



MALAYSIA DEVELOPING A SOLID WASTE MANAGEMENT

MODEL FOR PENANG



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WASTE MANAGEMENT

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Foreword

Preventing and managing waste is at the heart of sustainable development. Waste implies unnecessary depletion of natural resources, unnecessary costs, and environmental damage. Sustainable waste management is about using resources more efficiently.

Solid waste management is a major challenge for Malaysia to address in the light of Vision 2020 which lays out the direction for Malaysia to become a fully developed nation by 2020. The National Vision Policy (NVP), developed to meet the challenges posed by Vision 2020, incorporates key strategies of the New Economic Policy (NEP) and the National Development Policy (NDP). A key thrust of the NVP is *pursuing environmentally sustainable development to reinforce long-term growth*, which presents a challenge to established policies and practices in the rapidly expanding area of solid waste management.

Measures are being taken to meet this challenge. Malaysia is on the verge of significant change following the passing of the Solid Waste and Public Cleansing Management Act 2007, the main tenets of which underpin the institutionalisation of strategies and procedures for solid waste management. This legislation brings management of solid waste directly under the Federal Government's jurisdiction, allocates responsibilities to newly established agencies, redefines the role of local authorities, and aims to improve the collection, recycling and disposal of solid waste throughout Peninsular Malaysia. The changes to the administrative structure are substantial and the infrastructural improvements will be extensive, but to be effective, both require major changes in established disposal practices and in public attitudes and behaviour.

In recent years, disposal of solid waste throughout the State of Penang has been proceeding at a level of efficiency at least comparable with that in other states of Malaysia. The collection system is largely privatized and operated by contractors on behalf of the two local authorities responsible for waste disposal. Collection coverage reportedly approaches 90% of households on Penang Island and 70% of households in Seberang Perai on the mainland.

There have been several serious issues, however. Apart from a voluntary and unsystematic process of extracting a proportion of recyclable items from the main waste flow, all waste is simply disposed of in landfills. Nor is there a developed culture of waste minimization. Landfill capacity is severely limited and expansion of efficient, sanitary landfills, extremely problematic. Other difficulties relate to existing, short-term contractual arrangements; absence of support for recycling mechanisms at the community level; and limited land availability for transfer stations and landfill sites.

Consequently, with so many limitations, the Penang waste management system was seen to be in need of modernisation that would bring the system into environmental compliance and build the infrastructure necessary to maintain a more effective and sustainable operation.

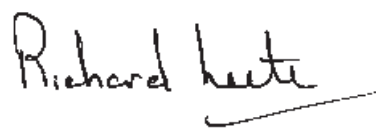
The Penang Solid Waste Management Project was launched at the beginning of 2006, to help the state implement a structured system of waste management that integrates sustainable and environmentally friendly methods of handling and disposing of solid waste. The study developed a model for dealing with the scale of solid waste forecast over the period 2005 to 2020 that addresses issues of public awareness

and education, stakeholder consultation, capacity building, solid waste treatment technologies, institutional organization and implementation of a pilot project. It is suggested that the strategies recommended and the institutional structure proposed for Penang could be replicated by other states in Malaysia.

The timely passing of the 2007 legislation and its implementation at the beginning of 2008 mean that, although some time may elapse while organizational, administrative and physical facilities and infrastructure are put in place, the basic strategic directives and regulatory provisions have been introduced that will enable the implementation of the Solid Waste Management Model developed for Penang. The system in operation prior to the new solid waste management framework, where waste was transported by any means to any number of destinations, and recycling was voluntary and largely determined by market forces, can now be replaced. Instead, waste will be collected by licensed operators and sent to designated facilities to be recycled or to be treated and disposed of by approved technologies.

This volume is the sixth in a series of periodic publications that report on UNDP Malaysia's work in its energy and environment practice area. The large range of projects being undertaken in this portfolio is designed to support Malaysia's efforts to achieve the Millennium Development Goal 7 of ensuring environmental sustainability.

The commissioned research was jointly funded by EPU and UNDP over a two-year period, 2006–2007. UNDP also gratefully acknowledges the participation of the Penang State Government; Penang Island Municipal Council (MPPP) and Seberang Perai Municipal Council (MPSP); the Ministry of Housing and Local Government, and a number of private and public sector stakeholders.

A handwritten signature in black ink that reads "Richard Leete". The signature is written in a cursive style with a long horizontal stroke at the end.

Richard Leete PhD
Resident Representative
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Contents

Foreword	iii
Boxes, Tables, Figures and Map	vi
Abbreviations and Acronyms	vii
Participants	viii
<hr/>	
The Global Issue of Solid Waste Management	1
What is Solid Waste Management?	
Uncoordinated Disposal of Solid Waste is a Problem	
The Importance of Local Conditions	4
The National Issue of Solid Waste Management	
Government Policy and Planning for Solid Waste Management	
Progress to Date	
Dealing with the Challenges of Solid Waste Management	
Developing a Solid Waste Management Model for Penang	17
Identifying the Main Elements of a Model	
Population Growth	
Solid Waste Generation and Collection	
Solid Waste Composition and Recycling	
‘Other Waste’ Fractions	
Solid Waste Management Costs	
Integrating the Institutional Framework	22
Governance	
Key Legislation	
Choosing the Best Option for Solid Waste Management	25
Determining Priorities in Solid Waste Management	
Business as Usual Option	
Composting Option	
Refuse-derived Fuel (RDF) Option	
Incineration Option	
Coordinating Stakeholder Strategies	32
Stakeholder Consultation and Cooperation	

Contents

Adopting Incentive Strategies	35
Optimizing Participation by Relating Costs Directly to Services Provided	
Implementing the Penang Solid Waste Management Model	37
Implementation of the Penang SWM Model Will Occur in Stages	
Stage 1: Initial phase	
Stage 2: Expansion phase	
Stage 3: Replication and refinement phase	
Actioning a Pilot Project	41
Benefits of a Pilot Project	
Implementing the Pilot Project	
<hr/>	
Lessons Learnt	43
Issues and Challenges	44
Sources of Information	45
Previous Reports in this UNDP Series	46

Boxes, Tables, Figures and Map

Boxes

- Box 1 Summary of the position in Malaysia
- Box 2 The Penang Solid Waste Management Project
- Box 3 Stakeholders in Penang Island's SWM and recycling network
- Box 4 The Solid Waste and Public Cleansing Management Act 2007
- Box 5 Stakeholder attitudes and behaviour

Tables

- Table 1 Population and average annual growth rates for Penang and Malaysia
- Table 2 Composition by weight of recycled items for MPSP
- Table 3 Composition of municipal solid waste for MPPP and MPSP
- Table 4 Estimates of other waste fractions in Penang
- Table 5 Summary of MPPP solid waste management costs
- Table 6 Fiscal gap for MPPP and MPSP solid waste management
- Table 7 Capital and operating costs for each option of SWM in Penang
- Table 8 Targets for municipal solid waste in Penang

Figures

- Figure 1 Mean monthly household income per capita in Malaysia, 1985, 1990, 1999 and 2004
- Figure 1 Methodology for developing the SWM model
- Figure 2 Population of Penang, 2000–2020
- Figure 3 Solid waste management costs incurred by MPPP and MPSP
- Figure 4 Solid waste management framework to 2007
- Figure 5 Solid waste management framework from 2008
- Figure 6 The waste hierarchy options
- Figure 7 Business as usual option
- Figure 8 Composting option
- Figure 9 Refuse-derived fuel option
- Figure 10 Incineration option

Map

- Map 1 States and state capitals of Peninsular Malaysia
- Map 2 Solid waste collection service areas on Penang Island
- Map 3 Solid waste collection zones in Seberang Perai

Abbreviations and Acronyms

BAU	Business as usual	NEP	New Economic Policy
CBO	Community based organisation	NGO	Non-Governmental Organisation
DLG	Department of Local Government	NSC	National Steering Committee
DoE	Department of Environment	NSP	National Strategic Plan (for Solid Waste Management)
DTCP	Department of Town and Country Planning	NVP	National Vision Policy
EPU	Economic Planning Unit	PE	PE Research Sdn Bhd
JKKK	Jawatankuasa Kemajuan dan Keselamatan Kampung (Village Development and Security Committee)	PPPUE	Public-private-partnership urban environment
JPPK	Jabatan Perkhidmatan Perbandaran dan Kesihatan (Department of Urban Services and Health)	RDF	Refuse-derived fuel
MHLG	Ministry of Housing and Local Government	RM	Ringgit Malaysia
MPPP	Majlis Perbandaran Pulau Pinang (Penang Island Municipal Council)	SERI	Socio-Economic and Environmental Research Institute
MPSP	Majlis Perbandaran Seberang Perai (Seberang Perai Municipal Council)	SWM	Solid waste management
MRF	Material recovery facility	UNDP	United Nations Development Programme
MSW	Municipal solid waste	UNEP	United Nations Environment Programme
NCLG	National Council for Local Government	UPEN	Unit Perancang Ekonomi Negeri (State Economic Planning Unit)
NDP	National Development Policy		
NSP	National Strategic Plan for Solid Waste Management		

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Department of Environment, Pulau Pinang

Housing and Local Government Department, Pulau Pinang

NGOs in Penang

CBOs in Penang

The Global Issue of Solid Waste Management



What is solid waste management?

For as long as people have been living in settled communities, the accumulation and dumping of rubbish, or garbage, has been a significant issue. The disposal of items that are spoilt, degraded, expended or simply no longer of use to the owner has become an increasingly important issue as large, modern societies generate far more rubbish than historically much smaller and less densely concentrated populations. Commonly known as 'solid waste' – to distinguish it from waste that is liquid or can be disposed off through pipes – this type of refuse requires systematic management to minimize undesirable impacts on people and their environment.

Early solid waste management consisted of digging pits near either temporary or permanent dwellings and burying the refuse. While this phenomenon engages

the interests of archaeologists and others attempting to determine the kinds of lives that people lived, growing populations and increasingly urban lifestyles made this practice unsustainable. Householders that did not have anywhere to bury their rubbish would throw it into the streets or watercourses, encouraging rodents, contaminating water and jeopardising people's health. Consequently, authorities were impelled to introduce measures for the collection and disposal of solid waste, and it is the systematic structuring and institutionalization of solid waste management that is the focus of this study.

Many human activities generate solid wastes. Large quantities are produced by agriculture and mining, but these wastes generally have less impact on the majority of people and are not included in this study. The rubbish impacting most conspicuously and negatively on people's lives and on the

crowded urban environment in which many live, is commonly termed 'municipal solid waste'. This waste originates from houses, streets, shops, offices, factories, hospitals and other institutions, and its collection and disposal is the responsibility of municipal or other government authorities.

Uncoordinated disposal of solid waste is a problem

If solid wastes are not managed properly, many risks and hazards for human welfare can result, although the relative importance of each depends on local conditions. For example:

- uncollected wastes block drains, cause floods, create insanitary conditions, and are an aesthetic nuisance;
- discarded cans and tyres encourage the breeding of flies, mosquitoes and other vectors that spread disease;
- uncollected or inappropriately dumped or decomposing waste attracts rodents that cause damage and spread disease, and aerosols and dust spread fungi and pathogens;
- open burning of waste causes air pollution including the release of toxins such as dioxin;
- hazardous wastes such as broken glass, razor blades, hypodermic needles, healthcare wastes, aerosol cans and potentially explosive chemical and other industrial containers pose risks of injury and poisoning;
- polluted water (leachate) flowing from waste dumps and disposal sites can cause serious pollution of groundwater and waterways;
- waste inefficiently disposed of is an



aesthetic nuisance because of its unsightliness and unpleasant aroma;

- liquids and fumes escaping from chemical wastes or as reactions from mixing different types of waste can have serious and even fatal effects;
- landfill gas (especially methane) from decomposing waste can be explosive, and constitutes a serious greenhouse gas;
- former disposal sites provide a dangerous, unstable foundation for large buildings.

The importance of local conditions

The nature and composition of solid waste varies significantly between more and less developed countries and this has implications for handling and disposal. Domestic waste in industrialized countries has a high content of packaging comprising paper, plastic, glass and metal, so that the waste has a low density that makes it

relatively easy to handle. The large amount of paper and the use of pre-processed food in particular, result in low proportions of moisture in the waste. In many developing countries, food waste in particular has a high water content, and casual disposal of sand and other building materials results in very dense waste which is much more difficult to handle. Containers, vehicles and systems that operate well with low-density wastes in industrialized countries may not be suitable or reliable in countries where wastes are usually heavier.

Frequency of collection of waste

becomes a critical issue in developing countries, especially those in the humid tropics where high temperatures and accelerated decomposition of organic waste is a major issue. Daily collection of waste not only requires a larger work force than in countries with a weekly collection system, but also has a significant impact on equipment and its maintenance.

Access to waste collection points varies greatly.

Collection of waste from sites or premises located in inaccessible streets and alleys can be problematic, and this is accentuated in localities like villages and squatter settlements with narrow or unformed roads and poorly developed collection systems.



