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MUNICIPAL SOLID WASTE MANAGEMENT STRATEGY FOR MALAYSIA: LESSON LEARNED FROM THE UNITED KINGDOM EXPERIENCES.

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Abstract

The rapid growth of urban areas in Malaysia has led to an increase in the generation and complexity of its municipal solid waste. The amount of municipal solid waste generated is estimated to be 8 million tonnes per year by the end of 2000. Realising the problem, this research was conducted to analyse quantitatively experiences learned from the United Kingdom (UK) upon the success through their municipal solid waste management system set-up which includes enforcement, legislation, economic instruments, education, institutions involved and other related issues. In order to achieve that, comparative studies were conducted between United Kingdom and Malaysian practices which included selected local councils, namely Dundee City Council (DCC) in the UK and Majlis Perbandaran Petaling Jaya (MPPJ) and Dewan Bandaraya Kuala Lumpur (DBKL) both in Malaysia to identify and how to overcome the problems. Apart from the above objectives, this research suggests that:

The most effective environmental solution is to reduce the generation of waste through reduction;

Where further reduction is not practicable, products and materials can sometimes be used again, either for the same or a different purpose that is through re-use;

Failing to do that, value should be recovered from waste, through recycling, composting or energy recovery from waste;

Only if none of the above offer an appropriate solution should waste be disposed of.

This is the best hierarchy for Malaysia to adapt in its future municipal solid waste management strategy.

In conclusion, this research showed that Malaysia's municipal solid waste management system and strategy have to be developed in term of its legislation and policy, the enforcement system, guidelines and target to be achieved and education as the key in developing awareness and knowledge.

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Abbreviations

Countries

M	Malaysia
UK	United Kingdom
US	United States of America

Organisations

AEA	UK Atomic Energy Authority
BSI	British Standard Institution
CEC	Commission of the European Communities
DBKL	Dewan Bandaraya Kuala Lumpur (Kuala Lumpur City Council)
DC	District Council
DoE	Department of Environment
EA	Environmental Agency
EC	European Community
ENDS	Environmental Data Services Ltd.
EEA	European Environmental Agency
EU	European Union
HMIP	Her Majesty's Inspectorate of Pollution, England and Wales
HMIPI	Her Majesty's Industrial Protection Inspectorate, Scotland
ISO	International Standards Organisation
IWM	Institute of Waste Management
JICA	Japan International Co-operation Agency
MC	Municipal Council
MHLG	Ministry of Housing and Local Government of Malaysia
MITI	Ministry of International Trade and Industry of Malaysia
MPPJ	Majlis Perbandaran Petaling Jaya (Petaling Jaya Municipal Council)
NRA	National Rivers Authority, England and Wales
NREL	National Renewable Energy Laboratory
OECD	Organisation for Economic Co-operation and Development
RAGS	Recycling Advisory Group, Scotland
RCEP	Royal Commission on Environmental Pollution, UK
SEPA	Scottish Environment Protection Agency
SIRIM	Standard Industrial Research Institute of Malaysia
UNCED	United Nation Commission of Environmental Development
UPM	University Putra Malaysia
USEPA	Environmental Protection Agency of the US

WHO	World Health Organisation

Terms

ABC	Action Plan for a Beautiful and Clean Malaysia
BAT	Best Available Technology
BATNEEC	Best Available Techniques Not Entailing Excessive Cost
BOD	Biochemical Oxygen Demand
BPEO	Best Practicable Environmental Option
BPM	Best Practicable Means
COD	Chemical Oxygen Demand
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EPA	Environmental Protection Act 1990, UK
HDPE	High Density Polyethylene
HHW	Hazardous Household Waste
IPC	Integrated Pollution Control
IPPC	Integrated Pollution Prevention Control
LCA	Life Cycle Analysis
LDPE	Low Density Polyethylene
MDPE	Medium Density Polyethylene
MRF	Materials Recovery Facility
MSC	Multimedia Super Corridor
MSW	Municipal Solid Waste
NEPP	National Environmental Policy Plan.
NFFO	Non-fossil Fuel Obligation
NIMBY	Not-In-My-Backyard
NPPG	National Planning Policy Guideline
OPP	Outline Perspective Plan
PE	Polyethylene
PET	Polyethylene terephthalate
PP	Polypropilene
PS	Polystyrene
PVC	Polyvinyl Chloride
RA	Risk Assessment
RDF	Refuse Derived Fuel
VOCs	Volatile Organic Compounds
WMP	Waste Management Paper

Measurements

kW	Kilowatts
km	kilometre

m	metre
MG	Megawatts
ppm	parts per million

MUNICIPAL SOLID WASTE MANAGEMENT STRATEGY FOR MALAYSIA : LESSON LEARNED FROM THE UNITED KINGDOM (UK) EXPERIENCES

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CHAPTER 1
INTRODUCTION

1.1 Nature of Waste

All products at the end of their useful lifetimes, become waste. In other words waste is any material that is discarded or is a surplus. Since the beginning of life on earth, man created these materials. It is an inevitable part of human activity and the natural world. Naturally, waste is classified as a by-product produced in the growth process, which is a production system of living organisms. On the other hand, living things, when they die, ultimately become waste. But the difference between waste created by man and that created by the production system of organisms is that nature can deal with its own waste effectively, but not with man's created waste.

As time passes, population growth followed by economic development and the consequent changes of life style increase the amount of waste produced. Waste becomes more complex. It has been since the Industrial Revolution that the amount and variety of waste has grown enormously. During this era, waste has been a by-product of industrial processes. Such waste has been managed only in the simplest, quickest and cheapest possible way. It has been disposed of into air, water and land with no environmental, economic and health consideration of the results. Waste management was not seen as an important issue. This technique of disposal did not show any significant problem because at that time people were unaware of the danger and land was in ample supply.

1.1.1 Increasing problem

Waste was realised to be a problem when the size of urban settlements increased. The practice of dumping waste into water and land without any control led to spreading of

disease by rats, parasites and insects. In 1967, the U.S Public Health Service reported that there are 22 human diseases, which are related to, inappropriate of solid waste management. Thus it became a health hazards. The natural world is therefore a crucial starting point in understanding and studying the environmental problem caused by waste and how it should be developed.

Basically, there are similarities in setting up strategies used to overcome waste disposal. In most cases, waste is considered independently of its sources, properties and distribution. Actions to be taken are concentrated on how to store, collect and dispose. Commonly used waste disposal methods are landfill, incineration, physical and chemical treatment and sea dumping. But today we realise that solution involves complex interdisciplinary relationships. It involves fields such as sciences, engineering, planning, politics, economics as well as public health (Tchobanoglous *et. al.*, 1993). Working on waste management includes financial, legal, administration and technical actions. Therefore the task of waste management is to provide management at all levels of scale and across many sectors of responsibility.

1.2 Notion of Sustainability

According to Reddy and Sarma (1992), our increasing dependence on energy resources for technological and economic advancements and the pressure on land supply must now be overcome by tackling the interest of long term viability of the earth as a habitable planet. Therefore, sustainable development should become the objective of all nations. It should be used as a basic principle to solve environmental problems for present and future generation.

Sustainable development is about the need to recover and retain the capacity of the ecosystem to renew itself and to support an economic system and life itself. Even though it cannot be done in all cases, it invites innovation of new technologies and new

ideas on economic techniques and formulation. In the Brudtland Report 1987, the World Commission on the Environment and Development mentioned that the whole world should strive towards sustainable development to meet the needs of the present without compromising the ability of the future generations to meet their own needs. To reach our aim of sustainable development will involve energy saving which will increase the efficiency and application of renewable of energy sources, to improve the quality of products, processes, raw material and waste, so that these substances can be reused in an economical cycle. In this context, the most important step is to close the cycle of substances in the chain from raw material to waste, using better management and conservation of raw material, and thus help to prevent burdening the environment with non-degradable or less degradable substances.

1.3 Role of Waste Management in Sustainability

In achieving sustainable development through better waste management there are principles of waste management which are widely accepted:

- *The proximity principle* indicates that all waste should be dealt with as close as practicable to where it is produced. It also encourages and helps to develop awareness to local people that the waste they produce is a problem that they have to deal with. This principle is also used as a tool for planning when considering the requirements and locations for waste management facilities. The second concern is to reduce transport of waste by road in order to reduce the emissions to air.
- *The polluter pays principle* indicates that the full cost of disposing of waste safely should ultimately be paid by the producer of the waste, thus providing an incentive to minimise the quantity and toxicity of the waste produced.
- *The precautionary principle* is perhaps more controversial, but it indicates that where waste is concerned it should not be necessary to prove cause and effect (i.e.

link between the waste and an effect on the environment) before taking steps to reduce to eliminate the potential that may exist.

Source: Haines, 1995 and Scottish Office, 1996.

Waste and management of waste has become a global issue. There is no exact law on waste management until people realise the impact of waste on the environment and problems on sustainable development. Roles of authorities and legislation have been mainly considered as part of waste management. In all industrialised countries, much legislation on waste has appeared during the past 20 years, but it seems that not one single country can yet claim to have resolved its waste problem. Therefore the discussion on how to legislate will continue. Whatever the law will be, there should first be agreed principles and objectives to guide all nations affords to formulate legislation.

1.4 Link To Wider Environmental Policy

Environmental policy aims at preserving, protecting and improving the quality of the environment, thus contributing towards protecting human health and the quality of life. In the United Kingdom (UK) for example, there are two basic concepts, which govern waste management: the best practicable means (BPM) and the best practicable environmental option (BPEO). BPM was originally applied to air pollution caused by alkali works. It has now also occupied the methods of tackling pollution in land and water. The aim of BPM is to prevent pollution and also to render any pollution that cannot be tackled practically. BPM is practised by the adoption of the course of action that best takes account all of the relevant factors such as financial implications, current knowledge of the effect of pollutants, present state of development of relevant control technology and the contribution of the manufacturing process or the disposal plant to the total load of the pollutant (Tripper, 1990).

There is a number of directives adopted by European Community (EC) based on the principle of the best available technology not entailing excessive cost (BATNEEC), essentially the same as BPM. The best available techniques (technology, operation or management practices) are used to prevent, or if it is not practicable, to minimise the releases of prescribed substances into the medium for which they are prescribed. Whereas, the concept of BPEO (Best Practicable Environmental Option) is used when a process is likely to involve releases into more than one environmental medium. This concept is on the need for finding the ultimate disposal method for each particular waste that will cause least damage to the environment. BPEO as defined by The Royal Commission on the Environment of United Kingdom in its 12th Report (RCEP, 1988) as:

"A BPEO is the outcome of a systematic consultative and decision making procedure which emphasises the protection of the environment across land, air and water. The BPEO procedure establishes for a given set of objectives, the option that provides the most benefit or least damage to the environment as a whole at acceptable cost in the long term as well as the short term".

In other word, BATNEEC, which includes references to design, construction and layout, is used to achieve BPEO. In conjunction with the above philosophies, waste disposal techniques must be built and designed upon the BPEO and BATNEEC which draw together the need to:

i. find the optimum blend of waste minimisation, treatment and disposal methods.

ii. protect the environment.

iii. have regard of the cost to the local community.

iv. take every opportunity to use waste as a resource.

Not only in developed countries, the urgent need for environmentally compatible waste management to protect the environment at a world-wide level and an international environmental partnership also involves developing countries (Topfer, 1990).

1.5 Public Awareness

To achieve waste management, the participation of society is required. The causes of environmental disturbances due to waste management must therefore be sought, predominantly in the early stages that are in the product design and production stages. We as consumers also have a responsibility for the situation of the way we handle and discard used materials.

To be a sustainable community, both urban and rural communities will need to make significant advances toward sustainability over the coming decades using the best environmental technologies appropriately and wisely.

For better waste management in the future we should innovate research, development and demonstration programmes to reflect a broadening focus from reacting to environmental damage to anticipating and avoiding it. We need also to produce more while using fewer natural resources and less energy, without forgetting the cost-effectiveness and the existing regulations, which must be adhered to.

1.6 Research Objectives

The objectives of this study were to analyse quantitatively and propose lessons learned for the Malaysian municipal solid waste management strategy from various experiences of other countries generally and from the UK particularly. In order to learn the experiences, this research intends:

i to study the formation of legislation in the major focus country on solid waste and its related issues.

ii to learn the implications of legislation and economic instruments in solid waste management from experiences in other countries particularly United Kingdom.

iii to assess whether the present waste hierarchy which suggests that *the most effective environmental solution is to reduce the generation of waste through reduction, where further reduction is not practicable, products and materials can sometimes be used again, either for the same or a different purpose that is through re-use; failing to do that, value should be recovered from waste, through recycling, composting or energy recovery from waste, only if none of the above offer an appropriate solution should waste be disposed of* is the best hierarchy for Malaysia to adapt in its future municipal solid waste management strategy.

iv to provide technical experience on present solid waste management practised in the UK from case studies presented.

v to identify and analyse problems which arise among urban local authorities (in this research, two local authorities in Malaysia were chosen) in the management of municipal solid waste.

vi to identify various available options, mechanisms and delivery modes to improve municipal solid waste management in Malaysia

vii to develop and recommend a municipal solid waste management strategy for Malaysia: at National, Regional and Local levels, where lessons learned from the UK are taken into account.

1.6.1 Research methodology

This study is a qualitative research project, which involves various parties and sources. Research was conducted between October 1994 to May 1998. Within that time frame, the research task was divided as follow:

Time-frame	Research task
October 1994 - May1998	• Literature search and analysis • Documentation search and analysis • Multi media search and analysis (via newspapers and internet/website)
• March 1995 - April 1995 • August 1996 - September 1996 • January 1997 • May 1997 • June 1997	Conducted interviews in the UK
• June 1995 - July 1995 • October 1995 - November 1995	Practical attachment with Mabbett & Associates - Environmental Engineering Consultant.
January 1996 - April 1996 January 1998 – May 1998	Field studies conducted in Malaysia which involves interviews, documentation analysis and site visits. Because of the privatisation of solid waste management, interviews involved two of the private companies: Alam Flora and Northern Waste.
• June 1995 • June 1997	Site visits and observations in United Kingdom

The scope of the research is mainly on the municipal solid waste stream and activities, therefore the parties that provide and use this services are the main focus. Because of the self-explanatory nature of this research, most of the data gained are from literature,

government and non-government documentation and media review and analysis. Interviews and site visits were conducted in order to understand and experience the practical observation. On the other hand, these interviews are also used to fill in the gaps concerning policy and legislation application in the action taken by both countries. A practical attachment with Mabbett & Associates Environmental Engineering Consultant, a US Company based in Scotland was arranged to provide the author with practical experiences on how a technology concept of a country could be adopted in another country.

In Malaysia, most data rely on interviews, personal contact and observations, which were used directly and indirectly in the research presentation. Among the problems occurred during the research in Malaysia were: lack of official data and published documents. To overcome the problem, interviews and visits were conducted from time to time to clarify any gaps. Malaysia is now undergoing its waste privatisation process which also involves both local authority in the case studies presented, the Majlis Perbandaran Petaling Jaya (MPPJ) and Dewan Bandaraya Kuala Lumpur (DBKL) which was taken over in July 1998 and February 1997 respectively. Data collected are valid as the changes made are only on the management side.

In the UK, problems occurred because during the research period, there were a number of changes including local authorities boundaries reformation which occurred in April 1995 and the formation of Environmental Agency (EA) for England and Wales and Scottish Environmental Protection Agency (SEPA) for Scotland, became fully operational on 1st April 1996. SEPA represent a radical new approach merging the expertise of the former River Purification Board, Her Majesty's Industrial Pollution Inspectorate and the waste regulation and air pollution powers held by Scotland's District and Islands Councils. Whereas for EA, it took over the functions of waste regulation authorities in England and Wales, responsible for the management and

regulation of the water environment (formerly discharged by the National Rivers Authority) and for controlling industrial pollution (formerly the work of Her Majesty's Inspectorate of Pollution). For the first time EA and SEPA creates a one-stop/door approach to the prevention of pollution and protection of the environment in England and Scotland. New legislation on Special Waste, Hazardous waste and landfill were also introduced during this period which are discussed further in this research.

1.6.2 Thesis structure

The structure of this thesis consists of three main sections in order to achieve the objectives mentioned above.

SECTION ONE: STATUS OF PAST, PRESENT AND FUTURE MUNICIPAL SOLID WASTE MANAGEMENT.

This section is built-up by three chapters, which are the analysis of literature, documentation and media sources on issues related to solid waste management system. Chapter one states the general overview of solid waste background and draws up the objective to achieve from this research. This chapter explains briefly the development of solid waste characteristics caused by changes and development in human life. The concept of sustainable development is also mentioned in general where it is a key to be adopted in future municipal solid waste management strategy.

Chapter Two introduces Malaysia and its status: geoghrapical, population, the institutions in Malaysia and the economic status. This Chapter examines present municipal solid waste management status from literature and documentation analysis and observations. In addition, world-wide development on municipal solid waste management strategy and practices are also reviewed. This is to provide and guide this research in a broader perspective.

In Chapter Three, literature review on lessons on UK practices towards municipal solid waste management are presented. This includes the legislation, waste authorities and the policy formation regarding municipal solid waste which are assessed through published documents by the UK government and by the EC. The problems and successes of municipal solid waste management system are assessed in order to consider the options of municipal solid waste management for Malaysia.

SECTION TWO: CASE STUDIES.

This section comprises of three chapters, which demonstrate case studies in the UK and Malaysia. Chapter Four and Five, which are the technical part of the research, are divided into four parts. These four parts are presented according to a waste hierarchy mentioned in the one of the objectives, which is now a world-wide approach towards a sustainable solid waste management system. What is expected to be learnt from these Chapters are the system and technologies available, which has been practised, are practised and is considered in the future in the UK. In these chapters, soft technologies available in the UK that derive the hardware technologies are also examined.

Chapter Six describes a case study on a local authority in the UK, the Dundee City Council particularly on its approaches towards sustainable municipal solid waste management. This case study is used to understand how government, economics and public pressure give an impact on solid waste management managed by the council. How the policy on solid waste management was formulated and adopted in their solid waste practices were also looked into. The reason of choosing Dundee City Council was because it is a national recognised City Council which has been awarded as the "Recycling City" in 1992 and has maintained to be one until today.

Chapter Seven describes case studies in two selected local authorities in Malaysia. These two were chosen because they manage most of the produced municipal solid

waste in their area compared to other area/states in Malaysia. From the case studies, the author attempts to describe, compare, and analyse the activities that should be learned or continue to be practised. Furthermore, from these case studies, the existence of problems on the management of municipal solid waste could be identified clearly.

SECTION THREE: LESSONS LEARNED FROM THE UK EXPERIENCES.

This section consists of two final chapters. Chapter Eight discusses on the approach of sustainable development done in other countries and the role of solid waste management in achieving a sustainable future. This Chapter discuss on the current situation which compared Malaysia's and UK's' situation and how Malaysia could move forward in developing a solid waste management system at National, Regional/State and Local levels. Since Malaysia is going towards full privatisation of its solid waste management system and at the same time Malaysia is experiencing its sewerage management system privatisation failure when the Government took over the management back in March 2000 which was awarded in December 1993 for 28 years to a private company: Indah Water Konsortium (IWK) is also discussed. This is another issue that solid waste privatisation should learn before it is fully privatised by July 2001. Chapter Nine concludes the findings from this research and recommends future research that should be considered.

CHAPTER 2
MALAYSIAN DEVELOPMENTS AND EXPERIENCES IN MUNICIPAL SOLID WASTE MANAGEMENT (MSWM)

2.1 Malaysia - An Introduction

Malaysia consists of two parts: East and West Malaysia (also known as Peninsular Malaysia). Peninsular Malaysia with an area of 131,588km^2 comprises of 12 states which are Johor, Melaka, Negeri Sembilan, Selangor, Federal Territory of Kuala Lumpur (Wilayah Persekutuan), Perak, Kedah, Pulau Pinang (Penang), Perlis, Kelantan, Trengganu and Pahang. East Malaysia which is 198,161km^2 consists of Sabah and Sarawak (Figures 2.1a,b). Malaysia's political neighbours are Thailand and Singapore in the north and south of Peninsular Malaysia, Brunei and Indonesia are situated at the boundaries of East Malaysia.

2.1.1 The Land and Climate

Malaysia has a range of steep and forest covered mountains that runs from north to south of Peninsular Malaysia and criss-crosses the interior of Sabah and Sarawak. It has extensive river system which flow through almost all the states in Malaysia. The longest river in Peninsular Malaysia is Pahang River which is 475km/250miles long and Rajang River of Sarawak in East Malaysia which is 563km is the longest in Malaysia.

