3) Target revenue from imposition of Commercial waste collection fee & Tipping fee :	0.0	0.0	1.6	3.0	5.1
4) 2) minus 3):	18.7	18.5	20.6	25.2	28.0

Note: For the estimation of the above costs, an annual inflation of 1.5% is assumed except for the emolument of the Council's employees which is assumed to increase by 2.5% per year.

(2) MPSP

a. Estimated Required Investment

Unit: Million Malaysian Dollar

	Construction of Sanitary Landfill	Collection Vehicle Purchase	Street/Drain Cleansing Equipment	Total
1990 - 1995	8.5	5.7	1.6	15.6
1996 - 2000	12.8	6.6	1.9	21.4
2001 - 2005	26.8	6.1	1.5	34.4
Total	48.1	18.4	4.9	71.4

Note:

1) Yearly breakdown of the sanitary landfill construction cost is as follows: M$0.3 million in 1990, M$8.2 million in 1991, M$12.8 million in 1996 and M$26.8 million in 2001.

2) The sanitary landfill construction cost, M$8.5 required during 1990 - 1995 includes design preparation cost.

3) Differences between the totals and sums of the respective amounts arise due to rounding errors.

4) An annual inflation of 1.5% is assumed in estimating the above costs.

b. Target Annual Costs and Fee Revenue

Unit: Million Malaysian Dollar

	1987	1990	1995	2000	2005
1) Operation and Maintenance & Interest Payment:	9.9	11.3	16.9	21.1	28.1
2) 1) plus Allowance for Depreciation:	9.9	11.3	19.3	25.7	37.1
3) Target revenue from imposition of Commercial waste collection fee & Tipping fee :	0.0	0.0	1.4	2.5	4.5
4) 2) minus 3):	9.9	11.3	17.9	23.2	32.6

Note: For the estimation of the above costs, an annual inflation of 1.5% is assumed except for the emolument of the Council's employees which is assumed to increase by 2.5% per year.

10. Important points to note with respect to the financial aspect are as follows:

(1) MPPP

a. Construction of sanitary landfill will cost M$6.2 million during the years 1990 and 1991.

b. Construction of the proposed sanitary landfill would not be made possible without the financial assistance by the Federal Government either in the form of loan or more preferably grant.

c. The target annual costs of SWM as shown in the previous section are estimated assuming that MPPP successfully achieved all the improvements on waste collection, haulage, street/drain cleansing as well as disposal system improvements as proposed in the Master Plan.

d. Annual costs will be much greater if the proposed improvements were not implemented.

e. The target annual costs (inclusive of payments of loan interest and allowance for depreciation) of SWM is expected to increase by 3% per year till 2005.

f. If, however, MPPP successfully collected tipping fee and commercial waste collection fee as proposed in the Master Plan, the net annual SWM costs (annual costs minus collected fee revenue) will increase by 1.5% only on average instead of 3%.

(2) MPSP

a. Construction of sanitary landfill will cost M$8.5 million during the years 1990 and 1991.

b. Construction of the proposed sanitary landfill would not be made possible without financial assistance by the Federal Government either in the form of loan or more preferably grant.

c. The Target annual costs shown in the previous section are estimated assuming that MPSP successfully achieved all the improvements on waste collection, haulage, street/drain cleansing as well as disposal system improvements as proposed in the Master Plan.

d. Annual costs will be much greater if the proposed improvements were not implemented.

e. The target annual cost (inclusive of payment of loan interest and allowance for depreciation) in 2005 will be as large as about 370% of the present annual cost. This follows that the annual cost will increase by 7.6% on average till 2005.

f. If, however, should MPSP successfully collect tipping fees and commercial waste collection fees as proposed in the Master Plan, the net annual SWM costs (annual costs minus collected fee revenue) would increase by 6.4% on the average instead of 7.6%. The percentage, 6.4% happens to be same as the annual nominal growth rate of the MPSP's revenue estimated in the Structure Plan.

Recommendations

The following recommendations are presented for both MPPP and MPSP.

1. Setting-Up Project Implementation Unit

In view of the large amount of work to be done for the implementation of the first phase projects, both Councils should set-up a project implementation unit respectively which would be responsible for systematic implementation of the project. Such unit should consist of staff of both Health Department, Engineering Department and some other relevant departments if necessary.

2. Replacement of Side-loaders with Large Compactor Vehicles

In view of the situation where new disposal sites which are expected to open in 1992 will be farther than the existing ones, the both Council should purchase compactor vehicles with capacity of 10 m^3 at the time of renewal of vehicles.

3. Expansion of 3 times/week Collection Area

A 3-times/week collection system which MPPP has been carrying out as a pilot project in Bayan Baru area should be expanded to all other residential areas in earliest possible time in order to reduce residents' complaints which may result from the difference in service frequency among areas.

4. Successful Deployment of Redundant Laborers

It is anticipated that many cleansing laborers would be made redundant in the future through the reduction in the frequency of waste collection and street/drain services. It is therefore extremely important for both Councils to find ways to deploy those laborers for other services.

Privatization should be promoted in such a manner as not to cause the under-utilization of the Councils' resources such as laborers and equipment particularly in the long term.

5. Plans for Efficient Waste Collection System for New Housing Developments

In developing new residential areas, careful planning should be made so that the planned area would be provided with an efficient waste collection system such as a waste station collection system which is proposed in the Master Plan.

6. Collection and Utilization of Data

Collection of relevant data is essential for the planning and evaluation of the existing situation and progress of solid waste management. Relevant data include waste amounts and composition which would change daily, seasonally and yearly. In this connection, weighbridges should be actively used.

7. Environmental Improvement on the Existing Waste Disposal Sites

Both Councils have greatly upgraded the standard of the existing disposal sites through the immediate improvement plans.

It is desired that the both Councils make further efforts for the improvement of those sites in view of the fact that residents' acceptability of the new disposal sites is largely influenced by the conditions of the existing sites and views of the residents living nearby the existing sites.

8. Strengthening of the Fee Collection

Tipping fees and commercial waste collection fees are to be imposed based upon the beneficiary-pay-principle.

MPPP has already collected those fees. It is advised that MPPP should gradually increase those fees in the future so that the cost of the services would be covered by those fees.

MPSP on the other hand has not collected those fees yet. The Master Plan proposes that MPSP should introduce the collection of those fees.

I. Master Plan

I. Master Plan

1. Introduction

1.1 Background of the Study

The Local Government Act (1976) of Malaysia stipulates that local authorities are responsible for the collection and appropriate treatment/disposal of the solid waste generated in areas under their jurisdiction. Pursuant to this Act, local authorities have been implementing various projects and facility construction to smoothly conduct solid waste management in their respective areas in cooperation with the Ministry of Housing and Local Government and have also been consolidating the related regulations and systems.

The systematic consolidation and improvement of facilities and systems based on medium and long-term perspectives instead of short-term plans which have so far been the case, however, is required to adequately deal with the rapidly increasing solid waste volume and changes in its quality due to conspicuous socioeconomic development in recent years and the subsequent population concentration in urban areas. In this context, the Ministry of Housing and Local Government prepared the national Action Plan for Beautification and Clean Malaysia (ABC Plan) in 1988, and one of its strategic program intends the preparation of master plans for 15 municipal councils in Peninsula Malaysian by 1995.

The Ministry of Housing and Local Government requested the Government of Japan to jointly conduct a solid waste management study for Pulau Pinang and Seberang Perai with the Penang State Government and the Pulau Pinang and Seberang Perai Municipal Councils so that the study could be used as a model for the master plans to be prepared for the remaining 13 municipal councils in the future.

1.2 Objectives of the Study

The objectives of the Study were the preparation of a master plan with a target year of 2005 and the implementation of a feasibility study on priority projects to be executed by 1995 in line with the master plan in view of the improvement of and facility consolidation for solid waste management in both Municipal Councils of Pulau Pinang and Seberang Perai from the medium and long-term perspectives.

1.3 Basic Study Policy

(1) Relationship between the Study and the National Plan

The conditions of municipal solid waste management in Malaysia have seriously deteriorated in the process of the rapid urbanization since the late 1970's. While the National Cleanliness Campaign was conducted nationwide in 1983 under the direct leadership of the Honarable Prime Minister to mobilize the public for the beautification of the country, the campaign's achievements fell short of expectations and a strong need was felt for the related ministries and agencies of the Federal Government to take the initiative and establish operational, financial and legal systems necessary for execution of municipal cleansing services and for continuous efforts under a comprehensive plan based on the medium and long-term perspectives.

In view of the above situation, the necessity for the preparation of a national plan was pointed out by WHO/PEPAS (The Promotion of Environmental Planning and Applied Studies). In accordance with the guidance given by WHO/PEPAS, the Malaysian Government requested Japan to provide technical cooperation in this field. As a result, an expert was dispatched from JICA.

With the cooperation of the Japanese expert, the Ministry of Housing and Local Government prepared the ABC Plan which consists of 12 programmes. Some of these programmes are currently in progress and have already made concrete achievements. In regard to the programme calling for the preparation of a solid waste management master plan for each municipal council, it was decided to firstly prepare a model master plan so that the experience gained in the model master plan preparation process could be applied for other municipal councils.

The present Study has generated the solid waste management master plans for the Municipal Councils of Pulau Pinang and Seberang Perai where the rapid industrialization is taking place and these master plans are intended to act as a model for other municipal councils. The Study was jointly conducted with the Malaysian side under the technical cooperation of the Government of Japan in view of Malaysia's lack of experience in the preparation of solid waste management plans.

(2) Joint Study

The essence of solid waste management is the prompt removal and appropriate treatment/disposal of generated waste. Of the processes involved in solid waste management, waste collection particularly presents a point of contact between the public and the administration. An appropriate collection system cannot be established without the mutual cooperation of these two sides. In this context, a proper understanding of the social and cultural background of the study area is essential in the preparation of a solid waste management plan. The selection of appropriate technologies which can be easily absorbed by the local community and technical transfer enabling the self-preparation of a solid waste management plan and self-review of the prepared plan by individual municipal councils are particularly important and here lies the reason for the joint implementation of the Study with the active participation of the Malaysian side which was responsible for the following work.

a. Solid waste analysis
b. Site selection
c. Environmental impact assessment
d. Execution of immediate improvement plan
e. Development of a programme to control data measured by weighbridge

(3) Handling of Toxic Industrial Waste

The subject solid waste of the Study is that currently handled by the Health Departments of Pulau Pinang and Seberang Perai Municipal Councils and excludes toxic industrial waste. The Department of Environment is currently preparing an improvement plan for the control of toxic industrial waste and, therefore, the solid waste management plans for Pulau Pinang and Seberang Perai have been prepared along the policy that toxic industrial waste will not be accepted at municipal disposal sites, i.e. municipal waste and non-toxic industrial waste only will be accepted.

Some toxic industrial waste is, however, dumped at the disposal sites run by the municipal councils due to the lack of a proper management system for the treatment and disposal of toxic industrial waste. In this context, the Study proposes the establishment of a system to prevent toxic industrial waste from being hauled into municipal solid waste disposal sites. The Study also proposes that priority be given to the construction and management of sanitary landfill sites (Level 4) with facilities to treat waste water to satisfy the effluent standards of the Department of Environment.

In view of the facts that the promotion of a project requiring substantial investment against limited financial resources may destroy the financial basis of the municipality and that the balanced development of the infrastructure (including sewage system) in addition to the solid waste management system is essential for the cost-effective preservation of a healthy environment for urban life, it has been decided that the disposal sites to be constructed in Phase I will be of Level 3 where the system of leachate monitoring and circulation to the disposal sites will be

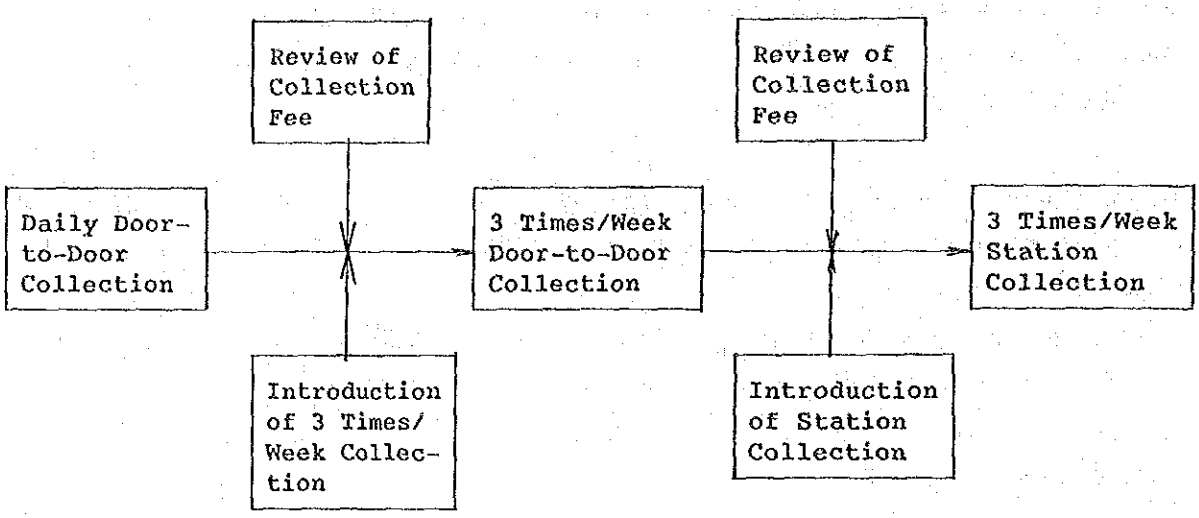
introduced, and that these will be improved to Level 4 with leachate treatment facility, etc. in Phase II or in Phase III onwards. This decision is also supported by the environmental impact assessment results showing the impact of Level 3 disposal sites on the surrounding environment to be minimal.

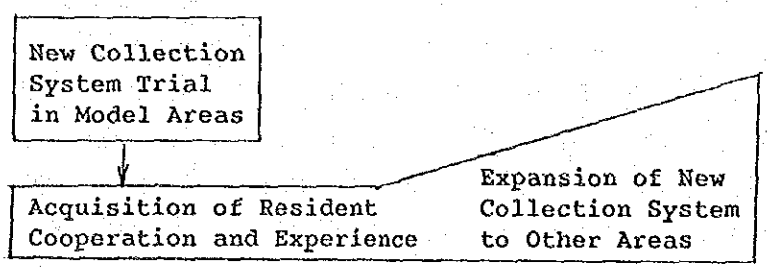
Against the above background, the Study proposes the establishment of measures to restrict the haulage of toxic industrial waste to the disposal sites and a water pollution monitoring system, including groundwater pollution in order to contribute to the environmental conservation around the disposal sites.

(4) Step-wise Approach

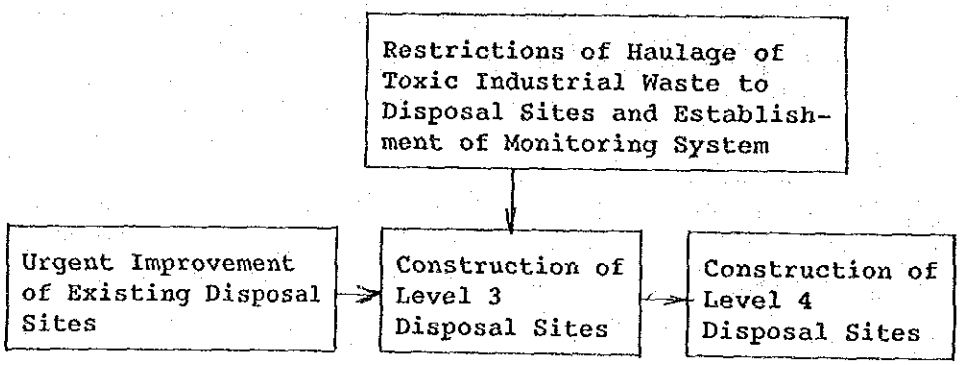
While the Study examines the desirable solid waste management system to be established by 2005, it also examines the Phase I improvement project to be implemented between 1991 and 1995 and interim measures to be introduced prior to the commencement of the Phase I project in view of the necessity for the step-wise improvement approach which should be compatible with financial capacity of the municipal councils. A small-scale pilot project has been implemented to respond to such requirements as the implementation of urgent improvement measures in line with the targets of the master plan and the verification of the feasibility of the master plan. With regard to the collection and disposal, it is proposed that the phased improvement be conducted in accordance with the following steps.

a. Solid Waste Collection and Cleansing





b. Disposal



The pilot project in Pulau Pinang consists of 3 times/week collection and once-a-week cleaning. In the case of Seberang Perai, a vehicle control system has been introduced as an urgent improvement measure in the North district whereby reserve vehicles are secured from existing vehicles to improve the vehicle maintenance and work systems. The embankments, on-site roads and effluent control facilities of the existing disposal sites have been improved and cover soil has been applied with positive results.

(5) Selection of Solid Waste Treatment and Disposal System

Although Pulau Pinang (MPPP) and Seberang Perai (MPSP) are separate local authorities located on opposite sides of the strait, they have begun to form a single economic zone with the completion of the Pinang Bridge. The area in question is one of the most advanced urbanization and industrialization areas in Malaysia and the advancement of urbanization is particularly noticeable in MPPP. Against these local conditions, the important points to be addressed in the planning of an appropriate solid waste treatment and disposal system were as follows.

a. Whether or not intermediate treatment is necessary. If necessary, which types of technologies should be introduced.
b. Whether or not the transfer of collected solid waste is necessary.
c. Whether or not an inter-municipal treatment and disposal system covering both Municipal Councils should be adopted.