Public awareness and attitudes to waste disposal

also vary greatly. There may be reluctance or even opposition among the populace to: carrying waste to a collection site; sharing waste containers; segregating various types of waste for recycling; and siting of waste collection, treatment and disposal centres. Even more fundamentally, lack of support through appropriate government policies, regulations, and funding, and a reluctance to involve NGOs and the private sector, may contribute to public apathy.

The National Issue of Solid Waste Management

Government policy and planning for solid waste management

In the fifteen years since the 1992 World Summit in Rio de Janeiro there has been a greater understanding of the position and function of solid waste management in the ecological, economic and social framework within countries. Preventing and managing waste is at the heart of sustainable development. Waste means unnecessary depletion of natural resources, unnecessary costs, and environmental damage. Sustainable waste management is about using resources more efficiently.

Solid waste management is a major challenge for Malaysia to address in the light of Vision 2020 which lays out the direction for Malaysia to become a fully developed nation by 2020. The National Vision Policy (NVP), developed to meet the challenges posed by Vision 2020, incorporates key strategies of the New Economic Policy (NEP) and the National Development Policy (NDP). A key thrust of the NVP is pursuing environmentally sustainable development to reinforce long-term growth, which strengthens Malaysia's commitment to the Rio Declaration.

In order to address these issues, Malaysia has developed a National Strategic Plan for Solid Waste Management that forms the basis for solid waste policy and practice in Peninsular Malaysia until 2020, and provides a foundation for development in the ensuing years. Completed in 2003, the Plan was formally adopted by government in 2005. The Ninth Malaysia Plan explicitly supports the National Strategic Plan (NSP) strategies including the adoption of sustainable waste management



through reduction, reuse and recycling which are to be given priority together with the use of appropriate technologies, facilities, equipment and service standards. The Ninth Malaysia Plan also announced the establishment of a new entity, the Solid Waste Management Department, under the Ministry of Housing and Local Government, to undertake policy formulation, planning, and management—including financial management—of solid waste.

The NSP is an attempt to move the somewhat inadequate management system currently in place towards one that is better, taking due consideration of economic development and the needs and responsibilities of the various stakeholders within society. In order to achieve this, the Plan addresses the current situation in all functional aspects of solid waste management – storage, collection, transfer, treatment and disposal, and outlines the basis for addressing the relevant issues and proposing solutions. An Action Plan, outlined within the NSP, provides the basis for future action to achieve the visions of the National Vision Policy.

The National Strategic Plan:

- provides a strategic framework related to the overall management of solid waste in Malaysia including the scope of privatization and implementation strategies, taking into account current obstacles or shortfalls in implementing the privatization policy;
- recommends an effective management plan that identifies the roles of each of the stakeholders, and actions that are required to be taken to meet the objectives of national development policy.

The principles of the strategy encompass:

- a strategic plan and phased action plan for solid waste management in Peninsular Malaysia until 2020;
- federalization of the solid waste management function;
- privatization of the solid waste management service;
- sustainable waste management through reduction, reuse and recycling, and the use of appropriate technologies, facilities and equipment to provide a sustainable and comprehensive solid waste management service;
- adopting service standards to achieve a clean Malaysia;
- federal/state/local government cooperation;
- a social framework comprising:
 - ~ increasing public awareness;
 - ~ increasing the government's understanding of effective solid waste management and public perception;
 - ~ building partnerships between all stakeholders including the public;
 - ~ social equity, with charges appropriate to the level of service and the ability and willingness to pay;



~ development of the national technical and managerial capability in solid waste management.

Importantly, the NSP reflects the existing concessions granted for waste collection by the Federal Government to three companies, with specific reference to the three designated geographical regions of Peninsular Malaysia (Northern, Central and Southern Regions) and the requirement to progressively extend service coverage to rural areas during the period of the concession. The companies have undertaken extensive work over several years to compile detailed master plans for waste treatment, disposal, and waste recovery. The government and concessionaires will use the National Strategic Plan as a framework for revisiting the terms of reference for privatization, and the master plans of the concessionaires to enable early progress to be made.

Progress to date

As noted earlier, solid waste consists of a heterogeneous mixture of materials, including paper, glass, metal, organic material and plastic, in varying quantities. It is estimated that currently 17,000 tonnes of solid waste is generated in Peninsular Malaysia every day, and this will increase to more than 30,000 tonnes per day by 2020 as a consequence of a growing population and increasing per capita generation.

However, not all solid waste generated is collected. In Peninsular Malaysia it was estimated that, in 1998, only about 75% of solid waste was being collected by the concessionaires, local authorities and their contractors. Equipment for collection of solid waste is diverse and much of it is old and inefficient. Because of the age and condition of the present fleet of vehicles, collection efficiency is poor and results in uncollected waste that is both unsightly and a threat to human health.

Modern lifestyles have led to more acute waste problems. Convenience products generally require more packaging and improvident habits associated with greater affluence lead to greater quantities of waste, as demonstrated by discarded wrappings and containers. Modern-day waste contains a high proportion of non-degradable materials such as plastics and chemicals.

At present, approximately 95–97% of waste collected is taken to landfill sites for disposal, with only a negligible proportion of the waste being subject to intermediate treatment. The remaining waste is sent for treatment at small incineration plants; diverted to recyclers and reprocessors; or dumped illegally. This means that about

Role of the Federal Government

- national policy and programme formulation;
- legislation;
- funding of facilities and equipment;
- research and development;
- human resources and development;
- public awareness and education;
- coordination and consultation with stakeholders;
- setting of national standards and service levels;
- monitoring and enforcement;
- regulatory agency for privatization;
- economic policies.



13,000 tonnes of solid waste are disposed of daily at landfill sites throughout Peninsular Malaysia.

Dealing with the challenges of solid waste management

In 2007, Solid Waste Management (SWM) is being managed, directly or indirectly at all three levels of government: federal, state and local authority; but there is a lack of capacity and focus in the administration and management of SWM at all levels. State governments, through local



authorities, have the jurisdiction to play a much larger role in SWM than the Federal Government; but ultimately it is the local authorities that are directly responsible for management of SWM services. These include solid waste collection, treatment and disposal; public health and environmental cleanliness; landscaping; planning; and other responsibilities such as licensing and enforcement of by-laws.

Other authorities involved in SWM play more of an indirect role. The Department of Environment, for example, is the authority responsible for the enforcement of standards for discharges and emissions into the environment. The Ministry of Health, through the Rural Environmental Sanitation Programme, promotes and supports the implementation of SWM in rural areas that are currently not serviced. The Economic Planning Unit of the Prime Minister's Department is the agency directly involved in the privatization of solid waste management throughout the country.

In addition to these authorities, other stakeholders that have a major role in solid waste management include waste generators (such as the public, industries and businesses), the concessionaires, manufacturers and waste recyclers/

Role of the State Government

- state-level policy and programme formulation;
- consultation and coordination with Federal Government;
- promotion and coordination of local authority cooperation;
- allocation of land and facilities;
- approval of inter-state movement of waste and location of facilities;
- assisting, monitoring and auditing local authorities;
- financial and other assistance for local authorities;
- formation of coordinating SWM Committee.

Role of Local Authorities

- assist state government in formulation of policies;
- enforce SWM legislation at the local level;
- monitor, audit and enforce concessionaire service levels;
- incorporate local requirements in operational plans;
- raise public awareness and promote education on waste minimization and recycling;
- provide advice on planning, siting and operating local facilities;
- enforce laws on illegal dumping, littering and open burning;
- collect tariffs and make payments as appropriate;
- collect, collate and disseminate appropriate data and information.



reprocessors. Waste generators constitute the most important group of stakeholders



as they include householders (the paying public), industries and businesses. At present, participation of waste generators in SWM is insignificant as there is no defined role or opportunity for them to participate, whether in planning, operation or management.

Manufacturers currently play an insignificant role in sustainable waste management practices, as there are no clearly defined policies or incentives for waste reduction, recycling of products, or recovery and reuse of materials. However, with the pressure for firms to meet the requirements of ISO 14000, especially for those involved in the export of manufactured products, more attention is being paid to such matters.

Some participants are involved in recycling and reprocessing of waste

Role of Service Providers

- cooperate and assist government and local authorities in implementation of policies;
- continuously improve expertise and efficiency;
- promote and develop expertise and efficiency of sub-contractors;
- adopt a long-term business vision for adequate levels of equipment, facilities and service levels;
- self-regulate and minimize the need for local authority intervention;
- promote public education and awareness;
- promote waste minimization and reduction strategies;
- collect, collate and disseminate useful data;
- undertake or support R&D initiatives.

materials such as paper, plastics, glass, ferrous metals, aluminium and other materials. Although there are no specific policies or incentives for recycling, many of these operators undertake such activities because of the financial returns for such investments.

The role of the public, other waste generators and public interest groups in SWM is currently insignificant. Public awareness in recycling and waste reduction is at a very early stage. The discriminate dumping of waste is still rampant, especially in smaller townships, squatter areas and many rural localities.

Box 1 Summary of the position in Malaysia

- Environmental awareness is low in Malaysia. The current recycling initiative, the National Recycling Programme, undertaken by the Ministry of Housing and Local Government, contributes to a greater awareness of the need to preserve resources, but the public response is disappointing, and more extensive public education and awareness is required.
- Overall institutional and organizational arrangements for SWM at the federal, state, and local authority levels have generally been weak and lack the resources for effective planning and management of waste. Such shortcomings are also evident in the day-to-day management of solid waste by states and local authorities: data on solid waste are often lacking and there is little forward planning.
- Service areas for solid waste collection are generally confined to urban and township areas with only limited collection in adjoining rural areas. Despite rural to urban migration, by 2020, 28% of the population is still expected to be living in rural areas. Areas outside local authorities do not receive any collection, but are subject to the Guidelines issued by the Ministry of Health under the Rural Environmental Sanitation Programme. Currently, 66% of rural households are self-reliant and undertake their own waste disposal by burial in proximity to their dwellings or in communal bins serviced periodically by contractor. Consequently, unofficial dumping and development of many small dumpsites is widespread.
- Malaysia is on the verge of significant change following legislation in 2007 that brings management of solid waste directly under the Federal Government's jurisdiction, allocates responsibilities to newly established agencies, redefines the role of local authorities, and aims to improve the collection, recycling and disposal of solid waste throughout Peninsular Malaysia. The changes to the administrative structure are substantial and the infrastructural improvements will be extensive, but this also implies that they will take time to implement, and that existing practices and procedures will not be superseded for some time.

Solid Waste Management in Penang



Don't be confused by the names

- *Pulau Pinang* is the official name of the state.
- *Penang* is used in this volume as a simpler name for the state as a whole.
- *Penang Island* is the part of the state on the island under the jurisdiction of the Majlis Perbandaran Pulau Pinang (MPPP) or Penang Island Municipal Council.
- *Seberang Perai* is the part of the state on the mainland under the jurisdiction of the Majlis Perbandaran Seberang Perai (MPSP) or Seberang Perai Municipal Council.

The State of Penang

Penang (Pulau Pinang) is one of eleven states in Peninsular Malaysia. The state comprises two segments: Penang Island (about 28% of the state's total land area of 1,053 km²) which is connected by bridge to

the larger segment, Seberang Perai, a few kilometres away on the mainland. Penang Island is predominantly urban, with a population of 678,500 in 2005, including the capital of the state, Georgetown. Seberang Perai has several towns but is



predominantly rural with a much less densely distributed population numbering about 790,300. The state's total population of approximately 1.5 million has grown steadily over the last 50 years but at a significantly slower rate than in most other parts of the country, especially in recent years (Table 1). Penang is the only state where the number of Chinese exceeds Bumiputera, and the state also has a significant Indian population.

Penang is among the most globalized and cosmopolitan of states in Malaysia and, along with Selangor and Johor, consistently records high economic growth rates. In the first decade of the twenty-first century the historic functions of trading centre, entrepôt and agriculture are greatly diminished, despite an important container terminal in Butterworth, and manufacturing is now the foremost economic activity. The highly industrialized southern part of Penang Island accommodates the modern factories of such well-known high-tech electronics firms as: Dell, Intel, AMD, Altera, Motorola, Agilent, Hitachi, Osram, Plexus, Bosch Seagate and others. Georgetown itself retains a fair proportion of its historic buildings and shophouse districts, but the

Table 1 Population and average annual growth rates for Penang and Malaysia

Locality	1957	1957–1980	1980	1980–2005	2005
	Number (000)	Growth Rate (%)	Number (000)	Growth Rate (%)	Number (000)
Penang	572.0	2.2	954.6	1.7	1,468.8
Peninsular M'sia	6,278.8	2.4	11,426.6	2.4	20,799.8
Malaysia	7,382.5	2.5	13,745.2	2.5	26,127.7

Source: Leete, 2007, pp. 52–54.

island especially is characterised by high-tech factories, modern office towers, and high-rise condominiums and apartment blocks.