Figure 2.1 Map of Malaysia

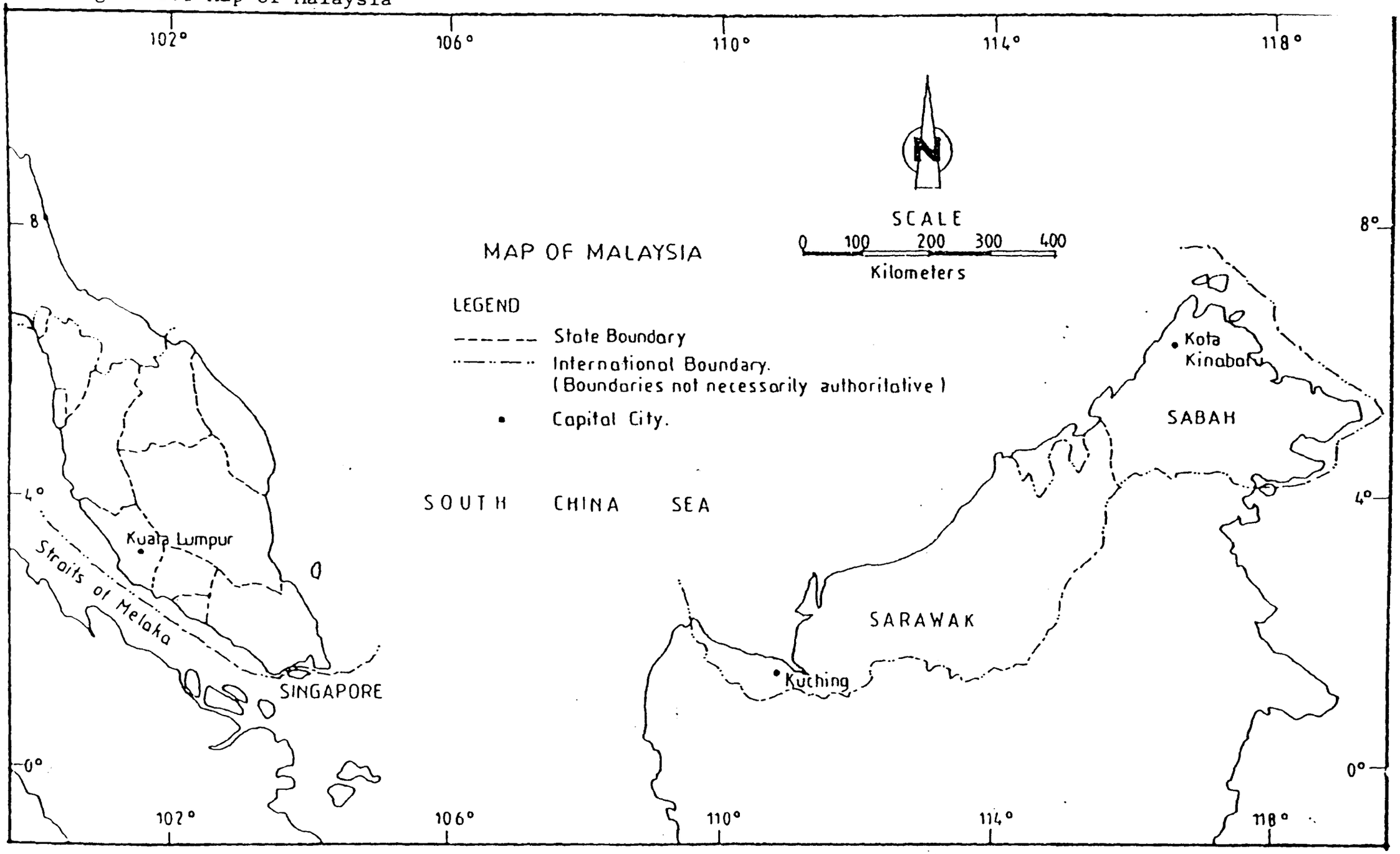
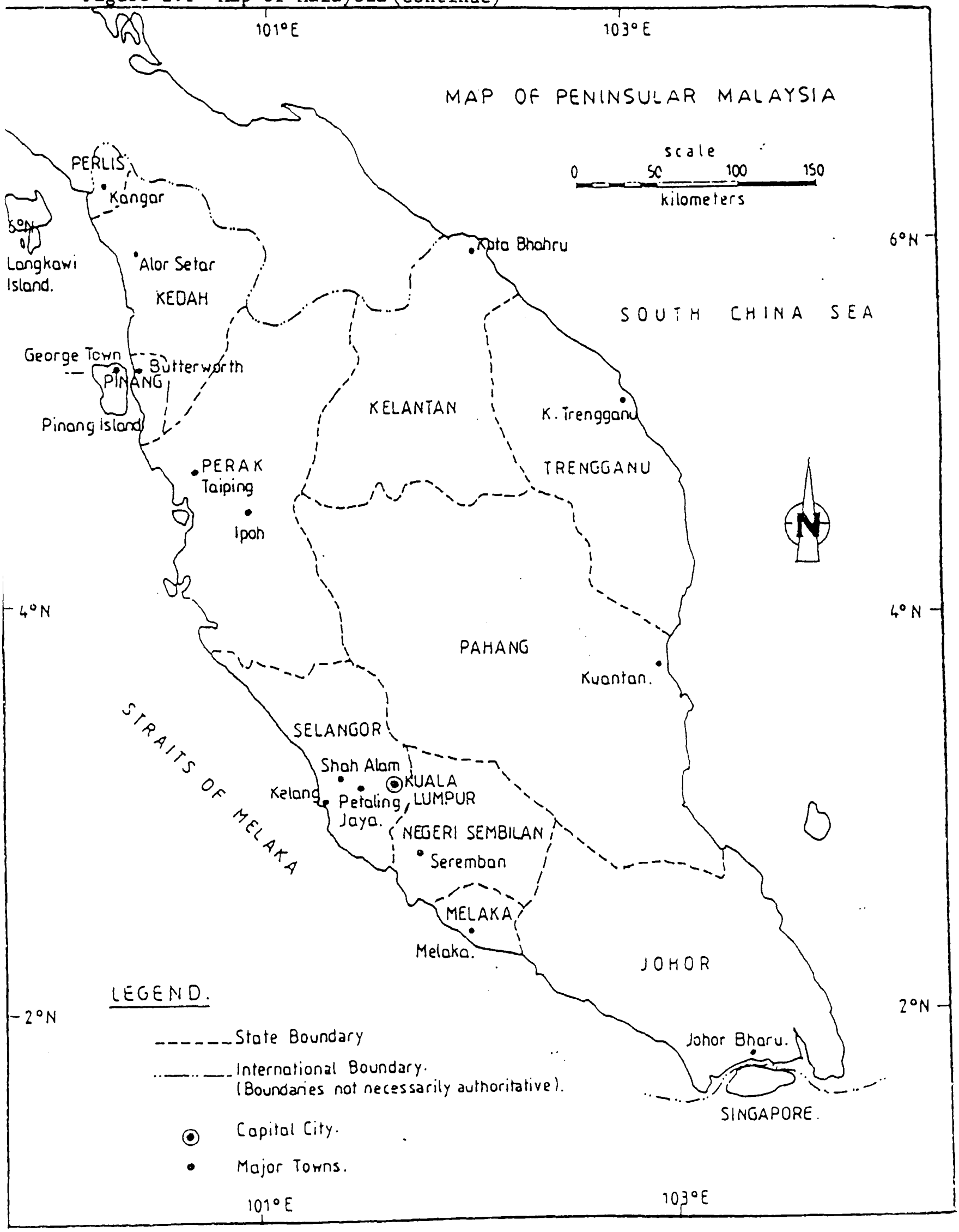


Figure 2.1 Map of Malaysia (continue)



Since Malaysia lies in the equatorial zone, the climate is influenced by the north-east monsoon from October until March and south-west monsoon, which blows between May and September giving the wet and dry seasons of Malaysia. Heavy rainfall occurs during the period of change between the two monsoons. The average temperature throughout the year is between 20°C(68°F) and 35°C(95°F) varying between the coastal and mountains area. Malaysia's humidity is high throughout the year, which is about 80% because of its high temperature, evaporation rate and heavy rainfall (annual mean rainfall is just over 254cm in Peninsular and 442cm in East Malaysia).

2.1.2 Population

In 1992, the population of Malaysia was 18,606,300 and is expected to reach 20.7 million by the end of year 2000. By the year 2020, the population is expected to reach 26.1 million with an annual rate of population growth of 3.2%. Most of the settlement (85%) is in West Malaysia which makes up 40% of the land area. 75% of this population is concentrated in the western part of Peninsular Malaysia. In East Malaysia, the population is concentrated at the coastal part of Sabah and Sarawak. Table 2.1 shows the population distribution population density of Malaysia.

Table 2.1 Population of states in Malaysia (at census of August 1991)

States	Area (km^2)	Population	Population Density (person/km^2)
Johore	18, 986	2, 074, 297	109
Kedah	9, 426	1, 304, 800	138
Kelantan	14, 943	1, 181, 680	79
Melaka	1, 650	504, 502	305
Negeri Sembilan	6, 643	691, 150	104
Pahang	35, 965	1, 036, 724	28
Perak	21, 005	1, 880, 016	89
Perlis	795	184, 070	231
Pulau Pinang	1, 031	1, 065, 075	1033
Sabah	73, 620	1, 736, 902	23
Sarawak	124, 449	1, 648, 217	13
Selangor	7, 956	2, 289, 236	287
Trengganu	12, 955	770, 931	59
Kuala Lumpur	243	1, 145. 075	4712
Labuan	91	54, 307	596
Total	329, 758	17, 566, 982	

(Source: World Yearbook, 1990)

The above table shows that the most populated state is Kuala Lumpur and Pulau Pinang reflecting the industrial development in these states attract the consequent increasing urbanisation.

The ethnic composition of Malaysia's population is highly varied which makes it one of the prime examples of a multi-racial society in the whole world. 56.6% of the total population is Malays, 32.8% is Chinese, 10.1% Indians and 0.6% is the smaller

communities which are made up of Arabs, Sinhalese, Eurasians and Europeans. Each ethnic group has a different life-style and festivals are celebrated throughout the year. These ethnic groups play an important role in Malaysia's economic development.

2.1.3 Malaysian economy

Malaysia is endowed with rich natural resources: its forests, crude oil, tin and cultivated land. Agriculture, including forestry and fishing, is the dominant sector of the economy. It contributes about 15.5% of the gross domestic product (GDP). In 1986, tourism was given an official status where its development plans' allocation was raised in every five-year successive development plan. Thus, tourism is becoming an important economic sector (Tan, 1991). Industry, including mining, manufacturing, construction and power contributed 43.3% of the GDP. 29.5% comes from manufacturing where the most important sectors are electrical appliances (particularly radio and television receivers, food products, rubber products, industrial chemicals, wood products, petroleum refining and motor vehicles). Energy is derived principally from Malaysia's own reserves of petroleum. In 1993, hydropower and coal accounted for 15% and 14% respectively of Malaysia's generating capacity.

In spite of promising economic conditions in the 1960s, with a GDP growth rate of 6% and a low inflation rate off less than 1%, Malaysia is facing problems of widespread poverty and racial as well as regional imbalance in the distribution of income, employment and ownership (Sinha, 1993). In 1970, the New Economic Policy (NEP) was formulated by the Government, to achieve a more equitable income distribution and to

eradicate poverty. It proposed a social restructuring to reduce ethnic, cultural and socio-economic differences and to provide a better direction for development over the next two decades. Since 1970, Malaysia's overall performance has been startling. Its economy, which is export-based, is one of the most impressive economies in Asia after Japan and Singapore. It is one of the upper-middle income countries of the world with a free market economy in which the private sector is dominant. But in 1984, during the world-wide recession, accompanied by the reduced demand for commodities, the Malaysian economy was seriously affected due to its dependency on the export of commodities such as rubber, palm oil, tin and timber. In 1985 the Malaysian economy recorded a negative growth for the first time. This resulted in reduced purchasing power for Malaysians. To revive the Malaysian economy, the government introduced privatisation as a policy to encourage private enterpreneurship and investment and reduction in the size of public sector and this has been implemented. In 1992, it was estimated by the World Bank that Malaysia's Gross National Product (GNP) was US$51,917m equivalent to US$2,790 per head. The GNP increased in 1995 by 9% to US$3,711 per capita. Malaysia was expected to experience strong economic growth in the following year and did so until interrupted by the Asian economic crisis of 1997-98. These development plans and industrial strategy have inevitable implications for waste management.

2.1.4 Institutional Framework

In Malaysia, the agencies and institutions that are involved directly in municipal solid waste management are divided among the Federal Authorities, State and Local Authorities. Non-governmental organisations and private sectors are also involved (as in

A Beautiful and Clean Plan for Malaysia (ABC), 1989)

2.1.4.1 Federal Government

2.1.4.2 Under the Federal Government, the authorities involved are:

i. The Prime Minister's Department

This department comprises of units, which are

- Economic Planning Unit (EPU),

This unit is responsible for the socio-economic development plan, including the Malaysian Five-Year Plans. Municipal solid waste management was included for the first time in Fifth Malaysia Plan (1986-1990), where issues only of final disposal of municipal solid waste were touched upon briefly. Other related issue such as environmental health in urban communities, plans and projects for municipal solid waste were not discussed. In this unit, the Social Service Section is responsible for solid waste management.

- Cabinet Division

This Department acts as the Secretariat to the Cabinet, Cabinet Committees, Conference of Chief Ministers and other Committees, which form the Cleanliness Campaign Committee to maintain, clean urban centres. Municipal solid waste is becoming this committees concern.

- Public Service Department.

This Department is involved with personnel management in public services. The Government's policy to reduce public servants has had an impact on municipal solid waste management because most municipal solid waste management activities in Malaysia involve non-skilled workers. Furthermore this action has forced Local

Authorities to improve their services through more mechanisation and privatisation of activities involved.

- National Institute of Public Administration

This is a national personnel training institute where solid waste management training is held and methods approached from these workshop are expected to be implemented at a regional level.

- Klang Valley Planning Secretariat.

This unit was set up between the Federal Government and the Selangor State Government in order to plan, co-ordinate and monitor development in this area where municipal solid waste management is an issue of concern.

ii Ministry of Finance

This Ministry allocates grants for government development projects including the development of municipal solid waste management.

iii Ministry of Housing and Local Government

Two departments of this ministry are involved in municipal solid waste management:

- Local Government Division

This Division, under its Technical Section, is responsible for providing technical advice on engineering functions in urban areas, which includes solid waste management. The Local Government's Policy and Planning Advisory Section is involved in preparing and reviewing existing by-laws and regulations concerning Local Authorities.

- Department of Town and Country Planning

This Department provides Structure Plans to Local Authorities and provides technical advice and assistance in forming planning policy. Unfortunately, municipal solid waste management is never mentioned in its Structure Plans.

iv. Ministry of Health

The division that deals with municipal solid waste management is the Engineering Services Division, Health Education Unit and Public Health Institute. The Engineering Services Division is incharge of the implementation and monitoring of the National Environmental Sanitation Programme (NESP) in rural areas where solid waste disposal is one of the problems. The latter units are involved in health education to the public and providing training for Local Authorities.

v Ministry of Science Technology and Environment.

Under this Ministry, the Department of Environment (DoE, Malaysia) was formed to provide the control of pollution and for enhancing the quality of the environment under the Environmental Quality Act of 1974. From the municipal solid waste management aspect, the DoE(Malaysia) is concerned with final disposal of waste because of its potential for causing environmental problems. Regarding this matter, the DoE (Malaysia) provides advice to Local Authorities for future disposal sites location, monitor existing sites and receive public complaints on inefficiency of waste handling.

Other related Ministries involved in municipal solid waste management are the Ministry of National and Rural Development which deals with infrastructure improvements in the

areas located outside the Local Authorities areas for example new villages and rural areas. The Ministry of Works does roadside maintenance, which includes collection of waste from roadside drains. The Ministry of Land and Regional Development is administering the policy on land development, which has an impact on the allocation of appropriate sites for sanitary landfill. In municipal solid waste management, the Ministry of Tourism and Culture is responsible for co-ordinating the tourist industry in the public as well as in the private sectors. The most important aspects under this Ministry are the cleanliness of parks, cities and towns, also the beaches within and outside the Local Authorities' area. The Ministry of Education, jointly with other Ministries such as the Ministry of Health in providing health education to school children and the general public. At the university level, seminars and training programmes are organised to provide technological "know how" for a municipal solid waste management system.

2.1.4.2 State Government

Under the State Government, government departments involve with municipal solid waste management are:

i. State Economic Planning Unit

This is an extension unit of the Federal Economic Planing Unit where its responsibility is to form planning of the socio-economic development of the state.

ii. State Division of Local Government

This division is in charge of budget approval for the constituent Local Authorities in the municipal solid waste management area. It is responsible for gazetting related by-laws and allocating land for final disposal.

iii State Medical and Health Services Department

This Department assists the Local Authorities in health aspects of solid waste management, drainage and sewerage and also to ensure that activities comply with standard health requirement.

iv. State Town and Country Planning Department

This Department advises the State Government on land development, which includes advice given on planning requirements for the plan approval process by local authorities.

Other departments that are involved in the municipal solid waste management processes are the State Drainage and Irrigation Department which oversees the effect on the drainage system of Local Authorities' development projects and the State Public Works Department which deals with roads and water works and is thus linked to transportation questions of municipal solid waste management.

2.1.4.3 Local Government

In Malaysia, Local Government is the third level of administration. It consists of three types of Local Authorities, which are the City Hall (includes Kuala Lumpur. Ipoh which is the capital city of Perak and Johor Baharu which is the capital city of Johor.), the Municipal Councils and the District Councils in Peninsular Malaysia. There are a total of 3 City Halls, 15 Municipal council and 78 District Council (Ministry of Housing and Local Government, 1996)

2.1.4.4 Private Sectors

In solid waste management, the private sectors are involved with waste collection either for domestic, commercial or industrial wastes. Private waste collectors of domestic waste are under the supervision of the local authorities where they are paid according to the number of premises and the quality they serve.

Only a small number of local consultants specialising in solid waste management exist. This reflects the relatively recent appreciation of the waste problem. Only after the Fifth Development Plan (1986-1990), was municipal solid waste considered with development plans.

In solid waste recycling activity, an informal sector is formed by scavengers and door-to-door house collectors who play a significant role in sorting the waste at source for recycling purposes. Because of the unhealthy environment for scavengers at the landfill sites and disturbance they caused during landfill operation, the local authorities are looking into the structure of this activity.

Non-governmental organisations and the rest of the voluntary sectors act more in an "observer role", being involved in activities such as cleanliness campaigns for the improvement of public living conditions.

2.2 Waste and its Development

Rapid economic growth in Malaysia for the past ten years has contributed to its fast development in term of the expanding of urban areas, population growth, greater level of consumption and changes of lifestyles. Unfortunate consequence to this rapid development is the resulting of waste and pollutants, which have adverse impacts to human and the environment. The increasing amount of wastes in Malaysia is mainly caused by the increasing size of the population, growing industrial activities and rising living standard leading to life style changes. Unable to cope with the large quantities and various types of waste produced, industries and local authorities have at times ended up with environmentally unsound disposal methods and ad-hoc based solutions. In Malaysia, waste management services: collection and disposal forms an integral part of the local authority administration. For providing these services, householders are charges through their house assessment payments. House assessment payment is charged based on the size of the house. In other word, a bigger house will be charged more compared to smaller house though the number of people living in bigger house is not necessary more than smaller house. Apart from the above, local authorities are also responsible for the implementation and enforcement of pollution control strategies. The Refuse Collection and Disposal By-laws 1983 is the basis for the local authorities to enforce waste disposal regulations. Although storage bins are mentioned in the by-laws, there is no standard set-up in the approved types of containers in regards to the size and materials to be used and issues on separation of waste. Furthermore, collection, transportation and disposal of waste were not referred in the by-law as well as restriction on dumping procedures and improper locations (Noorhajran, 1995). Without by-laws procedure, standard of services

of proper waste management will decline.

In 1995, 5.5 million tonnes of domestic and commercial wastes were generated in Malaysia. This amount had increased in 1998 to 6 million tonnes per year and is expected to increase to 8 million tonnes in the year 2000. These issues have brought the attention of the government, consumers, industry and the mass media as they realise that the scale and diversity of the problem needs a solution (Shafii, 1994). In term of waste characteristics generated, in general it varies depending on the areas it is produced. Greater consumerism tend to generate more packaging materials such as paper and plastics compared to organic waste. In Malaysia, urban areas generate more paper and plastic waste compared to the rural areas, which generate more organic waste. From a field surveys conducted by Nasir *et. al.*, 1995, on 30 municipalities in Malaysia, most of solid waste is generated from households (up to 40 percent), followed by industrial, construction waste, commercials and markets waste. As waste composition varies, and it changes according to the changes of lifestyle, examination of its changes should be conducted. Unfortunately, in Malaysia, there is no periodical analysis of waste generation which results with an outdated data. Without these data any future planning and development are almost impossible.

There are three methods of waste disposal and treatment in Malaysia: the open dumping (a waste disposal site without any leachate collection point/treatment), landfill (a waste disposal site with leachate collection point/treatment) and incinerator. There are only 10 landfills in the country. Nine of them owned by local councils and one owned by SITA

Worldwide a private landfill and the only sanitary landfill (landfill with lining to prevent from ground contamination, leachate treatment and methane gas collection) in Selangor. For municipal solid waste treatment, only the Kuala Trengganu Municipal Council in Trengganu had installed an incinerator. But this incinerator has stopped from operating due to the amount of waste received was not enough for the incinerator to operate daily. Recently small incinerators were installed at four island resorts namely Langkawi, Pangkor, Tioman and Labuan. The incinerators were installed because of the cost to transport the waste to mainland is very expensive.

In Malaysia, most of the municipal solid waste goes to the landfill or dumping sites. The non-hazardous and general industrial wastes are often treated together. The existing dumping sites mostly are not properly engineered (Figures 2.2a, b, c) and managed. Pollution from leachate, odours and open burning occurred most of the time. Therefore these sites have and will continue to pose short and long term hazards to human health and the environment. Pollutants that are released or discharged from the disposal sites could contaminate groundwater system, flora and fauna which will eventually cause direct and indirect impact to human life. Before 1989, Environmental Impact Assessment (EIA) studies was not mandatory to built up a disposal or landfill sites. Thus, disposal sites built before that year were in poor conditions with lack of cover materials, inadequate facilities and lack of pollution control measures especially on leachate and landfill gases emissions (Nasir, *et. al.* 1999). Most of the disposal sites and landfills operating now have less than 2 years of operating life emphasising the local authorities to secure new sites. Though facing with obstacles in getting new land for landfill, it is

Figure 2.2a Top Layer of Landfill

Figure 2.2b Recycling Activities by Scavengers

Figure 2.2c "Restored" Landfill

expected to remain the cheapest and favoured option for the local authorities. A study conducted by Nasir, *et. al.*, 1992 estimated that social cost (direct costs plus environmental damage) of landfills were at RM35 per tonne, compared to RM500 per tonne for waste incineration and RM216 per tonne to compost waste

.

The cost of waste management is the largest portion of the operating budget of most local authorities in Malaysia, yet waste collection does not served 100% of the total population. A survey conducted by Hassan, *et. al.*, 1995 found out that the percentage of population served in waste collection varied between 40% to 100%. Table 2.2-2.5 shows the selected city council, municipal and district councils and the percentage of population served with waste collection

Table 2.2 Percentage of population of waste collected in Malaysia (State of Selangor).

Local Authority	**Population**	**Amount of waste collected (tonne/day)**	**Population served (%)**
Gombak District Council	322, 909	420	100
Municipality of Klang	263, 205	360	90
Kuala Langat District Council	50, 169	90	90
Kuala Selangor District Council	37, 462	75	90
Municipality of Petaling Jaya	275, 249	550	100
Municipality of Shah Alam	109, 876	300	100
Petaling District Council	92, 710	200	88
Sabak Bernam District Council	44, 127	27	80
Sepang District Council	14, 667	20	65

Local Authority	**Population**	**Amount of waste collected (tonne/day)**	**Population served (%)**
Hulu Langat District Council	153, 416	200	80
Municipality of Ampang Jaya	377, 542	1, 000	100
Hulu Selangor District Council	46, 883	19	60
Kuala Lumpur City Hall	1, 237, 939	3, 000	90
Average		483	87

Source : Hassan *et. al.* (1995)

Table 2.3 Percentage of population of waste collected in Malaysia (State of Negeri Sembilan)

Local Authority	**Population**	**Amount of waste collected (tonne/day)**	**Population served (%)**
Seremban Municipal Council	197, 491	156	100
Jelebu District Council	28, 793	18	70
Jempol District Council	52, 273	27	83
Kuala Pilah District Council	48, 094	28	54
Port Dickson District Council	73, 665	52	100
Rembau District Council	22, 718	10	82
Seremban District Council	45, 000	35	100
Tampin District council	43, 986	39.3	70
Average		364.9	82.4

Source : Hassan *et. al.*, 1995.

Table 2.4 Percentage of population of waste collected in Malaysia (State of Melaka).

Local Authority	**Population**	**Amount of waste collected (tonne/day)**	**Population served (%)**
Melaka Municipal Council	319, 692	400	76
Alor Gajah Municipal Council	124, 875	90	70
Jasin Municipal Council	100, 264	36	40
Average		526	62

Source : Hassan *et. al.*, 1995

Table 2.5 Percentage of population of waste collected in Malaysia (State of Johor)

Local Authority	**Population**	**Amount of waste collected (tonne/day)**	**Population served (%)**
Johor Bahru City Council	354, 953	500	80
West Batu Pahat District Council	140, 709	140	85
East Batu Pahat District Council	36, 129	10	50
Central Johor Bahru District Council	131, 067	170	85
South Kluang District Council	35, 698	19	80
North Kluang District Council	115, 173	65	83
Kota Tinggi District Council	58, 543	22	77
Kulai District Council	75, 924	30	93
Mersing District Council	29, 194	12	80
South Muar District Council	189, 359	80	90
North Muar District Council	52, 855	27	90

Local Authority	**Population**	**Amount of waste collected (tonne/day)**	**Population served (%)**
Pontian District Council	49, 440	38	65
South Segamat District Council	37,244	58	60
North Segamat District Council	82,609	90	85
Local Authority of Pasir Gudang	37,718	42	100
South East Johor Municipal Authority	15, 870	12	95
Average			81.1

Source : Hassan *et. al.*, 1995

Waste management in Malaysia has thus several major implication issues to address: environmental impacts, pollution of water, land and air, increase in volume of waste, changing types of waste and accelerating financial implications. Ethnic composition, which is divided into four broad categories, as mentioned previously also contributes to the waste problem. Every ethnic group has its own lifestyle and big festivals celebration such as Hari Raya Puasa for the Malays, Chinese New Year for the Chinese, Deepavali for the Indians and Christmas for the Christians all affect the pattern and amount of waste generation. These festivals are celebrated at different times throughout the year. Adding to that, during the fruit season generally between July and September in certain areas, the generation of waste increases by as much as 4% (Sinha, 1990).