With regard to intermediate treatment (the above item a.), the feasibility of both composting and incineration was examined. It was subsequently judged that composting treatment was unfeasible due to the limited marketability and that the possible inclusion of incineration treatment in the master plan should be considered. Taking into account all the above three points, 8 alternatives have been proposed and evaluated from 4 aspects, i.e. technology, economy and finance, social system and environment.

- Separate Management -
  1. Direct Transport
  2. Transfer
  3. Incineration
- Inter-municipal Management
  4. Direct Transport
  5. Transfer
  6. Sea Transport
  7. Incineration
  8. Joint Incineration

The selected alternative is the separate management in view of easy management and the direct transport requiring the least investment given the financial background.

In regard to collection, the establishment of the 3 times/week station collection system by 2005 is proposed, assuming sufficient public cooperation in taking waste to the stations, in order to reduce the cost increase pressure caused by the increased waste volume, distant disposal sites and the introduction of sanitary landfill. In the immediate future, however, the introduction of the 3 times/week door-to-door collection system using plastic bags is aimed at.

(6) Environmental Study

Environmental studies have been made in the following process:

1) Selection of sites for major facilities such as disposal sites
2) Selection of technical system alternatives
3) Feasibility study of the first phase projects

a. Environmental Study Made in the Selection of Sites for Major Facilities such as Disposal Sites

In order to help to select most suitable sites from 21 potential sites initially identified, all those potential sites have been evaluated in terms of environmental impacts which may arise from the construction and operation of the proposed facilities. Field surveys and data analysis have been conducted for the environmental evaluation.

b. Environmental Evaluation Made in the Selection of Technical System Alternatives

Eight (8) alternatives with respect to technical system has been presented in the Master Plan. All those alternatives have been evaluated from environmental view points as well as from some other points. This environmental evaluation has been made qualitatively regarding 10 items including environmental impacts on public water.

c. Environmental Evaluation Made in the Feasibility Study

During the feasibility study, environmental evaluation has been quantitatively carried out with respect to the three important elements: water quality, atmosphere and noise which may be affected by the construction and operation of the future disposal systems in the three proposed sites: Pantai Acheh, Kuala Muda and Pulau Burong. The environmental evaluation during the feasibility study has been carried out more in detail than the previous two environmental evaluation.

On the other hand, University Sains Malaysia (USM) as a contractor of Ministry of Housing and Local Government has carried out an Environmental Impact Assessment (EIA) which would meet the legal requirement of Department of Environment (DOE), and submitted the EIA report to DOE. The results of the JICA's environmental evaluation have been extensively used in the above-mentioned EIA.

(7) Finance

The preconditions adopted in the preparation of the financial plan were (i) an annual municipal budget increase of 4.8% in real terms based on the structure plans of MPPP and MPSP, (ii) a reduction in the collection cost by the introduction of the 3 times/week collection system which is the key component of the solid waste management improvement plan, (iii) an increase in the revenue by reviewing waste collection and other fees and (iv) the completion of loan repayment or a firm prospect of repayment without increasing the budgetary share of solid waste management from the present level.

The loan repayment in the case of MPPP has been found to be feasible if the proposed cost saving in the collection and the cleansing services was realized. In comparison, however, the solid waste management cost will be a heavy burden on the municipal budget of MPSP due to the expansion of collection service areas and the increase of the service population, necessitating the financial assistance by the State or the Federal Government.

(8) Organizational and Institutional System

Solid waste management in both MPPP and MPSP is conducted by the Health Department which is also responsible for food hygiene and public health, etc. This institutional setup is understandable because urban cleansing is strongly related to public health by means of preserving a good living environment. However, this setup where the same staff are responsible for various works involving different technologies and management objectives is not necessarily desirable in regard to improving the expertise of staff members. In addition, the Health Departments of MPPP and MPSP are over-sized vis-a-vis other departments in terms of staff and budget and it is necessary that these imbalances be corrected. There is, in fact, now a trend for the section responsible for urban cleansing to be separated from the Health Department and transformed into a new department called Urban Service Department. In this context, the ABC Plan calls for a review of the administrative organization and the Study also proposes reorganization to follow this trend.

One of the national policies for solid waste management in Malaysia including ABC plan is the promotion of contracting-out of services to the private sector. As the private sector's share is already large in the case of MPPP, the study considers the improved efficiency of the directly managed solid waste collection and disposal system is as important as the promotion of contracting-out. Therefore, the Study proposes the maintenance of the private sector's present share and the improvement on the efficiency of direct management by MPPP. In comparison, the Study proposes an increase of the private sector's share in MPSP to 60% by 1995 in view of the need for rapid expansion of the collection and disposal services on one hand and the unclear prospect of successful development of the private sector on the otherhand.

(9) Planning Tools and Information System

The collection of basic data and provision of planning tools are essential for the preparation of a master plan for each municipal council which is the strategic target of the ABC Plan. The Ministry of Housing and Local Government has installed weighbridges in 11 municipal councils with the cooperation of JICA and has established a system for the common utilization of various data through the joint development with JICA of a computer programme for the effective utilization of these data.

With regard to planning tools, JICA study team and the Ministry of Housing and Local Government have developed a master plan preparation manual and plan to hold a workshop to encourage the wide use of this manual by the municipal councils.

The fostering of manpower and the establishment of an information system relating to solid waste management will be long term issues and, therefore, continuous efforts by all related organizations in Malaysia to this end are hoped for in the future.

1.4 Scope of the Study

(1) Study Area

While the Study took the entire areas of both Municipal Councils of Pulau Pinang and Seberang Perai (total area of some 1,000 km^2) into consideration, highly populated urban areas (some 500 km^2) were designated Priority Operational Areas for the master plan.

With regard to the feasibility study dealing with various projects to be executed by 1995, priority projects were selected from those relating to Priority Operational Areas for the master plan and were examined for feasibility.

(2) Types of Waste to be Studied

The solid wastes studied included domestic waste, commercial waste, market waste, industrial waste and litter collected from streets, drains, parks and beaches, etc. In the case of industrial waste, the Study excluded hazardous and toxic wastes currently treated together with other industrial waste by the generators themselves.

The Study also assumed the treatment or disposal of litter collected from streets, drains and parks, etc. by competent agencies or departments as has been the case up to the present.

1.5 Key Assumptions

Key assumptions used in this study as follows:

a. Socio-economic Conditions

	MPPP	MPSP
- Projected population in 2005 (persons)	718,000	754,000
- Population rate within a priority operational area	97%	85%
- Annual increase rate of GRDP in real term (both MPPP and MPSP)	. 1985 - 1990 : 5% . 1991 - 2005 : 4.8%	
- Future budget scale of the municipality	to increase in proportion to growth rates of GRDP based on the actual budget of 1985.	

* GRDP: Growth Regional Domestic Product

b. Waste Amount and Composition

	MPPP	MPSP
- Generation amount per capita per day in 1987	0.78 kg	0.70 kg
- Annual increase of per-capita waste generation rate	2%	2%
- Waste composition (both MPPP and MPSP)	paper and plastic will increase, while garbage and others will decrease in future.	

c. Organizations Responsible for Cleansing Services

The following organizations which are currently responsible for the cleansing services shall remain responsible for the services in the future.

	MPPP	MPSP
- Rivers and monsoon drains	DID	DID
- Grass cutting on state roads	JKR	JKR
- Grass cutting on municipal roads	Engineering Dept.	

d. Economic Life of Equipment and Facilities

	Economic life (years)	Salvage value (%)
- Container	3	0
- Vehicle and heavy equipment	7	10
- Machinery	18	0
- Building and foundation	30	0
- Oxidation pond	8	0

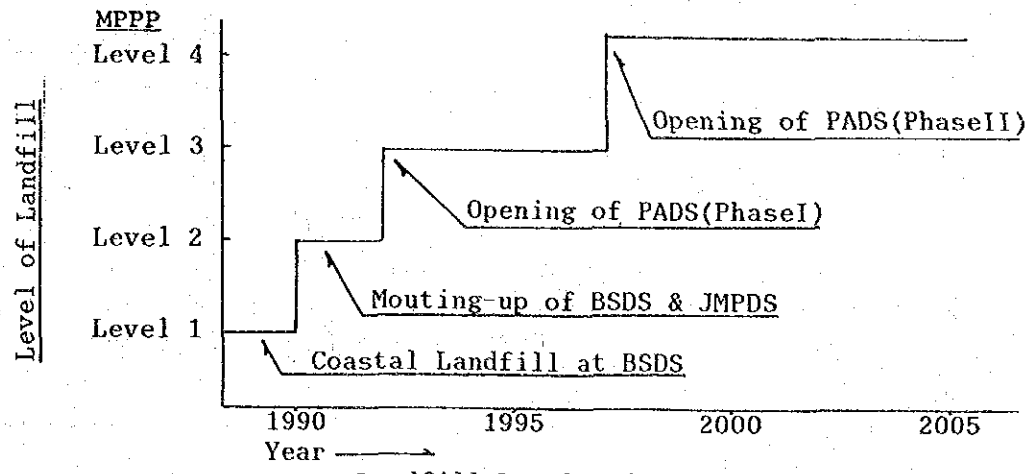
Note: Economic life of other facilities for the disposal site depends on the period of its operation.

e. Collection and Cleansing Improvement by Stage

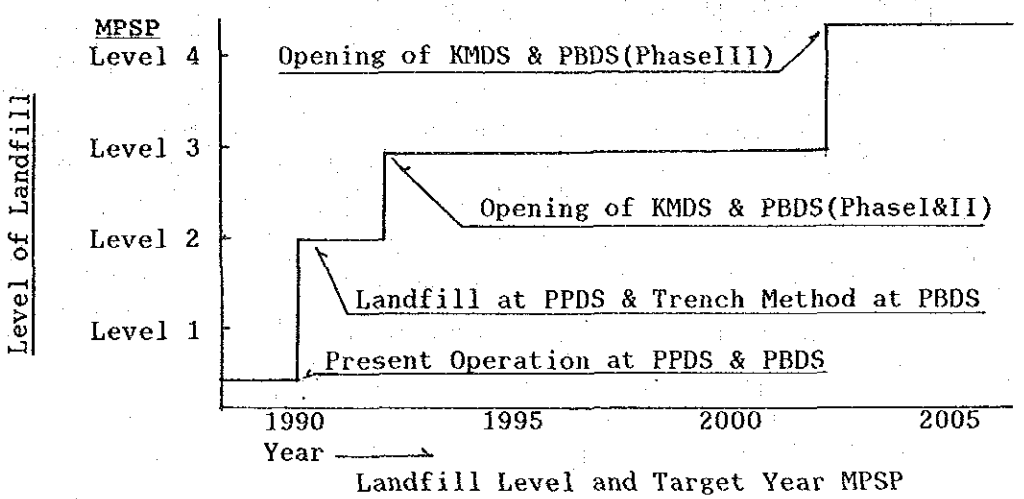
Successful introduction of reducing service frequency in residential area by 1995 and station collection by 2005 through the residents' cooperation and the smooth transfer of extra labors to the other departments.

f. Sanitary Landfill Development by Stage

Sanitary landfill will be developed in step by step manner as shown below.



Landfill Level and Target Year MPPP



Landfill Level and Target Year MPSP

g. Quantity and Quality of Leachate Estimated

	Pantai Acheh	Kuala Muda	Pulau Burong
- Quantity (m^3/day in 1995)	188	87	101
- Quality			
. BOD (mg/liter)	1,300	1,300	1,300
. COD (mg/liter)	1,500	1,500	1,500

h. Estimation of Fee Collection for Commercial Waste and Waste to be Hauled by Generators Themselves

Assumptions regarding Fee Collection (MPPP)

		1995	2000	2005
Fee tariff (M$/ton) 1987 price	- Tipping fee	6.6	9.9	13.2
	- Commercial	32.1	48.1	64.1
	- Waste collection fee			
Fee collection rate	- Tipping fee	100%	100%	100%
	- Commercial waste waste collection fee	100%	100%	100%

Assumptions regarding Fee Collection (MPSP)

		1995	2000	2005
Fee tariff (M$/ton) 1987 price	- Tipping fee	13.6	15.6	16.1
	- Commercial waste collection fee	58.4	58.4	60.8
Fee collection rate	- Tipping fee	100%	100%	100%
	- Commercial waste collection fee	45%	67%	100%

i. Loan Conditions

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

Other assumptions are described in the following Chapter or Sections by item:

- Chapter 7 ---------- Planning conditions
- Section 9.2.4 ---------- Cost estimation
- Section 12.2 and 13.2 -------- Financial plan

2. Current Conditions of Study Area

(1) Location and Area

The subject area of the Study (hereinafter referred to as the Study Area) is the entire Penang State, located in the northwestern part of the Peninsula Malaysian at $5^{\circ}25'N$ and $100^{\circ}19'E$. It is administrated by the Municipal Council of Pulau Pinang (MPPP) which has $292km^2$ and the Municipal Council of Seberang Perai (MPSP) which has $738km^2$ as shown in Fig. 2-1.

A half of MPPP area is mountainous with an elevation of 60 m or higher while MPSP is virtually flat with only 4% being mountainous with an elevation of 120 m or higher.

The average annual temperature and rainfall are $27^{\circ}C$ and 2,400 mm/year respectively. There is no clear distinction between the dry season and the rainy season, although rainfall is relatively low in December, January and February.

(2) Population

The estimated population of Penang State as of 1987 was 1,090,600 with MPPP and MPSP having populations of 559,300 and 531,300 respectively. The populations of MPSP by district are as follows:

MPPP:	Georgetown	225,300	(45.6%)
	Other Areas	304,000	(54.4%)
	Total	559,300	(100.0%)
MPSP:	North	244,300	(46.0%)
	Central	199,900	(37.6%)
	South	87,100	(16.4%)
	Total	531,300	(100.0%)
MPPP + MPSP:		1,090,600	

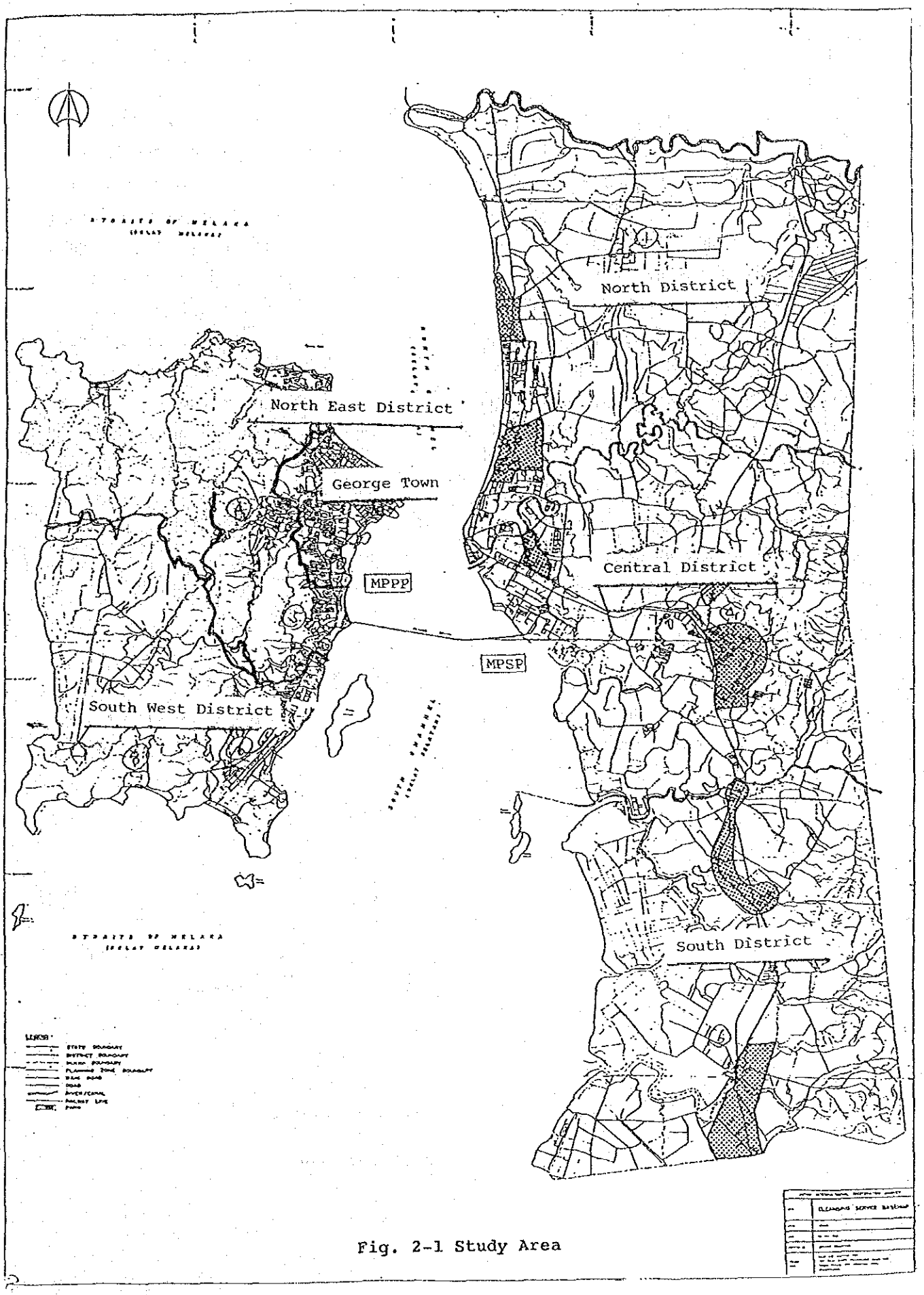


Fig. 2-1 Study Area

(3) Land Use

MPPP has a series of urbanized areas along the eastern part of Penang Island, with Georgetown at the center, while kampongs are scattered in the western part.