The solid waste system in Penang

Box 2 The Penang Solid Waste Management Project

The Project, formally entitled *Structuring and Institutionalizing Solid Waste Management in Penang*, is jointly funded by the United Nations Development Programme and the Economic Planning Unit. The commissioned research has been carried out by the Socio-Economic and Environmental Research Institute (SERI) and PE Research Sdn Bhd (PE). The project has a duration of 24 months from January 2006 to December 2007.

The Objectives of this Solid Waste Management (SWM) Project are to:

- establish a structured and institutionalized SWM model in Penang;
- establish a workable and functioning solid waste management institutional structure in Penang that can be replicated by other states in Malaysia;
- identify alternatives to mass collection and disposal through a qualitative research method;
- initiate capacity building and promote knowledge management with regard to the processes of creating and implementing an integrated SWM model based on the Penang experience.

Responsibility for solid waste management

As previously noted, all three levels of administration — federal, state, and local authority — have significant roles in solid waste management, but it is the local authorities that implement strategies and policies and provide the management and operational services. There are two local authorities in Penang: the Municipal Council of Penang Island (Majlis Perbandaran Pulau Pinang (MPPP)) and the Municipal Council of Seberang Perai (Majlis Perbandaran Seberang Perai (MPSP)), and these two councils cover the entire state. The Penang state government, to which both local councils are accountable, is responsible for any SWM system that is implemented. The state government takes an active interest in recycling of wastes and works closely with NGOs and the private sector on these issues. On matters such as infrastructure and technology investments the Federal Government makes the decisions, particularly when federal funds are involved. All levels of government are required to follow the laws and circulars issued by the Ministry of Finance on financial matters.

The scale of solid waste management that must be undertaken by the responsible authorities depends primarily on the size and growth of the population and the rate at which households generate waste. The current situation for Penang Island (administered by MPPP) and for Seberang Perai (administered by MPSP) is summarized in the following sections.

Solid waste generation and collection on Penang Island

The population of Penang Island is growing steadily, and is notable for the high-density lifestyle of households: 80% of housing units are in apartment blocks and condominiums, posing different issues from those in low-density and rural areas. From various local waste composition studies, it was estimated that in 2005, about 963 tonnes of waste per day are generated in Penang Island. This estimate includes municipal waste from households, commercial sources (wet markets, hawker stalls, hypermarkets), non-hazardous industry, and institutional sources such as hospitals, schools and universities, but excludes construction and demolition materials, and garden waste. Of the waste collected, 56.7% is recyclable, 32.5% is organic, and 10.8% is non-recyclable.

Garbage collection services are provided by the MPPP to 95% of the population on Penang Island. The remaining 5% are located in inaccessible premises on small islands, and in remote localities that are uneconomic to service. Since the early 1980s the MPPP's solid waste collection has been outsourced. From 1993, four contractors have covered 80% of the Island, with the MPPP providing coverage of the remainder. In addition, some premises, such as those of industries and hotels, have their own garbage contractors whose collection and disposal records are monitored. For the purpose of official solid waste collection, the Island is divided into seven zones as shown in Map 2.

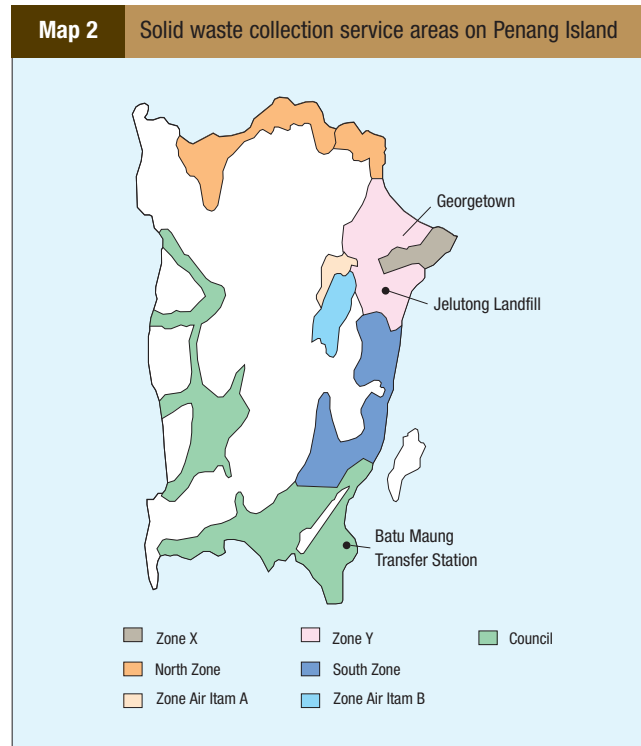
The current practice for waste collection is as follows:

- household waste is collected from landed properties three times per week (Air Itam has a daily collection);
- waste from shops, commercial premises and high rise residential premises is collected daily;
- institutional waste is collected daily.

The MPPP has made it mandatory for all waste collected on the Island to be sent to the Batu Maung Transfer Station operated by a private contractor, barged across to the mainland and disposed of at the Pulau Burong landfill. Currently the transfer station handles 600–700 tonnes of organic, domestic and industrial waste per day. The barges are designed to drain the leachate from the waste containers into the hull to avoid marine pollution and this, together with leachate from the transfer station, is transported to a sanitary landfill facility also on the mainland.

The only approved municipal solid waste landfill in the state has a total area of 66 hectares with an operational area of 33 hectares, and is located at Pulau Burong. This is a semi-aerobic landfill (known as the Fukuoka type) established in 2003. Because of its location near the sea, constant monitoring is carried out to detect any marine pollution. There is also a 20-hectare ‘landfill’ disposal site (essentially a dumping ground) at Jelutong that receives mainly construction and demolition material, and garden and other bulky waste.

In Penang, SWM practices involve only recycling and sanitary landfill. Of these two measures, it is only recycling that achieves waste minimization and resource recovery; landfill is the least favoured option in terms



Source: Project Final Report, 2007 Figure 2.2.



of environmental impact and efficient use of resources. In addition, Pulau Burong landfill site will reach its design capacity within 3–4 years if the amount of solid waste being disposed of is not substantially reduced. Even if the option for expansion of the present landfill were undertaken, it would not last more than a further 10 years. Since finding another landfill site would be difficult

in land-scarce Penang, it is imperative that a viable alternative system be identified and adopted to substantially reduce landfill disposal.

Recycling activities on Penang Island

Penang has a long history of recycling preceding the Federal Government

initiatives in 1993. Currently, the voluntary waste recycling and safe disposal programme includes:

- waste recycling of inorganic general waste;
- safe disposal of hazardous waste;
- composting of organic waste;
- recycling and safe disposal of e-waste (electrical and electronic waste).

The MPPP has formed alliances with numerous partners and stakeholders to

Box 3 Stakeholders in Penang Island's SWM and recycling network	
Participants	Roles
<i>Contractors</i>	
cleansing contractors	cleaning roads and drains; some recycling
waste collectors	collection of household, commercial and industrial waste; some recycling
transfer station	marine transfer of waste to Pulau Burong
disposal	operating landfill; scavengers recover useful materials
<i>Community-Based Organizations</i>	
NGOs	collect from members and the public; sell for recycling
residents' associations	collect from members and the public; sell for recycling
<i>Institutions</i>	
agencies	advice, education and consultancy
religious institutions	collect from members and the public; sell for recycling
educational institutions	collect from students; sell for recycling
hospitals	safe disposal; collect from staff/the public; sell for recycling
hotels	collect and sell for recycling
factories	collect waste from staff; sell with scrap for recycling
supermarkets/ department stores	collect own waste; sell for recycling; collection points including special bins for e-waste
<i>Recycling Businesses</i>	
agents/vendors/buyers	currently about 77 agencies and recycling specialists
recycling, resource recovery processors	separation, crushing, stripping, disassembling, baling specialist factories producing raw materials

Source: Project Final Report, 2007, Table 2.3.

develop a recycling programme that reaches many communities, and permits people to choose whichever vendor they prefer to handle the collection of recyclables. This arrangement frees the MPPP of operational concerns and allows it to concentrate on education and the promotion of recycling. In addition, the voluntary Penang Environmental Working Group is actively involved in planning and implementing programmes with the MPPP.

Penang Island recorded a recycling rate of 8.3% in 2003, much higher than in preceding years, and this leapt up further to 15.6% in 2004; estimates that included itinerant waste buyers raised this figure even higher to about 20%. This is significantly higher than the national average of 3–5%. However, this level was not maintained in 2005 when the continuing increase in population and less efficient collection caused the recorded recycling rate to fall to 12.5%. There is considerable uncertainty over the true trend: much of the variation is attributed to problems of data collection and the reluctance of recycling businesses to supply accurate information to the MPPP.

Solid waste generation and collection in Seberang Perai

Over the last two decades, Seberang Perai has experienced substantial population growth mainly in coastal and urban areas in the northern and central regions, and close to the Perak border in the southern region, along Federal Route 1. Not only is Seberang Perai less urban than Penang Island, but housing units are also notably



Source: Project Final Report, 2007, Figure 2.3.

different with only 31% comprising apartments and condominiums. These settlement patterns pose a somewhat different challenge for MPSP in waste collection and recycling from that of MPPP on the Island.

In Seberang Perai, MPSP has divided the collection areas into three main zones: northern, central and southern, corresponding to the three administrative districts. These zones are further divided into 12 sub-zones. As in the case of Penang Island, wastes in Seberang Perai are being collected by sub-contractors. Part of the waste collection and disposal contracts is outsourced to private contractors. Waste is collected on alternate days. The solid waste collection service is estimated to reach about 70% of Seberang Perai.

The Ampang Jajar Transfer Station was originally a landfill, but was converted to a transfer station after it reached capacity in 2001. All collected waste from the northern and central zones is transported to the Ampang Jajar Transfer Station to be compacted before being sent on to the Pulau Burong landfill for final disposal. Trucks transport solid waste from the southern zone direct to the landfill. Currently the transfer station handles 400-450 tonnes of solid waste per day. The contractor at the landfill site has about 40 registered scavengers ('waste pickers') who, for a fee, are permitted to work on site and sell recyclable materials direct to the recyclers at the landfill. The Pulau Burong Sanitary Landfill has two leachate treatment ponds, with one treatment plant currently in use and another to be constructed soon. The treated leachate water is used as dust control and for washing down, and is not discharged into the sea.

Recycling activities in Seberang Perai

MPSP implemented its recycling programme in 2000 following a directive from the Ministry of Housing and Local Government. The main objective of this programme is to divert 30% of waste from the landfill. MPSP has organised various activities to promote recycling, including:

- building recycling centres, sponsored mainly by the Ministry, in its capacity as the local authority and coordinator of the recycling programme;
- organizing recycling carnivals at various shopping complexes, exhibitions, quizzes, demonstrations and talks,



to promote recycling;

- building 14 community collection centres funded by the Ministry; a further 17 have been financed privately by NGOs.

Seberang Perai recorded a recycling rate of 5.4% in 2003, and this increased hugely to 17.5% in 2004, and to 18.8% in 2005. This rapid increase from a very low base prior to 2003 is partly due to improved recording but, most recently, is probably attributable in part to collection by some of the agents beyond the MPSP boundary. Whatever the explanation, like Penang Island, this is a significantly higher rate than the national average of 3-5%.

MPSP has also formed alliances with partners and stakeholders similar to Penang Island (Box 3) although on a more modest scale appropriate to the quite different communities that it is serving for collection and recycling of waste. This situation also implies that a significantly different approach is required for such processes as stakeholder consultation.

Developing a Solid Waste Management Model in Penang

Identifying the main elements of a model

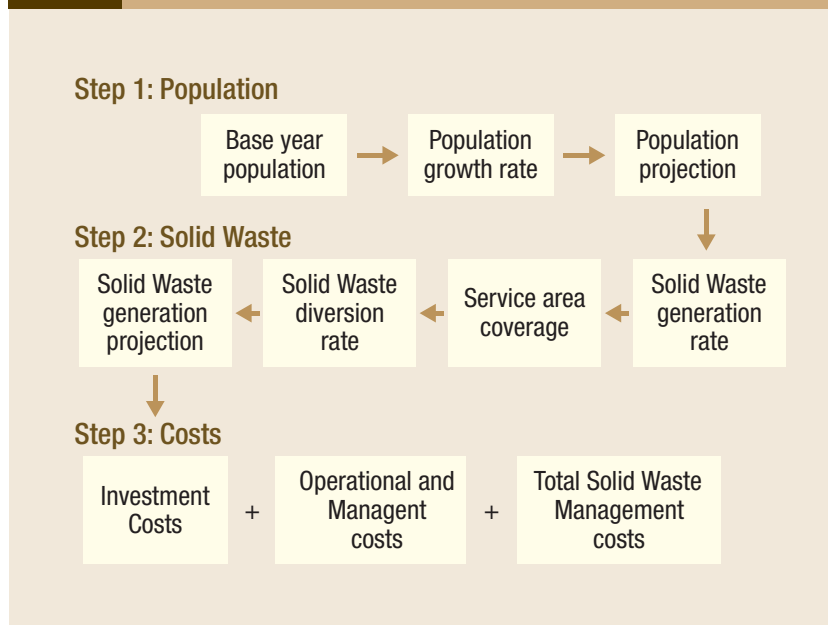
Although these provisions for the collection and disposal of solid waste in Penang in the middle of the first decade of the twenty-first century are as comprehensive as any in the country, they fall far short of what is required in terms of best practice given their voluntary nature, restricted coverage, and limited amount of recycling. A primary objective of the project is to develop a solid waste management model for the fifteen year period, 2005–2020, that can be incorporated in the institutional structure of the state, and that has the versatility to be adopted by other states of Malaysia. Three elements are required order to achieve this aim:

- establish base population numbers and estimate future population growth;
- estimate the solid waste flow which depends on the rate of waste generation, any waste diversion, and collection service coverage;
- determine cost for this amount of waste.