Besides that, Malaysian attitude towards waste also causes problems. The society has the 'so what' thinking which leads to the "not in my backyard" syndrome (NIMBY) and

generally careless approach to waste management. People do not realise the importance of systematic waste disposal practice and the need for the individual to contribute to this practice. When problems occur, people seek to blame each other rather than accept personal responsibility for their own waste disposal. Generally, there are six elements involved in waste management systems:

i. production of waste
ii. storage of waste
iii. collection of waste
iv. transporting and transferring of waste
v. processing and recovery
vi. disposal of waste

In Malaysia, only four out of these elements are being practised: waste production, storage, collection and disposal. Figures 2.3 and 2.4 show the normal scene of how waste is "disposed" before it is collected. This type of illegal dumping usually caused by commercial owners, stall owners and squatters. As for waste processing and recovery, it is not yet a popular element and is still at an early stage of development. In previous years, the government tried to implement recycling programmes but did not achieve its aims. Society did not show a good commitment to the idea and few people realised the importance of this programme for the future. This alerts us to a key problem - the need to change attitudes by way of a positive education programme, which will engage the attention of everyone from the government level down to the citizen.

Figure 2.3 Commercial and Illegal Dumping

Figure 2.4 Stalls and Squatters Areas

2.2.1 Production and collection

In Malaysia, each element practised has its own problems. In the production stage, local authorities have never recorded total of solid waste produced or generated annually. Because of lack of data, any further action is almost impossible. For the waste storage, there is no requirement yet by local authorities or by the law on using a standardise bins, therefore waste is not stored in proper bins and is thrown away at individual's convenience. Separation of waste is not a favoured individual task, especially householders. All household wastes are thrown out together with no attempt made to sort them. Therefore problems will occur at the disposal site and thus require more work. The cost of collection is increasing due to the increasing quantity and types of waste generated especially in the urban areas.

Malaysia, with an equatorial climate: has a high temperature and humidity that accelerate the decomposition of organic waste. Therefore waste should be collected more frequently than in temperate countries. From a comparative analysis made between local authorities and private contractor services in Malaysia (Sinha, 1993), it was concluded that the private contractor was more efficient. The analysis found out that the average number of trips made per contractor vehicle was 30% higher. Local authorities achieved an average of 1.2 trips per vehicle, collecting from 600 houses, while the contractors made 1.6 trips per vehicle collecting from 1200 houses within the same eight hours period of working. As for tonnes of waste collected, the most efficient contractor collected 8.5tonnes per vehicle per day whereas the most efficient local authority collected 5.7 tonnes per vehicle per day. There is a 49% increase in the efficiency by the private contractor. The

contractor cost is 32% less than the local authorities. It thus appears that the private contractor is more efficient in solid waste collection. This happens because local authorities' staff employment is very secure and lifetime employment is almost guaranteed, therefore output is usually low from the supervision as well as from the workers. At the end of 1992, most local authorities had contracted out between 10% to 80% of the solid waste collection services to between one to nine contractors.

In urban areas like Kuala Lumpur, most of the contractors use compactors to collect all the municipal waste, whereas in areas outside Kuala Lumpur, one tonnes lorry are widely used by contractors. The use of open lorry caused leakage of leachate from vehicles which also happen to old compactors and with the use of one-tonne lorries will results with odour, waste being blown away and it becomes a non-efficient operation when the lorry is used for collecting commercial waste.

2.2.2 Disposal

As for waste disposal facilities, local authorities in Malaysia set up about 280 dumping sites with an average area of 10-20ha. each site. Not all sites are managed with standard technique (sanitary system). 90% of the sites are located near town centres and the inefficient management of disposal generates a lot of complaints from people living near the disposal sites. Since their management is not up to standard, flies and odours are common problems and control of leachate treatment and methane gas from dumpnig sites have never been implemented. Adding to that, problems associated with the dumping sites; no daily cover with soil, no rainwater drain-off, no leachate containment or

treatment, no odour or vector control, no liners, no gas venting, frequent fires in the dumping sites, most are operated very close to the rivers and water catchment areas or close to valleys, poor road conditions leading to landfills, poor house-keeping and awareness, massive illegal dumping to the actual dumpsite and too many operating dumping sites for a small local authority are seldom looked into. Most municipalities in Malaysia will not consider installing an incinerator because of the cost of installing one is very expensive and also the moisture content in Malaysia's municipal solid waste is quite high which is about 70 percent. This will only be considered when there is very little land left in the surrounding area that can be used as a disposal site.

The problems of waste management become worse because local authorities do not make much effort to involve the public in discussion of the issues. There is hardly any attempt by local authorities to get public participation in any of their cleanliness programmes. The public appears resigned to the situation. Some attempts at public involvement, have faced problems. For example, when the Ministry of Housing and Local Government embarked on a national cleanliness campaign, highlighting the citizen's responsibility in maintaining cleanliness, most residents thought that there was a semantic error in the slogan, "When the Public is Clean, the Nation Will be Healthy". People found that it is hard to believe that they needed to make an effort to be clean. To them, it is the Government that has the duty to do the cleaning and to be clean. A recycling project, which was implemented several years back by the Government, did not succeed because the Government did not really explore the prospects of encouraging recycling and because the public did not get any strong lead they lost interest in the project.

2.3 National level approaches to waste management

Government has taken some actions to improve the waste management system. Householders, institutions and municipal workers can take important steps to good waste management at source involving the separation of waste. Waste producers need to separate waste into compostables and non-compostables types. Society needs to be informed and educated about the importance of participating in waste minimisation and management and this educational process should start at the earliest possible stage, which is at school level.

Systematic storage and collection from commercial and institutional locations should be conducted. Types and sizes of containers or bins used should depends on the character of waste, frequency of waste collection, types of housing area and number of people living in each area. At the commercial level, these actions apply to industries and manufacturing premises. For effective waste collection, waste producers should place waste at the road side for easier collection, public waste bins should be placed at a strategic site and design models for effective route collection should be implemented which will save energy and time.

Some attempt has been made by Government to address the problems, and the need for changes and development of policies and programmes. It is observed that waste management is an important element within any national approach to environmental planning and management. Due to the constraints and burden faced by the federal, state and local authorities in planning and implementing an effective waste management

system: the operational, technical resources, financial and infrastructural, privatisation of solid waste management was suggested as an alternative to improve the service and at the same time to reduce financial burden of local authorities. The objectives of this privatisation are to provide an integrated, efficient and affective technologically advanced management system that will enhances the quality of the environment through the practices of resource recover and waste minimisation (Gregory, 1996). In December 1995, the Government gave letters of intent to four consortium to undertake the national privatisation of solid waste management. Malaysia was divided into 4 regions to be served by these four consortium which are:

i Northern Region: Perlis, Kedah, Pulau Pinang and Perak

Consortium: KKI Industries (formed a single purpose company that is Northern Waste Industries Sdn. Bhd.)

ii Central and Eastern Region: Kuala Lumpur, Selangor, Pahang, Trengganu and Kelantan.

Consortium: HICOM Berhad (Alam Flora Sdn. Bhd.)

iii Southern Region: Negeri Sembilan, Melaka and Johore.

Consortium: Consees Gali Sdn. Bhd. (Southern Waste Management Sdn. Bhd.)

iv Sarawak, Sabah and Labuan Region:

Consortium: MMC Engineering (Eastern Waste Management Sdn. Bhd.)

At present the tariff structure and charges to consumers are being finalised by the Government. The four Consortiums are encouraged to have interim arrangements with the local authorities to provide the services. Under these interim arrangements the Consortium will take-over solid waste management in the local authority and the cost

will be borne by that local authority through their annual expenditure (Pillay, 1999) until full privatisation starts which is scheduled to be in July 2001.

As for hazardous waste in Malaysia, under the Environmental Quality Act, 1974 amendments: Scheduled Waste Regulation, 1989, it is termed as scheduled waste. Scheduled waste has a legal categorisation and is not a scientific term. Though most of scheduled waste is generated from industries but not all industrial wastes fall under Scheduled Waste Regulations 1989. Toxic waste is also part of scheduled waste. Legally, scheduled waste is sub-divided into two groups: non-specific sources and specific sources. Malaysia produced 400,000 tonnes of scheduled waste in 1998 and this will increase as the number of industry increases. Most of scheduled waste produced is incinerated through a private company, Kualiti Alam Sdn. Bhd. appointed by the government and the residue is disposed in a landfill next to the incinerator plant. The cost to incinerate this waste is about RM2000 per tonne (proposed by the private company) which is being the biggest barrier for industries to send their waste to be incinerated. Previously, wastes were stored and incinerated on site or exported to other counties. But because of the pollution and danger caused through the on site practice as well as Malaysia's commitment towards Basel Convention, these are prohibited by the law.

In the issue of clinical waste, 3.02 million tonnes of clinical waste was generated in 1998 with 15% increasing rate annually (Agamuthu, 2000). Three consortia are currently handling the clinical waste management in Malaysia, where most clinical waste is incinerated. Clinical waste management is controlled by several regulations namely,

Environmental Quality (Scheduled Waste) Regulations, 1989, Environmental Quality (Prescribed Premises Scheduled Waste treatment and Disposal Facilities) Regulations, 1989, Environmental quality (Clean Air) Regulations, 1978 and Control of Infectious Diseases Act, 1988. Major sources of clinical waste in Malaysia are generated from hospitals, medical and biotechnology laboratories and research centres, nursing homes, animal research and testing, autopsy and mortuary centres and nursing homes. This waste is generally classified into five categories: infectious waste materials and human /animal tissues, medical equipment, microbial cultures, pharmaceutical/chemical waste and containers used for waste.

It is observed that waste management is an important element within any national approach to environmental planning and management. Following to this, the Department of Environment of Malaysia has been systematically following a three-point strategy in developing its future plan on environmental planning and management (Yong, 1986) which includes:

i. In the short term; to deal effectively with the more pressing cases of existing environmental pollution and degradation through effective enforcement of control and regulations.

ii. In the medium term; through the provision of guidelines and advice to influence decision-making in the direction of environmentally sound development.

iii. In the long term; through proper environmental planning entailing a preventive approach by integrating an environmental dimension into development planning right from the base level.

The programme of action committed to broader environmental issues involves:

- advancing policies and programmes which help to achieve sustainable development, including the development of new and better techniques for integrating the environmental dimension in economic decision making.
- promoting the reduction and eventual phasing-out of substances depleting the ozone layer.
- promoting afforestation and agricultural practices to arrest the increase in atmospheric carbon dioxide and stop the deterioration of land and water resources.
- Strengthening international action to ensure the safe management and disposal of hazardous waste (scheduled waste) and to reduce transboundary movements of waste, particularly to prevent dumping in developing countries.
- strengthening national, regional and international institutions responsible for environment protection as well as the promotion of active programmes on environmental education to heighten public awareness and support.
- Integrate resource planning through integration between socio-economic development policies with physical land-use planning and integrate between land use with environmental consideration and assessment.

From the above, it is clear that the government is now considering waste management as one of its target field in the policy for sustainable national development.

CHAPTER 3

GENERAL APPRAISAL OF THE WASTE ISSUE

3.1 Definition of Waste

It is important to define waste in a specific manner, as it will reflect the actions involved in managing it as well as the range of policies and regulations and public understanding required to achieve success. In the past, waste was given a low priority in government policies, but in the 1990s the situation changed when it was realised that waste could give an impact to human life if poorly managed. This was particularly true of the management of solid waste. The World Conference on the Environment and Development has pointed out that the increasing production of waste poses significant threats for the environment and no longer can be accepted (UNCED, 1992). Waste universally is known as discarded or unwanted materials (distinguishable from raw materials, products and useful by-products). Once waste is generated, it can be re-used, recycled, incinerated to reduce the volume or to generate heat and power, whereas non-recoverable materials are sent for disposal. Waste characteristics can vary among different socio-economic groups and varies within a country and markedly, from country to country. Therefore it is important that each country has its own waste classification and fully analyses its own problems. Waste statistics across a range of countries will not then be strictly comparable in view of the variation in the definitions and classification system. This poses a managerial difficulty in respect of trans-national movement of wastes and the control of this. At international level, it has been realised that classification systems on waste need to be harmonised to some degree in order to co-ordinate international actions where there

are major global threats to the environment. It is possible to envisage the harmonisation of classification at international level (for world-wide threats) and at national or group-of-national level, to reflect the social and economic context. For example Appendix 1 (EEA, 1995) outlines the harmonising for waste classification systems across European Union countries. Clearer analysis of waste streams using appropriate classifications is essential as a basis for more effective planning and management of waste handling in a sustainable way.

In the US for example, waste is broadly classified as non-hazardous (most municipal waste) and hazardous waste. In 1965, the Solid Waste Act was passed to promote a management system for waste in order to improve the quality of air, land and water. Following the Act, technical and financial assistance was provided including programme set-up on the national database in order to help the states to improve waste collection, processing and disposal. Training, guidelines and standards for several processes in collection and disposal methods are also provided. Today, waste responsibility is under the Environmental Protection Agency (EPA), where a philosophy for waste management was set up as follow: firstly is waste minimization, then recycling and reuse, then energy recovery and landfilling as the last resort. Table 3.1 shows the chronological order of the United States federal solid waste legislation. These are Waste Acts, which will be updated every 4 to 6 years by the Congress.

Table 3.1 US federal Solid Waste legislation

Act	Date	Comments
Solid Waste Act (SWDA)	1965	Policed by the US Public Health Service to promote solid waste management and resource recovery including guidelines for the collection, transportation, separation, recovery and disposal.
National Environmental Policy Act (NEPA)	1969	Requires EIS on solid waste projects e.g. new landfills
Resource Recovery Act (RRA)	1970	Shifted emphasis of national solid waste programme from disposal to recycling and reuse and to conversion of waste to energy.
Resource Conservation and Recovery Act (RCRA)	1976	Provided legal basis for implementation guidelines and standards for solid waste storage, treatment and disposal.
	1978	EPA published guidelines on MSW management and revised them in 1984 and 1988
Comprehensive Environmental Response, Compensation and Liability (CERCLA)	1980	Mechanism for responding to uncontrolled landfills, i.e. sites with mixed municipal and hazardous wastes

Act	Date	Comments
Public Utility Regulation and Policy Act (PURPA)	1981	Directs public and private utilities to purchase power from waste to energy sources.
RCRA Amendments - Hazardous and Solid Waste Disposal Amendments RCRA (HSWDA)	1984	Ban on landfilling RCRA hazardous waste
California Assembly Bill (AB)	1993	Recycling goals - 50% of all MSW to be directed from landfill by 2000, 25% by 1995
Amendments to RCRA (RCRA)	1994	Includes recycling goals.

After Kiely, 1997.

Because the US government realise that its population growth will affect the volume of waste production in the future, the making of the legislation in a way helped the nation to understand the issue and to commit effort to limiting waste growth where possible and to more efficient management.

In the UK, waste as defined by the Environmental Protection Act 1990 is categorised as:

i. any substances which constitutes a scrap metal or an effluent or other unwanted surplus substance arising from the application of any processes; and

ii. any substance or article, which requires to be disposed of as being broken, worn

out, contaminated or spoiled (IPC, 1993). Under European Community Law, a definition of waste was provided by the original Waste Framework Directive 75/442/EEC. It defined waste as any substance or object, which the holder disposes of or is required to dispose of pursuant to the provisions of the National Law in force. The Waste Framework Directive, as amended by EC Directive 91/156, defines waste to mean any substance or object in the categories set out in Annex I of the Directive which the holder discards or intends or is required to discard. 'Holder' is defined as the producer of the waste or the person who is in possession of it. 'Producer' is anyone whose activities produce waste and anyone who carries out pre-processing, mixing or other operations resulting in a change in the nature or composition of the waste. Waste listed includes production or consumption residues, off specification products, spilled, lost or contaminated materials, products for which the holder has no further use, and contaminated materials resulting from remedial action with respect to land. Under the EC Law, waste is classify according to whether the materials have been discarded by the holder, or is intended, or is required to be discarded.

In general waste can be defined as a range of materials which are discarded because there are no further uses and we wish to get rid of. This could be waste products from our way of life and also products of the body, ranges of waste produced by individual as well as by industries and commercial society.

3.2 Types and Classification of Waste

Waste has been classified in various ways. For the purpose of this research waste is classified after Jane, B. (1996) which categorises waste as three types :

i. Non-hazardous wastes

ii. Hazardous waste

iii. Radioactive waste.

3.2.1 Non-hazardous waste

i. Household waste (not included hazardous household waste (HHW))

Waste, which is produced by private residential homes, educational institutions and nursing establishments (includes hospital, clinics but not clinical waste). This waste comprises all waste that is produced in everyday living lifestyles.

ii. Commercial waste

Waste from premises which are used mainly for the purpose of trade or business including sports, recreation (hotels, chalets, resorts) and entertainment.

iii. Industrial waste

Waste from factory or industrial premises. This includes construction waste, dredging spoil and sewage sludge but excludes mine and quarry wastes.

iv. Trade effluent

Waste substances, usually liquid in nature arising from a factory or industrial processes. This waste could be hazardous or non-hazardous.

v. Putrescible waste

Apply to waste that could be biodegraded through biological actions. For example food and vegetables. But waste with high cellulose content such as rice, wheat, paper

and wood although they are biodegradable but not necessarily classified as putrescible.

vi. Inert waste

Waste which are chemically and biologically stable. For example demolition waste.

vii. Sewage sludge

This waste result from the treatment of sewage and the character of sludge determines on the method of its treatment.

viii. Agriculture waste

Applies to manures produced by farm animals, fertilizers and pesticides. For fertilizers and pesticides, if they require special treatment to dispose, they are classified as Special Waste because of the chemical properties.

3.2.2 Hazardous waste

i. Special waste (Special Waste Regulations 1996, UK)

Some wastes need particular attention because of their toxic or other dangerous properties. In the UK these kinds of wastes are classified as "special waste" but for the EC and the Basel Convention, they are "hazardous" waste. The EC Council adopted a new Directive on hazardous waste in 1991. This new Directive is to approximate the laws of Member States on the controlled of hazardous waste management. This Directive was drawn up referring to Article 2.2 of the Framework Directives which enables the Council to adopt individual Directives on the management of particular categories of waste (Bates, 1999). Under this Directive hazard properties: "toxic", "harmful", "corrosive" and "irritant" was made the basis of the criteria contained in the EC Directive relating of classification, packaging and

labelling of dangerous goods. In the UK, Hazardous Waste Directive is implemented by the Special Waste Regulations 1996. This includes the wastes used to be special under the Control of pollution (Special Wastes) Regulations 1980. Special waste as defined by the Control of Pollution Act (1974) (UK) as 'waste which is so dangerous or difficult to dispose that special provision is required for its disposal. Household hazardous waste is at present excluded from the Directive. In Malaysia, special waste or hazardous waste is referred as scheduled waste

ii. Polychlorinated biphenyl (PCBs)

PCBs were originally added to transformer oils to improve electrical conductivity. Since then it was found that PCBs persist and accumulate in the environment and produce toxic substances such as dioxin and dibenzofurans during combustion. Today the use of PCBs is ban in most countries.

iii. Acid tars

Acid tars are produced from the acid washing of benzene, toluene and xylene fractions distilled from crude coal carbonisation of benzol, from the production of lubricating oils and from refining waste oils.

iv. Metal-finishing wastes

Metal finishing wastes are inorganic wastes. They are found in both liquids and sludge form.

v. Halogenated hydrocarbon solvents

These wastes may be in the form of solid residues, liquid oily waste or a sludge.

vi. Cyanide waste

Cyanide wastes result from coal carbonisation, metal plating and hardening, and are in the form of solid residues and liquids. The Disposal of Poisonous Waste Act 1972

was initiated following the discovery of uncontrolled dumping of cyanide.

v. Clinical waste

Principally wastes from hospitals, dental veterinary, pharmaceutical or similar practice and nursing homes. This includes bandages, dressings, syringes and being waste which may cause infection to any person contacted to it. Clinical waste is not officially classified as hazardous waste but it requires special handling and disposal generally incineration. Some clinical waste is classified as special waste, and therefore subject to additional controls under the Special Waste Regulations 1996.

vi Hazardous municipal waste (HMW)

Generally defined as any material that is discarded by household which is difficult to dispose of, or which puts human health or the environment at risk because of its chemical or biological nature (WB 55, 1997). Among them are paints, varnishes, adhesives, medicines, pesticides, aerosols, lead and nickel-cadmium batteries and mercury dry cells, hydrogen peroxide and bleaches, aerosols and lot more of households waste

3.2.3 Radioactive Waste

Wastes which are contaminated by reason of its radioactivity arising from a variety of sources including hospitals, nuclear power plants and defence installation. This waste is defined according to level of radio-activity, disposal purposes.

i. Low-level radioactive waste

ii. Intermediate-level radioactive waste

iii. High-level radioactive waste.

As explained above, waste could be in any form: solid, liquid or gas. As this research

continue, it will focus on municipal solid waste management and its related aspects.

3.3 Sources of solid waste

For the propose of this studies, sources of solid waste are classified as follow :

3.3.1 Household waste

- vegetables
- paper content
- metal content (ferrous and non-ferrous)
- rag content (including textiles and bagging)
- glass content (bottles and jars)
- plastic and polythene
- unclassified waste (combustible and incombustible)
- putrescibles

3.3.2. Commercial waste

- litter
- restaurants, clubs and hotels waste (similar to household waste)
- markets waste (vegetables, fishes, meal residues etc.)
- shopping complexes
- office complexes

3.3.3 Institutional waste

- schools, colleges and universities which discard stationaries, tables, chairs etc.

- government offices

3.3.4 Industrial waste

- ash
- fertilizers
- hazardous waste

3.3.5 Waste from construction and demolition

- dust
- concrete waste

(Source : Tchnobologus, 1993, Baron 1996))

Generally, wastes described above have both chemical and physical properties. The physical properties includes their density, moisture content, odour, putrescible content, calorific value as well as their formation: it is either in solid, liquid or gas form. Whereas the chemical properties include: their toxicity, organic or non-organic, combustible or non-combustible and ferrous or non-ferrous.

3.4 Factors Affecting Practices in Dealing with Waste

In order to consider waste management technology, it is important to know the factors that have an effect on the likely requirements of waste treatment. In setting up a waste treatment priority, the factors listed below (Crawford and Smith, 1985) should be analysed.

3.4.1 Composition of waste

The influence of life style. Variations in life style leads to significant variations in the nature of the waste stream, for example between developing and developed countries. In the developing countries, especially those with a hot and humid climate, household wastes comprises less tins and cans, plastics and disposable paper, but more vegetables matter and cooking residues. In the United Kingdom for example, household waste moisture content is around 27%, which is comparable with other European countries. Whereas in tropical countries, waste moisture content is as high as 60%. Therefore moisture content has major implication on the options for waste treatment.

3.4.2 Quantities of waste

The volume of waste generated will affect the required size of disposal area, the method of collection and transportation, the number of people involved in collection and the frequency of collection. Therefore, waste collection plans will differ from one place to another. Waste storage and best mode of transportation to the treatment site are also matters requiring analysis.

3.4.3 Climate

Rainfall and temperature are two main factors that impact on the organisation of a waste management system. Countries with a high amount of rainfall and a high temperature will need a different waste storage system and priority of treatment compared to temperate countries because the rate of decomposition of organic material will be much faster.

3.4.4 Culture

Cultural differences will affect the style of living, and this will have a knock on effect on the production of waste, in terms of volume and type. Particular problems might be expected to occur in waste management in a country with many cultural and ethnic groups in contrast to one that is more socially homogenous.

3.4.5 Geology

Geological factor should be considered in order to set up a technically efficient landfill for waste disposal, in order to contain effluent and prevent pollution escaping. For example if the rock and soil below a landfill is permeable, leachate can escape and contaminate surface or ground water system (Montgomery, 1992).

3.4.6 Economic development

National economic growth improves standards of living and will change the composition of waste and the preferred method of waste treatment. For example, in poorer countries supply of labourers is enormous and cheap, therefore techniques which involve mechanical plant will be less used. The pattern of subsidy from government for waste treatment is also important. According to Langley (1997), a combination of an improved economy, legislation to improve waste management, and some financial incentives to stimulate good waste practices are important in the waste management industry.

3.5 Waste Management Tools

3.5.1 Lifecycle Assessment (LCA)

According to the Society of Toxicology and Chemistry (SETAC) Code of Practice 1991, LCA is a process to evaluate the environmental burdens associated with a product, process or activity. An inventory of data on resource consumption, pollutant releases and waste generation associated with the relevant product, process or activity is compiled, the impact of these energy and material uses and releases into the surrounding environment is assessed, and opportunities for environmental improvement are identified and evaluated.