In MPSP, urban areas are seen along the coast, with Butterworth and inland with Bukit Mertajam, while kampongs are scattered in the remaining vast area.

Developed areas cover 65.41 km^2 in MPPP and 112.03 km^2 in MPSP, of which 38.91 km^2 and 85.87 km^2 respectively are used for housing purposes. The residential area of MPSP is almost 2.2 times larger than that of MPPP.

The aggregate length of roads in Penang State in 1985 was 551 km for MPPP and 1,133 km for MPSP.

(4) Industries and Income Level

The GRDP of Penang State in 1985 was M$4,283 million with a per capita of M$4,082. Fig. 2-2 shows the breakdown of the GRDP by industry, with the main industry being manufacturing (38.9%) followed by sales and restaurants (15.2%).

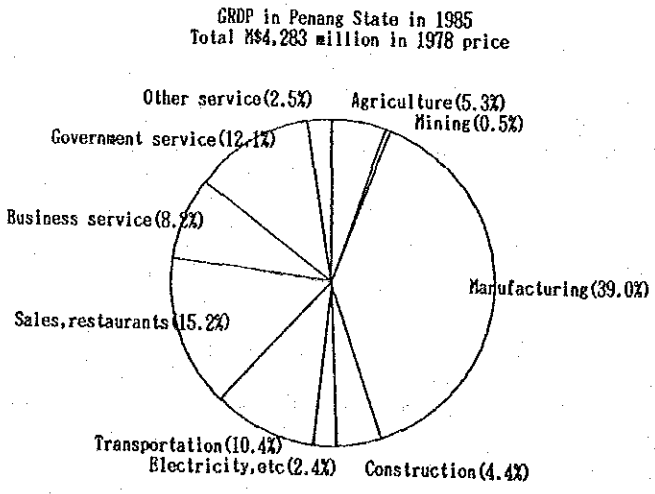


Fig. 2-2 Breakdown of the GRDP

(5) Local Finance

Property taxes and/or land rent are the main sources of revenue for local governments. In Penang State, MPPP and MPSP, however, the revenue from these sources has been stagnant or has even shown a tendency to decline in recent years, while expenditure has been steadily increasing. The balance in both fiscal 1988 and 1989 was in the red.

The estimated asset value in these areas has continuously declined since 1982 due to economic recession and the low and selective demand for properties. The decrease in grants and loans from the Federal Government in addition its own worsening financial situation have forced the both Councils to restrict their investments.

Under these circumstances, both Councils have now been forced to seek new revenue sources to change their revenue structure and to promote both administrative and financial reforms, including expenditure cuts.

3. Current Conditions of Solid Waste Management

(1) Served Population and Collection Amount

The populations of MPPP and MPSP in 1987 were 559,300 and 531,300 respectively. Solid waste collection is conducted in almost all areas of MPPP, except in kampongs located in rural areas far from access roads. The population with solid waste collection service in MPPP is estimated to be 494,000, i.e. 93% of the total population.

In the case of MPSP, it is difficult to estimate the population served with solid waste collection, as waste collection is not thoroughly conducted in kampongs near urban areas and also because the kampongs are scattered over extensive areas. The service coverage in MPSP is estimated to be some 60% in terms of population (319,000) based on the collected solid waste amount weighed at disposal site.

360 tons of domestic and commercial waste is collected daily in MPPP area, and disposed of at the Bakau Street Disposal Site. The collection amount per served population is 0.73 kg/day.

191 tons of solid waste is collected daily in MPSP area, and disposed of at the Permatan Pauh and Pulan Buron Disposal Sites. The collection amount per served population is 0.60 kg/day.

(2) Service Level

a. MPPP

Door-to-door collection is conducted daily in almost all areas of MPPP. This service is also provided in kampongs in Georgetown, indicating an excessive service level in MPPP. However, the frequency of collection in rural areas varies depending on kampongs from daily to twice a week collection.

b. MPSP

In MPSP, door-to-door collection, in principle, is conducted 6 days a week in residential and commercial areas. In the case of kampongs, however, collection from waste stations is conducted 2 or 3 times a week while the collection frequency in rural areas is very irregular. 6 days a week collection in residential area is considered to be an excessive service in view of the fact that MPSP; service coverage is low.

(3) Solid Waste Collection

a. MPPP

87% of solid waste collection in MPPP is conducted by private contractors with the following systems.

i. Domestic Waste Collection (280 t/day)

- Side Loader System
  used by contractors and MPPP itself for daily door-to-door collection

- Multi Lift System
  used by contractors for collection in kampongs; heapers collect waste from each household and load it into containers

- Bulk Bin - Compactor System
  used by MPPP Council; heapers collect waste from each household and load it into bulk bins

ii. Commercial Waste (80 t/day)

- Bulk Bin - Compactor System
  used by contractors to collect waste mainly from hotels, offices and flats

- Multi Lift System
  used by contractors and mostly installed at markets

The solid waste generated in Balik Pulau, located in the western part of Penang Island, is collected by the Council's own side loaders and transferred to multi lifts which are transported to the disposal site by contractors.

b. MPSP

76% of the solid waste collection in MPSP area is directly conducted by the Council itself, with the use of compactors and tipper trucks. Compacters are used mainly to collect waste from the communal containers to which the waste collected from households is brought by the heapers.

Tipper trucks collect bulky waste which cannot be handled by compactors, and the waste is piled up at collection stations. Because two types of waste collection are conducted, the collection areas for each truck are not clear.

(4) Street and Drain Cleansing

a. MPPP

In principle, the cleansing of streets and drains in MPPP area is conducted daily. However, the size of the cleansing areas for which workers are responsible is diverse, ranging from 400 m to 6,700 m for road cleansing and from 200 m to 3,700 m for drain cleansing, depending on the area.

In the future, the cleansing frequency required for each street and its side drains should be determined to reflect the relative importance of the streets.

The number of workers (excluding heapers and vehicle drivers) is 1,138.

Based on the average cleansing distance, the cleansing cost for 1 km of street (including 1.5 km of drains) is M$11,500/km/year which is a heavy burden on MPPP.

b. MPSP

While cleansing work, in principle, is conducted daily, the subject streets are mostly those in residential areas in MPSP.

In principle, all workers in MPSP are responsible for heaping, street cleansing and drain cleansing. Of the total 919 workers, some 350 are collection vehicle crew and, some 570 workers are assumed to be engaged in the above three types of work.

(5) Intermediate Treatment and Recycling of Resources

MPPP has the following carcass incinerators although they do not deal with domestic waste.

a. Old batch type incinerator at MPPP workshop

b. New rotary kiln type incinerator at MPPP workshop

c. Small batch type pig incinerator in Batu Maung

MPSP has no incinerator at present.

There are no other facilities to either mechanically or manually select valuable resources from solid waste for recycling purposes in both Pulau Pinang and Seberang Perai.

The recovery of recyclable items from waste in both Pulau Pinang and Seberang Perai is mostly conducted by individuals or small groups on a door-to-door basis at the sources of waste generation, including houses, markets and factories. Scavengers operate at disposal sites to recover recyclable items on a small scale.

The main recovered items for recycling are iron, non-ferrous metals, plastics, paper and glass bottles, etc. Iron, for example, is sold to a steel mill in Seberang Perai while glass bottles are sold in Kuala Lumpur. Plastics, non-ferrous metals and paper, etc. are exported in bulk to Thailand, Burma, Japan, India, Hong Kong and some other countries.

(6) Final Disposal Sites

a. Bakau Street Disposal Site (BSDS)

As of February 1989, all solid waste disposal in MPPP was conducted by coastal landfill at the BSDS where the controlled tipping method is employed and a closing band has been partially constructed. Both the controlled tipping and the closing band are, however, inadequate and there is a problem of outflow of solid waste and leachate into the sea.

In addition, the BSDS is close to urban areas, and the residents of these areas frequently complain about the bad odour and scattering of solid waste, etc.

The BSDS is outlined in Table 3-1.

Table 3-1 Outline of BSDS

a.	Service Area	:	Entire Penang Island
b.	Disposal Amount	:	414 t/day (1987)
c.	Subject Solid Waste	:	Mostly municipal solid waste plus some types of industrial waste, including construction waste or municipal waste such as domestic waste, commercial waste, street sweeping, drain and beach cleansing waste and non-toxic industrial waste accepted by the council such as construction and demolition waste
d.	Landfill Area	:	Approximately 10.4 ha
e.	Service Period	:	April 1987 (opened) - December 1990 (planned closure)
f.	Former Land Use	:	Beach
g.	Future Land Use	:	Undecided
h.	Land Owner	:	Penang State Government

b. Permatang Pauh Disposal Site (PPDS) and Pulau Burong Disposal Site (PBDS)

As of February 1989, all solid waste disposal in MPSP was conducted by low marshland landfill at the PPDS and PBDS. Both sites basically employ the open dumping method, causing various environmental problems which include fires and bad odour in their vicinities. Immediate improvement measures are, however, being implemented at the PPDS, the main disposal site, and the conditions of the site are rapidly improving. These sites are outlined in Table 3-2.

Table 3-2 Outline of PPDS and PBDS

	PPDS	PBDS
Service Area	North and Central Districts	South District
Disposal Amount	235 t/day	25 t/day
Subject Solid Waste	Mostly municipal solid waste plus some types of industrial waste, including construction waste or municipal waste such as domestic waste, commercial waste, street sweeping, drain and beach cleansing waste and non-toxic industrial waste accepted by the council such as construction and demolition waste	
Landfill Area	7.1 ha	4.0 ha
Service Period	1981 (opened) - December 1991 (planned closure)	1981 (opened) - December 1991 (planned closure)
Former Land Use	Low marshland	Low marshland
Future Land Use	Undecided	Undecided
Land Owner	State Government	State Government

(7) Main Equipment and Facilities

a. MPPP

MPPP has 22 collection vehicles: 14 side loader vehicles and 8 compactor vehicles.

Average vehicle age is 5.5 years. All of the compactor vehicles were bought in 1980. Three of them are out of order. The side loader vehicles were bought in 1983 and 1984.

MPPP employes 5 contractors for waste collection as of Feb. 1988. Each contractor has his own vehicles which consist of side loaders, compactor and arm roll vehicles. Total number of vehicle is 57 at present.

A bulldozer and a tyredozer are using at BSDS where a weighbridge is installed to measure the waste amount of each collection vehicles.

b. MPSP

MPSP has 54 collection vehicles: 30 tipper trucks, 15 large compactor trucks, 6 mini compactor trucks and 3 crane trucks.

The average vehicle age is 7.7 years. 48 vehicles are in operation and the remaining 6 vehicles seem to be out of order. 35 vehicles (65% of total number of collection vehicles) were bought before 1980. MPSP will have to purchase new vehicles within a few years.

MPSP employs 7 contractors as of 1988 with 1 ~ 3 collection vehicles each.

PPDS has a weighbridge installed in Feb. 1988 and heavy equipments for landfill are operated irregularly, while PBDS has no facility and equipment.

(8) Organization

a. MPPP

MPPP has two main departments involved in solid waste management (SWM), i.e. the Health Department and the Engineering Department. The former is the principal department responsible for SWM, while the Engineering Department bears responsibility for vehicle maintenance and disposal operation.

The present organization of the Health Department in MPPP chart is as shown in Fig. 3-1.

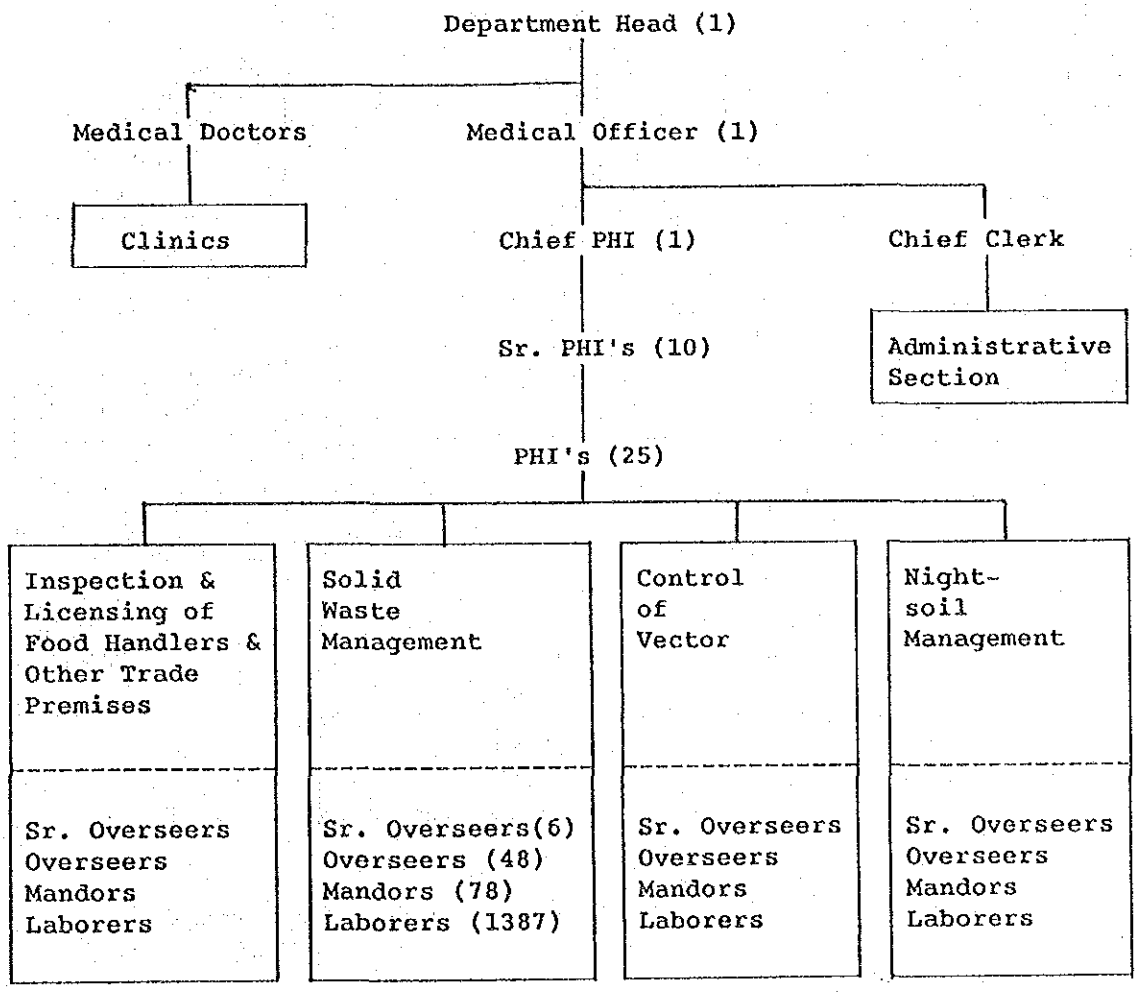


Fig. 3-1 Organization of MPPP's Health Department

1,550 persons approximately are involved in SWM in the Health Department.

b. MPSP

In MPSP, the Health Department is solely responsible for SWM; the department is responsible for not only waste collection and haulage but also disposal site operation.

The Health Department has an organization as shown in Fig. 3-2.

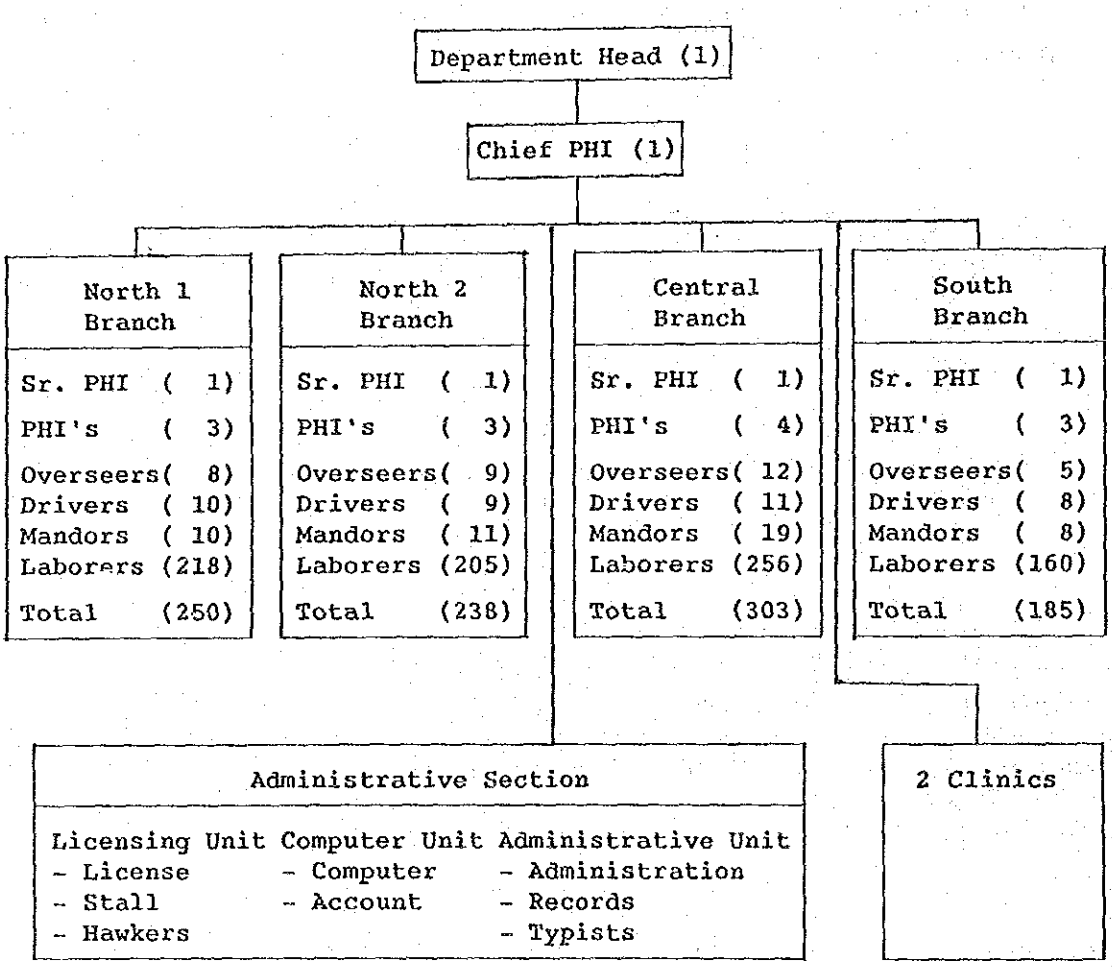


Fig. 3-2 Organization of MPSP's Health Department

About 1,000 persons are involved in SWM in the Health Department, which represents 86% of all the manpower (1,160) of the Health Department.