Population growth

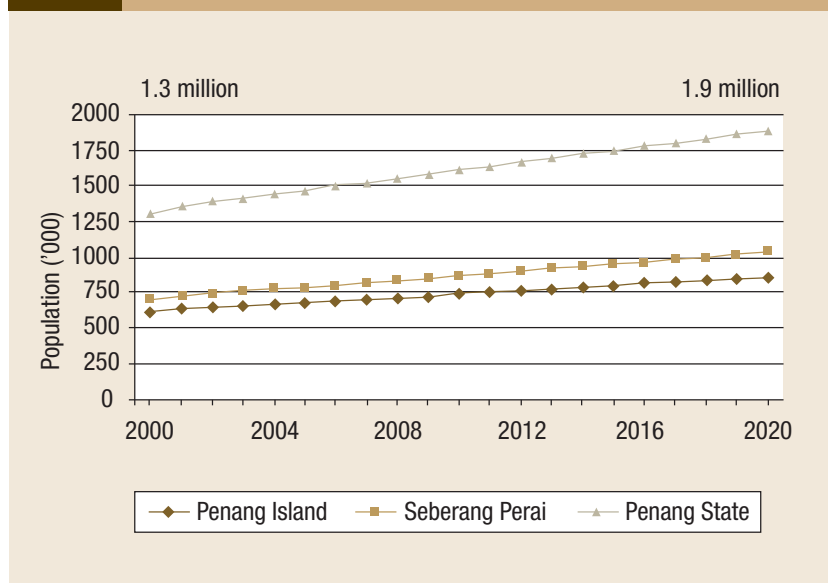
Based on its recent record of modest growth it is estimated that during the study period, 2005–2020, the population of Penang Island will grow by about 1.5% per annum, and that of Seberang Perai by 1.6% per annum, increasing the state's population numbers from 1.3 million in 2000 to 1.9 million in 2020. Average household size is expected to decline from 4.68 persons per household in 2000 to 4.23 persons in 2020 which could affect generation of solid waste per household. By 2020, households are expected to

Figure 1 Methodology for developing the SWM model



Source: Project Final Report, 2007, Figure 3.1.

Figure 2 Population of Penang, 2000–2020



Source: Project Final Report, 2007, Figure 3.2.

reach 215,000 on Penang Island and 231,000 in Seberang Perai.

Solid waste generation and collection

Utilizing data from Penang and from other studies, the Study Team estimated that, for the purpose of developing the model, residential waste generation rates were at about 1kg per capita per day, and set a 2005 baseline rate of 1.02kg per capita per day. This amounts to 657 tonnes per day for Penang Island and 668 tonnes per day for Seberang Perai. By 2020, the average amount generated for Penang Island is expected to be 982 tonnes per day and 1,114 tonnes per day for Seberang Perai. In 2005, industrial, commercial and institutional sources were estimated to have produced 1,400 tonnes per day on Penang Island, and about 1,500 tonnes per day in Seberang Perai.

Coverage for collection is estimated to be about 95% for Penang Island and 70% for Seberang Perai. While services are offered over a greater area, some small businesses are unwilling to pay the set amounts or prefer to make their own arrangements for disposal; on Penang Island, the central hilly areas are not served by MPPP's waste collection services; and in Seberang Perai, significant amounts of solid and organic livestock wastes are found in waterways.

Solid waste composition and recycling

Over the last decade, recycling has become common in Penang, as it has throughout much of Peninsular Malaysia. More than 100 agencies in the state have reported that they are active in recycling. However, there is no systematic institutional system for the collection of data, and because

Table 2 Composition by weight of recycled items for MPSP, 2005

Unit	Paper and cardboard	Plastics	Glass	Metals ¹	Total
Tonnes	84,823.2	2,486.2	170.2	8,552.9	96,032.5
Percent	88.3	2.6	0.2	8.9	100.0

¹ Mainly (>80%) various types of steel, but also aluminium, copper and zinc.
Source: Project Final Report, 2007, Table 3.2.

Table 3 Composition of municipal solid waste for MPPP and MPSP, 2003

Category	MPPP		MPSP	
	tonnes	percent	tonnes	percent
Food	206.2	33	605.8	51
Yard or garden	59.9	10	149.0	12
Paper	176.2	28	54.1	5
Plastics	89.9	15	208.1	17
Textile / rubber	19.0	3	38.5	3
Metal	29.1	5	43.4	4
Hazardous	1.9	0	2.7	0
Other	37.7	6	98.4	8
Total	619.9	100	1,200.0	100

Source: Project Final Report, 2007, Table 3.3.

transactions are not transparent and many participants are unwilling to divulge the requisite information, accurate estimates of amounts and costs are difficult to make. Consequently most information on recycling comes from the two local governments. Records from the MPSP indicate that the bulk (88%) of the recycled items, based on weight, comprise paper products, with metal products and plastics next.

'Other waste' fractions

Considerable amounts of waste were unaccounted for and several specific items not included in the statistics on the

composition of municipal solid waste for the two local authorities. These 'other waste' fractions were not trivial amounts in 2005 and likely to become much more significant by 2020 for such items as used tyres, household hazardous waste; discarded computers; used cellular phones; construction and demolition waste; and sludge.

Solid waste management costs

Determining the amounts that local governments actually spend on solid waste management is problematic owing to incomplete records and the difficulty of correlating expenditure with the amount of waste collected, transported, treated and disposed of by official services. This difficulty arises because of the nature of accounting at the local level, the hidden costs resulting from Federal Government payment of capital expenditure, and the effective subsidy by the state government in not charging full cost for the land allocated to waste management activities.

The National Strategic Plan for Solid Waste Management made an estimate of long-term average costs, with a 2005 starting year, that amounted to about RM225 per tonne of waste, covering collection, transport, treatment and disposal. About half of this amount is capital expenditure and the other half is operating expenses. Subsequent price hikes in the cost of oil are likely to raise operational costs further.

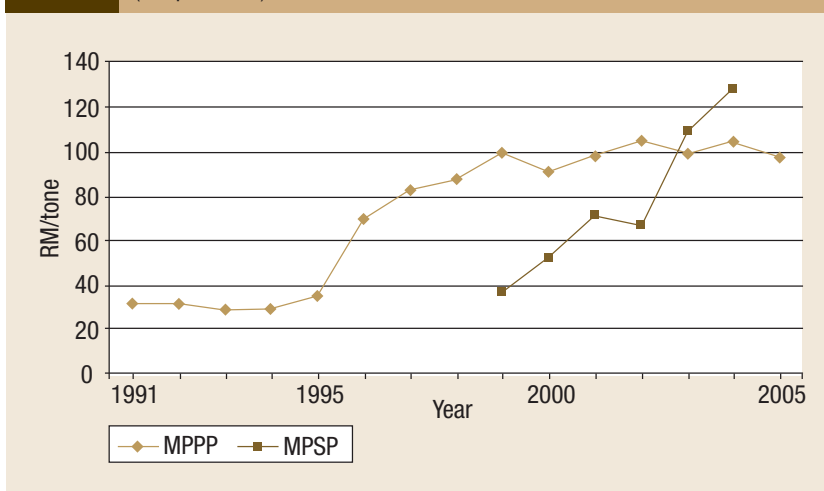
The relatively stable costs recorded by the MPPP from 1999 to 2005 (Figure 3) suggest that the local authority may have

Table 4 Estimates of other waste fractions in Penang, 2005–2020 (tonnes per year)

Other waste	2005	2020	2015	2020
Other waste	2005	2020	2015	2020
Used tyres	24,670	33,382	45,173	61,127
Household hazardous waste	50,395	55,237	60,073	64,819
Used computers	4,321	11,207	22,539	44,977
Used cellular phones	26	59	75	93
Construction and demolition waste	949,990	1,041,271	1,132,434	1,221,912
Sludge	345,792	379,018	412,201	444,770

Source: Project Final Report, 2007, Table 3.5.

Figure 3 Solid waste management costs incurred by MPPP and MPSP (RM per tonne)



Source: Project Final Report, 2007, Figure 3.3.

achieved economies of scale in provision of services. However, the cost per tonne is still rising for the MPSP. This could have resulted because economies of scale have not yet been achieved or because services have not reached optimal efficiency. However, the significant increases in costs could also be attributable to new activities

Table 5 Summary of MPPP solid waste management costs, 2000–2006 (RM million)

SWM Item	2000	2001	2002	2003	2004	2005	2006
Collection (contractors)	10.2	10.7	10.91.1	11.1	11.1	13.0	13.0
Collection (Council)	1.2	1.1	1.3	1.2	1.1	4.0	4.5
Land rental ¹	–	0.1	0.2	0.2	0.2	0.2	0.2
Transfer costs	–	3.3	7.9	7.9	7.9	7.9	9.6
Tipping fee	–	1.1	6.3	6.6	6.6	7.1	6.9
Jelutong Landfill	3.6	4.0	1.5	2.4	2.4	2.4	2.4
Vehicle purchase ²	–	2.0	–	–	–	–	–
Total cost	15.0	22.3	28.1	29.4	29.4	34.6	36.6
% of MPPP revenue	10.2	15.6	18.5	18.5	19.9	19.8	20.0

¹ For transfer station.

² Additional vehicle maintenance costs ranged between 0.01 and 0.06 million per annum.

Source: Project Final Report, 2007, Table 3.12.



such as haulage and landfilling, items that did not attract such high costs in the past.

Cost of SWM is a major item in a local authority's budget as illustrated by the example of MPPP. Between 2000 and 2002, SWM costs increased by 87% or RM13.4 million due mainly to the transfer of solid waste to the mainland, tipping fees, and the purchase of vehicles. Between 2004 and 2006 the Council's own collection costs and the transfer costs increased by another RM4.6 million or about 18%. As a proportion of the MPPP's

total revenue, SWM costs rose from 10% in 2000 to 20% in 2006.

A comparison of the data in Table 5 with the National Strategic Plan for Solid Waste Management long-term average cost estimates indicates a very large fiscal gap for solid waste management in Penang totalling RM2.267 billion, in present value terms, over the study period: RM1.026 billion for the MPPP, and RM1.24 billion for the MPSP. This implies that MPPP will have to allocate an additional RM1.026 billion between 2006 and 2020, and Seberang

Table 6 Fiscal gap for MPPP and MPSP solid waste management, 2006–2020

Local authority	Current expenditure (RM/tonne)	Long-term average cost (RM/tonne)	Total municipal solid waste (tonnes)
MPPP	98	250	6,756,492
MPSP	129	250	10,263,034
Total			17,019,525

Local authority	Current cost (RM million)	Estimated expenditure (RM million)	Fiscal gap (RM million)
MPPP	661	1,687	1,026
MPSP	1,323	2,563	1,241
Total	1,984	4,251	2,267

Source: Project Final Report, 2007, Table 3.13.

Perai, RM1.241 billion, to cover the costs of solid waste management. Based on 2006 population numbers, this would mean about RM1,500 per person or over RM6,000 per household over the 15-year period on top of current waste disposal charges which are paid as part of homeowners' local authority property taxes.

Although the national policy provides for the Federal Government to pay capital costs, and state and local governments are responsible for operating costs, in practice the more developed states are expected to pay their own costs. This was still the case in Penang in 2007, where the two local governments were paying for haulage and landfill activities without any capital expenditure subsidy from the Federal Government.



Integrating the Institutional Framework

Governance

Institutionally, SWM has been the responsibility of local government in terms of operations, with the Federal Government providing policy direction and funding, and setting technical standards and guidelines. The National Strategic Plan for Solid Waste Management, formulated in 2003, has defined the main strategy and overall management plan for the sector. Although the responsibility for SWM lies with local governments, they generally lack the financial and technical capacity to manage this complex task. SWM monitoring and reporting are also rather weak as there is no systematic procedure for reporting to such authorities as the Ministry of Housing and Local Government and therefore no basis for planning beyond the local level. Limited types of information are therefore obtained from commissioned studies or from the concession firms.

The governance and regulations for homogeneous waste are clear as this is the responsibility of the Department of the Environment and the waste is generated by an identifiable sector. However, the issue becomes somewhat confused when the stream is mixed, as in the municipal waste sector, where the responsibilities fall between the Department of the Environment, the Ministry of Housing and Local Government, and the local authorities themselves. Lacking an integrated framework and appeal body, agencies plan and deliver services according to their own objectives and mandates, and the lack of coordination results in an inability to resolve issues beyond their immediate jurisdiction. Handling and disposal of household

hazardous waste in the municipal solid waste stream is a notable example.