In the UK, the DoE is now seeking to apply the Lifecycle Assessment techniques to assist in evaluating waste management practice in a more scientific way. This is also because many have argued that the solid waste management hierarchy should not be a fixed model applied rigidly in every case but should be flexibly adapted to the situation in hand.

LCA is an effective tool for benchmarking environmental performance and can be used for comparative studies to determine the relative environmental advantages and disadvantages of products able to carry out the same function (Kirkpatrick, 1995). LCA is a systematic identification and evaluation of environmental benefits and disbenefit that result from a product or function throughout the product or function entire life. LCA on waste management could identify the possible impacts on the environment from any waste management practices. Thus LCA could provide the basis of making strategies on the ways which particular waste should be dealt with in

order to achieve a sustainable strategy for the management of waste.

There are three stages involved in LCA:

i. inventory analysis

ii. impact assessment

iii. improvement assessment

3.5.1.1 Inventory analysis

Inventory analysis quantifies the raw material and energy consumption together with all solid wastes, emissions to air and water (burdens) for all the process within the system boundaries that have defined for data gathering purposes.

3.5.1.2 Impact assessment

This second stage transforms and interprets inventory data into a manageable and meaningful form to the decision maker. There are no specific methods to analyse the data. It is also used to examine the potential and actual environmental and human health effects which are related to use of resources such as energy and raw materials and also pollution caused by the processes' emission (Pidgeon and Brown, 1994).

3.5.1.3 Improvement assessment

Improvement assessment is cited as being an integral part of LCA methodology. It is just an application of data for better management in the cycle route. In theory, LCA can be applied to most 'systems', where these systems are seen as a series of operations, which collectively fulfil some defined function for example processes suggested in the waste hierarchy..

Problems occur in practising LCA, notably to define the system and the system boundaries, how to specify the functional unit, how to identify and quantify the inputs to and the outputs from the system. LCA is seen as an abstract systems analysis tool, without an exact methodology.

In waste management, lifecycle inventory is used as a tool for optimising waste management systems compared to the overall environmental burdens and the overall economic costs. For example, the LCI model can be used in comparing different techniques in handling domestic waste. This model considers waste generated within an area, the collection system, transportation and disposal. Even among waste treatment options available, recycling for example, LCI can compare the collection from the kerbside, versus central point collection or back door collection. This can also involve the use of composting or biogasification for organic materials, the use of materials for processing recyclable waste, the use of thermal treatments such as mass burn incineration, burning refuse-derived fuel (RDF), and the use of landfilling. For each option mentioned, it is possible to calculate the overall energy consumption and emissions to air, water and land associated with waste treatment. But it is important to decide the environmental improvements needed for example, energy conservation, air or groundwater pollution, non-renewable conservation etc. Following this step, best practical environmental option (BPEO) could be identified, depending on what are considered to be the most pressing environmental problems in each case. In applying LCI model in integrated waste management, choices can be made to recognise which level of the hierarchy is the best being practised. When we rely on the hierarchy, major limitations are:

- LCI is claimed as having no technical or scientific basis,
- it is little use in considering combinations of options and does not address economic sustainability.

Whatever is going to be done needs to be affordable by the sectors and community where this system is adopted.

3.5.2 Economic instruments

Environmental economic instruments are becoming a well practised approach in waste management. In general, economic instruments are used to improve the quality of the environment. In most European countries like Denmark, Sweden, the Netherlands, Norway and Finland energy taxes have been implemented. In the US, a range of policies on solid waste management which include subsidies on recycling, taxes on primary inputs to production, deposit-refunds for containers and investment tax credits for recycling. (Turner, Powell and Craighill, 1997). In the UK, economic instruments are used in its waste management for example the Recycling Credits and landfill tax, which was introduced in April 1992 and October 1996 respectively. The Recycling credits scheme is a mechanism for passing on to recyclers the savings in the disposal and collection costs which results from household waste recycling activities (HMSO, 1996). As for the landfill tax, it was the first UK green tax and the liability falls on the "landfill site operators", who is the person holding the Waste management License, although it is expected that the costs will be passed on to the waste producers. Tax is payable based on the weight of the waste deposited which ranges from 7 to 10 pounds per tonne depending on the type of waste disposed. Inert or inactive wastes are charged "cheaper" compared to other waste, which are

mentioned under the EPA 1990. The tax rebate which is managed by an Environmental trusts is used to improve a sustainable waste management practices through research into new technologies, pilot projects or training scheme. According to Gregory (1996), economic instrument could serve as an alternative to control negative impact to the environment. Therefore economic instruments should be used and implemented in waste management policy in order to maintain the quality of the environment.

3.5.3 Environmental management system (EMS)

In 1980s and 1990s, academics, politicians and businesses began to realise the importance of sustaining the environment to business practice. In the UK, this was due to the increasing legislative requirements from the European Commission's commitment to sustainable development and pressures from stakeholders (Smith 1990, Roome 1992 and Hutchinson and Chaston, 1994). In the early 1990s, formalised environmental management system were BS7750 (was withdrawn in September 1997), EC Eco-Management and Audit Scheme (EMAS) and series of ISO1400 were developed to be applicable to all types and sizes of businesses. These environmental management systems are an expansion of self-regulation. With EMS considerably larger part of the environmental circumstances of the companies will be taken into consideration in their management. This is one of the aims of promoting these voluntary solutions (Hillary, 1994). Furthermore the adaptation of a management system will help to provide a structure that will allow managers to identify long-term goals, set performance targets, set up and implement action programmes to achieve goals, and periodically check progress (Gillies, 1996). With

this, an environmental management system can be applied not only to businesses but also to the management of waste.

3.6 Summary of European and UK Legislation

Many developments in UK national law have been driven by the EC that has been developing a body of environmental legislation. Since becoming an EC member in 1973, UK is subject to EC law and bound to the European Parliament decisions. Directives are the usual way in which EC law is promulgated and Member State will bring them into force by the statue, regulations or administrative provisions such as circulars or codes of practice that are necessary to comply with the Directives within the prescribed time-scale. International environmental law has also an impact on UK law since domestic law will follow any signature and agreement of an international treaty (Environment Council, 1996).

In the UK, regulation on waste started in 1972 with the Deposit of Poisonus Wastes Act 1972, which controls the deposit of hazardous waste. Soon it was replaced by the Control of Pollution Act 1974 (CoPA 1974) which introduced a more comprehensive system on waste disposal, by landfill or incineration. According to the Act, a waste disposal license is required from the waste disposal authority before "controlled waste" (which includes household, commercial, industrial waste or any such waste) could be disposed. CoPA 1974 has been a model for other countries and in particular for the EC Framework Directive on Waste (75/442/EC). The Framework Directive on Waste (75/442/EC, amended by 91/156/EC and adapted by 96/350/EC) was adapted into UK

law including the Environmental Protection Act 1990, Environment Act 1995 and other Regulations on various aspects of waste management.

In other word, CoPA 1974 was replaced with the Environmental Protection Act 1990 due to problems arising concerning organisational problems, a lack of central guidance on acceptable standards, a lack of strategic plans, the need to prove related offences and inability to control the licensing system. The Environmental Protection Act 1990 was a landmark in environmental legislation covering a broad spectrum of environmental issues and introducing new integrated pollution control and waste management regimes. In Part II of the Environmental Protection Act 1990 (EPA 1990), the framework for a new system of waste management was established. The concept of "waste disposal" used in CoPA 1974 was changed to "waste management" which involves more on controls over waste producers and waste carriers. The Act expressed the Government's desire to separate operational and regulatory functions and to vest responsibility for each in a different body. First is the waste collection authority (WCA) which has the duty to arrange for collection of household waste, industrial, and commercial waste if requested including the production of recycling plans in respect of commercial and household wastes as required by the EPA 1990; Second is the waste regulatory authority (WRA) which is the pollution control body that is responsible for the whole of the waste stream. WRA functions (now carried out by the Environmental Agency in England and Wales and Scottish Environmental Protection Agency in Scotland) include: preparation of a national waste strategy, making decisions on arrangements needed for the treatment and disposal of controlled

waste, supervision of the "duty of care", supervision of licensed activities, waste management licensing and inspection of closed landfills. All WRAs are required to follow guidance issued by the Government, most of which are statutory guidance. This included some 30 Waste Management Papers, Department of Environment circulars and Codes of Practice and Advise Notes. Whereas for the disposal of controlled waste and providing household waste sites is the duty of waste disposal authority (WDA). The WDA will normally be a county council or unitary councils and their contractors may be private sector companies, wholly owned local authority waste disposal companies or other waste disposal companies which local authorities had selected through tenders submitted. In the EPA Part II under Section 34, the "duty of care" was introduced where it imposes a statutory requirement that waste transferred to producers is only to properly authorised operators. This is to ensure that identified waste follows a controlled route from production to disposal.

The increase in awareness of environmental issues in the 1980s and the 1990s has been marked and legislated actively at national and international levels. In the UK, the Environmental Protection Act 1990 was a landmark in environmental legislation covering a broad spectrum of environmental issues and introducing new integrated pollution control and waste management options. Other statutory and non-statutory developments and the use of existing common law principles to deal with the problems have combined to produce a comprehensive framework for environmental regulation and guidelines.

3.6.1 The White Paper-Non-statutory Guidance

The White Paper brings together in one document the Government's current thinking and policy on the environment. But it must not be viewed in isolation. Collectively, the White paper, the Environmental Protection Bill (or Green Bill), and EC law and policy make a comprehensive unit of environmental planning and regulation. As a unit, they go a considerable way to identifying the economic forces and regulatory controls that could be used to protect and regenerate the environment. For example Government White Paper- This Common Inheritance and Making Waste Work which sets Government's strategy on sustainable development and achieving more sustainable waste management.

3.6.2 The Environmental Protection Act 1990

The Act enacted the Government's desire to separate operational and regulatory functions and to vest responsibility for each in a different body. The new Waste Regulation Authorities will no longer operate their own waste disposal sites, these being transferred to new waste disposal companies set up under the Act. The provisions in the Act dealing with waste management, together with a law: **The Duty of Care** imposed on producers of waste and the registration of carriers of waste under the Control of Pollution Act (Amendment) Act, 1989 are together intended to provide a comprehensive code covering the regulation of waste from its creation to its ultimate disposal. In other words, waste producers are responsible to keep their waste safe. If they gave the waste to someone, they must make sure that those people are authorised tp take it and can transport, recycle or dispose the waste safely. Waste Regulation authorities will be required to keep registers containing important

information relating to waste management licences. These registers will be open for inspection by the public.

The Act introduces tighter controls over the deposit of litter. In addition local authorities, government departments and educational institutions are now under an obligation to keep highways and other land clear of litter in accordance with a prescribed standard of performance. Local Authorities have power to declare litter control areas in which private land to which the public are entitled or permitted to have access can be made subject to similar obligations for the removal of litter. Local authorities are also given power to serve street litter control notices in respect of premises from which street litter is likely to emanate, requiring the provision and emptying of litter bins and the clearance of litter from the street (Environment Council, 1996).

3.6.3 Integrated Pollution Control (IPC)

Traditionally, each of the three environmental media: land, air and water, has been regulated by a different authority, under a different statutory regime. The relevant regulatory authorities are currently waste regulation authorities, local authorities and the National River Authority (NRA) dealing with land, air and water respectively. It is common for one business to fall under the control of each of these authorities and to require several permits. One of the major innovations of the EPA 1990 was the new system of integrated pollution control (IPC). Under the IPC, certain particularly polluting activities are designated for control by a central body, which will regulate the impact of the activity on the environment as a whole. This body is Her Majesty's

Inspectorate of Pollution (HMIP) in England and Wales and in Scotland it is called Her Majesty's Industrial Pollution Inspectorate (HMIPI).

3.6.4 Environmental Agency

In 1991, the Government proposed that a new Environment Agency should be set up, merging the functions of HMIP (a body controlling industrial pollution, the National Rivers Authority (a body responsible for the management and regulation of the water environment) and the waste regulation authorities, in an attempt to ensure a co-ordinated strategy for environmental protection. The Agency is responsible for environmental regulation of developments under the Environmental Act 1995 (DETR, 1999). In waste regulation and licensing, the agency is authorised to issue waste management licences by anyone wanting to deposit, recover or dispose their waste. These licences are only issued to fit and proper person and cannot be transferred without the consent of the Agency. The Agency also plays as a central role in putting Government's policies into practices. This will promote a more consistent approach to waste regulation and ensure that regulations are met. The EA and SEPA control day to day waste management activities. The Secretary of State (In Scotland it is called Secretary of State for the Environment will supervise the activities of the Agency. Besides the regulatory work, the Agency have a key role in the improvement of information about waste management which include details of all waste arising, waste management activities and becoming a centre of expertise that provides technical guidance and promotes good practice on waste management. In addition, the Agency will conduct a national waste survey on waste arising and facilities available asked by the Secretary of State. Therefore, this will improve the knowledge on present

practices on waste management and provide more basis for future policy development. This data will enables the Government to decide at what level a waste reduction or recycling target should be set. Under the Environmental Act 1995, any Minister may authorise relevant Agency to exercise on behalf any of his functions that is appropriate exercised by the Agency, but not on fixing fees or charges. In conclusion, with this new responsibility the Agency have a big role to play among which includes monitoring and enforcement, committed in processing of licence applications, having links with local authorities and to maintain as centre of expertise. Local planning authorities are the statutory consultees for waste management licence application whereas the Agency is the statutory consultee for development plan drawn up by planning authorities. In order to deliver waste strategy and target set up by collaboration work between the Government and the Agency, effective liaison between local authorities and the Agency is still retained.

3.7 The Actors and Players in Sustainable Waste Management

Working towards a sustainable waste management involves a wide-range of group and require commitment at all level. It is important that everyone: the Federal, Regional, local government, industry, non-governmental organisations (NGOs) and householders, is clear about their responsibility. In the UK among the organisations involved are: the **Central/Federal Government** which role is to make sure that adequate national planning policies are in place in order for sustainable waste management to be exercised and achieved at the regional and local levels in terms of the location and use of facilities (DETR, 1999) for example Planning Policy Guidance note *23: Planning and Pollution Control*. Regional Planning Bodies will apply the

national policies in their regional planning guidance. As for **local planning authorities**, they are responsible to ensure that an adequate planning framework exists. They are required to prepare waste development plans for waste generally which comprises the structure plan and the waste local plan which has taken into account of national and regional planning policy guideline. Planning authorities, they are responsible to draw up development plans under Town and Country Planning legislation. These will involve plans on waste facilities set up, criteria for land use that should be applied for the development of waste facilities. Therefore the Agency which controls and enforces waste management activities need to liase with local planning authorities on pollution control matters which is beyond the waste planning authorities judgement. Therefore the Agency has a biggest role in ensuring a sustainable waste management for the present and the future. It is the one that "police" the waste management practices, providing information to assist the waste collection authorities in their recycling plans and in making decisions on household waste collection arrangements, helping waste disposal authorities in determining their contract through best value system and local planning authorities by providing information required for development plans.

CHAPTER 4
WASTE MINIMISATION AND RECYCLING

4.1 Waste Minimization

4.1.1 Definition

Waste minimization is an important element in the hierarchy of waste management (Crittenden, B. D. and Kolaczkowski, 1992). The first step "prevention" is clearly the extreme case of the potential package of waste minimization measures. The term is associated with techniques and process activities in the production chain which involve use of resources, design of the product and production techniques, and which effectively reduces the volume of the waste stream (Enterprise Initiative, 1992). Because there is no specific single approach to the practice of waste minimization, a range of working definitions (Table 4.1) was identified that takes account of waste targeted for minimisation and the relationship between policy options and the handling of this waste.

Table 4.1 OECD Member countries - Waste minimisation working definition.

United Kingdom	reduction of waste at source
United States of America	reduction of the generation and subsequently treated, stored or disposed of hazardous waste, the reduction should be in the total quantity or volume as well as the toxicity.
Austria	qualitative and quantitative reduction in the generation of waste
Canada	reduction in the amount and the hazard of waste requiring final disposal : by source reduction, reuse, recycling and recovery.

continue

Finland	prevent or reduce waste generation and its harmfulness to health and/or environment in production and consumption
Germany	Waste avoidance, waste reduction and waste recycling
Japan	reduction of waste to be treated and disposed of at landfill sites by preventing waste generation and promoting waste treatment such as recycling, incineration, compression or shredding
Sweden	reduce volumes as well as hazardous materials content
Switzerland	reduce the generation of waste at source, minimise pollutant in processes and products and increase recycling and use of improved recovery technologies.

(Source : Organisation for Economic Co-operation and Development, 1994).

From the table above, waste minimization can be seen as a systematic approach to the reduction of waste at source. As reported by W S Atkins Consultants Ltd (UK) waste minimization is "a journey not a destination".

Because its approach is to prevent as far as possible and if not prevent then to reduce waste production, minimization is placed at the top of the waste management hierarchy and is widely used by countries including the UK and EC Countries to form their waste management strategies. Whenever waste is produced, its production should not contain materials that could cause pollution to the environment and those materials which cannot be further reduced in quantity should be prepared for recycling or re-use, only coming to final disposal when these other options have been exhausted. Waste prevention and minimization is usually linked with major industries (especially manufacturing) which means :

- reductions in resource use
- selectivity in resources required

- avoidance of certain types of waste

(Coggins, 1995)

In waste minimization, the term re-use is also one of the key words. Here, re-use means discarded items which require no additional processing before being used again (Coggins, 1995). These materials thus do not involve any expenditure of energy - a major saving in iteself. In re-use activity, there are aspects of the materials that should be considered in order to judge their suitability for re-use, for example :

i. Refillability. Can the containers be refilled.

ii. Durability and reparability. Examples are in furniture and machinery product.

iii. Reusability. For example plastic bags and kitchenware.

iv. Rechargability. Applies to batteries.

(Source : Fenton, and Hanley, 1995).

In waste minimization, focusing on only solid waste reduction could increase other types of waste such as aqueous and gaseous wastes. These wastes may be polluting to the environment, therefore waste reduction should consider carefully the possible effects on other elements of the waste stream as well.

4.1.2 Barriers to implementing waste minimization

In implementing waste minimization, barriers identified are as follows.

4.1.2.1 Lack of time or human resources

Lack of time and human resources to plan and initiate the programme and also insufficient guidance from local authorities or government on how to apply this scheme to different sectors of industry or business. The main obstacle is to allocate human resources and management time to co-ordinate this activity which is not core to the business (ENDS, 1995).

4.1.2.2 Cost of implementation

Some companies, especially small and medium companies (SMEs) are reluctant to implement such schemes in their companies as the operation may appear to require the investment of a large sum of money in the short term. Without a grant or support from government or other development organisation this would cause concern and reluctance to initiate schemes. Many companies would need to have initial auditing and monitoring of the present situation to identify areas of potential minimization in the production process and this might require the expenditure of money on consultants (ENDS, 1993).

4.1.2.3 Lack of commitment

Only companies with environmental concerns will be involved in this scheme. A survey conducted by March Consultants (UK) which involved interviews with 47 companies from a range of sizes and sectors found out that over 90% of the companies said they are familiar with the term waste minimization. Despite this, only 56%, mostly in the chemical sectors, had heard of the Government's waste minimization project - the Aire and Calder project -and only one third had been inspired to practice waste minimization as a result (ENDS Report 248; 1995). This is because waste minimisation is a voluntary approach and has no legal status.

4.1.2.4 Lack of information and need for leadership

Information on waste minimization and re-use of product should be publicised not only to industrial sectors but also to individuals such as householders and consumers as well as other waste producers.

4.1.2.5 Process constraints

The waste minimization concept requires a quantitative approach to enable the waste stream to be measured efficiently (Green, 1996). For example, the waste minimisation methodology developed by the Institution of Chemical Engineers (1992) outlined steps of its measurement:

Set goals and timescales

↓

Establish the assessment and evaluation team

↓

Obtain and interpret facts

↓

Identify significant waste generation practices

↓

Visit site

↓

Rank practical waste minimisation options

↓

Technically and economically evaluate highly ranked options

↓

Report on assessment and evaluation

↓

Implement waste minimisation projects

↓

Review and audit waste minimisation projects

↓

Feed back information

↓

Implement lower-priority projects

(Source: Crittenden and Kolaczkowski, 1992)

Without government help not all industries will be able to follow such a programme. SMEs especially may lack the qualified staff and the financial stability to enter what may seem heavy commitments of time and money.

4.1.2.6 Production pressures

In reducing the quantity of waste in industries, the design stage of the production process must be taken into account. This includes packaging of the product. The conventional waste management approach in waste minimisation adapted from Crittenden & Kolaczkowski 1992 and SERC Clean Technology Unit 1993 is as outlined below:

Input Changes : "Resource Management"

- using less raw materials for the same output
- using higher quality raw materials, resulting in less waste
- using different materials, that is input substitution which may be related to changing prices and/or process modifications
- using fewer and/or more toxic materials as inputs
- using input materials which are more easily recyclable
- using minimum percentages of recycled materials, but distinguishing between in-house and post-consumer sources.

Process Changes: "Design & Manufacturing Management"

- clean processes and clean technologies
- cost and compatibility of any new equipment
- producing less waste during the production process
- good housekeeping : materials handling and logistics

- equipment maintenance
- prevention of emissions
- waste segregation and storage.
- more in-house recycling of waste materials
- processing and/or sale of waste by-products.

Product change : "Product Management & Marketing"

- light (not heavy)
- product substitution (example plastic for glass, metal for aluminium in beverage cans)
- single material construction as opposed to composite products
- larger containers, economy-size items, bulk purchases
- less sales packaging, especially double packaging
- ease of recycling : extraction by recyclable category
- ease of disassembly
- re-usable, returnable products
- better quality, longer life and more reliable products.

4.1.3 Legal Aspects

Implementing waste reduction, needs changes in people's behaviour, individually as householders or collectively in businesses or community organizations. Thus co-ordination of publicity and education programmes are an integral part in waste reduction activity. As for industry and commerce, trade associations or regulatory authorities that provide advice on waste reduction methods to individual companies can lead initial publicity and information campaigns. It is necessary to formulate a coherent policy, which allows a better understanding and control of production and disposal of waste in an environmentally acceptable way (Lalonde, 1990).

A related *policy measure* is required in preparing waste management or waste reduction plans (Warmer Bulletin 46, 1995). In Austria for example, companies with more 100 employees must set up a waste management plan. The success of the *community right-to -know legislation* in United States led a number of voluntary initiatives where in one of the waste reduction programme, 1,250 companies signed up a 'contract' to reduce waste production by 33% by year A and 50% by year B. In another case in the United States, A WasteWi$e Program co-ordinated by the US Environmental Protection Agency, the companies participating have voluntarily made a public commitment to self-target waste reduction, prevention, recovery and secondary usage each year (EPA, 1994a and Department of Natural Resources, 1995). In June 1994, the UK Government (the Department of Trade Industry and the Department of Environment) has launched the Environmental Technology Best Practice Programme (ETBPP) which aims to promote waste minimisation strategies and cleaner technologies within industries, particularly in encouraging industries in reduction of waste at source.

Recently there have been a few economic instruments, which are used widely to achieve waste reduction (OECD, 1991). The waste *generator pays the full cost of collection, treatment and disposal* based on the quantity of waste they generate. This scheme applies to commercial and industrial waste, but seldom to household waste. In Switzerland and Korea, *weight or volume-based charges* have been introduced.

The traditional *deposit refund system* is still widely practice in Scandinavia where non-returnable containers are charged. This scheme has been adopted in United States under 'bottle bills' scheme in 1980s. This scheme for plastic containers has recently introduced in Austria, Germany and Netherlands. The deposit refund system has been

extended on car bodies as used in Sweden and Norway, batteries in Denmark, Netherlands and some part of United States and disposable cameras in Japan (Warmer Bulletin 46, 1995).

The *product taxes scheme* is now growing in many European countries. Prices are raised on disposable or non-recycables products relative to less environmentally demanding alternatives. In Norway and Finland, tax exemption is allowed when a certain return rate is achieved. Belgium and Switzerland introduces taxes on new products.