(9) Contracting Out

a. MPPP

In line with the national policy on privatization, MPPP first awarded a contract to a private company in 1979 to remove refuse for disposal. MPPP has probably more experience than any other local authority in Malaysia in the privatization of the waste collection service.

In the early stage of privatization MPPP had many problems, such as poor contract services and difficulty in controlling the contractors. MPPP has mostly overcome these problems.

The contracting out rate was as high as 95% in 1986 and 1987 in terms of waste amount collected. However, the rate of contracting out dropped to 87% in 1988 by the suspension of the contracts with three contractors.

b. MPSP

MPSP, upon conclusion of the contracts with former contractors, recruited seven contractors. None of them have previous experience in the waste collection service.

Since they began providing services on 1 May 1988, complaints from residents have increased. There is obviously much to be improved with respect to the contract services as well as MPSP's monitoring and supervision system.

Unlike the contractors employed by MPPP, MPSP's contractors are responsible for not only waste collection but also street/drain cleansing in the respective contract area.

It is estimated that the contractors collect 24% of the amount of waste collected in MPSP's area.

(10) Finance

a. Solid Waste Management Cost

The expenditure for solid waste management (SWM) is a major part of the total municipal budget in both MPPP and MPSP. In 1987, the expenditure for SWM shares 27% of the total municipal revenue in MPPP, and 31% in MPSP, as shown in Table 3-3.

Table 3-3 Financial Situation on SWM

(M$1,000)

	MPPP (1987)	MPSP (1987)
- SWM Expenditure (a)	18,729	9,864
- Total Revenue (b)	68,860	31,359
- Total Expenditure (c)	75,985	39,589
- Ratio of a to b (a/b)	27%	31%
- Ratio of a to c (a/c)	25%	25%

An estimation of SWM cost based upon the number of employees and vehicles involved in each service shows that the cost of refuse collection shares over 40% of SWM cost, while the cost of refuse disposal shares only 3% in MPPP.

The average cost of refuse collection by MPPP and its contractors is calculated as M$67/ton. And, the corresponding average cost of MPSP and its contractors is M$84/ton in MPSP. The said cost (M$84/ton) includes street/drain cleansing cost borne by the contractors as well. The cost of refuse collection and disposal will increase because of the following factors:

1) Waste amount will increase.
2) Disposal sites will get farther.
3) Disposal standard needs to be upgraded.

The refuse collection service is partly contracted out. Contractors receive 78% of the refuse collection expenditure in MPPP, and 32% in MPSP in 1987.

b. Fee Collection

In MPPP, fees for the collection of commercial waste and for special collection are charged, although the fees are not enough to cover the actual cost. On the other hand, fees for domestic waste collection are not collected because the assessment is supposed to cover almost all SWM costs.

Tipping fees (fee for the use of the dump site) are collected in MPPP. The amount does not depend on the amount of waste hauled. Instead, a fixed fee is charged per user, per month. It is said that the efficiency of the fee collection is nearly 100%.

MPSP, on the other hand does not collect either commercial waste collection fees and tipping fees.

4. Evaluation of the Current Conditions of Solid Waste Management

4.1 Appreciable Current Management Practice

Appreciable points with respect to solid waste management of MPPP and MPSP include the following:

(1) MPPP

a. MPPP provides high level collection service (door-to-door collection on daily basis) in almost all the MPPP area.

b. MPPP has two independent collection systems: one for domestic waste, the other for business establishments which discharge large amount of waste. To have those two independent collection systems is more efficient than a case where there is only one collection system for the two types of wastes. (domestic waste and large amount waste)

c. MPPP collects two kinds of fees from the service recipients: one is the fee for commercial waste collection, the other is tipping fee for disposal service. The fee collection system, if further developed, will contribute much to the strengthening of the financial base for solid waste management.

d. MPPP has made efforts for the standardization of storage and discharge system for highrise buildings (i.e. dust chute with bulk-bin).

e. Disposal standard at the existing site has greatly improved during the past few years through periodical soil covering.

f. MPPP uses a weighbridge for many years to monitor waste amount brought into the sites, through which contractors' performance has been evaluated.

g. MPPP under the leadership of Ad Hoc Committee has served as a pioneer in the promotion of privatization of solid waste collection service, and gained valuable experience in this field.

h. MPPP has small incinerators to treat waste such as dead animals which cannot be directly disposed of.

i. The pilot project for introduction of 3-times-a-week-collection and once-a-week-cleansing in Bayan Baru area has been successfully executed.

(2) MPSP

a. MPSP has been making efforts to provide better collection and cleansing services under the financial constraint.

b. Health Department has a sub-office and a garage in each district in order to provide waste collection and street/drain services at respective districts. Such system is good in view of the geographical conditions in MPSP area.

c. MPSP has provided depo and improved hand-carts in new housing development area, through which waste collection efficiency has been increased.

d. MPSP has been making efforts to develop Local Authority Management Information Service (LAMIS) and some mapping system together with USM.

e. MPSP demonstrated its ability to improve waste disposal standard within a short period by construction of on-site roads and application of covering soil.

f. MPSP has been actively and creatively using weighbridge in order to improve waste collection efficiency.

All the above appreciable points have been taken into account in the preparation of the master plan.

4.2 Major Deficiency of Current Management Practice

Major deficiency of the current management practice is caused by the following problems and issues.

(1) Low operational efficiency
(2) Inadequate sanitary landfill
(3) Weak management
(4) Inadequate citizens' cooperation
(5) Weak financial base for solid waste management
(6) Insufficient service coverage (MPSP)

There are many factors which lead to the above problems and issues as shown in Fig. 4-1 to 4-7.