To some degree an integrating function is provided by the Economic Planning Unit (EPU) of the Prime Minister's Department through its overseeing financial role. The EPU produces medium and long-term development policies and budget allocations for the national five-year plans and ensures that developments conform to the current outline perspective plan. In 2006, a Cabinet Committee on Solid Waste Management and Environment was formed under the chairmanship of the deputy prime minister, and includes federal ministers and state chief ministers. The Committee's initial decision was to establish a sanitary landfill policy and close unsafe landfills.

Key legislation

Until 2007, provisions for dealing with solid waste were partly dealt with under the Local Government Act where local authorities were delegated with the responsibility for 'managing nuisance' likely to be injurious to health or property, and public cleansing, supplemented by the Street, Drainage and Building Act which required properties to be kept clean and waste construction material removed, and the Town and Country Planning Act. With the passing of the Solid Waste and Public Cleansing Management Act in July 2007, the Federal Government has assumed executive authority for all matters relating to the management of solid waste and public cleansing throughout Peninsular Malaysia. In addition, in a second Act also passed in 2007, a corporation is to be set up to



administer and enforce the solid waste and public cleansing laws. The three earlier laws were updated to accommodate these changes in jurisdiction.

The new SWM Act has defined solid

waste to include 'any scrap material or other unwanted surplus substance or rejected products arising from the application of any process; or any substance required to be disposed of as

Box 4 The Solid Waste and Public Cleansing Management Act 2007

The Act, which had been in preparation for several years, was passed by the Malaysian Parliament in July 2007.

Under the Act, house owners will continue paying annual property taxes to their local authorities, and collection and disposal payments by local governments will be directed to the new Solid Waste Management Corporation to pay for the services of concessionaires and their contractors. The Federal Government will continue to make up any shortfall as well as funding capital investments in transfer stations, landfills and incinerators.

The Act is comprehensive in coverage, including the collection and disposal of solid waste from commercial centres, public sites, construction sites, households, industrial zones, and institutions such as schools and universities. However, the Act does not stipulate any special requirements for disposal of hazardous waste generated by households and other non-industrial sources.

The main impact of the legislation is to bring solid waste management directly under Federal Government jurisdiction and to privatize the handling of solid waste by contracting three concessionaires, each operating in one of the three regions that cover the peninsula. The newly created National Solid Waste Management Department will oversee these operations, draft policy, determine strategy, and implement action plans. Under a second Act, also passed in 2007, the Solid Waste and Public Cleansing Management Corporation will take over the role of local authorities, supervise the operations of the concessionaires, and carry out enforcement. The Corporation has a RM1 billion setting-up resource allocation and a staff of over 2,000 people. A Tribunal for Solid Waste Management Service is to be set up to deal with complaints and disputes.

All companies and other groups collecting, transporting, storing, recycling and disposing of solid waste are required to be licensed and to dispose of waste only at approved facilities. There is uncertainty as to how this will affect some charitable groups such as NGOs and CBOs that collect and sell recyclable waste to generate funds for groups such as the elderly, the disabled and orphans.

The existing concessionaires already have considerable experience and the requisite master plans are already drawn up. In addition to collection and disposal of solid waste, the concessionaires are responsible for cleaning up roads, public places, public toilets, drains, markets, hawker centres, and beaches.

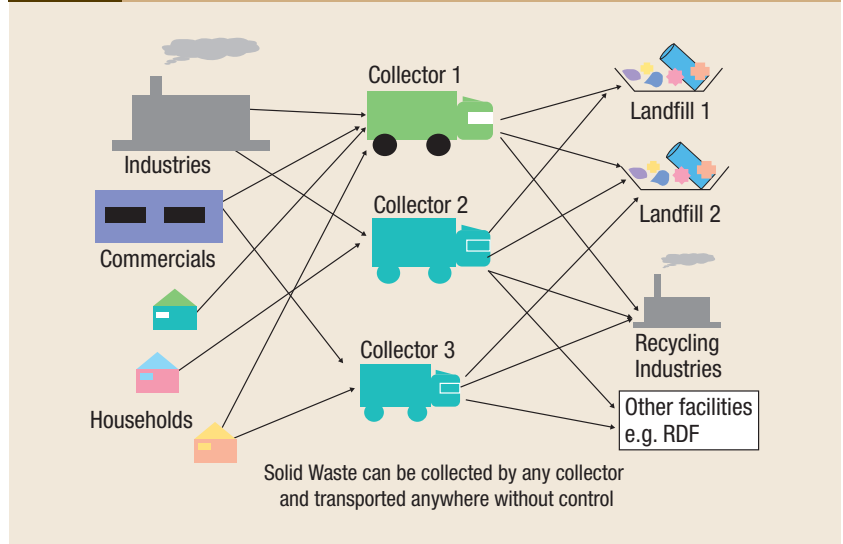
While the Act does not stipulate 'mandatory waste separation at source' or provision for 'user pays' funding, it anticipates the introduction of both of these requirements in future. There are also provisions for the Minister to require manufacturers to operate a 'product take-back' system, or to implement the 'extended producer responsibility' concept, but the intention is to ensure that the basic system is in place and running efficiently first.

being broken, worn out, contaminated or otherwise spoiled; or any material that... is required by the authority to be disposed of, but does not include scheduled wastes,... sewage,... or radioactive waste'. The legal instruments for dealing with hazardous waste come within the Environmental Quality Act and include substances that alter the quality of the environment or are potentially hazardous to health including objectionable odours, noise, radioactivity, and other physical, chemical or biological changes to the environment. However, there is no clear basis for coordination operationally in dealing with hazardous waste substances that are mixed in with municipal waste.

Hazardous waste is comprehensively regulated from generation to disposal. Hazardous wastes are listed in a schedule (now including e-wastes) and scheduled waste management activities are governed by the Scheduled Waste Regulations and Order, 2005. The order classifies the various types of prescribed premises from which such activities may be carried out. An integrated hazardous waste treatment and disposal facility has been operated by Kualiti Alam at Bukit Nanas since 1995, and is licensed by the Department of Environment to design, finance, construct, operate, and maintain the scheduled waste treatment system.

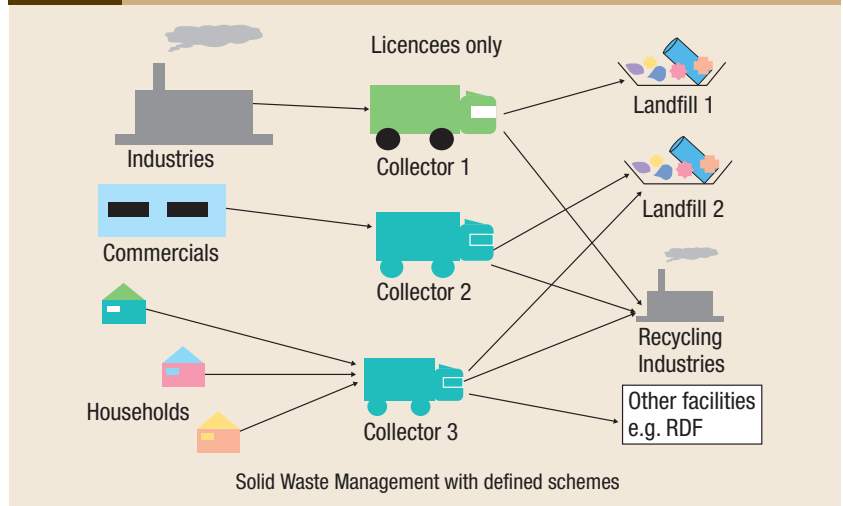
The key differences between the SWM system to 2007 and the SWM system from 2008 following the new legislation are illustrated in Figures 4 and 5. In the earlier system, solid waste could be collected by any collector, transported by any firm or vehicle, treated by any other party, and disposed of in any location. From 2008,

Figure 4 Solid waste management framework to 2007



Source: Project Final Report, 2007, Figure 4.2.

Figure 5 Solid waste management framework from 2008



Source: Project Final Report, 2007, Figure 4.3.

each stage of the solid waste lifecycle will be licensed. From the point at which solid waste becomes a controlled item, its travel path, mode of transport, collecting and transporting agency, and place of disposal will all be predetermined.

Choosing the Best Option for Solid Waste Management

Determining priorities in solid waste management

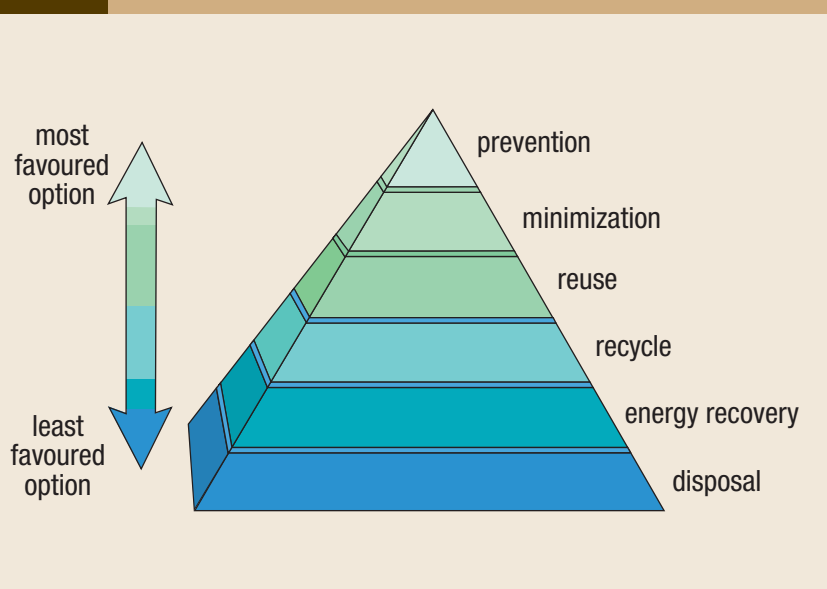
Agenda 21 of the United Nations Conference on Environment and Development in Rio de Janeiro in 1992 emphasized that reducing wastes and maximizing environmentally sound waste reuse and recycling should be the priorities in waste management since these not only promote environmentally sound practices such as resource recovery, but also reduce the amount of solid waste directed to landfill sites, and minimize landfill emissions of methane. While a hierarchy of options of this sort is widely favoured, in practice the decision on which option to adopt in any particular instance depends on cost, access to technology, availability of qualified personnel, and similar practical issues.

Solid waste management deals with the generation of waste, collection, and disposal, and the issues with each of these may vary depending on the types of waste and the locality. The Penang Solid Waste Management Project considered four options. The strategy that is eventually adopted could comprise a combination of more than one of these alternatives.

Business as usual option

Business as usual (BAU) reflects the current practice of waste management in Penang. Old newspapers and other recyclable items are removed from the waste streams and private contractors or concessionaires appointed by the municipal councils then collect the balance. Any other recyclables left in the waste are removed by private agents and NGOs which play an important role in collecting recyclable items.

Figure 6 The waste hierarchy options



Consequently, waste arriving at the transfer stations is largely free of recyclable material except for heavily soiled or damaged items with no market value.

Vehicles transport the waste to one of three weigh bridges in the state where it is weighed and the information recorded and used as the basis for charging; some is at a fixed monthly rate, other waste is charged according to whether it is domestic or industrial.

This scenario assumes that the national recycling target of 20% of solid waste is reached by 2020, up from just 8% in 2005. In 2005, the total waste generated in Penang was 0.99 million tonnes (about 1,864 tonnes per day), and this is expected to reach 1.54 million tonnes in 2020. About 10% of the collected municipal solid waste by weight is 'lost' as garbage is compressed in the collection trucks and leachate escapes. The waste is then transported to the Pulau Burong Landfill.



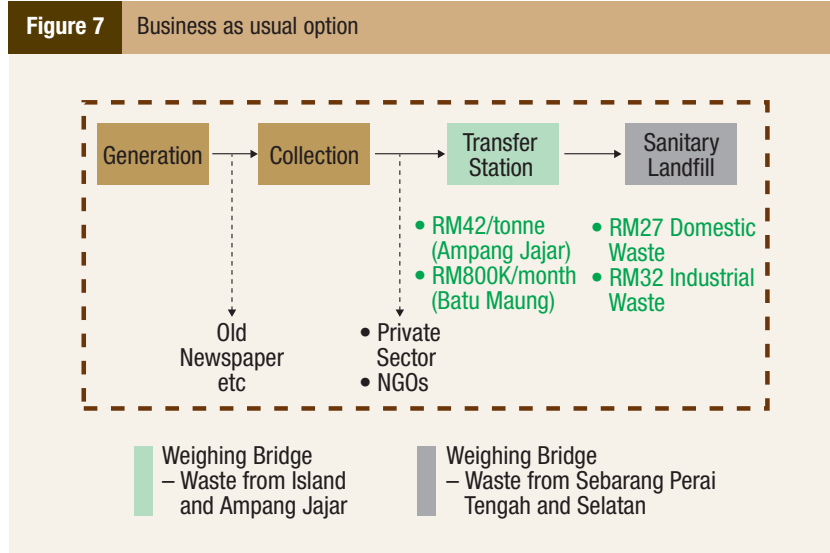
The critical issues of this alternative are:

- existing landfill capacity in the state is extremely limited;
- once capacity is reached, an existing facility either has to be expanded or an alternative site found;
- either way this represents considerable expense if the landfill site is to be developed according to best practice;
- using landfill to dispose of virtually all solid waste is an extremely inefficient method of dealing with the problem.