A raw material tax is also being implemented in Europe. It is a tax on raw materials used for production. A *'producer responsibility' scheme,* has been developed in countries such as Austria, Belgium, Denmark, France, Italy, Sweden and Germany. Through this scheme, the waste producer: manufacturers, importers, distributors and retailers takes the responsibility for the products they produce while society pays for waste collection and disposal. In UK, the Government's White Paper, Making Waste Work listed producer responsibility initiatives (Table 4.2) which led companies to set up their re-use and recovery targets.

Table 4.2 Potential benefits of producer responsibility.

- A business-led approach in achieving re-use, recovery and recycling of waste in most efficient way, while ensuring that costs are reflected in decisions on product design and content.
- An expansion of markets for materials, which have been recycled.
- A more efficient use of secondary materials by industries.
- An incentive to divert more post-consumer and other wastes towards re-use and recovery options, and reducing the quantity going to final disposal.
- An incentive on waste producers to minimise waste. The producers will seek improved waste management practice to reduce the cost burden.

- An incentive to minimise waste on which the producer responsibility obligation falls (e.g. a form of levy to help fund recycling programme)
- A supplement to the existing activities of local authorities, voluntary groups and individuals in supporting recycling activities.
- Effective treatment and disposal arrangements for wastes, which are an environmental hazard or nuisance if, disposed irresponsibly.

(Source : Making Waste Work, DoE(UK); 1995).

In the UK, legislation passed, which involves waste minimization, includes:

i. Environmental Protection Act 1990 (EPA)

Part I of the EPA 90 - Integrated Pollution Control: relate processes to achieve BPEO and BATNEEC to ensure that all environmental impact on air, land and water is minimized

Part II of the EPA 90 - Duty of Care: responsibility for controlled waste on wasteproducers and all involve in waste handling.

ii. Special Waste Regulations 1996

Increasing the costs of treatment and disposal of special waste and increase financial and environmental benefits for reducing the volume and hazardousness of special waste.

iii. Waste Minimisation Act 1998

It gave power to local authorities to undertake initiatives to inform or educate householders about measures to reduce waste. The Government aims to produce guidance on implementing the Act.

iii Water Act 1989

iv the Health and Safety Act 1989

v Clean Air Act 1956

4.1.4 Case Study - The Project Catalyst : Waste minimization of raw material use.

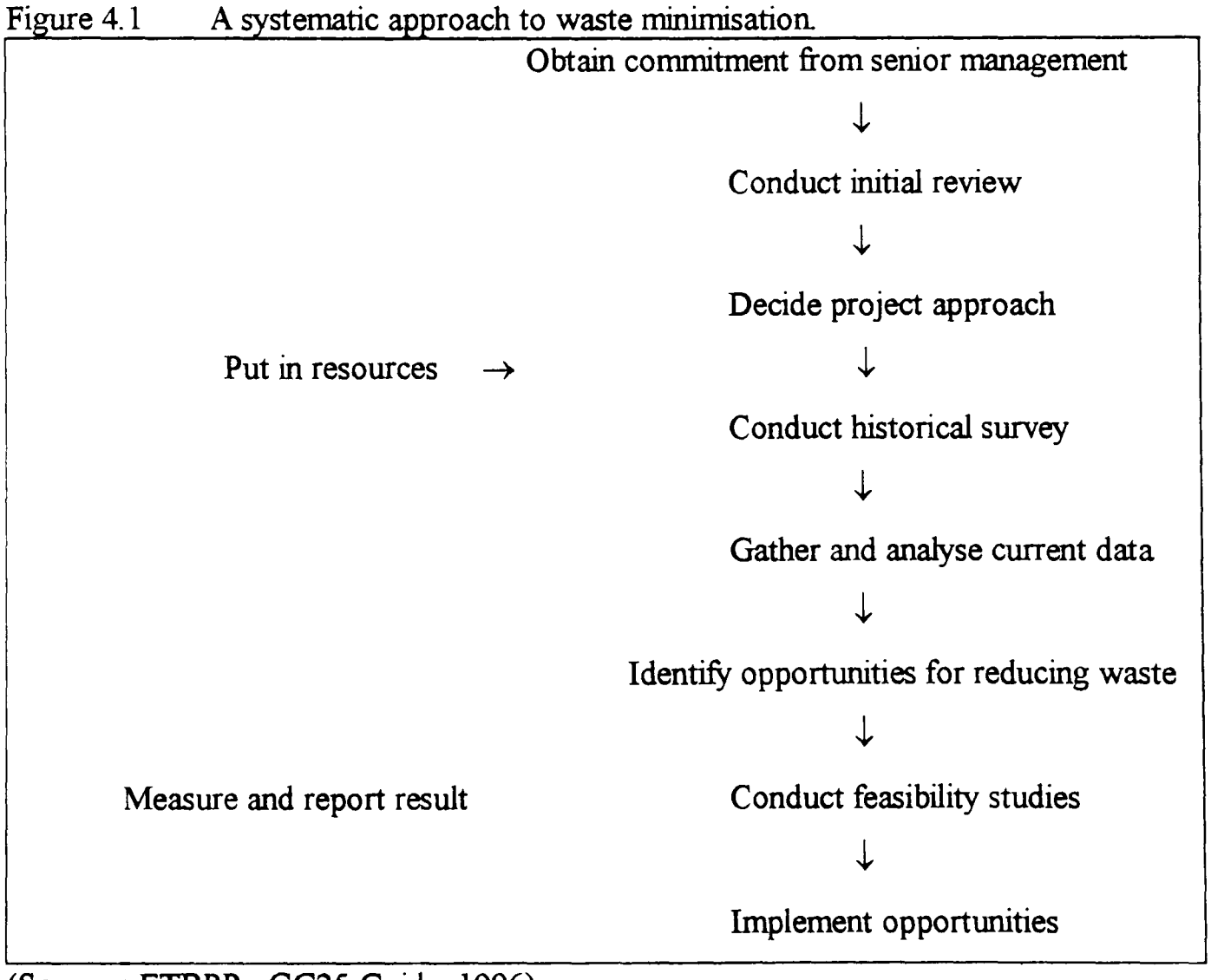
This project involves 15 participating companies in the Mersey Basin. It is one of the initiatives developed by the UK Department of Trade and Industry (DTI) to help stimulate interest among UK industries in implementing waste mninimisation. It is done together with Department of the Environment where both departments launched an initiative called the Environmental Technology Best Practice Programme (ETBPP) and managed by AEA Technology, Environmental Technology Service Unit (ETSU) and the National Environmental Technology Centre. The project involves consultants from WS Atkins Consultants Ltd., March Consulting Group and Aspect International.

Companies involved are guided by the consultants in looking for solutions of reducing emissions to air, water and land and waste reduction at source. Opportunities identified involve 55% of technological changes, 19% of good housekeeping, 23% of recycling and 3% of product modifications. This project targeted that releases of waste to all media would be a reduction of 50-80% in effluent charges, 20-50% could be reduced

in water consumption, 10-30% in energy consumption and 10-30% in solid waste disposal (ENDS Report 221, 1993).

The objective of the ETBPP in introducing this programme is to promote the use of better environmental practices in order to reduce costs involved in production to industries and at the same time reducing emissions of pollution to the environment. A series of waste minimisation clubs were set up throughout the UK. Each of the clubs involves a number of companies with a commitment to waste minimisation. Project Catalyst is one of the regional club and involved industries in the Mersey Basin with a successful pilot scheme. A standard systematic approach to waste minimisation as shown in Figure 4.1 was adopted by the Project Catalyst participants who have demonstrated the benefits in doing so.

Figure 4.1 A systematic approach to waste minimisation.



(Source : ETBPP : GG25 Guide, 1996)

An industry example of waste minimisation success in this Project Catalysts club is on Royal Mail (North Wales/North West). This division is responsible for the collection, distribution, processing and delivering mail in that region. Employing around 21, 000 people on 267 sites, it is responsible for handling 2.5 billion of posted letters annually, collected from more than 15, 000 post boxes and 5, 000 companies in that area as well as delivering letter to 3.5 million addresses. These activities use up around 3, 750 vehicles mail processing machinery and administration centers.

About 80,000 pounds was spent by the Royal Mail (North Wales/North West) on new laser printer toner cartridges in 1993. After use, they are replaced by new cartridges. Therefore waste minimisation opportunities are identified in this production process.
In doing so, the first step was to agree a specification for recycled toner cartridges with the Information Systems Group Royal Mail. Samples of cartridges were obtained from the toner recycler and samples were carried out for several week to select recycled toner which is best all-round performance in terms of cost, printing quality, number of copies the cartridge was capable of producing and the amount of packaging used. Toner cartridge recyclers that met the required specification were invited to supply Royal Mail (North Wales/North East) with recycled toner cartridges on a contract basis.

Today, recycled toner cartridges are used throughout Royal Mail (North Wales/ North East) and this practice has reduced expenditure on toner cartridges by an estimated £50, 000 per year and office waste going to landfill has also decreased by 1.5 tonnes per year.

In the UK, because of the success of the waste minimisation club project, the Government and a number of organisations had implemented similar projects, which are:

i. The Aire and Calder Project

Project launched in a Yorkshire river basin and participated in by 11 companies. This project concentrates on effluent discharge and water consumption.

ii. River Dee Catchment Project

A project in Wales involves 14 companies in the River Dee Catchment area

iii. Medway and Swale Project

12 companies in Kent participated in this project which was scheduled to start in the second quarter of 1996.

iv. Textile Sector Waste Management Project.

A project based in Northern Ireland, which concentrates, on only textile industries.

(Envirotec, 1996)

4.1.5 Application of waste minimization practice

The waste minimization programme is one of the current UK government's actions to implement policies relating to industry and commerce. However, from the examples given it is still only achieving partial success. In implementing waste minimisation, multi-national companies have the abilities especially in resources, where smaller companies do not. Large companies are able to link product quality, cost savings and environmental performance to achieve greater consumer satisfaction. Only the large companies have been able to lead the way.

The small and medium-sized enterprises (SMEs) are vitally important to the economy, since they make up a large part of it and have the potential to create many jobs, to be a source of innovation and competition, to create a healthy market economy and to preserve a stable economy base. Therefore government agencies need to encourage

small industries to adopt waste minimization and inform them of the economic benefits from positively managing their environmental performance. Many small companies are

- unaware of the relevant legislation
- unconvinced of the potential cost savings and market opportunities
- out of step with their customers' requirements
- disassociated from their stakeholders concerns

Surveys on small industries' attitudes found that many see no reason to address the environmental aspects of their businesses. Any action taken is often a negative response to legislative and regulatory pressures rather than positively seeking new opportunities from environmental management. The implications of making waste minimization the top stage of the waste hierarchy are considerable.

i. National level policy makers need to set up clear policy guidelines for industries and offer strong incentives to aid implementation

ii Supporting organizations need to develop strategies, which deal with the internal weaknesses in small industries, and deliver affordable company specific advise.

iii Regulators need to understand the workings of smaller businesses, and their limitations both in financial and human resources.

iv Researchers need to identify cost effective management and technological solutions that meet the payback periods demanded by industries especially the SMEs.

v Larger businesses have to work in partnership with their supply chain to improve environmental performance all the way down the line.

vi Small industries need to take responsibility for their environmental impacts in order to participate in sustainable economic development

(EPA, 1994b; ENSIC, 1994; ERL 1993)

4.2 Waste Recycling

4.2.1 Introduction

Under the European Commission 5th Action Programme "Towards Sustainability" (CEC., 1993), recycling (material recovery) was set on the next rung of the hierarchy after waste minimization, prevention and reuse. Recycling is defined as processes aimed at making waste reusable or reclaiming substances from it. At the initial stage, it is necessary to realise that if recycling is to offer a real economic solution, there must be an effective interaction between four key conditions:

i. efficient collection and transport.

ii. good cleanup and sorting systems following collection

iii. new processes to suit reclaimed materials.

iv. market demand for the recycling product.

In the UK, the Government has set a recycling target for local authorities to achieve. By the year 2000, 25% of household waste will be recycled. Waste recycling is considered as one of the best waste treatments because of the benefits, it:

i. Conserves natural resources.

ii. Saves energy in production and transport.

iii. Reduces the risk of pollution as well as saving cost in waste monitoring, treatment and disposal.

iv. Reduces the demand for waste disposal facilities and landfill space, especially in urban areas.

v. Produces goods more cheaply.

Recycling consists of five interdependent processes:

i. Reclamation of material from the waste stream by collection and separation.

ii. Intermediate processing such as sorting and compaction

iii. Transportation from recycling banks to recycling facilities plant

iv. Final processing to obtain marketable materials

v. Marketing of the products

People nowadays are more convinced by the idea of recycling as one of the instruments of environmental conservation. Evidence shows that a large majority of consumers in the UK think that recycling is important but only a minority of people actually sort and recycle their wastes. Only 5% of household waste that is thrown away is currently recycled.

4.2.2 Kinds of waste recycled

The present recycled materials are:

i. paper and card.

ii. glass

iii. plastics

iv. metals

v. textiles

vi. wood

vii. garden/yard waste

viii. miscellaneous: household waste, batteries and tyres.

4.2.2.1 Paper and Card

In the UK, the production of paper and board was 4.8 million tonnes in 1990, but the consumption of paper in UK reached 9.3 million tonnes in the same year. Around 3.1 million tonnes of wastepaper were recovered from all sources in this year. The term wastepaper includes paper, waste board, paper and board laminates with either plastics or metals. Wastepaper can be classified as:

i. the substitute for primary pulp for example in the production of printings and writings, craft wrappings and tissues. These are the pulp substitute grade group;

ii. the 'bulk' grade which is referred to as materials for the production of packaging and board products where the use of primary pulp is uneconomic. This paper grade does not require de-inking process. It is mainly used to produce container board, liner and medium for corrugated containers, egg cartons and pressboard and also felt paper and wallboard.

iii. Pulp substances, which are recycled paper that is added directly to paper pulper without treatment.

Besides these main uses, recycled paper is also used in the following:

- Building products. Recycled paper is used to make gypsum wallboard, loose-fill, spray-on insulation and saturated felt roofing paper.
- Refuse-derived fuel(RDF). This is produced from municipal solid waste.
- As Exports. United States is the largest waste paper exporter in the world. Most of US papers are exported to Mexico, South Korea, Taiwan and Japan. Other large consumers of US papers are Indonesia, Hong Kong, China and Japan.

Paper recycling processes involve the stages of paper pulping, followed by the cleaning process to remove contaminants such as staples and glues. Then the papers are de-inked. For the high quality papers such as newsprint, tissue and writing papers, they undergo a bleaching process. In paper recycling, wastepaper is recycled to recover the content of its fibre. The non-fibrous material that composes a proportion of the wastepaper weight could be lost during this process. This material varies depending

on the wastepaper grade. For example, post-consumer old newspaper and magazine mixtures waste resulted in 15 to 20% loss of non-fibrous material of the waste.

Types of paper and card recycled.

There are four types of paper and card which are used for recycling purposes;

i. Newspaper

Newspaper after de-inking process is used to produce

- tissue
- high-quality paper
- container board and construction products.

ii. Corrugated cardboard

This is the largest single source of waste paper for recycling. Recycled corrugated cardboard is used to make liner or media for new containers.

iii. Mixed paper

Includes carbon paper (limited to only 10%), newspaper, magazines and mixed long-fibre papers. This paper is mainly used as container board and pressed products.

iv. High grade paper.

Post-consumer papers such as computer paper, writing or typing paper and book covers. This paper can also be used as a substitute for wood pulp or can be de-inked to produce high quality bond papers and tissues.

4.2.2.2 Glass

In the UK, 8% by weight of municipal solid waste is glass. From this, 90% is green, amber or colourless bottles and container glass and the remaining 10% is mostly glassware and plate glass.

Uses of recycled glass

i. Glass bottles and containers

Raw materials such as sand, soda ash and limestone are added to cullet to reduce furnace temperature. Manufacturers are now looking at the energy saving aspect, therefore they use cullet even if the price is slightly higher compared to raw materials.

Energy is conserved because cullet melts at a lower temperature than the combined raw materials. By using cullet the furnace can be used longer. This will reduce the overall cost of glass manufacturing. The only disadvantage of using cullet is that usually it contains contaminants that could change the product quality or colour. When this happens, the manufacturer will look for in-house cullet or ff-spec' products because of its known composition and its contaminant-free state.

ii. Fibreglass

Cullet is used as an integral part of the fibre-glass manufacturing industry. Cullet is usually clear glass with almost no organic, metals or refractory materials.

iii. Miscellaneous uses

Glass is used for the manufacturing of glasphalt (paving materials) and building materials. In producing glasphalt, crushed and broken glass is used as part of the aggregate used in bituminous road paving. In manufacturing building and construction materials, glass is used in producing clay brick and tiles, masonry blocks and glascrete. It is used as a lightweight aggregate in concrete and plastic and foamglass for construction board and insulation. As its uses have been more widely developed recently, glass is now made for glass wool insulation, as abrasives for telephone poles and fence posts (made of small glass beads), agricultural soil conditioners to improve drainage and moisture distribution and also various other construction and textile materials.

In choosing glass for recycling, there are a few characteristics of the glass that should be considered. Fundamentally, glass to be used for new bottles must be sorted by colour and must not contain any contaminants. As mentioned above, contaminants could be in form of ceramics, rocks, high-temperature cookware (e.g. Pyrex) and dirt. Different contaminants have an effect on different stages of the process. Laminated glass is not allowed because it contains plastics. Plate glass will affect the melting temperature of the mixture. As for aluminium caps and paper labels, they have to be removed before further processing.

In solid waste management, recycling is one of the elements that is considered along with waste collection and disposal. The recycling programme is important in order to conserve energy and it gives a cost-effective product. As explained through its process, glass is made of abundant cheap virgin materials. Glass composition in municipal solid waste is only 2% by volume but it comprises 7% to 8% of municipal solid waste by weight.

4.2.2.3 Plastic

Plastics become waste because their usage as packaging contributed 1.4 million tonnes with less than a year lifetime. In the UK plastics represent 13% of waste by weight compared to paper and glass which are 41% and 26% respectively.

Polyethylene terephthalate (PETE)

Recycled PETE is used in producing polyester fibres for making pillows, quilts, sleeping bags and cold weather clothing. Moulded products such as food and non-food containers, strong plastic for engineering-automotive industry is also produced from PETE.

High-density polyethylene (HDPE)

HDPE contains a variety of properties depending on what product it is used for. For example, HDPE used for milk products containers contain resin with a low melt index. Resin with high melt index produces rigid HDPE. This resin can easily flow into a precision mould form. Whereas granulated, cleaned plastics are known as "regrind" HDPE properties will depend on type of resin which is blended together by processor or end-use manufacturer in order to produce the required melt index. Examples of postconsumer HDPE products are detergent bottles and motor oil containers. These containers are made of 3 layers, with the centre layer containing recycled materials.

Polyvinyl chloride (PVC)

There is now very little PVC being recycled. This is due to the cost of collecting and sorting the material. Recycled PVC includes non-food containers, toys, flower pots, shower curtains and garden hoses. Products, which are made from recycled PVC, have good markets in the form of mouldings, pipes, fillings and sheets.

Low-density polyethylene (LDPE)

Most of polyethylene film ends up in a waste stream, and in US it contributed 16% by weight of discarded plastics. LDPE is mostly used for food packaging, trash bags, agriculture and construction. Effort has been made to recycle LDPE such as disposable recycling system, but it is not a success because the programme was not economical. In carrier bag recycling, problems occur when printing ink of original bags led to a dark inconsistent coloured regrind. There have been several attempts at banning plastic and disposable diapers in US.

Polypropylene (PP)

PP is usually used for bottle and jar labels, containers caps and to a lesser extent for food containers. PP is processed depending on its intended uses.

Polystyrene (PS)

In US, 25% of PS is used for food packaging, famously used for clamshell fast-food containers, cups, plates and packaging materials. PS contributes only 0.26% of municipal solid waste by weight and 1% by volume. It is required to reduce the production of it because PS leads to unnecessary packaging. Recycled PS is used to produce office accessories, toys, insulation board and injection-moulded products.

Mixed and multilayer plastics.

This type of plastics is used to package foods and products such as salad dressings, tomato ketchup and mini cheeses. These containers have no market as recycled material.

To obtain quality recycled plastic, it is necessary to undergo certain processes starting from collection centres to the formation of clean flakes for manufacturing. Processes involved are:

- bale breaking and sorting
- granulation and washing
- material separation
- drying
- air classification
- electrostatic separation
- reclaim extrusion
- pelletising.

4.2.2.4 Metal

Metal recycling is divided into two general types, ferrous metal and non-ferrous metal.

Ferrous metals

Iron and steel are classified as ferrous metals. These metals constitute 6% of municipal solid waste in the UK. Ferrous metal includes scrap metals and steel cans. Sources of scrap metals are home scrap, which originates in a steel mill, such as mill rolls, broken ingot moulds and scrap sheets. Whereas prompt industrial scraps are produced by operations in creating products made from steel. This involves machining, stamping and fabricating processes. Obsolete scrap comes from products made of iron and steel, which are discarded after being used for example railroad track and old automobiles.

Non-ferrous metals

3.5% of MSW consist of non-ferrous metal, which comes from commercial and industrial wastes. It is distributed widely as a household metal items such as kitchen appliances, furniture, cookery sets and hardware. In demolition and construction, non-ferrous metals are used for making doors and windows, pipes, wires and plumbing supplies. Non-ferrous metals are also used in building automobiles, boats, trucks, aircraft and other heavy industrial machinery. In UK, it is estimated that the total quantity of discarded household non-ferrous metals waste is between 200,000 to 300,000 tonnes per year. Out of this amount, it is estimated that 60% or 150,000 tonnes per year is aluminium based alloys. Copper is 15-20%, zinc including brass and die cast alloys 5-10%, tin and tinplate and other alloys 2-4% and all form of lead is 1-3%. Aluminium recycling is the most important process in conserving energy and materials. Common sources of non-ferrous metals and its uses are as shown in Table 4.3.

Table 4.3 Sources and Uses of non-ferrous metals

Metal	**Recycling Percentage**	**Common Sources**	**Products and uses**
Aluminium	34	containers, outdoor furniture, gutters, siding, windows, cookware, autos, boats, trucks, aircrafts.	same as sources
Copper (including brass and bronze)	50	wire, tubing, plumbing fixtures, valves, cooling coils and fins, radiators, bearings.	same as sources plus alloys, electronics, chemicals, elector-plating.
Lead	61	tire weights, batteries, cables, solders, wine bottle seals, bearings.	batteries, solder, bearings, shots, alloys.
Nickel	27	high-strength and corrosion-resistant alloys, jet engines, industrial machinery.	high-strength and corrosion-resistant alloys, stainless steel.
Stainless steel	NA	commercial kitchen-ware, countertops, industrial scrap	corrosion and heat-resistant alloys for a variety of products.
Tin	18	solders, bronze, bearing materials, tinplate.	solders, alloys, coatings, plating.
Zinc	27	alloy scrap, shredded automobiles and appliances, galvanising wastes.	galvanised products, brasses, alloys.

(Sources: Tchobanoglous, Theisen and Vigil, 1993)

4.2.2.5 Textiles

Textile waste discarded in UK household waste is about 0.5-0.75 million tonnes per year. Post-consumer textiles are recycled as either for good quality second-hand

clothing or old textiles are used for wiper cloth products and in the flocking industry. In the flocking industry, old textiles are shredded and use as fillings in furnishings. This could be used as an alternative to the use of polyurethane foam fillings for furniture, which is toxic on combustion. In textile recycling, charities can take part by receiving and selling used clothing.

4.2.2.6 Wood

Wood is used for construction, furniture, containers, nursery and kitchen utensils. Wood waste is mainly generated from construction and demolition, mill residue, yard, orchard and agricultural waste. In wood waste recycling processes, specifications for recovered wood depends on the market requirement. For example, a boiler fuel plant prefers clean construction and demolition waste. Wood waste which is contaminated such as pressure treated wood and painted wood, plywood, telephone poles, large tree trunks, dirty stumps or railroad ties treated with tar are rejected because they could affect the boiler performance and cause air pollution violations.