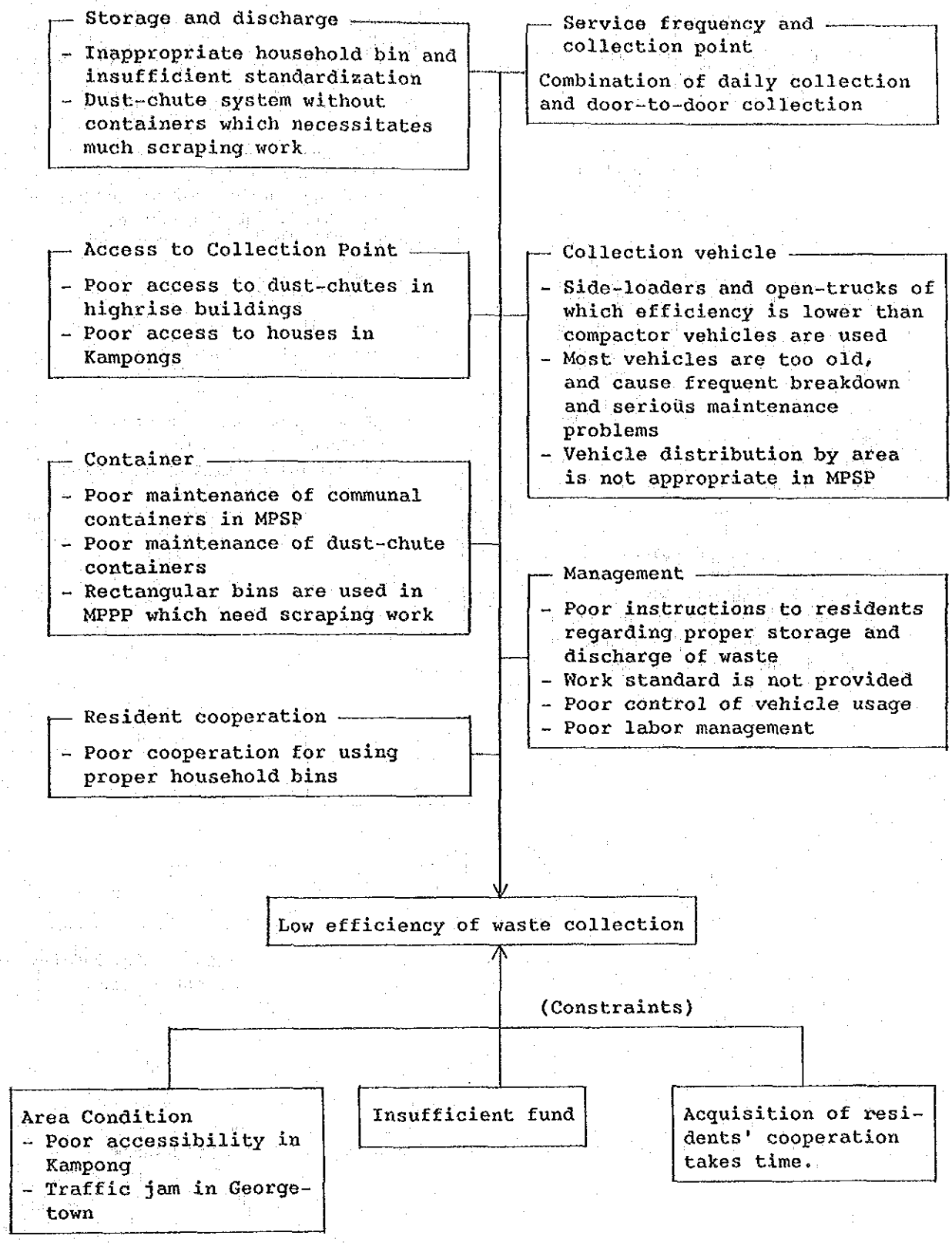


Fig. 4-1 Factors which Cause Low Operation Efficiency

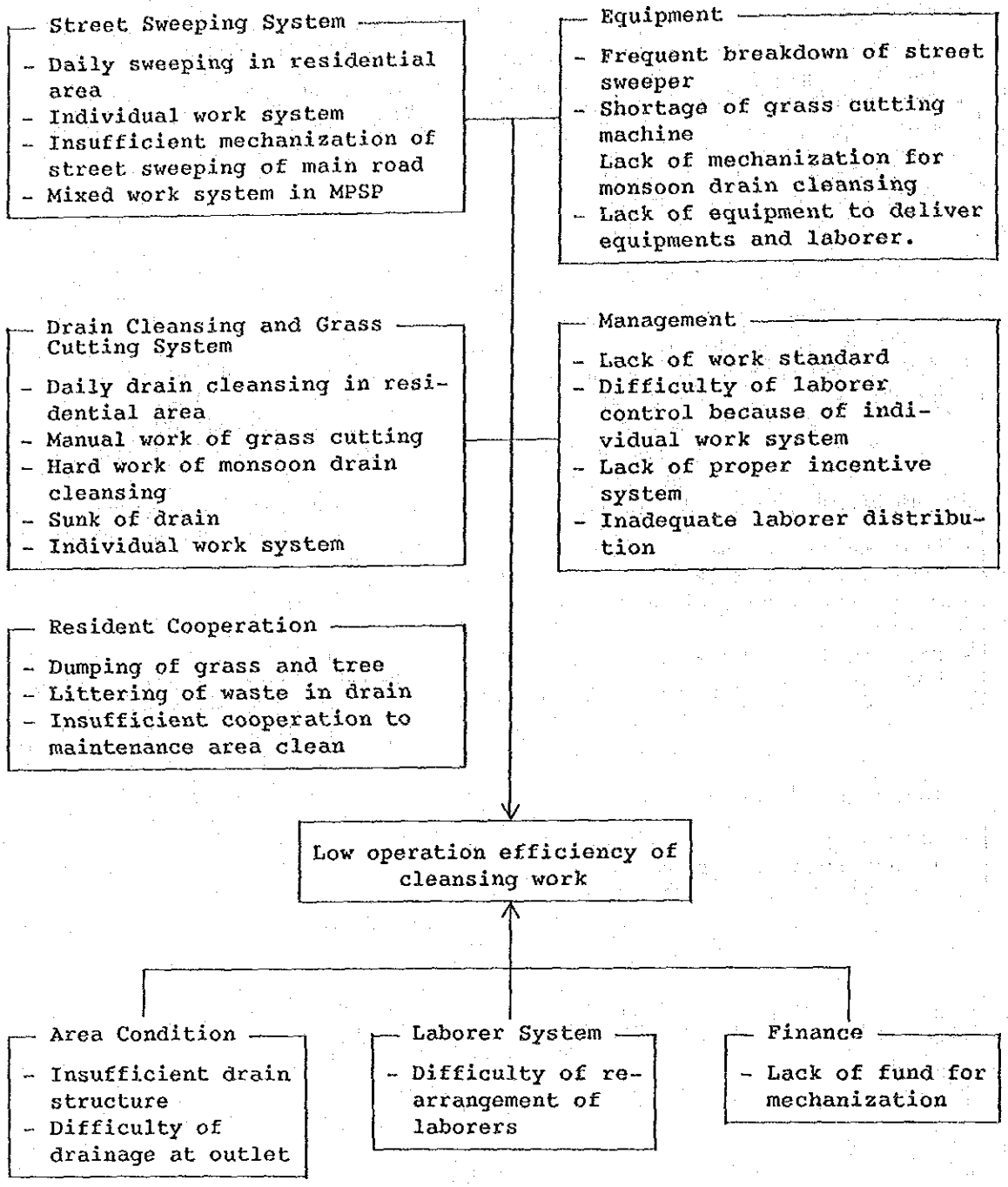


Fig. 4-2 Factors of Low Operation Efficiency of Cleansing Work

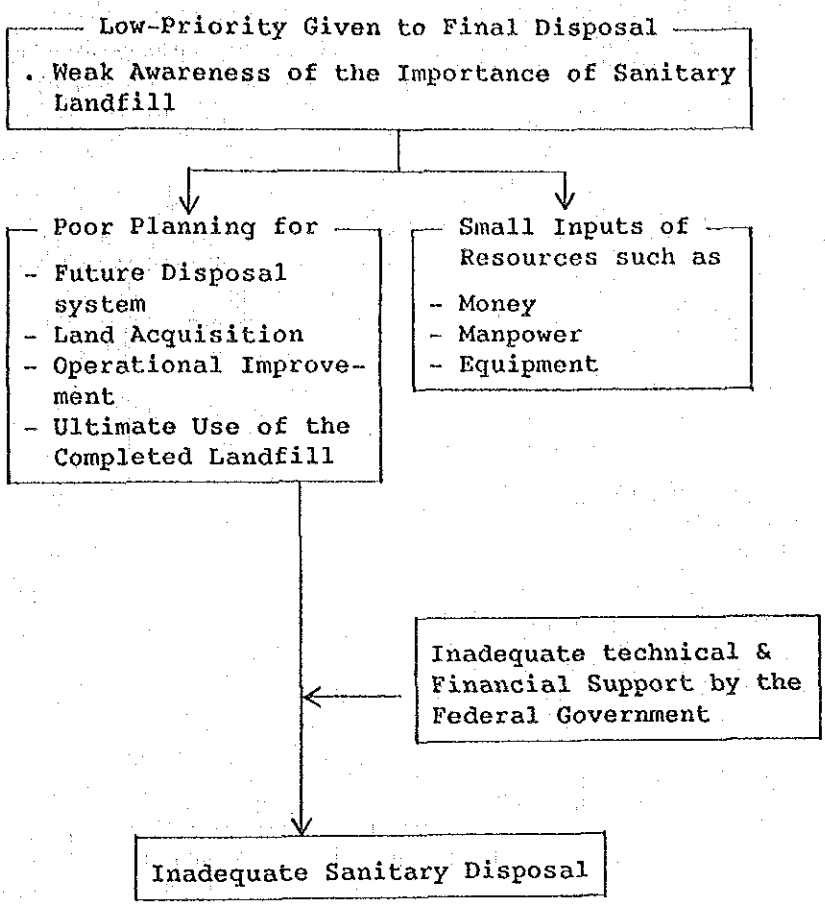


Fig. 4-3 Factors Leading to Inadequate Sanitary Disposal

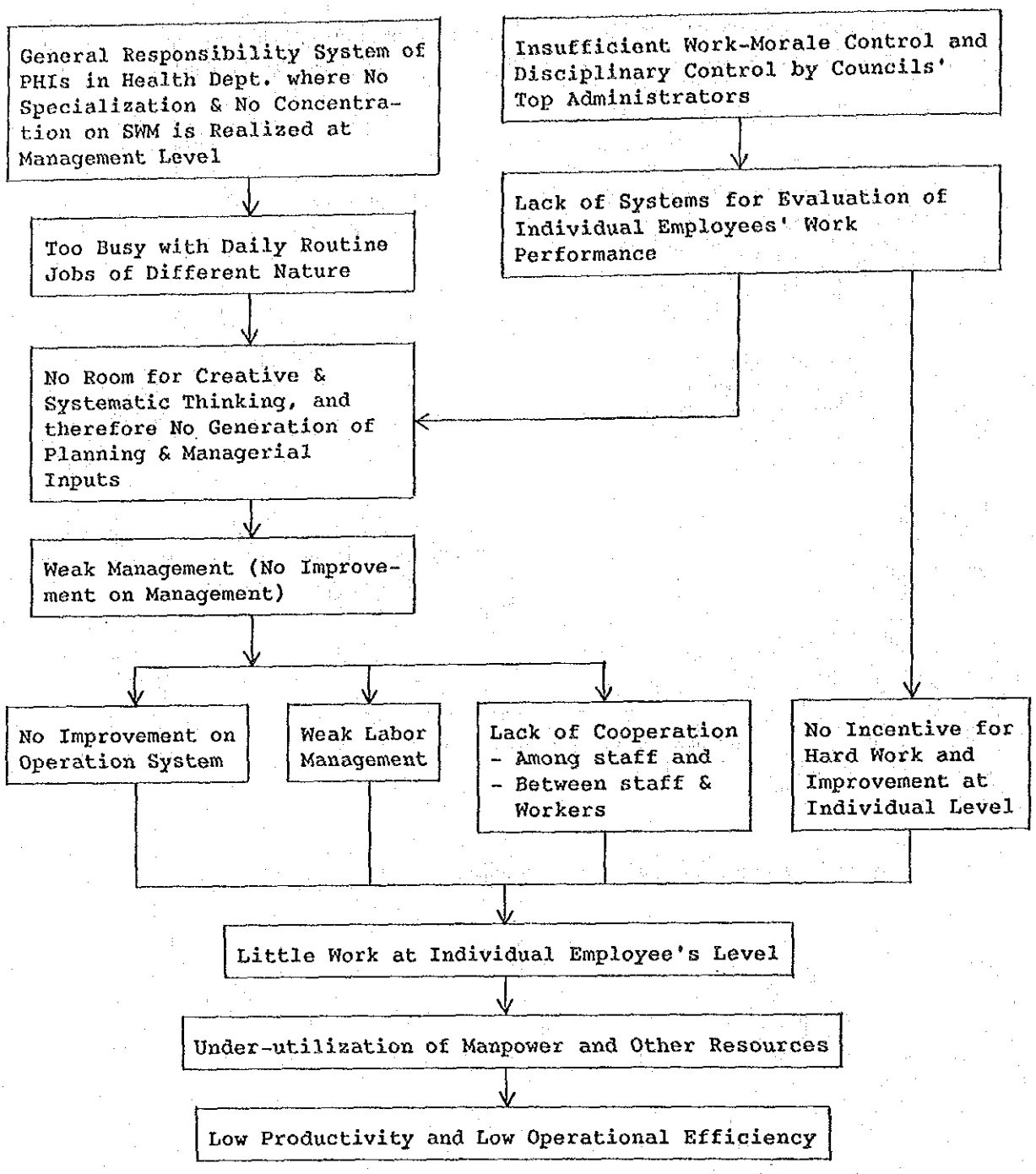


Fig. 4-4 Factors Related to the Weak Management

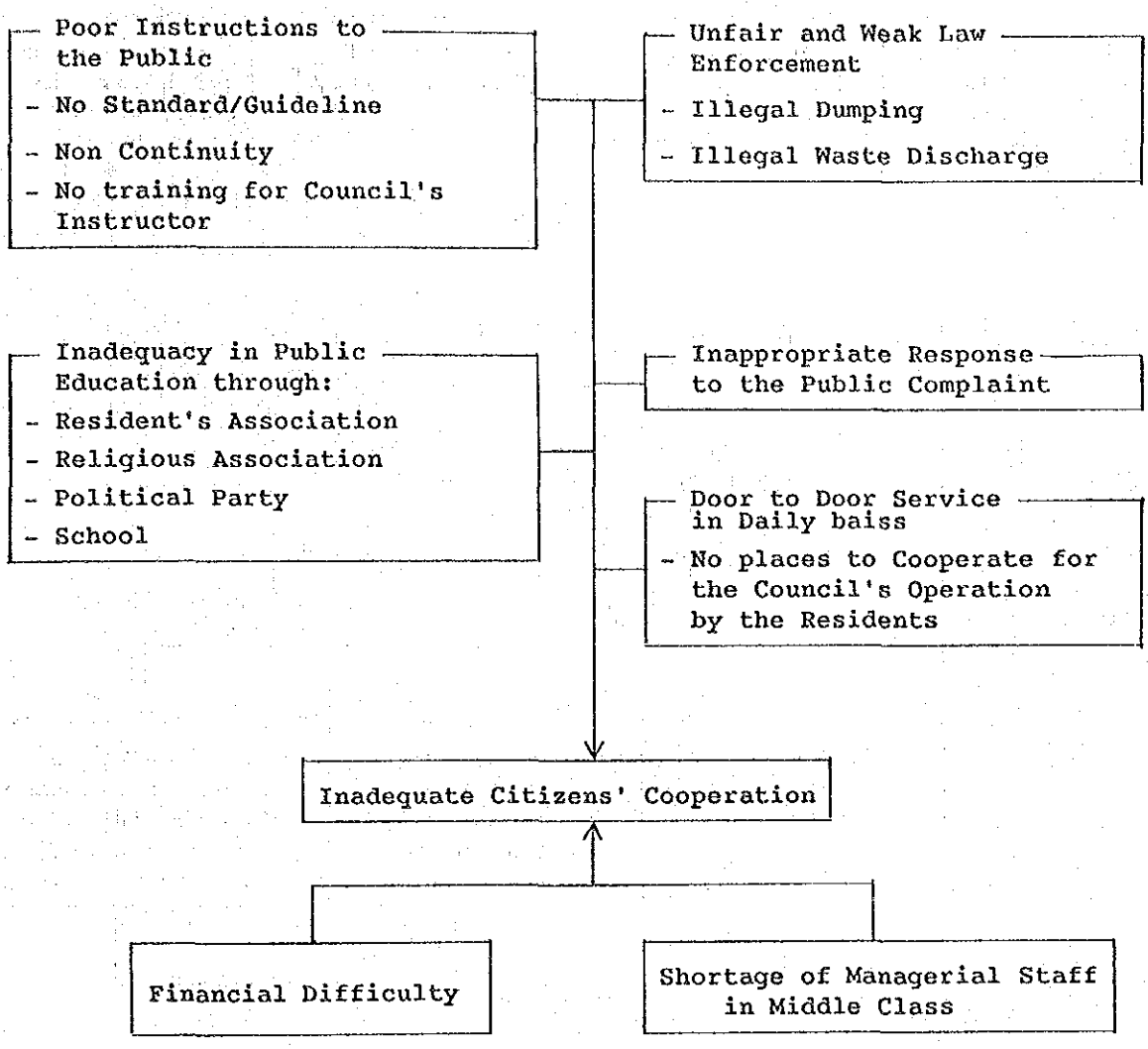


Fig. 4-5 Factors Related to the Inadequate Citizens' Cooperation

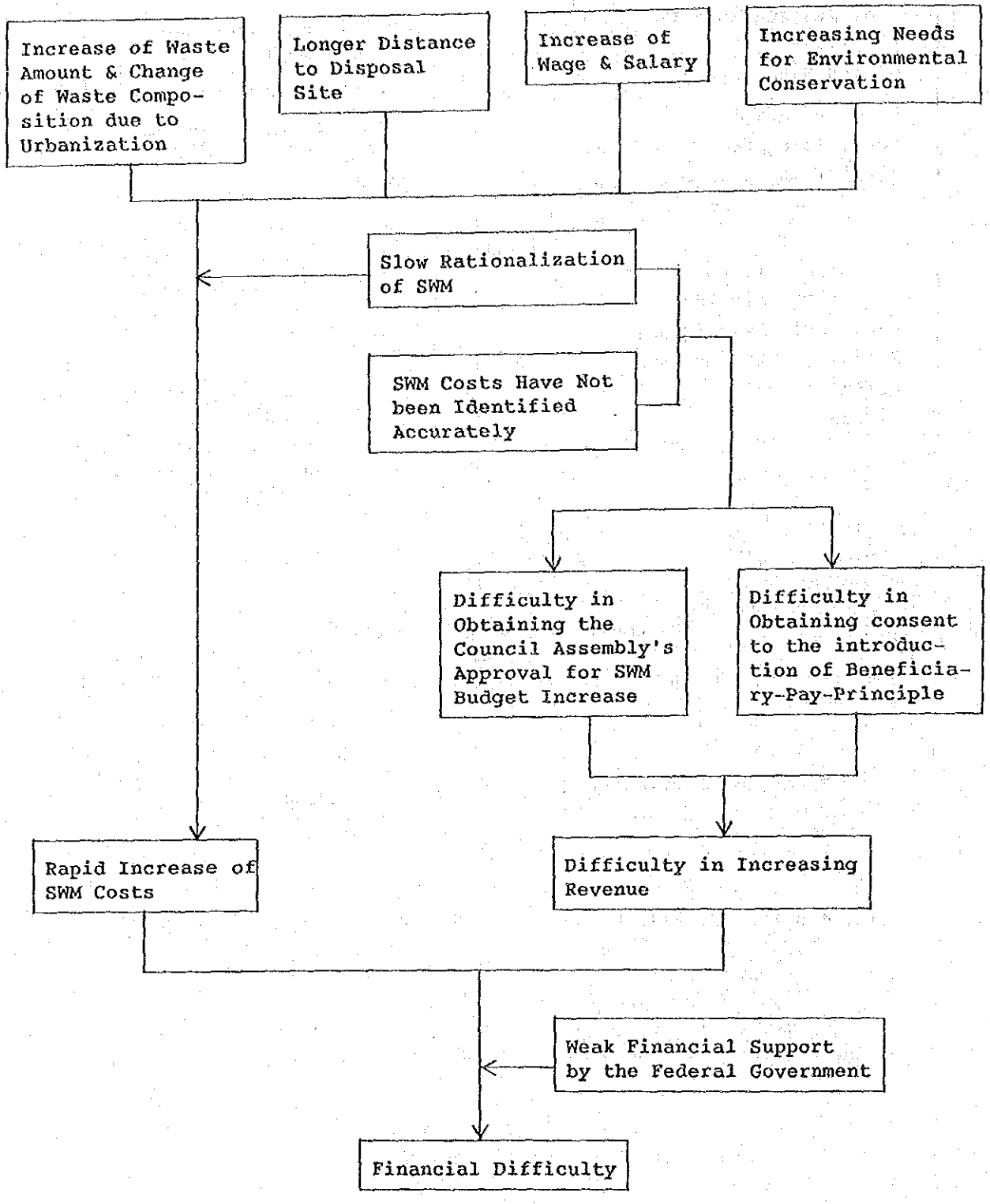


Fig. 4-6 Factors which Cause Financial Difficulty

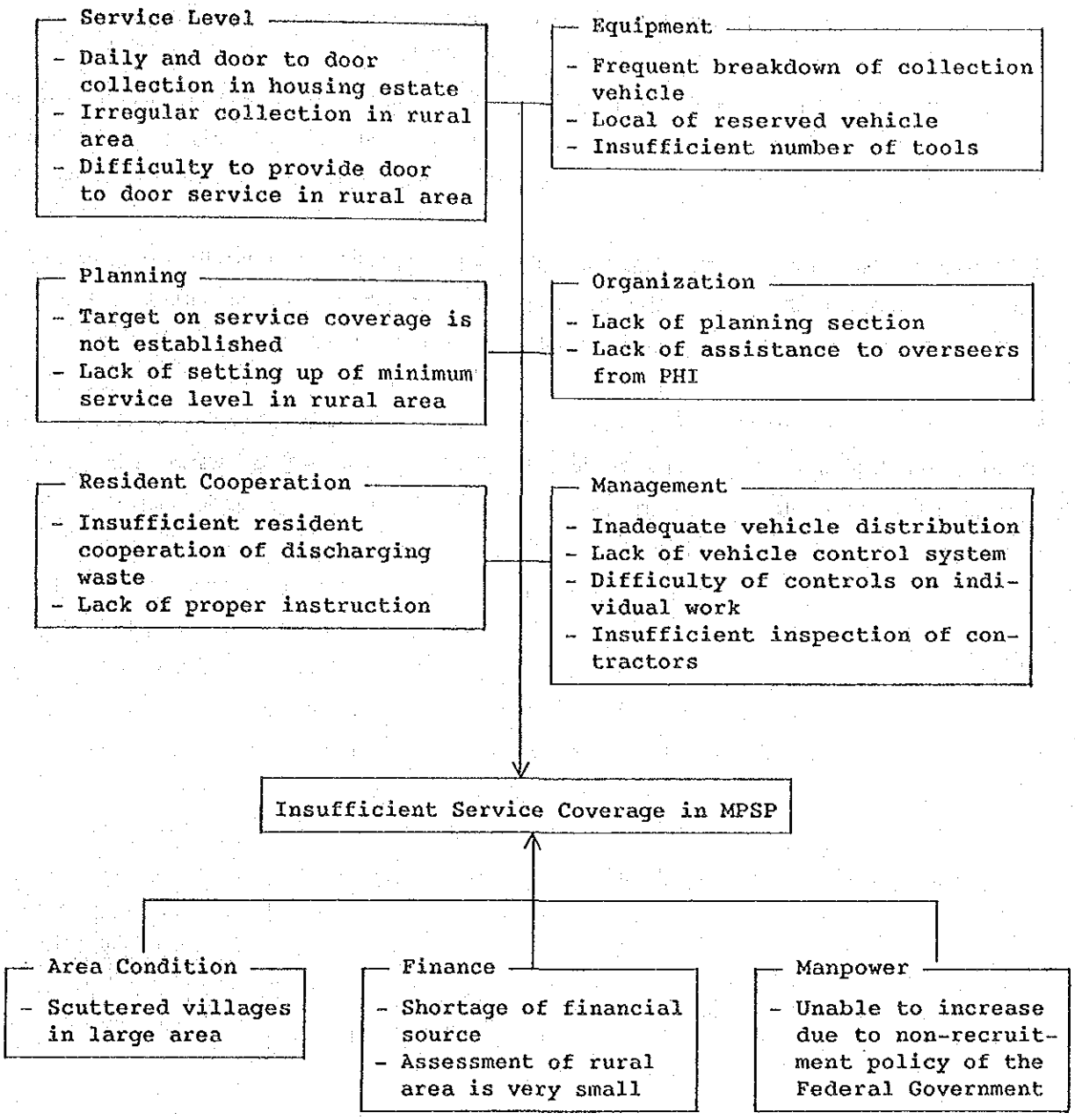


Fig. 4-7 Factors related to Insufficient Service Coverage in MPSP

4.3 Needs for Short Term and Long Term Improvement Plans

The problems mentioned above are classified into two categories; these which may be possibly improved in short term and those which may only be solved in long term due to financial and social contraints.

Improvement plans which do not require large initial investment can be implemented immediately, while those which require a large initial investment may have to be implemented in a longer term and stepwise manner.

Execution of interim measures and immediate improvement plans including pilot projects will be usuful to examine the feasibility of long-term plans.

5. Goal and Targets

5.1 Goal

The goal of the Master Plan is proposed as follows:

"Development of a Beautiful and Clean Living Environment towards the 21st Century through Citizen' Participation and Establishment of Self-Sustainable Solid Waste Management"

The following should be implemented to attain the above goal.

(1) Establishment of an efficient solid waste management system
(2) Establishment of reliable collection system under which regular service can be provided.
(3) Construction of sanitary landfill which employs sufficient measures for environmental protection
(4) Establishment of Beneficiary-Pay-Principle under which service recipients pay tipping fee and commercial waste collection fee.
(5) Thorough control of hazardous and toxic waste
(6) Provision of appropriate waste collection service for squatter area
(7) Strengthening of the management and administration system
(8) Rationalization of solid waste management through the promotion of privatization

5.2 Master Plan Targets and Planning Conditions

(1) Collection Service Coverage

The entire population in the priority operational area will be served by 1995.

		MPPP		MPSP	
	UNIT	1995	2005	1995	2005
- Population	Person	615,700	718,000	627,100	754,100
- Service Population	Person	584,400	695,500	485,200	641,000
- Service Coverage	%	95	97	77	85
- Non-Service Population	Person	31,300	21,500	142,100	113,100
- Collection Amount	t/d	470	670	342	540

(2) Final Disposal (Sanitary Landfill)

All the waste collected and hauled directly to disposal sites will be disposed of by sanitary landfill method from 1995 and thereafter.

		MPPP		MPSP	
	UNIT	1995	2005	1995	2005
- Disposal Amount	t/d	539	770	437	679
- Sanitary Landfill	t/d	539	770	437	679
- Ratio	%	100	100	100	100

(3) Securing Financial Resources for SWM

SWM expenses will be covered by assessment and waste collection fees which will be collected from business establishments as well as by tipping fees collected from disposal service recipients.

5.3 Approach to the Attainment of Goals and Targets

Establishment of an efficient waste collection and street/drain cleansing systems as well as realization of sanitary landfill are two major goals. Fig. 5-1 schematically shows goals of the Master Plan.