Composting option

Composting is the controlled decomposition of organic matter by micro organisms into a stable humus material. During composting, biodegradable organic materials are broken down to simpler forms by naturally occurring micro organisms (mainly bacteria and fungi) under predominantly aerobic conditions. The solid wastes of many developing countries are suitable for composting as they tend to contain a much higher proportion of organic material than developed countries. Composting systems can be operated at various scales: backyard, neighbourhood and large-scale centralized facilities.

The composting strategy relies heavily on biodegradable or compostable waste such as wet waste, especially uncooked or waste food and garden waste. Composting in an integrated solid waste facility involves the biological decomposition of the wet or organic waste portion of the solid waste. To be successful, this strategy requires the separation of all biodegradable waste at source: by households, and by food outlets such as



Source: Project Final Report, 2007, Figure 5.1.

coffee shops, food stalls and restaurants.

After separation, the high organic content waste will be directly transferred to a composting plant of which there would be five – two on the island and three on the mainland. The outputs of composting, which are largely determined by the quality and type of input material, would be compost, soil conditioners, fertilizers, and a growing medium for landscaping and gardening activities. There is also the option of using the finished product as cover material at the landfill site, both in the operational phase and as cover for the progressive restoration of the site.

In Penang, food waste has been estimated at between 35 and 45% of total waste, and the inclusion of other organic fractions raises this proportion even higher. In an integrated facility, the transfer station and the composting plant would be located together as a single unit, greatly reducing transportation costs. The most realistic scenario for Penang is to compost

20% of the organic fraction of the municipal solid waste.

To make composting a feasible option for Penang, detailed attention needs to be given to siting of facilities, quality of the input stream, level of technology, achievement of a substantial scale, and adequate market development. Experience suggests that the issue of establishing markets is likely to be the most serious barrier to a successful composting operation.

This scenario envisages that the current recycling rates would be increased by separating recyclables and organic waste at source, which currently is not done comprehensively. The recyclables would continue to be sorted and collected by the appointed agents. The remaining waste would be sent to the transfer station. In 2005, of the 13.5 million tonnes of municipal solid waste collected annually, 42% was organic waste, 43% was recyclable and 15% was non-recyclable.

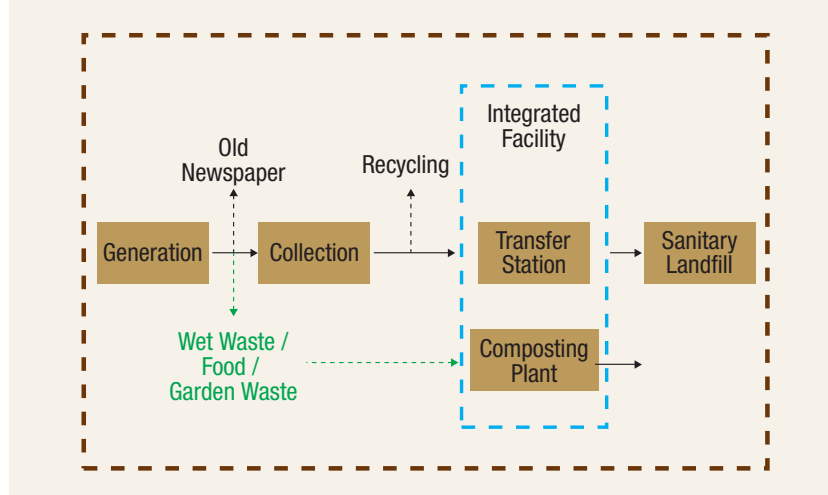
The benefits of composting are manifold. They include:

- production of a valuable soil amendment or mulch;
- removal of compostable materials, a major component, from the waste stream;
- flexibility for implementation at different levels from small backyard operations to large-scale centralized facilities;
- relatively low capital and operating costs;
- low-level technology requirements.

Critical issues for composting include:

- the capital costs of land acquisition, and construction and maintenance of composting plant;
- the operational costs of collection of

Figure 8 Composting option



Source: Project Final Report, 2007, Figure 5.3.

- biodegradable waste;
- the implications of increased frequency of collection;
- the challenge of achieving a high participation rate;
- the difficulties of establishing markets and marketing effectively;
- maintaining quality despite inexperienced staff and variable feedstock quality;
- the nuisance potential of odours and vermin.

According to UNEP, many centralized mechanical solid waste composting plants in Asian cities are not functioning effectively or have been closed down due to lack of a market for the compost, and poor standards of operation and maintenance of the facilities. However, composting technologies are well developed and composting is a viable option for solid waste management in Malaysia, since local climatic conditions are particularly favourable for biological decomposition processes.

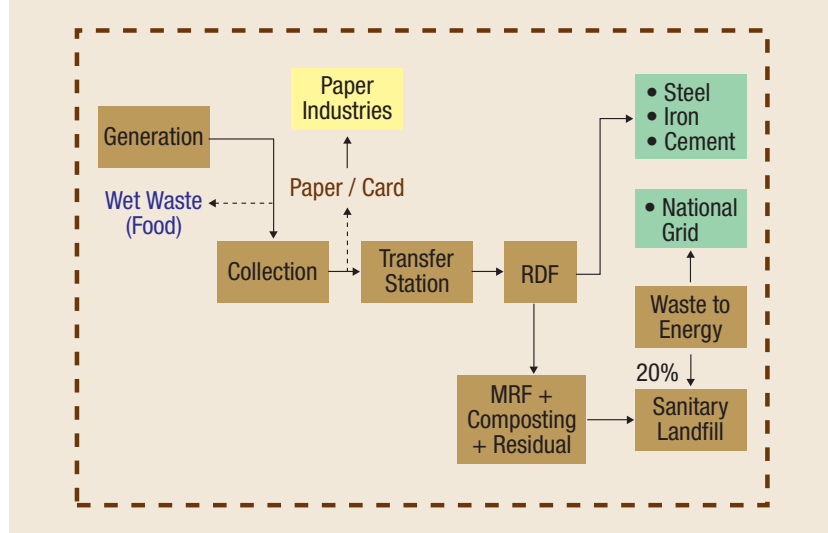
Refuse-derived fuel (RDF) option

RDF is based on a process that selects the high calorific fraction of municipal solid waste and converts it into a form that allows the generation of energy from the waste product. The key aspect of the process involves the separation of the non-combustibles from the high calorific combustibles, mainly dry residues of paper, plastics, and textiles, in the waste. This product can be palletized or processed in some other form for ease of storage and transportation. RDF can serve as a substitute for fossil fuel in high demand energy processes. Sound solid waste management can adopt this process as a complement to other processes such as composting.

RDF producers accept mixed solid wastes from which any remaining recyclable or non-combustible component is then removed. Usually a material recovery facility (MRF) is used to recover these non-combustible and recyclable items such as glass, plastic and metallic materials. The remaining material is then dried, shredded and processed into a uniform material to be used as fuel. Dry stabilisation may be used to dry materials through a composting process that produces a material of higher calorific value. Waste separation at source further enhances and expedites the operation of this system, but under the current voluntary arrangement, this is of limited benefit. Unwanted residues would be sent to the Pulau Burong sanitary landfill.

The RDF product may be in shredded, cubed or pellet form according to the market's feedstock demands, and is typically used as a co-incineration fuel for

Figure 9 Refuse-derived fuel option



Source: Project Final Report, 2007, Figure 5.5.

cement kilns, steelworks and iron industries. RDF can be used for co-combustion in coal-fired boilers, or by co-gasification with coal or biomass. If used locally, the energy generated could be bought by Tenaga Nasional Berhad and fed into the national electricity grid. Estimates indicate that less than 20% of the waste from utilising the RDF will remain as a residual requiring landfill disposal.

If RDF were to be adopted in Penang it would be used as a technique to complement composting. The critical issues for the RDF alternative are:

- waste separation at source;
- removal of toxic items and substances such as batteries;
- maintenance of quality and price to meet market expectations;
- the need for secure product markets;
- high electricity consumption in processing
- reliability and air pollution problems in processing plants;

- inferior quality compared to most other fuels;
- incompatibility with high rates of recycling of materials such as paper and plastics which provide much of the high calorific value for RDF.

Although Federal Government policy considers this alternative a viable option, at present there is no commercial entity operating in Malaysia to create a market for refuse-derived fuel. Given that the viability of any such operation would depend heavily on the quality of RDF and that no commercial arrangements dealing with either the use or pricing of such a product have been set in place to proceed with such a project, this appears not to be a practicable option in the immediate future.

Incineration option

Incineration, or thermal treatment, involves combustion of solid waste at high temperatures. Incineration converts waste materials into heat, gaseous emissions and residual ash. Incineration processes are among the most expensive solid waste management options and the plants require a skilled workforce for their operation and maintenance.

Incineration is an option for combusting waste and can be undertaken with or without energy recovery. Under the proposal, slightly less than half of the municipal solid waste would be incinerated and the remainder would be sent to the landfill without incineration. Wet waste, primarily food waste, would need to be separated out and pre-dried before treatment in an enclosed furnace at an extremely high temperature. Energy



recovery would provide a significant benefit in each case.

There are three main thermal processing systems: combustion, pyrolysis, and gasification. The need to screen and sort the feedstock would be dependent on which of these thermal treatment is adopted.

The combustion system requires solid waste to be burnt with 'excess air' (relative to the stoichiometric or ideal fuel/oxygen ratio) that will ensure that combustion is relatively clean and no combustible residue remains, all having been transformed to hot gases, water vapour and ash, with energy recovered by heat exchange. Large capacity stoker systems that combust solid waste with no pre-processing are commonly referred to as mass-burn incinerators. Those designed to burn processed solid waste, or refuse-derived fuel (RDF), are known as RDF-fired incinerators.

The pyrolysis system thermally decomposes solid waste at very high temperatures in the absence of oxygen. The process produces a mixture of combustible gases, liquid, and solid residues. Despite widespread industrial

uses, the pyrolysis of solid waste has not been very successful due to the inherent complexity of the system and the difficulty of producing a consistent feedstock from municipal solid waste. The combination of technological difficulties and high cost makes the pyrolysis system an unattractive option for a developing country.

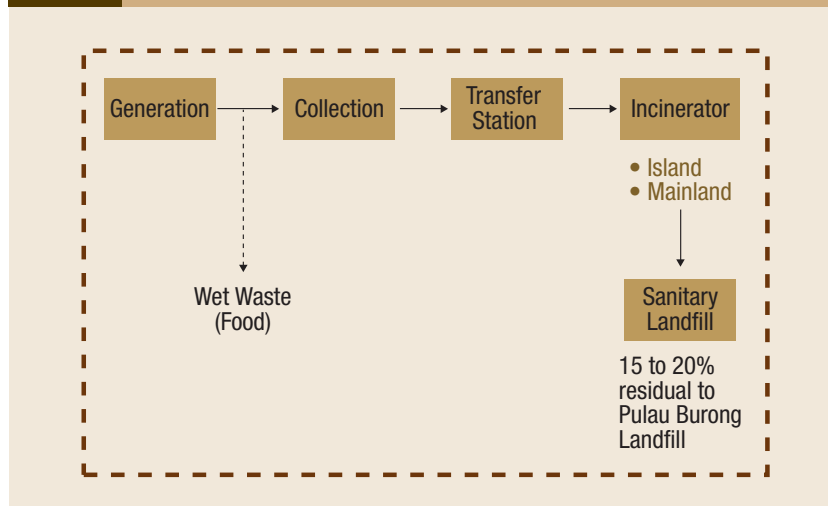
The gasification system involves the combustion of the solid waste with less than the stoichiometric amount of air to generate a combustible fuel gas. This method is more expensive than the combustible system, but it holds the greatest potential for future development because its air emissions are considerably lower than for an excess-air combustion system.

If there is a serious shortage of land for landfills, incineration is likely to be a favoured option for cities like Singapore, Tokyo and Taipei. Singapore operates three plants incinerating about 90% of the municipal solid waste collected daily. However, there is a major concern over the greenhouse and other gases released by incineration. In the United States this disquiet has reached such proportions that public pressure in many states and local authority areas has resulted in the decision to ban or strictly regulate the operation of incinerators. Consequently, use of incinerators has been on the decline over the last decade or more.

Advantages of incineration are:

- the original volume of the combustible solid waste can be reduced by 85-95% through incineration;
- the process provides for the recovery of energy in the form of heat;

Figure 10 Incineration option



Source: Project Final Report, 2007, Figure 5.9.