4.2.2.7 Green waste

Green waste includes leaf falls, grass, grass trimmings and woody wastes: branches, stalks and roots. Green waste is mainly recovered into compost or mulch. Major types of green waste in percentage is shown in Table 4.4

Table 4.4 Percentage of green waste composition (by weight)

Type	**Percentage (%)**
Leaves	19.28
Grass	54.64
Woody waste	17.18

(Sources: Tchobanoglous, Theisen, and Vigil, 1993).

Other recyclable waste

Today, recycling programmes are also looking at recycling hazardous household waste such as solvent in domestic waste, tyres, batteries and construction and demolition.

4.2.3 Impact of recycling on the environment

Recycling activities by themselves do not have a large direct impact on the environment. Its greatest effect is indirect in the saving of scarce resources. Less raw materials are consumed, less energy is used and less waste is dumped at disposal sites. However the collecting, transporting, the bringing of the recycling materials to recycling banks, the washing and refilling of used materials, the de-inking process all do have some environmental impacts. The process of recycling may be polluting. The distance between recycling bank and materials recycling facilities plant, will generate traffic and thus create more energy consumption and vehicular pollution. On top of that, a large amount of water and chemicals are used to ensure that recycled materials meet the standard and regulations of cleanliness and safety. As for refillable glass bottles, more raw materials are used for the stronger and heavier glass needed compared to single use bottles. The heavier the bottles, the more it will cost for transportation.

4.2.4 Barriers to recycling

Identifying the barriers to recycling can lead the way to finding solutions by making recycling more viable. It will also increase the amount of potentially reclaimable materials. This will improve the market for recycled materials. Some of the barriers to recycling are discussed below.

4.2.4.1. Quality of recycled materials.

The physical and chemical properties of materials are important. Manufacturers require materials, which conform to certain limitations of composition and level of contaminants. Most contaminants can be removed by sorting, cleaning and refining, but not all these contaminants could be removed totally. This would depend on their chemical and physical bond into the structure of the materials. Contaminants may be classified as:

i. contaminants, which are not removed during the pre-treatment and processing, stages. This residual contaminants would affect the quality of the recycled material.

ii. contaminants that could be removed but the removal process reduces the yield of recycled products.

Contaminants cause problems in most recyclable materials. These are shown in Table 4.5

Table 4.5. Contaminants in recycled materials

Recycled material	**Residual contaminants (contaminant i)**	**Non-residual contaminants (contaminant ii)**
Iron and Steel	Copper, tin, nickel	Zinc
Aluminium	Iron, silicon	Lithium, glass, siliceous dirt, magnesium, zinc, tin, lead
Paper	Flexographic inks (> 10%), water-resistant coatings.	Adhesives, wire staples, plastics.
Glass	Iron and chromium colourants	Metals, ceramics
Plastics	Fillers, colorants	Other polymers, bacteria, inks, labels, adhesives
Compost	Heavy metals	glass

(Sources: Waste Management Paper, No. 28).

4.2.4.2 Economic perspective

Recycled materials have to compete with other raw materials in the market. The vagaries of local market conditions are evidenced by the rapidly changing "demand" for waste paper for recycling. Efforts must be made to encourage industries to use recycled materials for example through an initiative scheme such as the eco-labelling that could provide opportunities to the industries on becoming more environmental concern in their product (Welsh, 1994 and Ryding, 1998). It is often the case that paper users are told that it is "not worth" sorting paper for recycling. Opportunities for recycled materials should be considered not only for local industries but also as export materials.

4.2.4.3 Public participation

The public should be educated on the importance of recycling, its benefits to public and for the good of present and future generations (Yang, 1995). The public also should be informed about processes involved in recycling and what happen if materials they use are not recycled (Beltan *et. al.*, 1994, Chung and Poon, 1994 and Marans and Lee, 1993).

4.2.4.4 Government's role

It is vital for Government to take the lead in the business of recycling. Only Government has the power to set laws and policies and exercise financial inducement so that recycling could be a successful and beneficial programme (Singer, 1995, Chung and Poon 1994, Mutammara *et. al.*, 1994 and Levenson, 1993)

4.2.4.5 Recycling facilities

Problems occur when the public does not really use recycling facilities for example bringing recycling materials to the banks. Sometimes this may be due to poorly

located facilities . There are also possibilities that the public has difficulties in participating because not all places have recycling banks and collection by council or private contractors. Not many councils in the UK have separate bins for household sorting of waste. Studies done by Friends of the Earth (1991) found out that the majority of recyclers start to use recycling banks because they notice them, not as a result of publicity.

4.2.4.6 Public attitude

Surveys conducted by Save Waste and Prosper (SWAP) found out that 28% of UK's population do not recycle. In Dundee District Council, 24% did not, in Glasgow District Council 40% did not. From a survey by Faulds Advertising Ltd. , it was found that the level of recycling activities are lower compared to the purchase of recycled and recyclable products. At the same time, economic incentive is a more powerful drive for the public to participate in recycling activity (Chung and Poon, 1994). This suggests an opportunity to improve.

Adding to factors mentioned above, a survey done by the Scottish Office on 48 Local Authority plans towards recycling programmes found that there are nine potential barriers to the future development of recycling:

lack of market for collected materials	88%
lack of funding for recycling	88%
the possibility of increased road traffic in a district	60%
poor participation of residents in the collection of materials for recycling	48%
the lack of appropriate land, sites or building	46%
the level of support required by the local authority	33%
the likelihood of reaching the recycling target	6%

contamination of the materials during storage 6%

population density of the district 2%

From the percentage shown above, funding and market value of the recycled materials are the main constraint in making the programme a success. Therefore this should be looked into, especially by the Government before setting up a target for any recycling programme.

4.2.5 Legal Aspects

Below is a summary of legal aspects relating to recycling:

4.2.5.1 The Control of Pollution Act 1974 (CoPA)

A structured approach to waste management in the UK is developed in this Act. It is mainly about waste disposal regulations and the introduction of licensing. Collection and disposal of household waste is covered as well as the Local Authorities of Scotland role and powers in this area.

4.2.5.2 The Environmental Protection Act 1990 (EPA)

Part II of the Act deals with recycling. Recycling is encouraged through the reforming of waste disposal and management and setting of a framework. In the reform of waste disposal and management, the duty of care - Code of Practice is introduced. Local Authorities are in charge of collection and disposal of household and trade waste. Waste handlers will have to face tougher penalties for failing to comply with standards. In the framework set by EPA, recycling plans have to be produced by Councils. Recycling credits which is a financial incentive to encourage recycling is also introduced.

4.2.5.3 This Common Inheritance 1990

This Government White Paper announced the target of 25% of household waste that is to recycled by the end of this century (the year 2000) by Local Authorities.

4.2.5.4 Waste Management Paper No. 28 (Recycling, 1991)

A series of non-statutory Codes of Practice produced by the Department of the Environment. The purpose of this Waste Management Paper is primarily to assist the Waste Collection Authorities (WCAs) in providing information and background on recycling, suggestions on how to draw recycling plans and advice on how to prepare and implement recycling strategy in order to meet UK Government target to recycle 25% of the household waste by the year 2000. This paper is also a good guidance for people involve with recycling activities.

4.2.5.5 European Legislation

There are various pieces of European legislation to encourage recycling. Some are already in force in the UK. These include:

- the Directive on hazardous waste
- the Directive on battery collection and disposal
- the Regulation on a community eco-label award scheme
- the Directive on Packaging and Packaging Waste
- the Directive on the landfill of waste
- the Directive on the incineration of hazardous waste

4.2.5.6 Other UK legislation and official documents (1974 - present)

- War on waste: a policy for reclamation - 1974
- Report of the Committee on Waste Paper Supply - 1980
- (DTI and DoE)

- The Wealth of Waste: together with the proceedings of the Committee relating to the report, the minutes of evidence and appendices - 1984
- Disposal of waste oils : with evidence - 1985
- Managing waste : the Duty of Care. 11th Report Royal Commission on Environmental Pollution (RCEP) 1985.
- Managing waste : the duty of care : the Government's response to the 11th report of the RCEP - 1986.
- Digest of environmental and water statistics No 12 - 1990

(DoE)

4.2.6 Options for recycling systems

Before waste can be recycled, there are different methods of waste sorting which are practiced today:

4.2.6.1 The 'bring system' (Figure 4.2 Recycling bank)

Consumers will sort their waste and take the recyclable material to the recycling banks provided by local authorities. It is a flexible system where bins are collected by local authorities when full. The siting of the bins is important. Bin sites should be convenient for householders and not require a special journey. Ideal sites are at city centre car parks, shopping complexes area, at supermarkets and at community halls. This system saves local authorities transport cost.

4.2.6.2 The 'collect system'

The Kerbside Sorting - 'blue box' schemes

Householders separate recyclable materials from their waste. These material are than sorted by the collectors at the kerbside into a compartment vehicle.

Figure 4.2 Recycling Bank

The wheeliebin and multicoloured sack scheme

These schemes require householders to segregate their recyclable materials into different coloured sacks or in a separate compartmented bins or separate wheeled bins. These materials which are collected by compartemented or separate vehicles are then sorted at a central material recycling facility (MRF).

The mixed refuse

Recyclable materials are thrown in the bin and taken to a central Super MRF. This is where materials are sorted. The problem of this scheme is that materials are contaminated by being mixed with others and this affects the value of reclaimed materials.

4.2.6.3 Backhauling

This method is similar to the 'bring system' where shops are the 'recycling bank'. Householders bring back used containers to the shop to be recycled. The shops then return these containers to the producer.

4.2.6.4 Composting

Organic household waste such as food leftovers, garden waste: leaves, grass cutting and trimmed branches and farm waste are composted. Method involved are

Home composting

Operated by householders themselves: by forming compost heaps, using digesters such as the Green Cone and Recycone and the wormeries technique where the Tiger worm, *Eisenia foetida* is used to produce compost and liquid plant feed.

Central composting

Mixed household waste composting is carried out at large central areas. Methods have been used are such as using anaerobic digesters - the BFI-Paques system or the Buhler system where composting is operated in a smaller enclosed area. The common method is the windrow where material is spread into long rows and then once a week it is turned using a tractor shovel.

(Source: IWM, 1994)

4.2.7 Case study - recycling activity in South Ayrshire Council area

The South Ayrshire Council has a population of 113, 960, comprising an area of 262.0 km2. Tourism is one of the biggest industries in the area. This district is well served by road, rail (electrified line from Glasgow), air (Prestwick Airport with Glasgow Airport is an hour's drive away) and sea (ferries from Ireland arrive at Cairnryan and Stranraer on the south). River systems are small and local. Ayr is Scotland's oldest port and there are harbours still operating at Troon and Girvan. Its rainfall is approximately 850 mm per annum at the coastal area and rising up to 1, 500mm inland depending on the altitude. Because of tourism activity, its beach cleaning and waste management has seasonal variations. Owing to its rainfall regime, geology, Sites of Special Scientific Interest (SSSI) and protected tourist areas, the availability of possible sites for landfill is very limited. Therefore recycling is an attractive alternative for waste management in this district.

4.2.7.1 The District profile as it bears upon recycling

i Household sources of waste

Population density of the district can be divided into 3 groups (Table 4.6):

Table 4.6 Population groups

Settlement	**Population**	**No. of household**
GROUP 1 : Large towns with relatively high density population comprising majority population of the district.	82, 414	34, 724
GROUP 2 More isolated burghs with population approximately 2, 000 or more but are a distance from large towns **GROUP 3** More isolated small villages with population under 1, 000 and are far from large towns.	21, 947 8, 548	8, 915 3, 508
Total	112, 908	47, 147

Source : South Ayrshire Council, 1997

The type of housing in this district are as shown in table 4.7 below :

Table 4.7 Type of housing

Type of house	**Total**
Council House	13, 954
Scottish Homes	829
Owner Occupied	29, 851
Private rented/ housing association	2, 513
Total	47, 147

(Source : South Ayrshire Council, 1997)

Because of the "3 group" distribution, different strategies on recycling activities are required to cover the area in the future.

Other domestic properties contributing to the waste stream :

i Schools and colleges

ii Nursing homes and convalescent homes

iii Residential and retirement homes

iv Hospitals

v Caravan sites and other holiday accommodation

ii Commercial and Industrial premises

There is a total of 2, 689 commercial and industrial premises from which the council collects waste in 2, 019 cases. The balance is collected by private contractor.

iii Difficult premises

There are many isolated houses and farms in the district as well as premises on main streets of the small towns where waste collection vehicles have difficulties of access., or where the householder may have difficulty in reaching the uplift point.

Controlled Waste Arising in South Ayrshire Council

An average of 800 kg./household of waste is produced every year. This amount is higher than the UK average amount, which is 650kg./household. The different of the amount is because of the influx of tourists to the district. Waste generated from each premises are as follow :

Premises	**Waste generated (tonnes)**
Residential/Household	53, 426
Commercial	26, 450
Industrial	29, 894

(Source : South Ayrshire Council, 1997)

4.2.7.2 Recycling Implementation

The framework and development for recycling in South Ayrshire Council relies on the input and support from :

- the public
- the Council
- local commerce and industry
- voluntary groups, and
- central government.

Evidence from the UK and longer running programmes in Europe and North America shows that the public is an important element in being willing to support and participate in recycling activities proposed by the Council. However, education and publicity by the Council are important in providing motivation and information on how to join in recycling practice. Support from local industry and commerce is vitally important and could involve developing sponsorship scheme, joint programmes with local schools and private recycling initiatives. Voluntary group co-operation is needed in maximising public participation in recycling. Central government support is needed to achieve the 25% waste recycling target by the year 2000. Legislation alone is not enough. Stable markets for recyclable material and market based instruments (MBI)

are effective mechanisms in making recycling a successful programme but these also require government leadership. Examples of MBI are:

i Material levy - tax on raw material

ii Product change - higher charges on products made from wholly virgin material

iii Deposit refund system - a 'money back' on return system

4.2.7.3 Problems faced by the Council in implementing recycling programme

Paper

In order to allow the Local Authority to implement paper and board collection schemes, further paper mills and a de-inking plant are needed. Further uses for reclaimed paper should be sought, possibly in compressed blocks to be used as fuel.

Glass

The main problem here is that glass collected for recycling becomes contaminated if it is not properly segregated. When this happen, contaminated glass is not accepted for further processing. Hence the need for more work on collection methods

Ferrous metals

The processing factory for steel cans is far from the council collecting centres, thus initiating increased traffic volumes.

Aluminium

The production of aluminium is energy intensive and the recycling of aluminium is very energy efficient. Existence of a valuable and stable market has encouraged the growth of many voluntary group collections throughout the UK. Within the South Ayrshire Council's area, aluminium recycling activity rate is still low.

Plastics

Plastic is relatively difficult to recycle because :

i There are different types of plastic that are used. There are 2 major kinds of plastics, which are : thermosets (15%) and thermoplastics (85%).

At present mixed plastic waste are valueless. Different types of plastic used are not labelled on the packaging and not necessarily easy to separate.

ii There are many products made of different plastic types, which are laminated and cannot be separated

iii Plastic is very light, not easily crushable, therefore it is expensive to transport.

Textiles

Most recycling of textiles is carried out by charity shops. The rags' industries prefers material from the shops rather than from recycling banks, as they are better sorted and not wet. Recently, charity organisations have been setting up textile banks in conjunction with local authorities. There is a good market for high quality second hand clothing, and the market for shredded material for fillings in furnishing is expanding.

Other wastes

This includes demolition waste, furniture, batteries and tyres. Most of these wastes are sent to landfill except for furniture where under the auspices of the North Ayr Training Group, a free transportation from householders is operated for used furniture. This furniture is refurbished and made available to families in need.

In the South Ayrshire Council area, types of available storage system used and percentage of waste composition that are recycled are as Table 4.8 and Table 4.9 below:

Table 4.8 Types of Storage System

Residential	240 litre wheeled bin
Commercial	Wheeled bin or/and plastic sacks or/and skips or/and palladins
Industrial	Wheeled bin or/and plastic sacks or/and skips or/and palladins
Institutional	Wheeled bin or/and plastic sacks or/and skips or/and palladins
Markets	Wheeled bin or/and plastic sacks or/and skips or/and palladins
Other sources	Wheeled bin or/and plastic sacks or/and skips or/and palladins

(Source : South Ayrshire Council, 1997)

Table 4.9 Composition of waste recycled

Waste composition	**Percentage**
Paper, cardboard and paper products	30.6
Vegetables and putrecibles	28.0
Rags and textiles	1.9
Ferrous metals	7.0
Non-ferrous metals	0.6
Glass	9.5
Plastics	8.4

(Source : South Ayrshire Council, 1997)

In deciding the storage/collection system for dry recyclables i.e. glass, paper, cans, plastics and textiles which is non-putrescible fraction of waste, studies by the Council have shown that kerbside collections are extremely expensive. Even the Leeds system, which is the most successful of the kerbside schemes in UK, has been mostly subsidized by grants from Central Government and other sources. In the absence of this kind of support, these schemes are impractical. Therefore, it has been decided that dry recyclables will be collected by an extension of the recycling bank system. Expansion of this includes the increasing number of sites and adding the collection of new material at each bank site, where feasible.

There has been considerable difficulty in locating sites for the present skip type of bank because of its appearance. These banks have an additional problem of requiring two journeys to the Depot, one to empty and one to return the skip. The new banks purchased will be emptied at the site, thus eliminating this double journey. Such banks can be of two types, either Hi-ab bubbles or wheeled Eurobins. The metal Eurobins are preferred by the council because of their attractive appearance and robust design despite smaller capacity (1.1 m^3) but the use of Eurobins and the Hi-ab bubbles requires new vehicle design for servicing, thus adding a cost to the overall programs.

4.2.8 Lessons learned from the case study

In considering recycling as one of the waste management strategies, the economics of recycling need to be thoroughly assessed. It is not really efficient to make a special journey by car or walking to recycling banks. Therefore banks need to be sited in areas where people make journeys for other purposes. Where transfer sites for gathering and processing reclaimed materials are placed, the sites should be able to

minimize the journey especially when small amounts of reclaimed material are to be transported. Recycling initiatives in the more isolated areas proved to be expensive and difficult.

Support from the government is important not only by imposing regulations on recycling but also by controlling the market value of the recycle materials. This is because the development of markets and the increa sed availability of reclaimed materials must develop 'hand-in-hand'. The cost of recycling should take into account the collecting, sorting, processing and transporting of recycleable materials. Local markets for this material would normally be important. Government and private bodies could also support this activity by providing grants, setting up material recycling facilities (MRF), de-inking plants and sites to set-up recycling banks.

Above all, recycling plans must be flexible and open. This is important because the legislation, economic and industrial environment will change over the years and will have a direct effect on encouraging recycling initiatives. Therefore this activity needs to be monitored and updated continually.

CHAPTER 5
WASTE INCINERATION AND DISPOSAL

5.1 Incineration of Waste (Energy-from-Waste)

5.1.1 Introduction

Today, energy-from-waste (EfW) is becoming one of the components in an integrated waste management system. The increasing interest in EfW is because of its capability to reduce waste volume and to generate energy in the process. In addition, with EfW a number of benefits are identified which involve saving non-renewable resources by replacing fossil fuels usage and producing energy from non-recyclable materials. The process reduces up to 90% of the volume of waste and 70% of waste weight. In Europe, 33 million tonnes of its municipal solid waste is burnt for energy recovery (EEWC, 1996). There were 313 EfW plants in Europe in 1994 where the energy capacity produced was equivalent to 11 million tones of coal a year (EEWC, 1996).

In Europe, the increasing development of EfW is affected by the new regulations on incineration, which came into full effect at the end of 1996. This forced the closure of incinerators that did not meet the EU standard. This regulation which is now adopted at national level, makes EfW one of the considered options for integrated solid waste management. With new regulation and tax on landfill, notably landfill Directive and landfill Tax, incineration is becoming a more attractive alternative to landfill.

It has been realized that over-reliance on only one method of waste treatment does not work and a mix of options offers a more sustainable approach. Experience

shows that even successful schemes of waste reduction, re-use and recycling cannot deal with more than 40-50% of the municipal solid waste produced. Therefore the concept of an integrated waste management system based on environmental considerations, energy production, economic operation and socio-political acceptability has a better chance of striking a right balance between the environmental impact, economic efficiency and societal needs.

The EU has issued several directives regarding incinerators and air emissions in order to overcome the waste disposal problem.

i Air Framework Directives (84/360/EEC).

This directive requires member states, subject to prior authorisation to prevent or reduce air pollution from industrial plants including incinerators. A specific emission standard should also be met and operated based on BATNEEC principles (Castle and Harrison, 1995).

ii Municipal Waste Incineration Directive on new MSW Incineration plants (89/369/EEC)

A limit of emission is set for dust, heavy metals, hydrogen chloride, hydrogen fluoride and sulfur dioxide in this Directive. The emission values for pollutants such as dioxins and furans are also specified. The amount varies depending on the size of the plant capacity. Stringent limits apply to the largest incinerators. This directive specified the detail requirements relating to the operation, combustion, monitoring and emergency procedures.

iii Municipal Waste Incineration Directive on existing MSW Incineration plants (89/429/EEC)

This sets out the emission limit values, and requirements for operation and monitoring procedures. This Directive aims to bring the existing plant standard gradually within the standard outlined for new plants.

iv. Hazardous Waste Incineration Directive (HWID) (94/67/EEC)

This Directive applies to solid or liquid hazardous waste as defined in the Hazardous Waste Directive. Its trend is toward an integrated regulation, which aims :

> *"to prevent, or where that is not practicable, to reduce as far as possible negative effects on the environment, in particular the pollution of air, soil, surface and groundwater, and the resulting risks to human health, from the incineration of hazardous waste"*

This directive does not include municipal hazardous household waste.

v Waste Incineration Directive (WID)

This is still at proposal stage and will apply to all wastes excluded from HWID. The aims of this Directive is to reduce the emissions to air, water and land from the incineration of non-hazardous wastes, through the extension of emission controls to processes outside the Directive 94/67/EC on the incineration of hazardous waste scope and to impose more stringent controls on municipal waste incineration plant required by 1989 Directives (89/369/EEC and 89/29/EEC), which were only concerned on certain air emissions.

vi *Directive on Integrated Pollution Prevention and Control (IPPC).*

This directive is formed to prevent where possible or minimise the pollution caused by industry to air, water and land. From 24th September 1996, the Member of State had until 30th. October 1999 to include the EU Directive on IPPC into national legislation. This Directive will affect the manufacturing industries, energy production and landfill operators.

In the UK, these directives are applied through the Environmental Protection Act 1990 (EPA) which requires compliance on meeting emission limits at source and on operation standards relating to processes contributing to emissions. Procedures on incineration plant were also set out in the Royal Commission on Environmental Pollution's 17th Report "Incineration of Waste". To make sure that BATNEEC is applied to existing plant, the Chief's Inspector Guidance Notes on incineration process were published. In Scotland, the importance of using renewable energy was announced in the National Planning Policy Guideline 6 on Renewable Energy by the Scottish Office, which stated that :

"Planning authorities should seek through their policies and decisions:

- *to provide positively for renewable energy developments, where this can be achieved in an environmentally acceptable manner;*
- *to safeguard sites with potential for renewable energy projects against sterilisation by types of development that would prevent or hinder such projects and could be accommodated elsewhere;*
- *to protect areas of important natural and built heritage from inappropriate forms of development, and*
- *to achieve acceptable operating standards during the working life of any project and the early restoration of sites, once operation has permanently ceased.*

(Source SOEnD, 1994)

In the UK, the *Environmental Protection Act 1990 (EPA)* embodies the approaches of EU Directives and requires compliance on meeting emission limits at source and on operation standards relating to processes contributing to emissions. The Integrated Pollution Control (IPC) system introduced in the EPA, controls releases of pollutants to air, water and land and its major principles are summarised as

- *to prevent or minimise release of prescribed substances and to render harmless any such substances which are released; and*
- *from industrial processes to all media in the context of the effect on the environment as a whole.*

(Source Castle and Harrison, 1995)

The waste category and quantity percentage limit of waste category that is allowed to be burnt in an incinerator accepted by the IPC Authorisation is as Table 5.1 below:

Table 5.1 Percentage of waste acceptance limit

Waste	**Maximum acceptance limit**
Municipal waste	100%
Sewage screenings	5%
Special waste	5%
Clinical and Hospital waste	<15%
Small animal carcasses	1%

Source DERL, 1994.