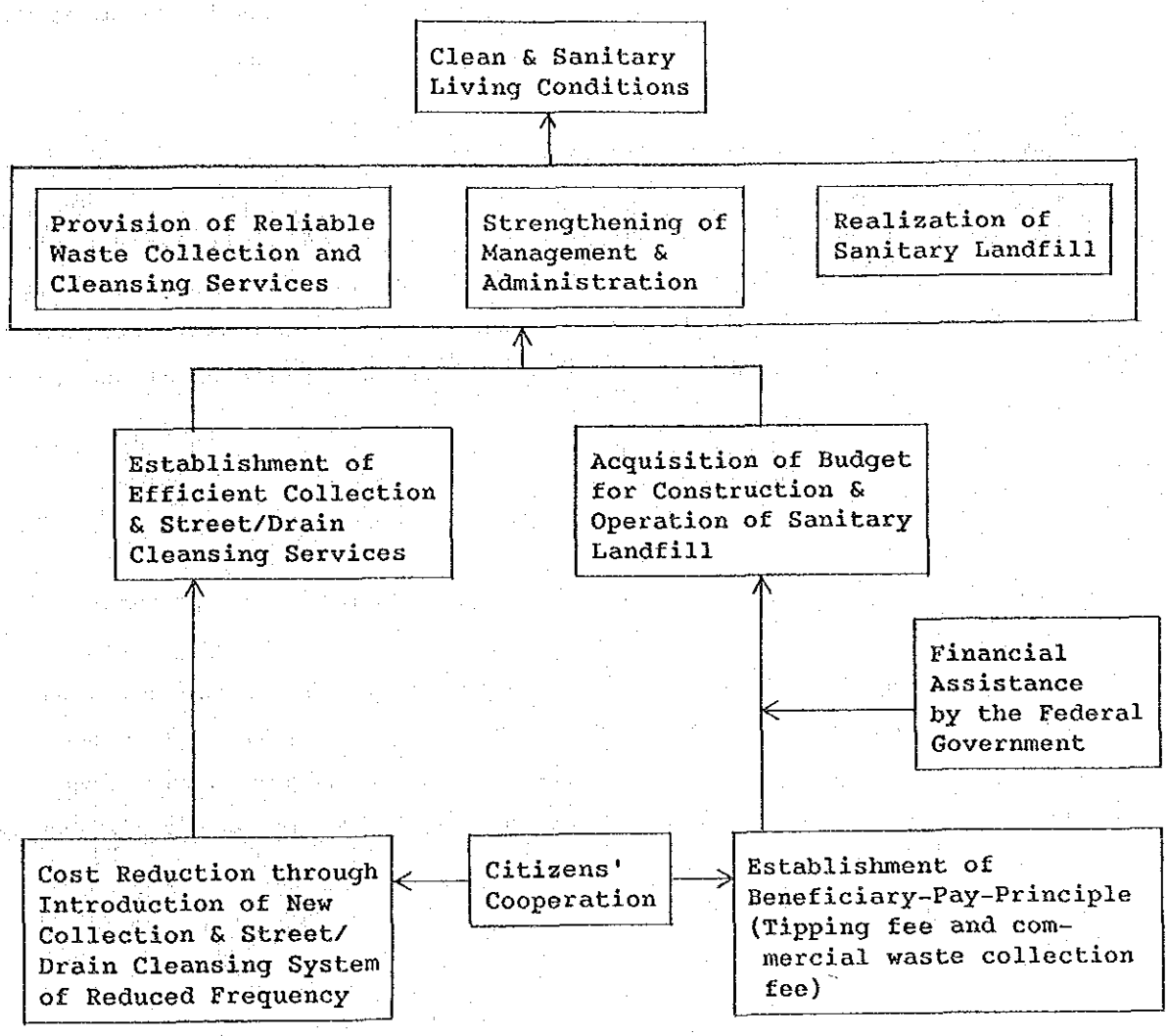


Fig. 5-1 Approach to the Attainment of Goals

Stepwise (Phased) Improvement

The Master Plan Goals cannot be attained in a short time. Stepwise improvement is a practical and wise approach for the attainment of the Master Plan goals. It has been proposed that the Master Plan period (from present to 2005) be divided into three Phases; Phase 1 (1991-1995), Phase 2 (1996-2000) and Phase 3 (2001-2005). Fig. 5-2 illustrates thing to be done in each phase.

Immediate Improvement Plan and Interim Measure

Some of the improvement plans which do not require much initial investment can be implemented even before the start of Phase 1. The implementation of immediate improvement plans and interim measures are extremely important in the sense that it would lay a foundation for smooth execution of subsequent plans.

Pilot Projects

The execution of pilot projects will be required before the implementation of certain improvement plans if their feasibility needs to be proved beforehand. Examples of this type of plans include the introduction of a 3 times/week collection which has been successfully tried by MPPP in Bayan Baru and a waste station collection system which is recommended in the Master Plan as a future collection system in view of increasing efficiency.

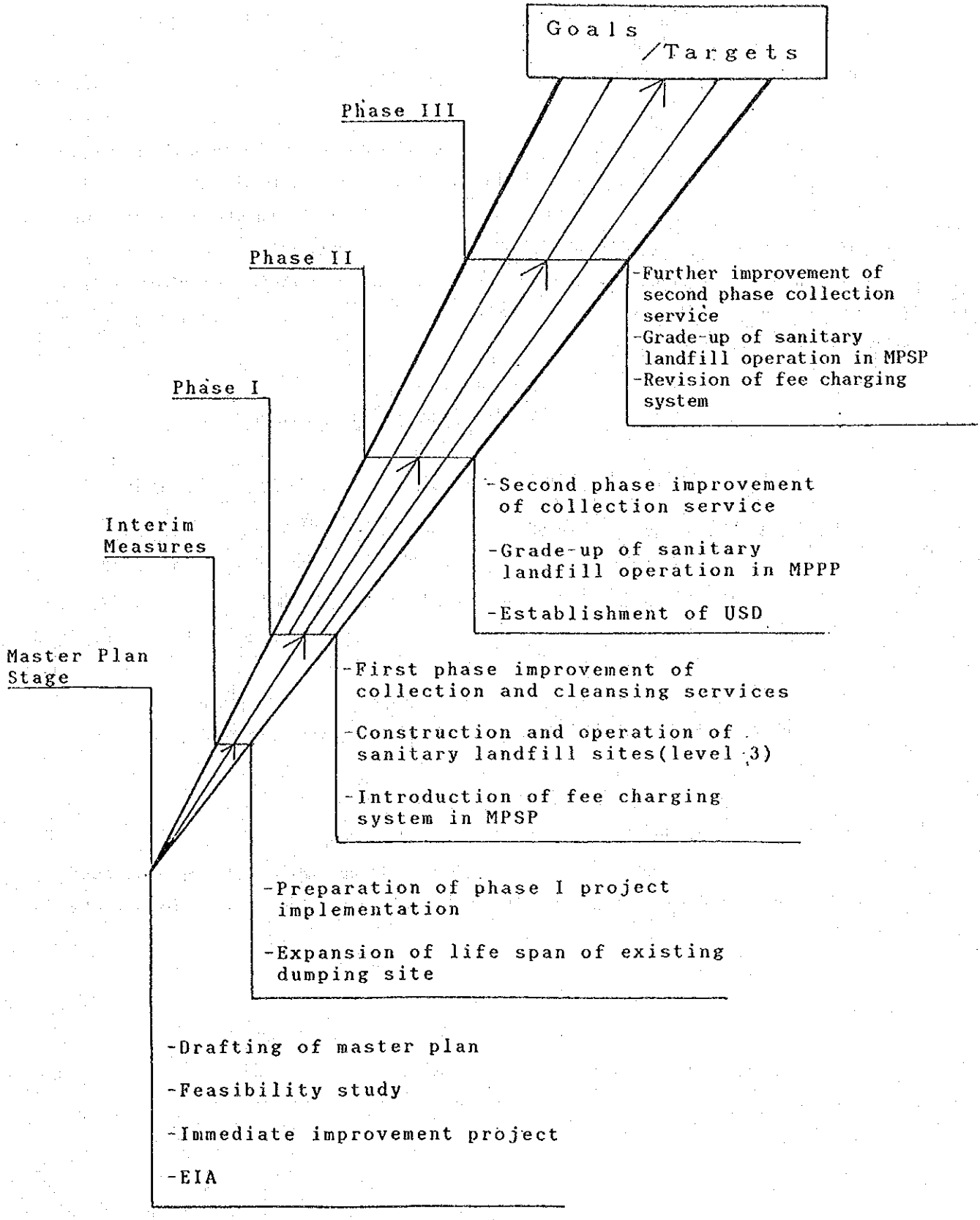


Fig. 5-2 Phasing to Goals and Targets

6. Basic Planning Conditions

(1) Future Population

1995 population is projected at 615,700 in MPPP and 627,000 in MPSP, as shown in Table 6-1, i.e. 1.10 and 1.18 times higher respectively than the present population, while 2005 population is projected 718,000 in MPPP and 754,000 in MPSP, i.e. 1.28 and 1.42 times higher respectively than the present population. The population in Penang state in 1995 and 2005 will be 1,242,800 and 1,472,100 respectively, i.e. 1.14 and 1.35 times higher respectively than the present population.

Table 6-1 Planned Service Population (Persons)

	1987	1990	1995	2000	2005
MPPP	559,300	568,000	615,700	667,400	718,000
MPSP	531,300	565,400	627,100	691,900	754,100
Total	1,090,600	1,133,400	1,242,800	1,359,300	1,472,100

(2) Future Land Use

Total land development of 2,950 ha. by 2005 is required for MPPP, and 2,441 ha for MPSP.

New roads will be constructed at the rate of 0.2 km/ha and 0.05 km/ha in residential areas and 0.05 km in other areas respectively. Additional road length will be 381 km in MPPP and 314 km in MPSP upon the completion of the new roads.

(3) Future Solid Waste Amount and Composition

The amount of solid waste to be generated will increase in accordance with the increase of population and per capita waste generation rate, which would be caused by the rise in the living standard. The future per capita generation rate is expected to increase by 2% a year.

The daily generation amount of solid waste in MPPP and MPSP for specific years will be as shown in Table 6-2.

Table 6-2 Daily Generation Amount (t/day)

	1987	1990	1995	2000	2005
MPPP	432	464	556	660	784
MPSP	372	419	514	627	754
Total	804	883	1,070	1,287	1,538

In general, the ratios of waste wood and garbage decrease and the ratios of paper, plastics and incombustible waste increase with an improvement of the living standard and expansion of industrial activities.
The future composition of solid waste has been estimated based on the following assumptions and is shown in Table 6-3.

- annual increase rate of paper and plastic waste : 1%
- annual increase rate of incombustible waste : 3%
- annual decrease rate of waste wood and garbage : 1%

Table 6-3 Future Solid Waste Composition

	DOMESTIC WASTE			COMMERCIAL WASTE		
	1987	1995	2005	1987	1995	2005
a. Composition (%)						
- Paper	25.5	27.5	30.1	31.5	34.0	37.2
- Textile	3.4	3.4	3.4	2.9	2.9	2.9
- Plastic	11.2	12.1	13.2	11.8	12.7	13.9
- Rubber	0.8	0.8	0.8	0.8	0.8	0.8
- Wood	14.4	13.3	11.8	9.7	8.9	7.9
- Garbage	32.8	30.2	26.9	30.9	28.5	25.4
- Metal	2.6	3.3	4.1	3.3	4.1	5.1
- Glass	1.4	1.7	2.1	1.0	1.2	1.5
- Stone	0.2	0.2	0.3	1.0	1.2	1.5
- Others	7.8	7.6	7.4	7.3	5.8	4.0
Total	100.0	100.0	100.0	100.0	100.0	100.0
b. Moisture Content (%)	55.2	54.1	52.7	53.5	52.3	50.9
c. Organic content (%)	35.4	35.6	35.8	36.1	36.3	36.6
d. Ash content(%)	9.4	10.3	11.5	10.4	11.3	12.5
e. Net Calorific Value (KCal/kg)	1600	1600	1700	1600	1700	1700
f. Density (t/m^3)	0.19	0.19	0.18	0.17	0.16	0.16

(4) Financial Conditions

The annual growth rate of the GRDP of Penang State is assumed to be 5% until 1990, which is the same as that used in the 5th Malaysian Plan, and declines to 4.8% thereafter. This 4.8% is the minimum growth rate suggested in the Structural Plan for MPSP. Table 6-4 shows the resulting future GRDP of Penang State.

Table 6-4 Estimated Future GRDP of Penang State

(1978 price)

	1985	1990	1995	2000	2005
Growth Rate (%)		5.0	4.8	4.8	4.8
GRDP (M$ million)	4,283	5,479	6,926	8,756	11,069

The same growth rates are used to estimate the future revenue sizes of MPPP and MPSP which are shown in Table 6-5 based on the actual revenue of 1985.

Table 6-5 Estimated Future Revenue of MPPP and MPSP

(M$1,000 in 1987 price)

	1985	1990	1995	2000	2005
MPPP	68,860	79,714	100,772	127,394	161,047
MPSP	31,359	36,302	45,892	58,015	73,342

7. Immediate Improvement Needs and Plan

7.1 Immediate Improvement Needs

Immediate improvement needs have been identified considering following criteria:

a. Possibility of immediate improvement.

b. Efficient use of existing resources without large investment.

c. Achievement of tangible improvement effects in short time.

d. Possibility to become a model for future improvement.

There are two types of immediate improvement needs as shown below:

a. Improvement needs in crucial area which has specific problems.

b. Improvement needs to demonstrate the feasibility of introducing a future system. (Eg. Pilot project for the introduction of 3 times/week collection system in Bayan Baru)

The implementation of those immediate improvement projects is very important in view of the fact that the Master Plan targets will be achieved only through step-wise improvements.

Immediate improvement needs in MPPP and MPSP have been identified as follows:

(1) Collection and Cleansing

a. Conversion from the double handling system adopted in some areas to single handling;
b. Discharge of solid waste by residents of medium and high rise flats;
c. Discharge of solid waste by using plastic bags;
d. Introduction of the three times a week collection system;

e. Improvement of collection service to kampongs by regular collection together with public cooperation in solid waste discharge;
f. Establishment of regular collection service and improvement of the collection efficiency by using weigh bridge;
g. Reduction of road and drain cleansing frequencies.
h. Execution of preventive maintenance for collection vehicles.
i. Stepwise increase of the rates of fees for commercial waste collection (MPPP)
j. Introduction of fee collection system for commercial waste collection (MPSP)

(2) Final Disposal

a. Improvement of the surrounding environment of the present disposal sites
b. Strengthening of the present landfill management
c. Fuller utilization of existing manpower and equipment
d. Modification to the disposal fee system (MPPP)
e. Introduction of the disposal fee system (MPSP)

7.2 Immediate Improvement Plan

(1) MPPP

a. Collection and Cleansing

It has been proposed that the following immediate improvement projects be implemented in Bayan Baru.

i. 3 times a week and door to door collection in residential area

ii. Use of plastic bags

iii. Team works in street sweeping and drain cleansing and clearing of bulky and garden waste once a week.

Frequency of street sweeping	
- In front of shops	Daily sweeping
- Residential area	Once a week
Frequency of drain cleansing	Once a week
Grass cutting	Once a month

iv. Monitoring Indicator

The following monitoring indicators should be used

1) Cleanliness of town (Bulky and Garden Waste)
2) Ratio of plastic bag use
3) Waste amount collected by one vehicle (t/day/unit)
4) Waste amount collected by one laborer (t/day/person)
5) Street and drain length covered by one laborer (km/person)

The implementation of the above projects have been started on 1st of March 1989.

b. Final Disposal

i. Construction of Buffer Zone

In order to mitigate the complaints, it has been proposed that a buffer zone which consists of an embankment, vegetation and a gas removal facility be constructed in front of the new low cost housing.

ii. Construction of an Enclosing Net Fence

In order to prevent floating items from being washed away into the sea, it was recommended that an enclosing net fence be installed.

iii. Modification of the disposal fee rates

The present disposal fee is a uniform rate of M$60 per month for each applicant for the use of the BSDS for an unlimited disposal amount. The Study Team has proposed MPPP to reconsider the disposal fee system.