- incineration is an efficient way to reduce demand for landfill space in a heavily populated area;
- the technologies employed in mass-burn and RDF-fired incinerators are well developed.

The critical issues for this option are:

- high capital and operating costs make this the most costly option;
- skilled staff are required to operate the complex incineration plants;
- a significant amount of the energy generated is consumed by the use of the air pollution control equipment needed to clean up the flue gases;
- there are concerns about the health effects of hazardous components of the gaseous and particulate emissions;
- the safe disposal of the ash as the end product must be dealt with;
- a stable supply of combustible waste of at least 50,000 tonnes per year is needed to make incineration viable;

CHOOSING THE BEST OPTION FOR SOLID WASTE MANAGEMENT

- the large fraction of solid waste not suitable for incineration that would still go directly to the landfill.

Evaluation of the options for disposing of municipal solid waste

After reviewing all the options, their cost, and the selection criteria laid down by the EPU and the National Strategic Plan (NSP) for Solid Waste Management, the Study Team recommended the adoption of the composting alternative. The priorities of the EPU are to determine a least cost solution, and ensure that the life of existing landfill facilities is extended for as long as possible.

The NSP promotes the waste hierarchy in which waste reduction assumes the greatest importance followed by reuse and recycling. Application of treatment



technologies such as composting follows recycling, and this is followed by incineration (with some energy recovery) and finally dumping any remaining residuals in landfill. Composting fulfils the lowest cost requirement and is also compatible with the reduction, reuse, recycle requirements.

Table 7 Capital and operating costs for each option of SWM in Penang, (RM per tonne)

Alternative	Capital expenditure	Operational expenditure	Total
Business as usual (BAU)	957.53	160.39	1,117.93
Composting	848.06	184.20	1,032.27
Refuse-derived fuel-1 ¹	947.31	238.53	1,185.84
Refuse-derived fuel-M ¹	1,088.88	207.98	1,296.85
Refuse-derived fuel-2 ¹	1,188.12	223.13	1,411.25
Incineration	1,321.49	1,063.18	2,384.67

¹ Three possible versions of refuse-derived fuel (RDF) were considered.
Source: Project Final Report, 2007, Table 5.2.

Coordinating Stakeholders Strategies

Stakeholder consultation and cooperation

For the purposes of this project, a stakeholder was deemed to be any person, group or institution with involvement or interest in SWM activities, plans and programmes. As participants in this process in one role or another, the involvement of stakeholders is essential if SWM objectives are to be achieved.

An earlier UNDP-Penang Public-Private-Partnership Urban Environment (PPPUE) project provided useful experience in determining appropriate consultation methods and then developing informed strategies for achieving a vision of what might be achieved by SWM efforts in Penang. The intention of the current project is to fully engage all concerned stakeholders in environmental issues within their own localities. They need to be aware of the detrimental impacts of poor waste management practices on the environment in which they live. The biggest challenge is to change the behaviour of the numerous actual or potential stakeholders in the SWM system so as to encourage maximisation of waste reduction, minimize disposal and optimise waste material recovery.

The development of this proposed new solid waste management institutional arrangement demands that various stakeholders all play their complementary roles proficiently, particularly where this involves their direct involvement and participation. Residents, businesses, institutions and governments must take responsibility for reducing, reusing, and recycling the solid waste that they generate and in this way assist in minimizing landfill waste.

Consultative sessions in the form of individual and group interviews were conducted on both Penang Island and in Seberang Perai. A wide range of groups was consulted including owners and occupants, managers, officials, and operators of: high-rise dwellings; terrace and semi-detached houses; kampungs; hospitals; hotels; factories and small and medium-sized enterprises; hawker centres; restaurants; wet markets; developer and contractor enterprises.

From these interviews and consultations the Study Team identified three distinct target groups on the basis of their attitudes (in some instances coloured by their circumstances and location) towards getting recycling adopted: willing adopters, potential adopters, and reluctant adopters (Box 5).

Other stakeholders that must be included in the consultation process include community-based organizations (CBOs) and non-governmental organizations (NGOs), private recycling businesses, and local authorities.

CBOs and NGOs often serve as solid waste collecting centres in the community. Their methods and motives vary: some have permanent collection centres to store recyclables whilst others have recycling days for their members to bring or collect recyclables for sale to recycling agents. Most are raising funds for community projects of some sort. These operations could be supported and improved by:

- providing communal bins for different categories of waste at convenient sites;
- collecting wet waste daily;
- increasing participation rates by providing incentives;

Box 5 Stakeholder attitudes and behaviour

- **willing adopters** are those that would require little persuasion to get recycling adopted; they comprise the groups from wet markets, hotels, hospitals, and schools. Their feedback suggested that:
 - a better infrastructure is required (possibly as simple as extra receptacles) especially for food waste which is very bulky;
 - government needs to put the proper mechanisms in place;
 - a need for more public education and awareness campaigns;
 - organic waste needs to be collected daily;
 - incentives for separating waste would encourage the practice;
 - management needs to be supportive;
 - most of these groups need separate bins as sharing between private households/wet markets/hospitals/schools is unhealthy.

 - **potential adopters** are groups that generate a lot of waste which they want to dispose of but will require significant effort to persuade to establish a viable recycling programme. Notable features:
 - this group comprises mainly those from high-rise dwellings, where there is a convenient point source with high volume of waste but a low participation rate under the existing system;
 - many high-rise dwellings require proper provision of facilities for waste collection, and the proposal was made that it should be mandatory for developers to set aside space for collection of recycling materials and composting waste;
 - high-rise dwellings with rubbish chutes pose a serious problem because people are lazy when it comes to carrying their waste downstairs, and this makes waste separation at source almost impossible.

 - **reluctant adopters** comprise groups that are difficult to deal with and often dispersed; they would require considerable effort and substantial cost to get recycling adopted. The Study Team concluded that the following actions would be required if waste separation and recycling are to have any chance of success in this instance:
 - implementation of legislation requiring active participation;
 - introduction of mandatory programmes of waste separation and recycling;
 - development of a proper supporting infrastructure;
 - introduction of economic incentives;
 - introduction of appropriate mechanisms for dealing with different premises such as houses and high-rise dwellings;
 - a need for campaigns to educate, raise awareness, and change attitudes and behaviour.
-
- encouraging NGOs to clarify their objectives for recycling so that members can offer informed support;
 - involving NGOs as allies of the local authorities in the designing of programmes;
 - identifying, recruiting and training local champions among member organizations
- that are passionate in environmental protection programmes to run recycling activities.
- Private sector** participation in the recycling business extends from small-time itinerant collectors to big businesses, but all are integral to, and crucial components of

Penang's recycling network. This economic activity can be regarded both as a model of resource conservation and as an example of efficient materials utilization. Private sector participation could be extended if some of the following were put in place:

- establishing more drop-off recycling provision in shopping complexes;
 - providing incentives for private companies that are practising recycling and installing environmental protection equipment;
 - encouraging firms to collect and purchase bulky items such as furniture and obsolete equipment;
 - providing a mechanism to monitor highly volatile market prices of recyclable items;
 - initiating government intervention to provide subsidies when recyclable prices drop sharply;
 - reducing undercutting practices so that recycling businesses remain sustainable;
 - introducing tax incentives for purchases of recyclables processing equipment;
 - providing soft loans to businesses involved in recycling and material recovery.
- Local authorities** play a crucial role in ensuring that mechanisms for waste minimization are in place and running smoothly at all levels of stakeholder operation. They provide legislative and administrative functions as well as essential services to all participants. Strategies that might be adopted to enhance their role further in SWM include:
- setting up waste minimization units to oversee the SWM programmes;
 - setting up and maintaining an up-to-date website for recycling and waste minimization to promote community participation and activities;
 - developing a comprehensive plan and programmes for public awareness and education;
 - providing infrastructure support for recycling including: collection centres, separation and collection of household hazardous waste;
 - increasing the number of household hazardous waste collection points throughout Penang and setting up a household hazardous waste collection depot for items such as paint, oil, acids, aerosol cans and the like;
 - extending the e-waste collection programme to household electronic and electrical appliances such as refrigerators, washing machines, television sets, toasters, electric ovens, radios and the like, in collaboration with private recycling businesses;
 - setting up a mechanism for the collection of bulky furniture;
 - selecting appropriate technologies for material and resource recovery and composting at the municipal level;
 - making it mandatory for recycling businesses to register with the local authorities so that their activities can be monitored and regulated efficiently;
 - making it mandatory that registered agents and businesses submit monthly data returns on the recyclables collected.

Adopting Incentive Strategies



Optimizing participation by relating costs directly to services provided

Historically, most local authorities in Malaysia have funded solid waste services from property taxes irrespective of the quantity or toxicity of the waste being collected. Growing population numbers and consumption have resulted in increasingly large proportions of local authority revenues being devoted to SMW, whereas generators of solid waste effectively behave as if the services were free and the disposal of solid waste completely benign. No matter what demands they make on these services, the producers of the waste incur no additional cost and gain no benefit from producing less. This results in unnecessarily large amounts of discarded

solid waste with excessive environmental and financial costs.

A key component is the adoption of stable, long-term funding mechanisms that provide sufficient revenue for local and state programmes while providing incentives for greater waste reduction and diversion. They facilitate implementation and support the provision of SWM services that are efficient, environmentally and economically sustainable, and fair.

To date, recycling in Penang has largely been achieved as a result of unregulated market forces: aluminium and paper have achieved significant levels (while other items have not) because they have a resale value greater than the cost of collection. In these circumstances, private entrepreneurs are unlikely to undertake significant capital investment to systematically expand the

scale and breadth of their waste recovery activities. Consequently, most recycling of other materials is carried out in an informal manner by the staff of waste collectors who sort the waste as they haul it away, to complement their incomes.

This situation is exacerbated by the fact that the supply of recyclables is left mainly to the good will of the generators of the waste. Existing waste diversion activities rely almost exclusively on the goodwill, generosity, and dedication of hundreds of citizens, NGOs, charity organizations and businesses. But such voluntary efforts can only achieve limited results, and it is difficult to compete against the provision of kerbside collection services that appear to be free and demand no effort to separate out reusable or recyclable items. To a large extent, these factors explain why recycling rates in Penang have not risen above about 10–15% and are even lower in the rest of Malaysia.

A key recommendation of the project is therefore that participation in recycling programmes should be made mandatory. A phased-in approach targeting specified types of waste and selected waste generators is more likely to be successful than an attempt to target all waste and all generators. Where products are not



discarded or replaced frequently it may be more effective to require retailers and manufacturers to implement take-back systems as part of an extended producer responsibility programme. Tyres, batteries, electronic waste and cell phones would be in this latter category.

A comprehensive waste separation and recycling programme needs to be accompanied by an appropriate monitoring and data collection system not only to determine the economic benefits of the programme, but to provide an informed basis for future planning. Introduction of user pays charges creates an incentive for households and enterprises to reduce their production of waste, but the main purpose would simply be to recover the cost of providing collection and treatment services.

Implementing the Penang Solid Waste Management Model

Implementation of the Penang SWM model will occur in stages

The proposal for institutionalising and structuring SWM in Penang within the new framework was approved by the project's National Steering Committee in December 2006. At the national level, during 2007, parliament passed the Solid Waste and Public Cleansing Management Act, the main tenets of which underpin the institutionalisation of strategies and procedures for solid waste management. This development has enhanced the efficacy of the project proposals, and the findings provide the Federal Government with information at the local level that can assist and facilitate in the implementation of the new regulations.

The timely introduction of the legislation means that, while a significant period is likely to elapse while organizational, administrative and physical facilities and infrastructure are put in place, the basic strategic directives and regulatory provisions have been introduced for implementation of the SWM model developed for Penang. This means that the system in operation prior to the new SWM framework, where waste was transported by any means to any number of destinations, and recycling was voluntary and largely determined by market forces, can now be superseded. Waste will be collected by licensed operators and sent to designated facilities to be recycled or to be treated and disposed of by approved technologies (Figures 4 and 5).

Stage 1: Initial phase

In Stage 1, the informal system of recycling and waste management would be replaced by a mandatory system implemented and enforced at the local authority level. The entire industry will be licensed, service standards will be defined and the industry regulated according to the principles laid down in the Act. This means that SWM is federalised in the sense that the federal ministry will set the standards, introduce key performance indicators, specify the nature of the service, and determine levels of payment. With institutionalization, all solid waste would follow a predetermined channel for collection, transportation, recycling or treatment and disposal of residue. It is anticipated that the 12–15% of solid waste that is already removed from the waste stream will increase significantly so that 85–88% no longer goes for disposal in the landfill without any further reduction or treatment.

Treatment procedures would also be introduced during this stage, as soon as the infrastructural requirements could be constructed. A materials recovery facility (MRF) will be needed at an early stage to replace the transfer station at Batu Maung which is the site on Penang Island of the second bridge crossing from the mainland that is about to be constructed. An MRF would enhance the capacity for the recovery of recyclable materials and will have to be constructed soon at an alternative site. It is also intended that the composting of food, green and other types of organic waste should also commence

during this first stage. However, this major step forward depends not only on the construction of composting facilities but also on the successful separation of organic waste from the remainder of the waste flow.