From the table, it is clear that municipal waste is given priority for its treatment through incineration. The IPC limit is also to make sure that municipal solid waste disposal to landfill will be decreased.

5.1.2 The EfW mechanism

In an EfW plant, waste is burnt at 850-1350^{o}C, to destroy 80% of the contaminants. The combustion system will convert the energy content in the waste into heat. This heat then will be converted into electricity via an alternator. The energy potential contained in some type of waste is more than in other solid fuel. Therefore, sorting waste at source is essential. This is shown in Figure 5.1.

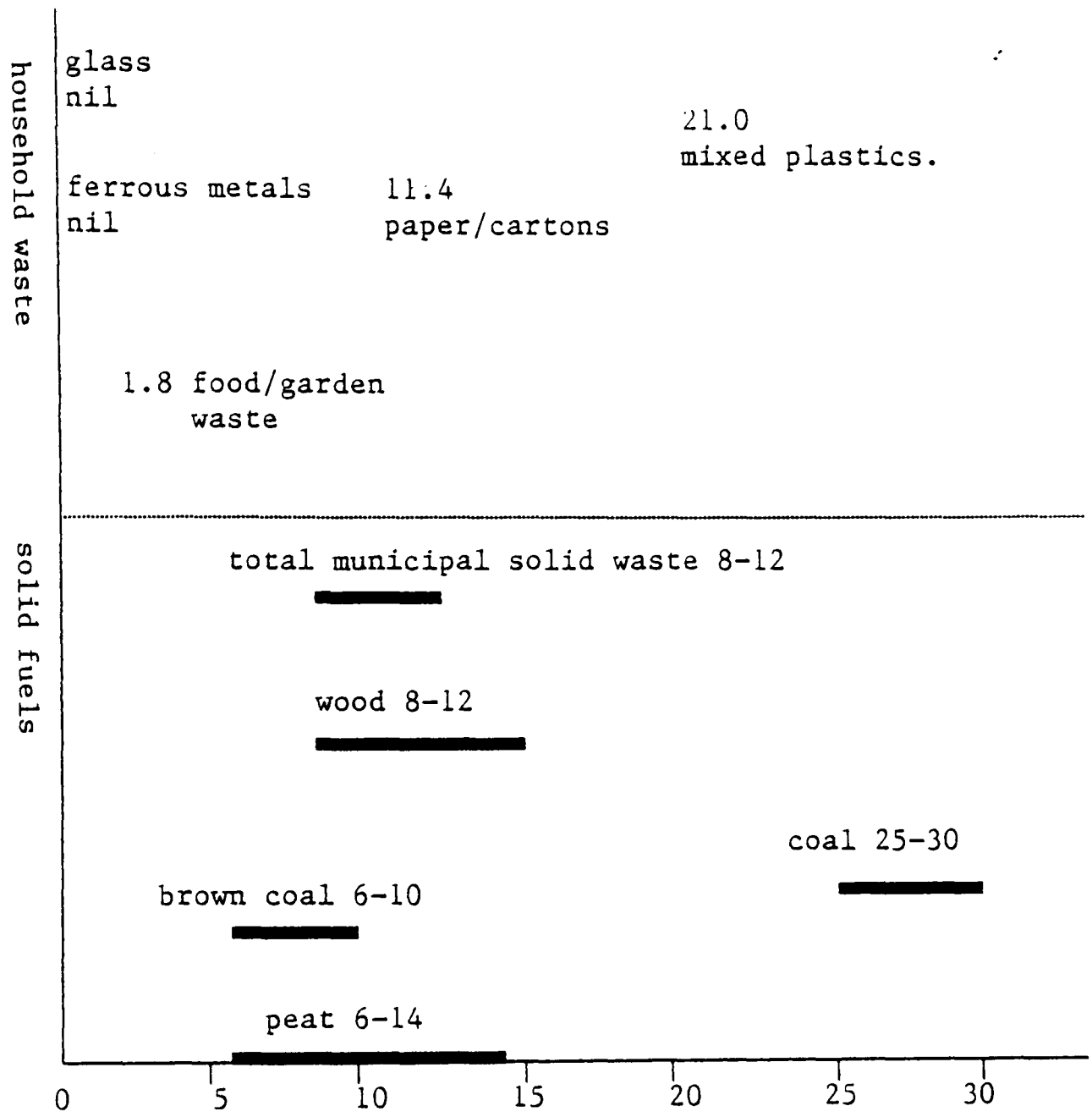
The first incineration plant was built in the UK in the 1870s, following the increasing interest in public health. In the early twentieth century, incineration plants were built using waste to generate electricity by steam production, but because they were uneconomic to operate, the technology was not developed. After the late 1960s, waste incineration become a key element of waste treatment in most industrial countries. Figure 5.2 shows the current incineration status in the European Union. From the table, Germany and France are leading other EU countries in incineration plants with heat recovery.

The UK Government's Energy Paper No. *62 'New and Renewable Energy: Future Prospects in the UK'* 1994 stated that

"Government policy is to stimulate the development of new and renewable energy sources wherever they have prospects of being economically attractive and environmentally acceptable in order to contribute to:

- *diverse, secure and sustainable energy supplies*
- *reduction in the emission of pollutants*

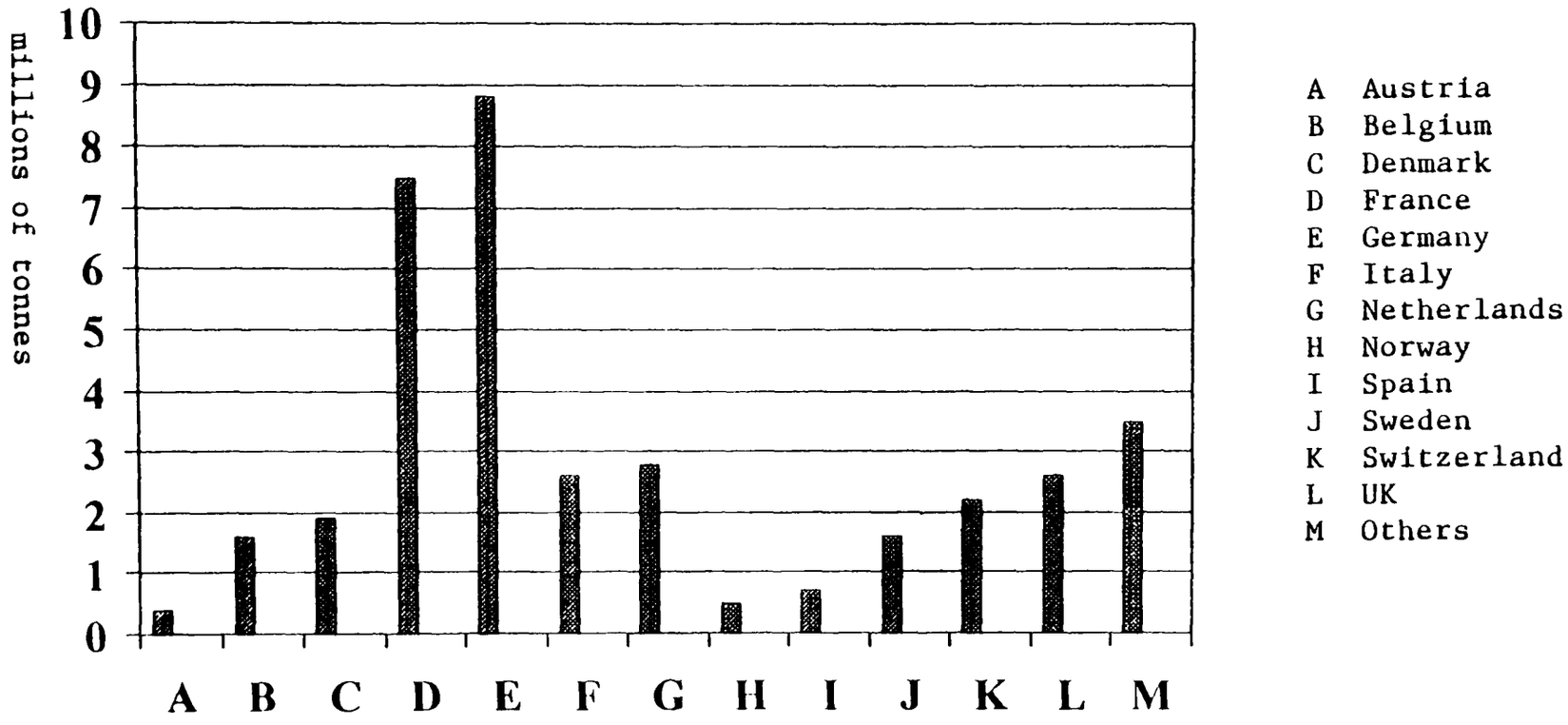
Figure 5.1 Potential Energy of Waste in Household Waste Compared to Non-renewable Fuels.



1000KJ of energy per kg. of material.

(Source: EEWC, 1996.)

Figure 5.2 Amount of waste burned in the EU in 1994.
90% was burned in waste to energy plants.



Source. EEWC, 1996.

This is also stated under Scottish Renewable Obligation 1993 (Scottish Office, 1993). The UK Government's White Paper on environment (1990) - '*This Common Inheritance'* set a target that by the year 2000, a new renewable capacity of 1000 MW was to be met. This has been revised to 1 500 MW in March 1993 in the Coal Review White Paper. In the UK, categories of incineration plants mentioned below are under HMIP (after April 1996, it is under Environmental Agency/SEPA) control:

i. All sizes of incinerators burning waste chemicals or waste plastic arising from the manufacture of a chemical or the manufacture of a plastic.
ii All sizes of incinerators burning chemical waste comprising in elemental or compound from bromine, cadmium, chlorine, fluorine, iodine, lead, mercury, nitrogen, phosphorus, sulphur and zinc.
iii Any other waste, including animals remains, where the plant design capacity is 1 tone or more per hour.
iv. The cleaning for reuse of metal containers used for transport or storage of a chemical by burning out their residual content.

(Adapted from Bryce, 1995)

5.1.3 Case study - Baldovie the proposed waste-to-energy incinerator at Dundee

5.1.3.1 Introduction

Dundee is situated on the East Coast of Scotland on the North side of the River Tay estuary. Its estimated population is 165,630 people. The District Council handles municipal Waste Management in Dundee. A study was carried out to evaluate various options for waste disposal and it was found that a new incinerator coupled to a combined heat and power plant (CHP) would be the best environmental solution. This new plant will be able to convert energy into 9.6 MWe in the form

of electrical power, high-grade energy in the form of steam and low grade energy in the form of hot water. It will be fuelled with local municipal solid waste (MSW), industrial waste and clinical waste. The electrical energy produced will be used by the local area, with process industry using the high grade energy while the low grade heat is used for space heating of industrial premises or municipal housing.

This new facility covering approximately 5.0 hectares (ha) will be able to convert 73,000 tonnes of MSW per year which come from Dundee Council area, with spare capacity for additional domestic and industrial wastes received from other sources in the surrounding region and a small proportion of clinical and special waste. Dundee's waste is highly mixed with MSW and trade waste, which contain plastics and synthetic compounds. Some of these materials are non-separable biodegradable and with limited technologies and markets available, it is difficult to recycle these materials in an effective and economic way. However, high calorific value and the energy released during incineration can be converted effectively into heat and electricity. This plant is designed and will be operated to comply with EC Directive 89/429/EEC and HMIP document IPR 5/3. Table 5.2 shows the characteristic of waste the City of Dundee, which is handled by the Baldovie energy-from-waste Plant.

Table 5.2 Amount of waste to be incinerated

Waste stream	Tonnage	Percentage
Domestic Refuse	74, 400	62.0
Civic Amenity Waste	6, 600	5.5
Commercial waste	15, 000	12.5
Industrial waste	8, 400	7.0
Rubber tyres	1, 200	1.0
Special waste	3, 600	3.0

Waste stream	Tonnage	Percentage
Clinical and Hospital wastes	9, 800	8.0
Others (sewage screenings, bottom grits)	1, 200	1.0
Maximum Operational Tonnage over weighbridge	120, 000	100.0

Source DERL, 1994.

The principal features of this waste to energy incineration plant comprises:

i. The main incineration block (3,660m^2) which includes:

- tipping hall - an area for maneuvering and tipping incoming refuse
- waste storage pits - for storage and mixing of the waste
- furnace chamber, containing two rocker grate furnaces
- control room
- small animal crematoria
- ash handling and ash storage plant.

ii. A 70m high twin flue chimney stack

iii. The amenity block (450m^2) including offices

iv. Boiler house (190m^2)

v. Gate house and weighbridge

vi. Ancillary storage including, liquid waste storage tanks, metal bales store bay, road sweepings transfer bay and civic amenities compound for skip waste.

5.1.3.2 The process

The process of waste handling by this EfW plant is outlined in Figures 5.3 and 5.4 which show the waste reception and recycling routes of the main waste streams (DERL, 1994). All wastes, excluding special liquid waste are directed to the

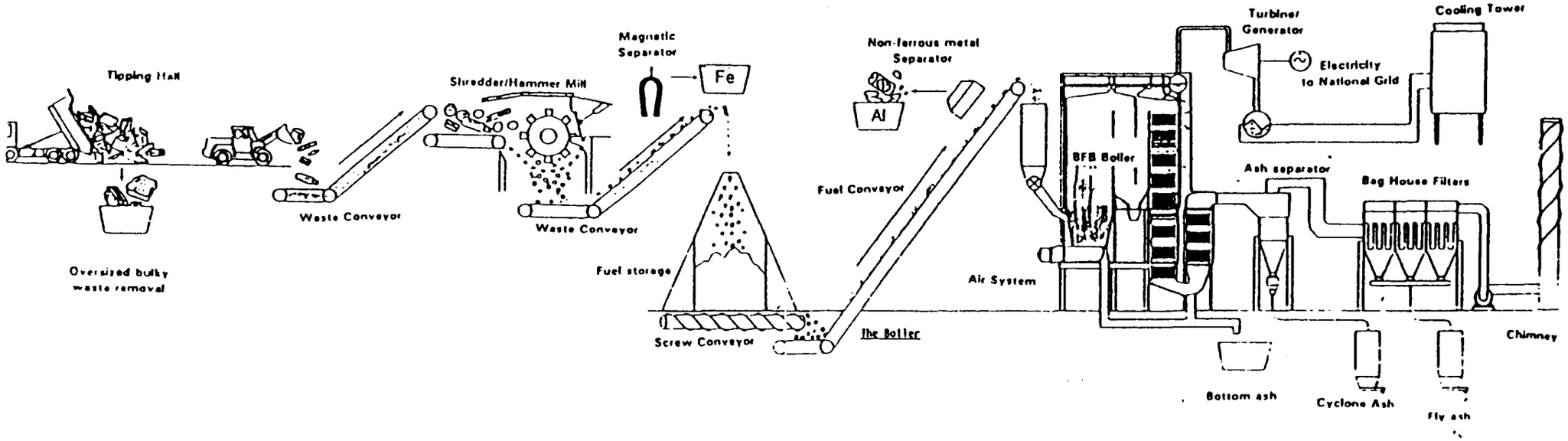


Figure 5.3 Process of Waste Handling by Waste-to-Energy Baldovie Plant.

(Source: ScottishPower, 1994)

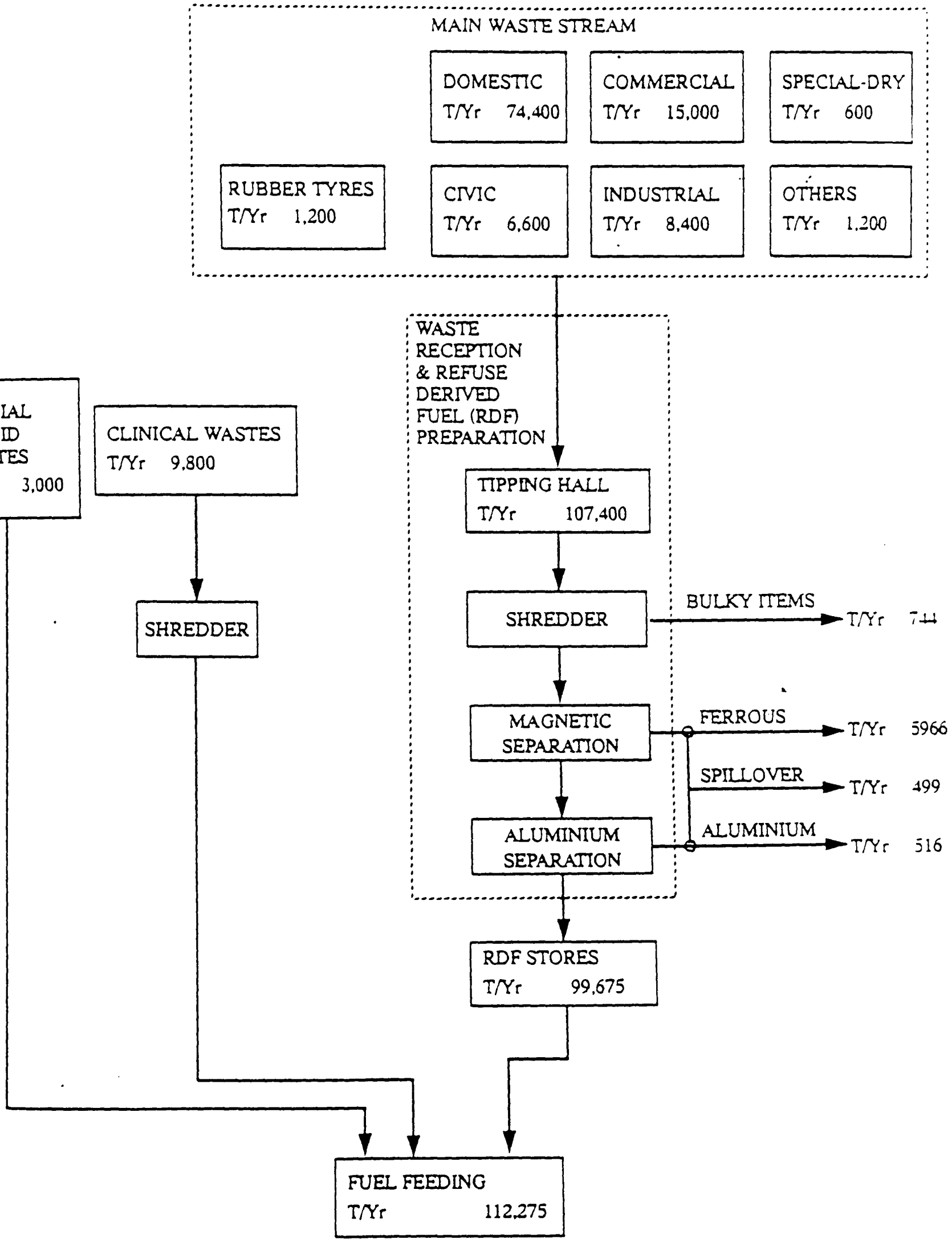


Figure 5.4 Waste Reception and Recycling

tipping hall. In the hall, MSW and trade wastes are deposited on the flat floor and are then processed in the residue derived fuel (RDF) preparation plant. Clinical waste is directed to the clinical waste reception and is shredded and fed directly into the boilers.

A front-end loader will lift MSW and trade waste into one of two feed hoppers, feeding a plate feeder for transfer to one of two shredders. The raw household and commercial waste is then shredded into a more suitable form for storing and conveying to the fluidised bed boiler. This shredded waste, known as residue derived fuel (RDF) size is less than 150 mm.

The waste incineration capacity is 16 tonnes/hour. At full operational capacity the annual quantity of RDF requiring handling and storage is estimated at 98,475 tonnes after ferrous and non-ferrous metallic separation (6,500 t/yr.) and the removal of bulky items (750 t/yr.). In the RDF-storage area, belt conveyors and a travelling conveyor spreading the RDF over the complete storage area and further ensuring mixing distribute the RDF. The fuel storage area is sized for approximately 48hours full load operation. At one end of the storage building, RDF is discharged into an elevated belt conveyor system taking the RDF up to the boiler feed system.

The boiler feed system operates on an overflow basis, keeping the boiler fuel feeding lines 100% filled at all times. Overflow material is then fed back to the RDF transfer conveyor system for redistribution in the RDF store.

Clinical waste is treated separately from the MSW. It is transferred straight into an enclosed storage area to minimise the risk of opening bags during storage. The storage area is facilitate with a walking floor type feeder in the bottom. A large screw conveyor at the end of the storage continuously feeding the bags to an elevated apron conveyor that discharges to a shredder which reduce size of the clinical waste to 80 mm. From the shredder material is fed to the boiler through totally enclosed screws and drag link chain conveyors. All equipment in the clinical waste handling facility is designed to contain spillages and to facilitate effective disinfection. As with the RDF areas, all ventilation will be under a slight negative pressure to minimise the escape of material into the atmosphere, with all out flowing air being directed to an injection site on the Fluidised Bed boiler and used as combustion air.

The disposal of residue consists of three (3) systems:

i. **Bottom ash system.**

Bottom ash is continuously bled from the boiler to a drain located at the furnace base. The bottom ash will then be fed to a classifier (a separate fluidisation vessel) designed to separate the coarse particles from the bed material. Bed material (sand) is returned to the Fluidised Bed boiler. The coarse ash is cooled and removed by a water cooled conveyor. This system is designed to have a controlled drain flow in order to keep the bed clean. This ensures low emission and prevents the bed from sintering. The outflow feed rate from the ash classifier will match the ash flow variations from various types of waste. This system is also connected directly to the bed and can be used to drain the bed rapidly for maintenance or bed removal. The inert bottom ash will be retained in an enclosed silo prior to removal to landfill.

ii. Cyclone ash

Ash from the cyclones is directed to a separate silo prior to removal to landfill.

iii. Fly ash treatment

This process converts the ash into a synthetic rock or concrete blocks, the nature of which makes it difficult for toxic substances to escape. This treatment process is predicted to reduce leachate levels from the fly ash below that of the proposed EC Landfill Directive for leacheability.

(The above technical description has been paraphased from the Environmental Assessment Report on the Impact of The Baldovie Incinerator and material from the Scottish Power (Technology Division), 1994) and through interviews with the engineers involved.

5.1.4 Key lessons from the Baldovie case

EfW incineration should be considered as one of the important elements in waste treatment. It is the only method able to reduce the quantity of combustable waste going to landfilll by 90% (Hjelmar, 1996). Before considering waste incineration there should be a regulation set up to control emissions from the incinerator and clear guidelines on the design of the incinerator, the location of the plant and its method of operation.

The aim should be to ensure that:

- there will be no harmful effect which could cause nuisance to the public living nearby and to the environment;
- best available technology should be introduced in the plant process to control emissions and to prevent harm to the environment
- residues should be minimised and wherever appropriate be recycled before going to landfill.

Energy generated that is not used should EfW be used within the operation of the plant.

The disadvantages of going for as one of waste treatment options is the cost involved, not only to the operator but also to the public. In the UK for example, the cost of waste going to an incinerator costs £10 to £30 per tonne more than waste going to landfill. The disposal strategy for municipal solid waste incinerator (MSWI) residue should be studied as the landfilling of MSWI may have long term consequences on potential leaching of contaminants.

5.2 Disposal to landfill

5.2.1 Introduction

Landfilling has been practiced since ancient times but with only primitive technologies involved until recently. Landfill is used as the main option for waste disposal but now it is realised that this activity can have serious environmental impacts. A landfill without proper technological control emits methane gas to the air and releases leachate to the groundwater. The present role and future of landfill is changing rapidly (Cossu, 1989). In the UK, landfill disposal has been developed from the controlled tipping system which was used since 1930s, where waste was disposed to land and sea. International conventions have progressively restricted dumping at sea and of the result, UK had stopped dumping sewage sludge at sea since 1998.

Landfill use cannot be banned entirely since there remain materials and residues that cannot be treated, reused or recovered. There are two typical landfill systems which are designed to protect the water resources. These are:

5.2.1.1 dilute and disperse system

This is a traditional form of landfilling. The system applies to permeable strata sites usually with highly amount of clay. The attenuation mechanisms work by dilution and dispersion through pores and micro-fissures into the underlying saturated strata

(Kiely, 1997). This system is now not acceptable and does not meet the EU requirements.