(2) MPSP

a. Collection and Cleansing Work

Control of collection vehicles should be done at garages of collection vehicle located in Mak Mandin. The proposed organization scheme for vehicle control system is shown in Fig. 7-1. It shows that both a vehicle overseer and a research and planning section are responsible for vehicle control and its improvement.
Their functions are as shown below:

i. Vehicle Overseer

- Instruction of daily works
- Recording on daily collection work of vehicles
- Collection of data
  - . Weighbridge data
  - . Weekly drivers record
  - . Maintenance record and schedule
- Preparation and submission of weekly report.

ii. Research and Planning Section

- Preparation of monthly report
- Preparation of plans for proper vehicle assignment.
- Instruction and guidance to vehicle overseer

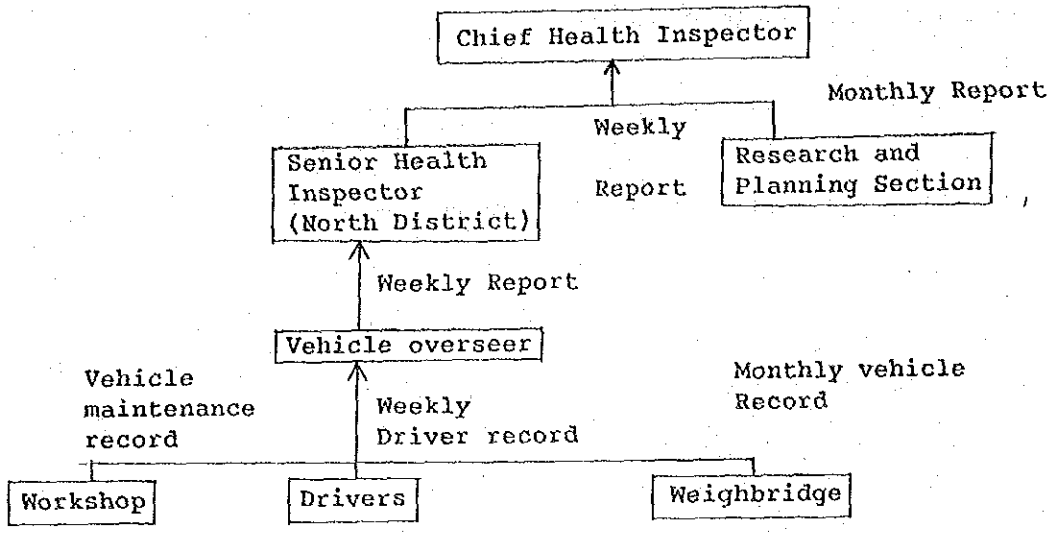


Fig. 7-1 Organization for Vehicle Control

b. Final Disposal for MPSP

i. Improvement of on-site road at the PPDS

In order to maintain smooth access to the working face and to protect collection vehicles from frequent damage, it was proposed that MPSP improve the on-site road by embanking and gravel pavement.

ii. Application of cover materials

Minimum application of cover material was proposed to prevent surrounding environment from damages and nuisance.

iii. Establishment of disposal site boundary at the PPDS

In order to minimize the surrounding area from being affected by operation at the PPDS, it has been proposed that a site boundary to be as follows:

- To clear, compact and level the site boundary
- To construct an enclosing bund using burn-out waste and soil available at the site
- To cover the bund with soil

7.3 Interim Measure During 1989 - 1991

(1) MPPP

Upon the commencement of the Pantai Acheh disposal site, the collection and haulage cost will increase. More collection vehicles, laborers and money will be required because it takes about 2 hours to make a round trip to and from the site.

To mitigate the cost increases, it is proposed that MPPP change the type of collection vehicles from sideloaders to compactors and introduce the 3 times a week collection system before the commencement of the Phase I project.

The new disposal site in Pantai Acheh which is located 30 km away from Georgetown is scheduled to begin its operation in 1992 and until that time, the present disposal site (Bakau Street) and the previous disposal site (Jelutong) will be used for final disposal site by mainly mounting up methods.

(2) MPSP

Upon the commencement of Kuala Muda disposal site (KMPS) and Pulau Burong disposal sites (PBDS), the collection and haulage cost will increase. KMDS is located 20 km to the north of Butterworth, while PBDS is located 35 km to the south of Bukit Mertajam. More collection vehicles, laborers and money will be required because a round trip to and from those sites will take about 1.5 to 2 hours.

To mitigate such cost increases, it is proposed that MPSP change the type of collection vehicles from tipper trucks to compactors and the 3 times a week collection system introduce before the commencement of the Phase I project.

Both KMDS and PBDS are scheduled to begin operation in 1992, and until that time, the present disposal sites (Permatang Pauh disposal site and the Pulau Burong disposal site) will be used as final disposal sites by mainly mounting up methods.

8. Site Selection

(1) Site Selection Process

The selection of sites for main facilities (final disposal sites, incineration plants and transfer stations, etc.) largely consists of 3 stages as shown in Fig. 8-1, and the following 5 points are considered as key factors in site selection:

- Possibility of land acquisition;
- Possibility of obtaining the concensus from neighbouring inhabitants;
- Compatibility with regional development plan;
- Economic feasibility;
- Environmental acceptability.

For the environmental evaluation, the following 7 items are considered.

a. Possibility of water pollution
b. Impact of flooding
c. Possibility of noise, bad odour and dust problems
d. Compatibility with neighbouring land use
e. Impact on plants and animals
f. Impact on natural landscape
g. Impact on historical remains

(2) Selection of Candidate Sites

As a result of the above-mentioned selection process, the following sites were selected as candidate sites in order to incorporate them in the technical alternatives which have been examined in Chapter 9.

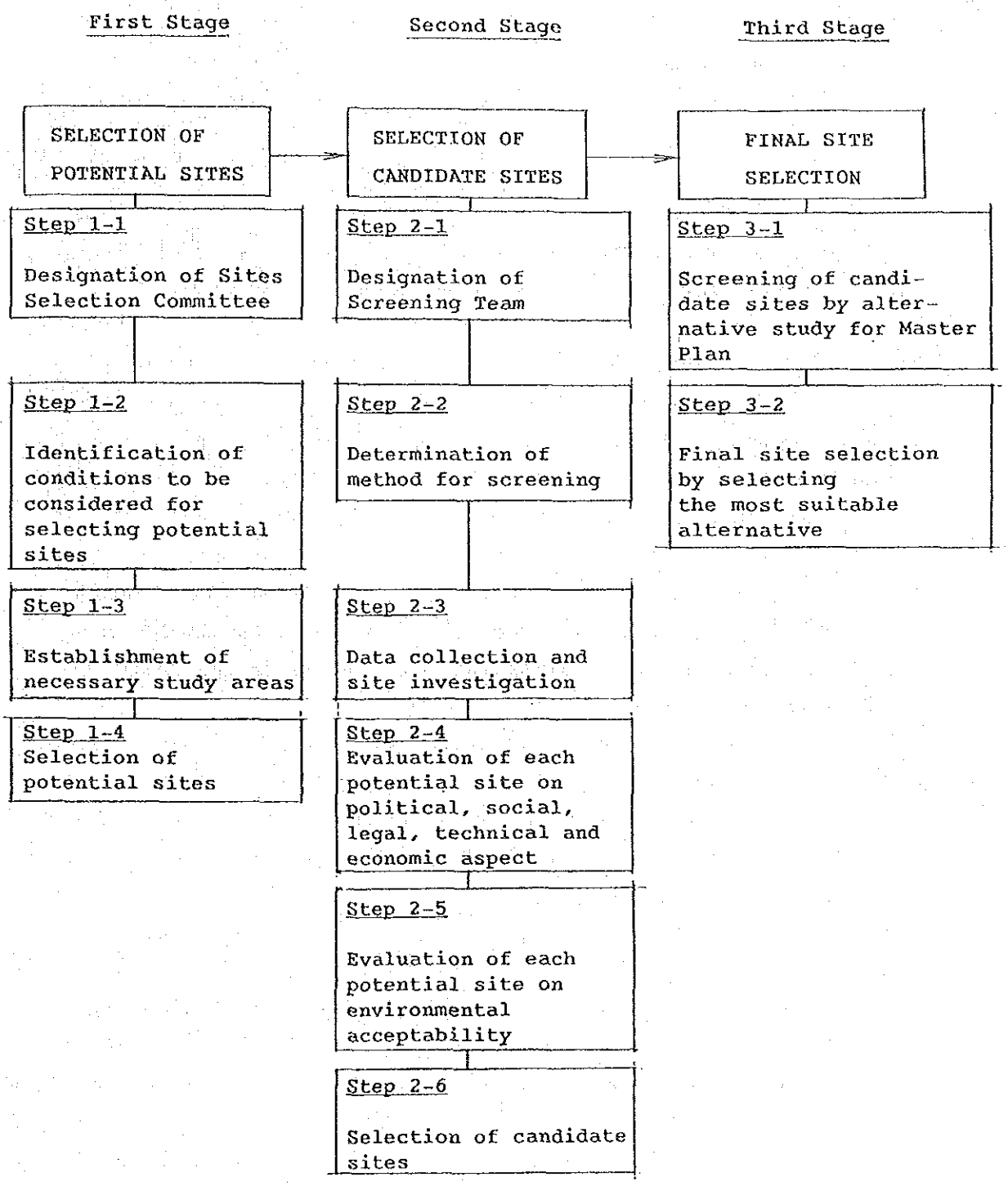


Fig. 8-1 Site Selection Process

a. Disposal Sites

- Pantai Acheh in MPPP
- Kuala Muda in MPSP
- Pulau Burong in MPSP

b. Incineration Plants

- Free Trade Zone in MPPP
- Perai Industrial Complex in MPPP

c. Transfer Stations

- Jelutong Mole in MPPP
- Free Trade Zone in MPPP
- Balik Pulau in MPPP
- Mak Mandin in MPSP

Note: Selection of incineration plants and transfer stations were necessary to examine the feasibility of those facilities though they turned out to be infeasible as a result of the feasibility study mode in Chapter 9.

9. Alternatives for Technical System

9.1 Examination of System Components

(1) Storage and Discharge

a. Residential Areas

In view of collection efficiency, fixed bins + plastic bags or portable plastic bins are recommended. In the case of plastic bag without bins, the public should discharge their bags in the morning of the collection day to prevent the waste being scattered by cats and dogs.

In the case of station collection, a container may or may not be provided at the station. The use of plastic bags should be adopted in ordinary residential areas except in those places where containers may be installed without any special site arrangements.

b. Kampongs

Since access to kampongs by collection vehicles is generally difficult, the discharge of solid waste in plastic bags for collection at stations is the most realistic method. Waste stations should be established as many as possible and the provision of communal containers is preferable.

c. Commercial Areas

As the provision of communal containers or fixed household bins is difficult in commercial areas, either portable bins or plastic bags should be used. The latter is preferable in view of easy collection.

d. Housing Complexes

Two types of dust chute systems are currently employed in housing complexes, i.e. (i) a container is provided in a storage room at the bottom of the dust chute and (ii) no container is provided.

In principle, it is preferable that the use of dust chute be terminated in view of their adverse effect on the environment vis-a-vis bad odours and the scattering of waste, etc. and that a system be employed whereby the residents of housing complexes take their solid waste to specified points by using plastic bags.

For those housing complexes where one dust chute with a container is provided for each 25 households and where collection vehicles can be accessible to the container, the use of dust chute may be continued. In this case, the solid waste should be collected daily to prevent its overflow and bad odour.

e. Premises Generating Large Amounts of Waste (Hotels and Markets)

Particularly large containers are required to deal with the large amounts of waste generated by hotels and markets, etc. The provision of hauled containers is preferable for markets, while containers for compactor collection should be provided for hotels, as in the case of housing complexes.

(2) Waste Collection System

a. Collection System for Domestic Waste

The cost of solid waste collection is largely influenced by the haulage distance to the disposal site and by the generation density of waste. In turn, the generation density depends on the population density and the collection frequency.

The loading efficiency increases in proportion to the waste volume at each station. In addition, the speed of the collection vehicles between stations declines when the distance between the stations is shorter.

The waste volume at each station is small in the case of daily collection, and the distance between stations is shorter in the case of door-to-door collection.

Consequently, station collection of 3 times a week is recommended for both MPPP and MPSP in order to extend the collection service area with efficient system in 2005.

b. Independent Collection System for Large Amount Discharger

As in the present case of MPPP, hauled containers and bulk-bin will be used for the generators of large amounts. This system will be continued in the future.

On the other hand, an independent collection system for large amount waste will be introduced by using compactor vehicle with container in MPSP.

c. Bulky Waste and Garden Waste Collection System

The independent collection of bulky waste and garden waste should be continued with the improvement of the discharge methods and collection frequency.

d. Introduction of Large Collection Vehicles for Domestic Waste

The positive effects of using large collection vehicles increase in accordance with the longer haulage distance and higher personnel cost. Side loaders should be replaced by compactors when new landfill sites are opened. The current compactor size of 10 m^3 is large enough and cost reduction can be expected by increasing.

(3) Street and Drain Cleansing

a. Cleansing Frequency

The weekly cleansing of drains in residential areas should be sufficient, as in the case of street sweeping. Similarly, once a month of grass cutting should be sufficient, while beaches should be cleaned every day to give the clean and beautiful image of Penang to tourist. The desirable frequencies for each type of cleansing are as follow:

- Street Sweeping	:	Commercial areas (daily)
	:	Streets in residential area (once a week)
	:	Main roads in rural areas (once a week)
	:	Other roads (once a month)
- Drain Cleansing	:	Drains which are likely to be blocked frequently (daily)
	:	Drains in residential areas (once a week)
	:	Others (once a week)
- Grass Cutting	:	Drain sides (once a month)
- Beach Cleansing	:	(daily)

b. Mechanization

The following work should be mechanized in view of the difficulty of its manual implementation.

- Sweeping of main roads
- Cleansing of monsoon drains
- Grass cutting

c. Work System

Cleansing work in residential area is conducted once a week and the work will be conducted by a team.

(4) Transfer Haulage

In order to select the types of transfer stations, the following aspects are to be considered;

- Economic feasibility according to the capacity requirements
- Easiness and stability in operation
- Flexibility
- Safety
- Easiness of operation and maintenance
- Space for the transfer stations
- Environmental acceptabilities

Based on the above mentioned considerations, the following types are selected for the proposed transfer stations.

i. Transfer haulage by motor vehicles

- Direct re-loading type to the transfer haulage vehicles for small scale
- Indirect re-loading type with compactor and without storage facilities for large scale

ii. Transfer haulage by ocean-going vessels

- Direct re-loading type to the ocean-going vessels
- Indirect re-loading type with crane and without storage facilities for unloading from ocean-going vessels

(5) Intermediate Treatment

a. Compost

According to the detailed examination on the marketability of the compost, the following problems were identified in regard to the composting of solid waste in Penang State.

i. The market size for compost is limited due to the wide use of various types of organic fertilizer such as chicken and cow dung.

ii. The production and transportation costs for composting are very high while the actual application of compost involves heavy labour.

iii. The composting of solid waste is not very effective in reducing the solid waste volume and weight.

iv. Raising livestock, which provides organic fertilizer, is expanding.

Composting was dropped from consideration in view of these problems.

b. Incineration Plant

The amount of municipal waste has increased remarkably with the increase in population and the rise of living standards. The State of Penang is one example where the industrial development and the elevation of living standard are significant. On the other hand, acquisition of suitable land for final disposal has become more and more difficult. The present situation shows that the time has come for the Penang State to start considering the introduction of an incineration system for her future SWM.

In order to assist the introduction of a proper incineration system for future SWM in the Penang State, a study on the introduction of an incineration plant is carried out with consideration of the following aspects:

- Purpose, merits and acceptability of incineration system
- Current situation of incineration system in advanced and developing countries
- Incineration system in Malaysia (present situation and issues)
- Approach towards introduction of incineration plant in Penang State (waste quality and desirable system)
- Economic Evaluation Result (sensitivity analysis)

- Privatization of Incineration Plant (example of privatization and issues)
- Proposals in consolidating the introduction of incineration plant (stage plan and consideration for the introduction)

(6) Final Disposal

Although the open dumping and controlled tipping methods are generally employed in Malaysia, the use of these methods should not be tolerated in the future in view of their adverse effects on the landscape, public health and environment.

Therefore, it was decided that the sanitary landfill method should be adopted as the final disposal method for the master plan.

The level of sanitary landfill development and operation can be classified into the following four levels:

a. Level 1 Controlled tipping
b. Level 2 Sanitary landfill with a bund and daily soil covering
c. Level 3 Sanitary landfill with leachate circulation
d. Level 4 Sanitary landfill with leachate treatment

In order to satisfy the following standards and guideline, the sanitary landfill level for the alternative study is set up at the level 4.

i. DOE Standards

- Recommended Code of Practise for the Disposal of Solid Waste on Land
- *Environmental Quality (Sewage and Industrial Effluents)* Regulations 1979, Regulation 8 Standard-B

ii. A guideline on the Storage, Collection, Transport and Disposal of Solid Waste in Malaysia, Technical Unit of Local Government Division, Ministry of Housing and Local Government.

iii. Other aspects

- Social acceptability on noise, littering, landscape, odor, etc.
- Eco-system acceptability
- Operational acceptability

9.2 System Alternatives

Alternatives should have two directions; one is to maintain an independent disposal system and another is to create an inter-municipal disposal system. Eight Alternatives have been proposed as shown in Figs. 9-1 and 9-2.