The role of local authorities changes under the new SWM Act. During the first year, contracts with waste collectors will be novated to the three federally contracted concessionaires (Alam Flora, Southern Waste Management and E-Idaman), and the status quo on existing contract payments, where they exist, will be honoured. These concessionaires, who have already been operating over the three regions into which the peninsula is divided for waste management purposes, will now have a concession agreement with the National Solid Waste Department instead of local authorities. The Public Waste and Public Cleansing Corporation will take over the supervisory and monitoring role of the local authorities and carry out enforcement.

The main role of local governments will be promoting the implementation of the new recycling-composting strategy. This will involve development of action plans that identify target groups and institute social programmes to raise public awareness, encourage reduction in waste generation, increase recycling, and activate effective waste separation at source. These activities are essentially a continuation of the strategy already being followed by the two local authorities in Penang.

The transition process will be expedited when the National Solid Waste Department, through the concessionaires, achieves its intention of issuing two free bins to each household, for recycling and organic wastes. The Director General of the



Department is also reported as saying that information on solid waste management will be disseminated for up to two years, at the end of which time it is intended that the Act's provisions for mandatory sorting at source will be implemented. He stated that immediate introduction of this requirement throughout Peninsular Malaysia is considered unreasonable. In fact, many states and local authorities do not have solid waste management systems that are as advanced as that of Penang.

By the end of Stage 1, which is expected to last for up to two years, it is envisaged that the new SWM system will be in place and the major problems of implementation resolved. While somewhat dependent on Federal Government action in setting up the new organizational and physical infrastructures, it is to be expected that institutional coordination will have been achieved for the handling of household hazardous wastes, market based instruments arranged to manage the various fractions of municipal waste, and payment systems agreed. By this time also,

public awareness of the new regime and its requirements should be much more widespread, and the 'willing' category of adopters recruited to active participation in the 'reduce, reuse, recycle' enterprise.

This first stage will confront all participants with a steep learning curve as they attempt to implement the new SWM framework. It will require a high level of cooperation between the local authorities, the state government, and the new SWM Corporation in parallel with a programme of education and increasing awareness among the public at large. The state government is envisaged to play an important role in determining the strategic direction for managing SWM, introducing the new technologies, and resiting the requisite infrastructure to achieve the framework's objectives.

Stage 2: Expansion phase

With the basic elements of the new SWM system in place and the administrative and physical infrastructure required by the Act becoming more comprehensively available, this stage would be looking to involve more groups, notably the 'potential adopters', as participants in the programme. If the mandatory requirement for waste separation has, in fact, been implemented by this time, incorporating a much larger section of the public in actively pursuing the reduce/reuse/recycle principles will be greatly facilitated. Product take-back, which has been adopted in some more industrialized countries for waste such as batteries, electrical appliances, tyres and construction materials, is being considered but may take longer to introduce.

Incentives for product take-back are more likely to take the form of facilitation, as with allowing the importation of the necessary equipment tax free, rather than as monetary incentives.

With respect to the treatment technologies, the refuse-derived fuel (RDF) option could be introduced during this phase. With the MRF technology introduced at Stage 1 enhancing the separation at source process, the RDF option could operate on top of the separation/compost strategy to achieve higher levels of recycling and recovery, and reduce further the residue being directed to the landfill.

Stage 2 expansion is likely to take something between two and five years to complete. Any remaining organizational and infrastructural requirements not completed in Stage 1 should be achieved early in this phase and by the end of Stage 2 it is to be expected that at least 15% of the solid waste will have been removed by collection for recycling, a further 15% by processing at a material recovery facility (MRF), and another approximately 20% by composting treatment, leaving about 50% for disposal in a landfill site. Formal procedures for disposing of household hazardous waste, and of construction and demolition materials, will also be put in place during this period.

If data collection systems have not been set up earlier they would be a priority in this stage of the implementation of the solid waste framework. Accurate and comprehensive data are essential in order to enable the analysis of requirements and enable effective planning for expansion and improvement during this and the

following stage of the project. This would enable the refinement of the Study Team's estimates (summarized in Table 8) on the basis of actual experience of the SWM framework's operation.

Stage 3: Replication and refinement phase

The efficacy of the new SWM model having been demonstrated, greater involvement of the public and further development of social networks is to be expected. Guidebooks and manuals describing standard operating procedures will be readily available, and public awareness campaigns will still be continuing. Well-established procedures and the mandatory waste separation requirements would provide strong leverage to ensure widespread participation by all economic and social sectors including the 'reluctant adopters' group.

Fine tuning of the system is likely to be necessary to ensure that the system is sustainable by being cost effective: contracts must be delivering efficient services and reasonable returns to the contractors; and waste processing procedures and technologies must be providing effective solutions acceptable to the public. At some point, after sustained education and awareness efforts have been widely promoted, user pays and polluter

Target Year	Amounted generated (tonnes/day)	Percent recycled	Percent composted	Percent converted to RDF	Percent landfilled
2010	1,454	13	8	5	74
2015	1,580	17	17	5	61
2020	1,705	22	25	5	48
2025	1,855	26	34	5	35

Source: Project Final Report, 2007, Table 8.1.



penalties will need to be introduced, and other instruments applied to influence behaviour and ensure compliance in the interests of the wider society.

Actioning a Pilot Project

Benefits of a pilot project

To facilitate gaining a head start on the steep learning curve that implementation of the SWM framework presents, the Study Team proposed a pilot project in Stage 1. The objective of the pilot project would be to develop prototype systems, to study the behaviour of groups, and to learn lessons to be passed on to facilitate Stages 2 and 3. The pilot project would work within the new legislation and the plans already in place at the federal, state and local government levels. These key lessons would reduce the cost and smooth the path of the SWM framework's implementation.

Malaysia will implement the Solid Waste and Public Cleansing Management Act 2007, on 1 January 2008. With the new Act, all waste operators, recyclers, and organizations engaged in any activity that involves controlled solid waste will be required to obtain a licence. A pilot project would assist in finding ways to implement the Act in ways that invite the least resistance from the public, the firms and the institutions that have to operate within its jurisdiction.

At the state level, Penang needs to find an alternative to the Batu Maung Transfer Station which has to be replaced because of the second bridge's construction. Currently the state government, whose responsibility it is, is considering using the Jelutong landfill site to build a material recovery facility to compost organic waste and reduce the amount of solid waste being transported to Pulau Burong landfill.

A pilot project that follows up the main study described here, can help to find the most effective way to carry out waste separation at source (especially at

household level), determine ways to improve recycling and reduce the amount of solid waste that needs treatment and disposal. The local authorities will adapt their roles from being directly responsible for managing solid waste to partnering the Federal Government in monitoring, evaluating and enforcing the Act. They will, however, continue promoting source separation, recycling, and the broader issues of public awareness and education.

Implementing the pilot project

The main objectives of the pilot project will be:

- to study the potential for implementing mandatory waste separation in selected residential and commercial areas in Penang;
- to undertake at a pilot level the composting of the organic solid waste fraction so as to reduce the solid waste flow to the landfill;
- to use various methods for segregating, transporting and managing household hazardous substances beyond the household level.

The pilot project would consist of three components and be implemented in selected areas of the state, as follows:

- introduce households to a 2-bin system, one for organic food waste and the other for the rest of the solid waste;
- establish a system for collecting household hazardous waste;
- develop a programme to raise awareness and build capacity to ensure households understand and participate in the solid



waste separation and recycling activities. The sites for implementation of the pilot project will be high-rise apartments; landed properties on Penang Hill; and a wet market in Seberang Perai, to test separation of waste at source and participation in community composting. The following matters are expected to be addressed:

- introduction of waste recycling awareness training;
- development of a community composting system where organic waste is deposited and composting activities can be undertaken at a nearby site;
- design of economic incentives to influence behaviour.

These measures will provide data, test systems, and provide demonstration sites that can be used throughout Penang to explain and encourage participation.

The pilot project will be undertaken under the auspices of the federal Solid Waste Management Corporation, the Penang state government, Penang local authorities (MPPP and MPSP), and local communities including residents and market associations, with the assistance of a local consultant for twelve months.

Lessons Learnt

- Ensuring as far as possible, that all appropriate data and information are accessible and able to be used for the project is a primary consideration. Unavailability of the requisite information because records are withheld or are otherwise not available, poses serious problems and may necessitate adopting assumptions that are difficult to validate.
- Continuing issues in raising awareness and achieving public cooperation in dealing with the various aspects of solid waste management have shown that capacity building still requires immense time and effort. Even when progress has been made on some issues, continuous follow up and encouragement is required to consolidate achievements.
- Gaining stakeholder confidence and cooperation is essential if strategies being put in place are to succeed. Carrying out the tasks specified in the project document required the active cooperation of all stakeholders. In addition to the efforts of the Study Team, this was achieved through the participation and support of the relevant federal and state government agencies and both local authorities.
- Ensuring efficient communication with stakeholders is essential, particularly with those such as the state government and local authorities that have their own statutory obligations, strategies and regulations. This is especially important in order to ensure that a project's objectives and recommendations accord with broader strategies and plans at all levels.
- Understanding and empathizing with local circumstances and conditions is essential since implementation of strategies and plans is heavily dependent on local political, financial and other socio-economic resources and requirements. Solid waste management is a global problem that requires a local solution.
- Recruiting local expertise to work on a project such as this is highly desirable but can prove to be difficult because qualified, experienced people are frequently not available.

ISSUES AND CHALLENGES

- Implementing the SWM framework in Penang under the provisions of the 2007 Act will require active cooperation between all levels of government, especially where responsibilities have shifted between local authorities and the new federal agencies that have been created.
- As long as participation in the waste management system and in waste separation remains voluntary under the new Act and there is a virtual absence of direct incentives, major effort will be required through awareness campaigns and education measures to encourage households, businesses and institutions to improve their performance in waste reduction, reuse and recycling.
- The issue of mixed waste in the municipal waste stream makes its sustainable management problematic. Under the new Act, there is provision for compulsory waste separation at source, but until this provision is implemented effective management of scheduled (that is, mainly hazardous) wastes will be difficult to carry out effectively in the best interests of the public.
- Despite the new legislation, the difficulties envisaged by the Study Team in dealing with other waste fractions such as discarded tyres, electronic products and construction waste seem certain to persist because responsibility is uncertain and appears either to fall between agencies, or to suffer from weak enforcement provisions.
- Capacity building is required to improve solid waste management. More experienced staff are required at all levels of government to overcome skills shortages and skills deficits in organizing local communities, promoting recycling and composting, consulting the public, managing contractors and service providers, monitoring performance, and developing key performance indicators.

SOURCES OF INFORMATION

Goh, L (2007) Serious About Managing Solid Waste, *The Star Online*, October 25.
<http://thestar.com.my>

Government of Malaysia (2007) *Solid Waste and Public Cleansing Management Corporation Bill 2007*, D.R. 25/2007.

Government of Malaysia (2007) *Solid Waste and Public Cleansing Management Bill 2007*, D.R. 26/2007.

Leete, R (2007) *Malaysia: from Kampung to Twin Towers: 50 Years of Economic and Social Development*, Oxford Fajar, Shah Alam, Malaysia.

Malaysia Economic Planning Unit (2001) *Eighth Malaysia Plan 2001–2005*, Kuala Lumpur, Malaysia.

Malaysia Economic Planning Unit (2006) *Ninth Malaysia Plan 2006–2010*, Kuala Lumpur, Malaysia.

Malaysia Local Government Department, Ministry of Housing and Local Government (2003) *National Strategic Plan for Solid Waste Management, Volume 1: Draft Strategic Plan*, unpublished.

Nadzri Yahaya (2007) *Solid Waste Management*, presentation to UNDP Conference on Climate Change Preparedness, Deputy Director General, National Solid Waste Department, Kuala Lumpur.
http://www.undp.org.my/uploads/files/c_Solid_Waste_Management_MHLG.pdf

SKAT (2007) *Sanitation Connection: Introduction to Solid Waste Management*.
<http://www.sanicon.net/titles/topicintro.php3?topicId=4>

Tan Cheng Li (2007) Cautious Act, *The Star Online*, July 10. <http://thestar.com.my>

UNDP (2005) *Structuring and Institutionalising Solid Waste Management in Penang*, Project Document, unpublished.

UNDP (2007) *Structuring and Institutionalising Solid Waste Management in Penang*, Final Report, October, unpublished.

UNEP (2005) *Solid Waste Management*, Volume 1. United Nations Environment Programme, Nairobi.

United States Environmental Protection Agency (2007) *Municipal Solid Waste*.
<http://www.epa.gov/msw/facts.htm>

Waste Management Association of Malaysia. <http://www.wmam.org>

World Bank (2004) *Toolkit: Social Assessment and Public Participation in Municipal Solid Waste Management*. <http://www.worldbank.org/urban/uswm/socialassesstoolkit.pdf>

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