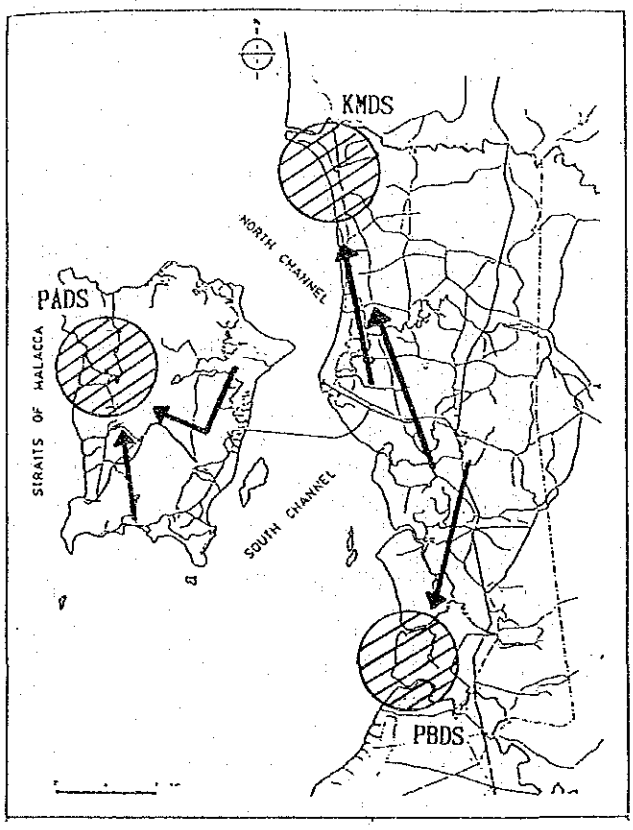
a. Independent disposal systems

i) Direct haulage to disposal site	Alternative - 1
ii) Introduction of transfer station	Alternative - 2
iii) Introduction of incineration plant	Alternative - 3

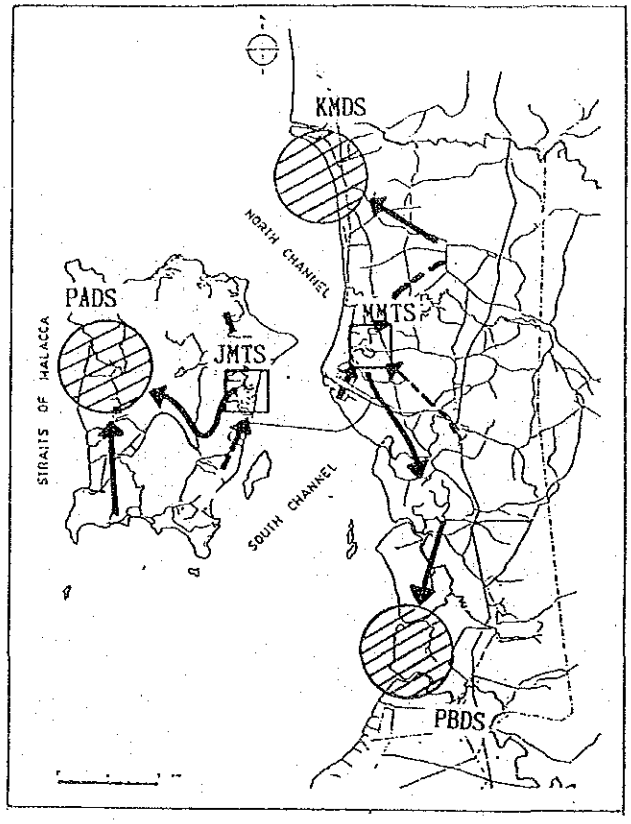
b. Inter-municipal disposal systems

i) Direct haulage of all waste to disposal sites in MPSP	Alternative - 4
ii) Introduction of transfer stations for motor vehicles	Alternative - 5
iii) Introduction of a transfer station for ocean-going vessels	Alternative - 6
iv) Independent management of incineration system	Alternative - 7
v) Intermunicipal management of incineration system	Alternative - 8

Alt.1 Independent Disposal-Direct Haulage



Alt.2 Independent Disposal-Introduction of Transfer Station



Alt.3 Independent Disposal-Introduction of Incineration Plant

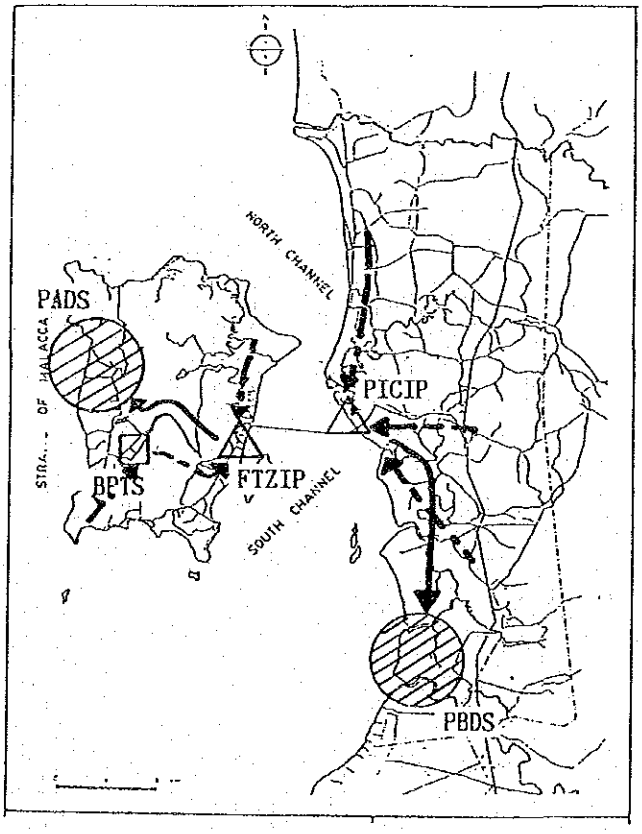
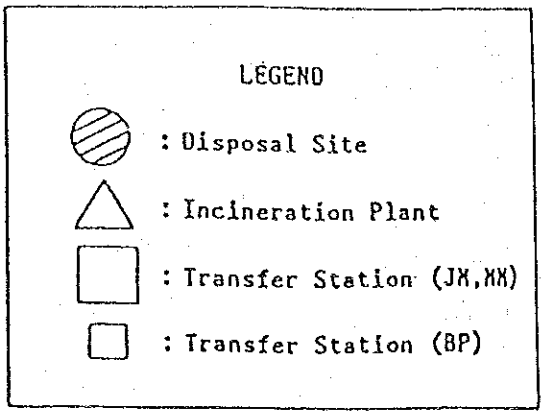
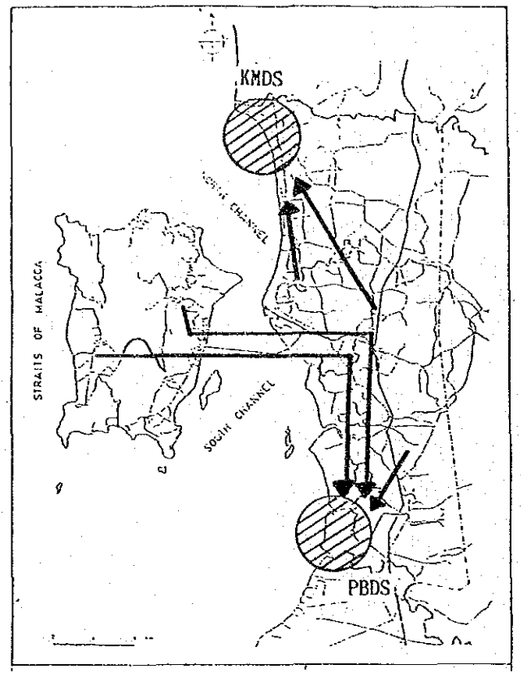


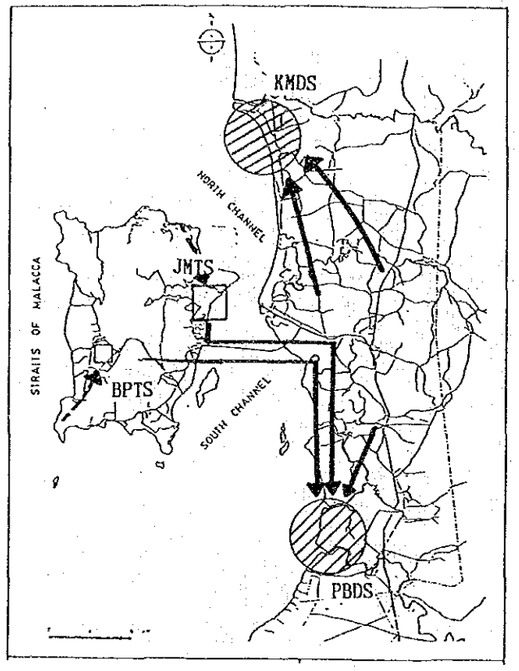
Fig. 9-1 Independent Disposal System



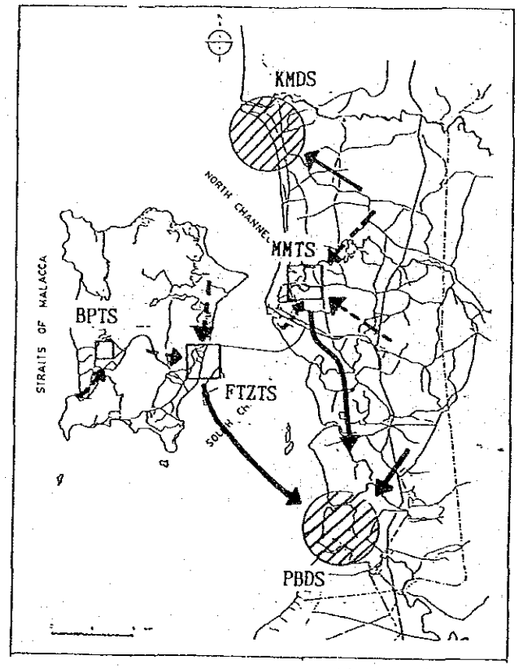
Alt.4 Intermunicipal Disposal-Direct Haulage



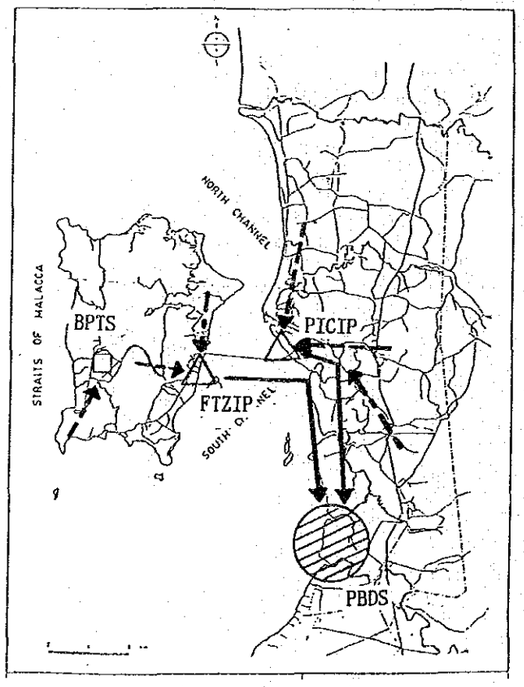
Alt.5 Intermunicipal Disposal-Introduction of Transfer Station for Motor Vehicles



Alt.6 Intermunicipal Disposal-Introduction of Transfer Station for Ocean-going Vessels



Alt.7 Intermunicipal Disposal-Introduction of Incineration Plant



Alt.8 Intermunicipal Treatment and Disposal -Introduction of Incineration Plant

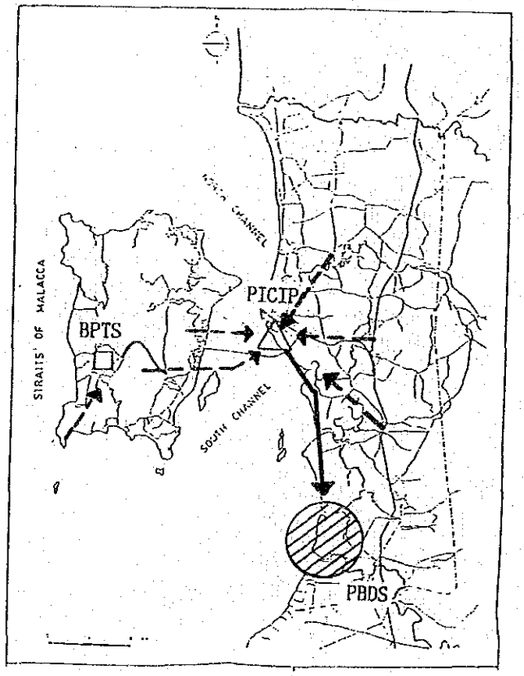
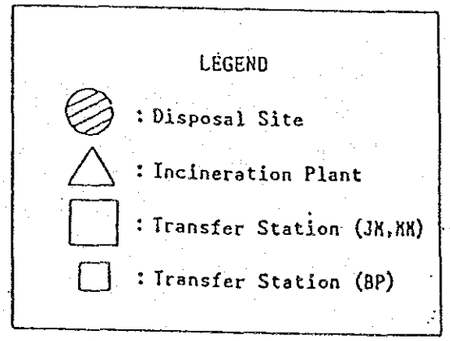


Fig. 9-2 Inter Municipal Disposal System



All the eight alternatives have same systems for collection and street/drain cleansing as follows.

a. Refuse collection system and service frequency

- Domestic waste collection : 3 times a week and station collection system
- Bulky waste collection : Once a month and station collection system
- Large amount collection : Daily and door-to-door collection system

b. Street and drain cleansing

- Commercial area : Daily street sweeping and once a week drain cleansing
- Residencial area : Once a week street and drain cleansing
- Rural area in MPSP : Once a month street sweeping

c. Grass cutting of drain side : Once a month cutting

d. Beach cleansing : Daily cleansing

9.3 Cost Estimation of Each Alternative

The initial investment cost for all facilities and equipment to be introduced by 2005, and annual expenses of operation for dealing with the volume of estimated solid waste in 2005, were estimated for each alternative plan based on the cost estimate conditions, and such estimation results are given in Tables 9-1 and 9-2.

Table 9-1 Investment Cost

(M$ million)

	Alt-1	Alt-2	Alt-3	Alt-4	Alt-5	Alt-6	Alt-7	Alt-8	No Change
Collection	92.4	69.4	75.8	110.8	77.6	71.6	75.4	81.2	84.0
T. Station	-	68.9	2.3	-	43.6	39.0	2.3	3.3	-
L. Facility	-	-	-	-	-	62.3	-	-	-
Incinerator	-	-	295.9	-	-	-	296.5	241.5	-
Final Disposal	84.5	77.4	34.6	59.9	59.9	55.3	21.3	20.7	84.5
Total	176.9	215.7	408.6	170.7	181.1	228.2	395.4	346.7	168.5

* Purchase costs of vehicles & heavy equipment were counted double, while purchase cost of barge was counted only one time because of its useful term.

Table 9-2 Annual Expenses in 2005

(M$ million)

	Alt-1	Alt-2	Alt-3	Alt-4	Alt-5	Alt-6	Alt-7	Alt-8	No Change
Collection	23.1	17.1	18.7	28.9	19.2	17.6	18.6	21.1	30.4
T. Station	-	9.2	0.3	-	6.5	4.3	0.3	0.5	-
L. Facility	-	-	-	-	-	14.2	-	-	-
Incinerator	-	-	27.1	-	-	-	27.4	22.5	-
Final Disposal	9.6	9.2	4.3	7.1	7.1	6.9	2.6	2.5	9.6
Cleansing Work	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1	11.1
Total	45.8	48.6	63.6	49.2	45.9	56.1	62.0	59.7	53.2

9.4 Evaluation of Alternatives

The evaluation results from technical, economic, transaction and environmental aspects are summarily presented in a matrix form in Table 9-3.

Table 9-3 Overall Evaluation

	Alt1	Alt2	Alt3	Alt4	Alt5	Alt6	Alt7	Alt8	NO CHANGE
Technical Aspect	B	B	A	C	B	C	A	A	C
Economic Aspect	A	B	C	B	A	B	C	C	C
Transaction Aspect	B	B	B	C	C	C	C	C	B
Environmental Aspect	B	B	A	B	B	C	A	A	C
Overall Ranking	1	2	1	3	2	4	2	2	4

Note: "NO CHANGE" refers to an alternative which employs the sanitary landfill disposal system in Alt1 and the existing collection/ haulage system.

The matrix implies the following overall ranking of alternatives.

i) Alternatives 2, 4, 5, 6 and "NO CHANGE" are dominated by Alternative 1, regardless of any set of weights to be associated with the evaluation criteria.

ii) Alternatives 7 and 8 are dominated by Alternative 3, regardless of any set of weights to be associated with the evaluation criteria.

iii) Alternatives 1 and 3 are not dominated by any other alternative, and therefore they may be considered to be good alternatives.

iv) Alternative 3 may not be economically feasible.

v) Alternative 5 is inferior to Alternative 1 only with respect to the transactional aspect.

vi) Alternatives 7 and 8 are inferior to Alternative 3 only with respect to the transactional aspect.

In view of the foregoing evaluation results, the solid waste management system to be established in Penang State by 2005 should be selected based on Alternative Plans 1 or 3, both of which have independent disposal systems for MPPP and MPSP respectively.

Given the financial capability of MPPP and MPSP and the local conditions for possible disposal sites, two further alternatives are presented here for both MPPP and MPSP for examination of their feasibility, particularly from the financial point of view.

i) MPPP

Alternative 1 : Direct sanitary landfill of all solid waste at the Pantai Acheh Disposal Site

Alternative 1-A : Incineration of all solid waste and sanitary landfill of residual waste (ash) at the Pantai Acheh Disposal Site

ii) MPSP

Alternative 1 : Direct sanitary landfill at the Kuala Muda and Pulau Burong Disposal Sites; generated solid waste is divided and hauled to these two sites on the basis of optimal haulage efficiency

Alternative 1-B : Only the Pulau Burong Disposal Site will be used; cases for having a transfer station are studied.

The feasibility will be examined for the further alternative suggested in this Section from which the following three sub-alternative have been developed for MPPP.

- Reduction of the construction costs of incineration plants by 20% or 40% from the original level by lowering the specification.

- Gradual consolidation of the incineration plant in response to generated solid waste volume

- Construction and operation of the incineration plant by a contractor

Based on the above argument, it is clear that MPPP would face a heavy financial burden if the construction of an incineration plant were included in the plans.

It was reconfirmed that Alternative 1, which does not include the construction of an incineration plant, would incur the minimum cost. Consequently, Alternative 1 was selected as the best choice for the Master Plan and the feasibility study.

In the mean time, the following three sub-alternatives have been developed and examined from financial view point for MPSP.

- One disposal site without transfer stations (Alt. 1-B1);
- One disposal site with one small transfer station (170 t/day) (Alt. 1-B2);
- One disposal site with one large transfer station (420 t/day) (Alt. 1-B3);

The financial analysis of the sub-alternatives for MPSP resulted in the following conclusions.

- The total cost is lower with two disposal sites than with one disposal site.

- The introduction of transfer stations has no advantage even though only one disposal site is selected.

Alternative 1 was found to be the most flexible alternative for MPSP and, therefore, was selected as the best choice for the Master Plan and the feasibility study.