5.2.1.2 concentrate and contain system

This system isolates the wastes, its leachate and gas from the surrounding environment by natural clay or synthetic bottom liners (Kiely, 1997). The philosophy of this system is that leachate and gas within the site are not allowed to leave the area either through the ground or its surrounding (Baron, 1995). Leachate and gas collection facilities are installed and are regularly monitored. This system gives maximum protection to all groundwater in the area.

It is estimated that 70% of municipal waste and 35% of industrial waste produced throughout the European Community is landfilled. In the UK, 90% of controlled waste is landfilled, 9% is incinerated and 1% goes under other waste treatment (Singer, 1995). In the UK, the types of waste going to landfill and the volume disposed are limited by the conditions of the site license over a certain period of time. Typical wastes placed in landfill are:-

i *inert waste* : non-special or non-difficult waste with no potential to harm the environment and which will not biodegrade under normal environmental conditions. For example building materials not including asbestos.

ii *biodegradable waste* : includes household, commercial and biodegradable industrial waste, that is those wastes of a nature similar to household waste. Biodegradable wastes are non-difficult wastes which will readily degrade under the action of bacteria normally present in the landfill environment. Under the anaerobic conditions in landfills, this process will produce leachate and landfill gas. This type of waste consists of paper, plastic and organic matter.

iii *hazardous waste* : difficult and special industrial waste. These waste are harmful either in short or long term to humans because of their chemical and toxicological properties. This includes waste with a potential harm to the environment. (Street, 1994).

iv. *'special waste'* : waste which require special handling such as medical waste. It is not necessarily toxic or hazardous. In 1996, this waste is classified as special waste (Special Waste Act, 1996)

Therefore, landfill sites are classified into three types depending on the type of waste accepted. In general these sites are:

i. mono-disposal sites-only one homogenus type of waste is deposited for example on-site disposal site by industry of one particular waste type.

ii. Multi-disposal sites-Used for the disposal of household, commercial and general industrial waste.

iii. Co-disposal sites-Used for disposal of non-hazardous and hazardous waste. The co-disposal sites are the commonly used sites.

5.2.2 Impact of landfill on the environment

Impact of landfill practice on the environment can be categorised as:

i *Chemical impact* : Landfill gas (methane (CH_4), carbon dioxide (CO_2) and over one hundred trace gaseous compounds) and leachate are two main chemical substances emitted from landfill sites. Both are the result of biochemical reaction within the landfill site (Kiely, 1997). Typical landfill gas composition is as shown in Table 5.3. As illustrated in Figure 5.5 landfill gas is produced when biodegradable waste is mixed with water in a sealed site with a low permeability cover. Leachate is a pollutant in a form of liquid which will go into the groundwater system. When leachate enters the system it will cause pollution.

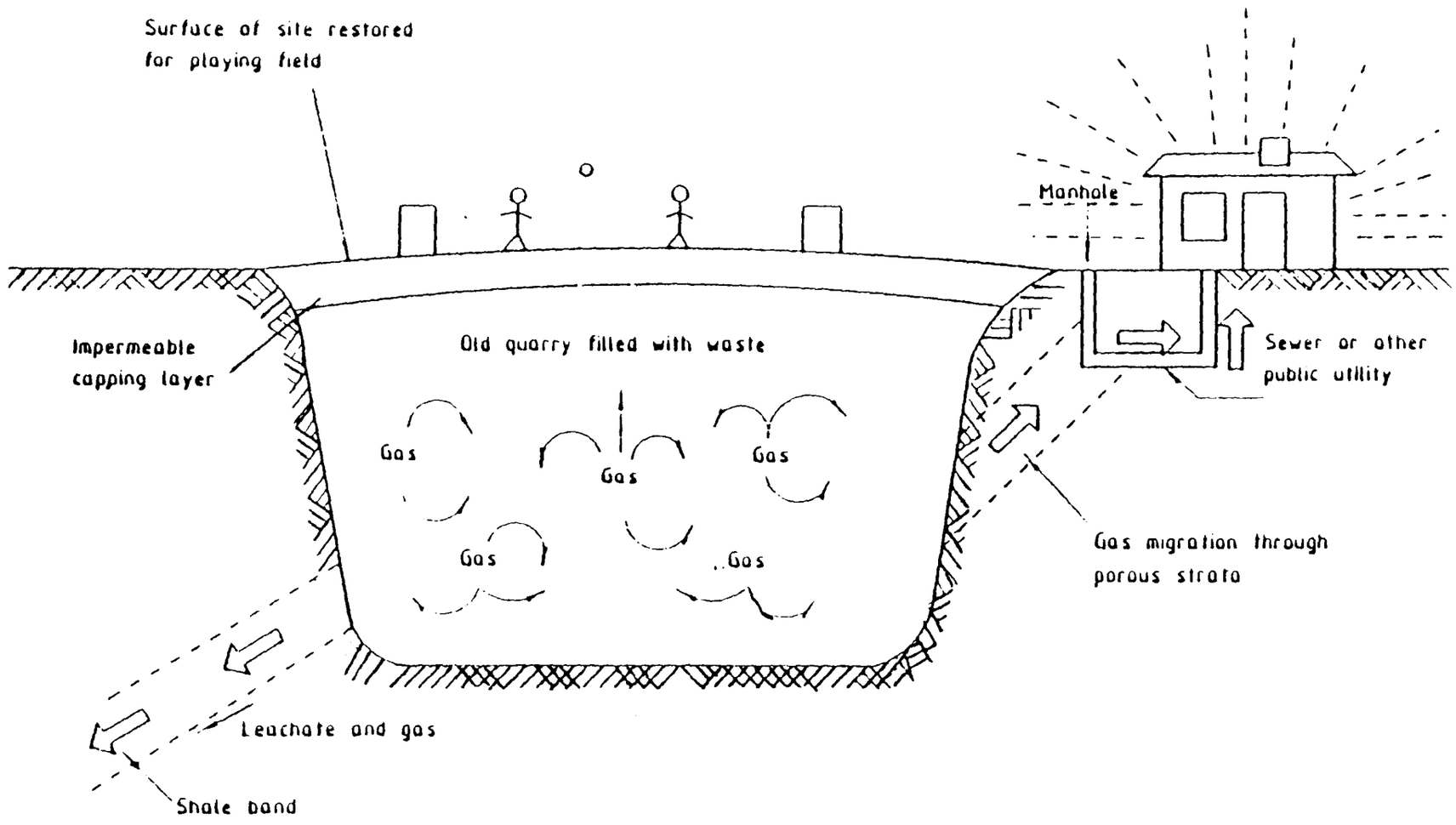


Figure 5.5 Production of Landfill Gas
(Source: Barron, 1996)

Figure 5.6 illustrates pollution caused by leachate as the result of biochemical reaction formed by contact of water and refuse which contains contaminants.

Table 5.3 Typical landfill gas composition

Component	**Typical value (% volume)**	**Observed maximum**
Methane	63.8	77.1
Carbon dioxide	33.6	89.3
Oxygen	0.16	20.93
Nitrogen	2.4	80.3
Hydrogen	0.05	21.1
Carbon monoxide	0.001	
Saturated hydrocarbons	0.005	0.074
Unsaturated hydrocarbons	0.009	0.048
Halogenated compounds	0.000 02	0.032
Hydrogen sulphide	0.000 02	0.0014
Organosulphur compounds	0.000 01	0.028
Alcohols		0.127
Component		
Temperature, C^{O}	38 - 50	
Specific gravity	1.02 - 1.06	
Moisture content	Saturated	
HHV (Hawf), kJ/L	15 - 38	

Source Kiely, G. 1997.

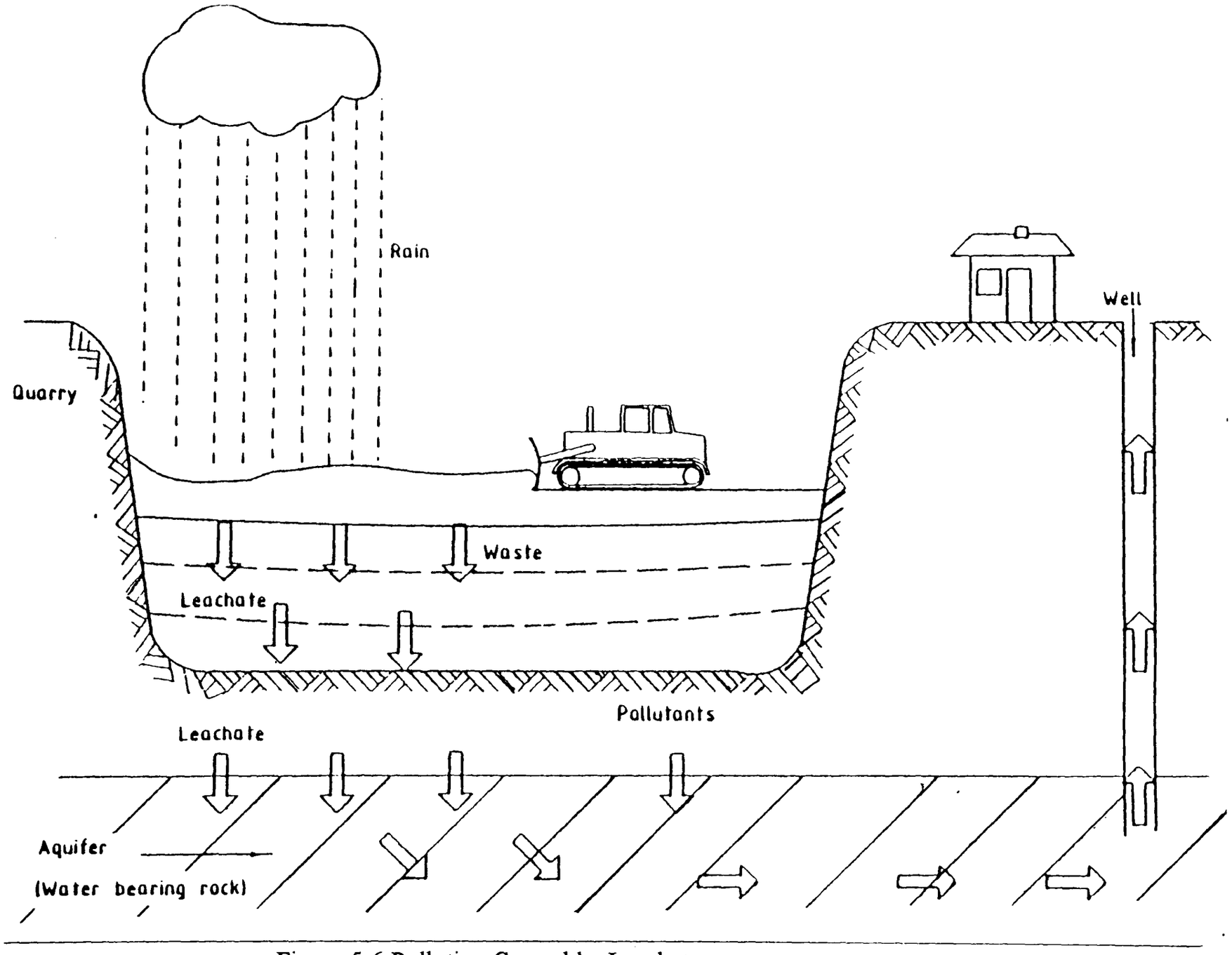


Figure 5.6 Pollution Caused by Leachate
(Source: Barron, 1996)

ii *Physical impact* : A landfill site is one of the 'not in my backyard' items which causes public reaction. Obvious effects of landfill to the local community are the heavy lorry traffic which causes nuisance from noise, vibration, exhaust, dust, visual dirt and visual intrusion. Heavy vehicles on narrow roads will delay other traffic.

iii *Biological impact* : Landfill sites usually take place in a quarry or mineral excavations, derelict land or less frequently on undisturbed ground or agricultural land. Any landfill operation will cause significant ecological change including the destruction of existing vegetation and a disruption to animal life.

5.2.3 Legal aspects

In the UK, landfill waste disposal operates within a well-defined framework comprising four distinct elements which are :

i Planning controls

ii Site licensing

iii Enforcement

iv Defined standards

Regulations which guide landfill practices are:

i The Control of Pollution Act 1974 (CoPA)

ii The Environmental Protection Act 1990 (EPA)

In Part II of EPA 1990, "relevant objectives" were set out in relation to the disposal or recovery of waste to ensure that waste is recovered or disposed of without endangering human health and without using processes or methods that could harm the environment.

iii EC Groundwater Directive

This Directive imposed on the possibility of waste disposal operations impact towards water resources and aquifers. This applies to licensing of waste disposal. of site for disposal.

iv EC Landfill Directive

This Directive is to ensure that all European landfills are strictly controlled upon the operation, environmental monitoring and long-term care after closure. It also requires waste to be treated before sending to landfill, especially in reducing the hazardousness and volume of waste being landfilled as well as reducing the methane gas from landfill sites. Limits on the landfill of biodegradable waste is also mentioned.

In the UK Waste Management Strategy, landfill is considered as the last option of the waste management hierarchy (DoE, 1995). This is because of the problem of the availability of land for landfill sites. Other methods can be encouraged through economic instruments which raise the price of disposing waste at landfill sites. Other costs involved in operating a landfill are:

i. *Cost of land* - depending on whether the land is hired or purchased.

ii. *Maintaining and purchasing of equipment and vehicles* for solid waste collection.

iii. *Cost of labour*

iv. *Infrastructure and supporting facilities* for waste transportation. For example roads, electricity, water, telephone, fences around the landfill and signs for operation.

v. *Expenses on site survey*, the designs, plans and specifications for a landfill.

Before considering a landfill operation, Crawford (1989) suggested that the possibility of problems occurring during the operation should be taken into account. These include:

i *Insufficient cover material*

Every day the waste layer should be covered with a minimum thickness of 1-2 metres of earth. Therefore the quantities of cover materials should be calculated at the design stage and must be located at suitable sources nearby. Without the cover materials, infiltration and precipitation can happen that leads to increased leachate production.

ii *Weather conditions*

Since landfill is an open area, weather conditions give impacts to the landfill site. During heavy rain, the surface area will become soft and this causes problems to the access for vehicles. In contrast, during hot periods, dry weather results in a layer of fine dust being formed.

iii *Fires*

On landfill sites, fires occur as a result of several situations. The waste chemical contents in some industrial waste and hazardous household waste have a tendency of spontaneous combustion when sufficient oxygen is available.

iv *Bulky waste*

Bulky wastes includes tyres, furniture and household equipment such as cookers and refrigerators. These waste causes uneven settlement in the landfill. As for tyres, they tend to form to their original shapes even after compaction and because of the substantial calorific value, they can be easily ignited and the fire is difficult to put out.

v. *Vermin*

It is difficult to exclude vermin, including rats and insects from landfill sites. These species could transfer diseases to the people working on site and in the neighbourhood.

vi *Birds*

Birds usually feed on waste disposal sites before they are covered and also spread the waste beyond the landfill to the neighbourhood. Problems might occur when the same bird then swims in a nearby water supply reservoir.

vii *Windblown refuse*

Since the landfill site is an open area, windblown refuse such as plastics and papers will cause problems in adjacent fields and hedges.

viii *Dumping outside landfill area*

Waste is dumped at the landfill entrance outside working hours. It is difficult for the workers to clear up the next day.

ix *Waste delivery cycle*

Depending on type of landfill (either mono-, co-, or multi-disposal), waste delivery can affect the site operation in a certain manner. Collection patterns for municipal, industrial and commercial waste are different. For example, the municipal waste collection system may have daily and weekly pattern of collection, whereas industrial and commercial wastes are collected in a different pattern.

x *Vehicles/machines used on landfill*

It is important that the machines used such as bulldozers and trucks are designed to be used on landfills. Machines must be maintained regularly. It is also important for the operators to be educated in the landfill fundamentals and technology and to understand principles of the design of sites on which they work.

xi *Collection vehicles*

Landfill operators must inform collection vehicle drivers on where to tip the wastes. Problems could occur if they tip the waste on the waste layer or the cover material.

xii *Settlement*

Settlement in landfill sites occurs because organic materials decomposes and hollow containers collapse either as a result of subsequent degradation or simple mechanical loading. This becomes a problem when the settlement is uneven. This could strain the cover material and allow water, insects and vermin to enter the landfill layers.

5.2.4 Case study - Summerston Landfill Site (Glasgow City Council)

5.2.4.1 Introduction

Summerston landfill owned by the Glasgow city Council is situated 4 miles north of Glasgow City Centre. The eastern boundary of the site is the A879 road to Milngavie and the River Kelvin runs along the north and west of the site. The gross air space area is 40 millions (m^3) and has 16 years of life expectancy. It started operating in 1986 and will continue until the year 2002. This landfill site receives municipal baled waste from the Glasgow city centre area. The waste is

compacted and baled into $1m^3$ (1m X 1m X 1m) size at a nearby material recycling facility (MRF) owned by the council.

Before this site was developed in 1986, this area consisted of construction waste from the Clyde Tunnel, old railway embankments, and abandoned brickworks which were active from 1930s until 1970. This area is a low lying flood area and surrounded by agricultural land.

5.2.4.2 The Landfill Design

The Summerston site has been developed in phases. Every phase constructed was installed with a 2.0 mm HDPE liner overlaying a natural lining system installed to protect from groundwater contamination caused by leachate.

Site management (Figure 5.7)

This site receives waste on 2 shifts between 7.00 am to 6.00 pm and the second shift is between 8.00 pm to 7.00 am from Monday to Saturday. All waste collection vehicles entering the site are controlled by a computerised barrier system. Every vehicle uses a magnetic identification tab to enter the site. Restriction hours are imposed for contractors importing inert and demolition material for daily cover, formation of site haul roads and restoration work. Site personnel involved are:

1 Supervisor

1 Landfill technician, 20hours/week

1 Chargehand/operator

4 Landfill operators

2 General labourers

Figure 5.7 Site Management

1 Landfill operator (night shift)

1 General labourers (night shift)

The active cells (an area of the landfill site that receive waste) are shielded from the outside view by constructing baled bunding with a cover of inert material. These bales are placed on shelves of 4 bales high in order to achieve desired contours unde the over of the inert material.

Leachate control

Leachate generation has been minimised by the infill of the peripheral of the site in the early phases to encourage surface run-off from the completed areas of the landfill to the perimeter surface water drain. "Filters" by aggregates are used in a 500mm gap between the baled waste from the base level for leachate collection. The shape of the base is such that two low points have been provided with manholes for the collection of leachate, prior to on-site treatment, the reminder of the base is graded to a minimum of 1 in 80 to achieve leachate drainage collection.

Leachate recirculation is done in an overland flow system in which the leachate is applied to the upper parts of the site by mobile pumps into a maximum waste depth of 28m. This increases the stabilisation of the fill and promotes the development of an aerobic bacterial population within the fill.

On-site leachate treatment (Figure 5.8, 5.9, 5.10)

The on-site treatment used is the aerobic biological process within a $1000m^3$ capacity of HDPE lined lagoon. Floating surface aerators are used for aeration process.

Aeration degree of the lagoon is controlled by the immersion of the aerator impeller. The dissolved oxygen (D.O) in the lagoon is maintained during the

Figure 5.8 On Site Leachate Treatment Pond I

Figure 5.9 On Site Leachate Treatment Pond II

process. The treated effluent then is transferred to a polishing lagoon with a diffused aeration system before entering a $100m^3$ discharge lagoon to allow discharge to the River Kelvin through a "hydro brake" and flow meter at the conditions of consent issued by the Clyde River Purification Board (now under SEPA).

This landfill site is maintained through monitoring of parameters involved in treatment process and the discharge of treated effluent within the sites which includes:

i. Programmed inlet flows
ii. Programmed effluent outlet flows
iii. Programmed aeration period
iv. Programmed settling period
v. High/low level : dissolved oxygen
vi. Lagoon temperature
vii. Air temperature

Since the plant was commissioned in 1990, the critical parameter on the system is the lagoon temperature. Problems were encountered during the first twelve months of operation, but these were attributed to a number of inter-reading factors which are: subtract availability, phosphate, increase in leachate concentration and extreme variability in temperature. The main problem of the temperature is when rapid chilling occurs, it may freeze the aerators and stop the overall aeration process.

Gas management

Gas collection pipes have been installed for local control by encapsulating vertical HDPE perforated pipe with stone material within a geogrid cylinder from the base

of the site, feeding into a collection system for extraction into the sites 1000m^3/hr diesel powered flare stack. The utilisation of gas is being pursued for the :

i. 3MW electricity generating plant.

ii. Supply to the adjacent brickworks site to the fuel kilns.

A detection system has been installed outside the perimeter of the site comprising a series of monitoring points capable of detecting migration laterally off site.

Environmental monitoring

Site monitoring is carried out for the collection of data on :

i. leachate

ii. discharge effluent

iii. under liner drainage

iv. groundwater

v. landfill gas

vi. meteorological parameters

Part of the landfill site is now restored and landscaped with extensive tree planting, wild flower and grass mix (Figure 5.11). The achievement of the design, operation and restoration of this site involves integration of disciplines within the Cleansing Department of Glasgow City Council. Therefore personnel training will continue to be an important factor in providing an environmentally safe method of disposal of the Council's waste within current legislation and Waste Management guidelines.

5.2.5 Landfill practice evaluation

Landfill must be considered as one of the waste disposal alternatives since it has to be the ultimate route for some residues. Not all wastes are suitable for waste

Figure 5.10 On Site Leachate Treatment Pond III

Figure 5.11 Restored Landfill Site

minimisation, recycling or incineration, therefore landfill will remain an important option (Street, 1994). It is expected that with an integrated waste management approach the amount of waste for final disposal will reduce. It is important to identify the type of waste going to landfill and the design of landfill must also suit the character and composition of the waste. The regulations and economic tools (such as the landfill tax mentioned above) are important elements in enforcing a good standard of landfill operation.

Lessons learned from current landfill practice are as listed below:

i Landfill should be classified according to the type of waste it receives for example as outlined in the EC Landfill Directive, which are :

a. contaminated soil
b. construction industry waste
c. domestic waste
d. industrial waste
e. toxic or hazardous waste

ii Co-disposal of wastes to landfill should be banned and should be considered only as the last option. For example the Netherlands do not practice co-disposal landfill (Street, 1994).

iii Waste that is unsuitable going to landfill should be banned. This includes

a. liquid waste which is incompatible with other waste
b. any liquid waste
c. infectious waste
d. flammable waste
e. mixture of inert and hazardous waste for the purpose of dilution.

iv Guidance on landfill engineering design in order to reduce the impact of landfill practice on its environment. Design features such as the natural or/and synthetic barriers for protection of the groundwater, and procedures on landfill gas and leachate control, should be enforced.

v Educate the landfill operators on basic knowledge of the landfill design to make sure that the operation is done by people who know what they are doing.

vi Giving guidelines on procedure for landfill monitoring during its life span and after it is closed.

CHAPTER 6
POLICY AND IMPLEMENTATION
UK CASE STUDY - DUNDEE CITY COUNCIL (DCC)

6.1 Geographical Introduction

The City of Dundee is situated on the North Bank of the River Tay, which is in the centre of Scotland's finest agricultural land. As an established City and one of the most attractive spots in Scotland, Dundee, a medium sized city, was considered third in the Quality of Life Index in the UK. The urban area covers an area, which is 8 miles east to west, and 3 miles north of the Tay, in a basic semi circular form. The rest of Dundee District is in landward areas including small rural settlements and housing in agricultural land.

Over the past 5 years, the population within the administrative city boundary has been declining gradually. In 1982 -1983, the population was 183, 355 and will continue to fall from 150, 250 in 1996 (Scottish Office, 1996a) to 140, 000 in 2006. One of the reasons is suburban growth and the rise of commuter settlement in the region. Dundee has 78, 078 households with 56% is Local Authority Housing and Housing Association properties and the rest are privately owned or let accommodation. The four main types of housing are:

i Detached/semi-detached
ii Terraced
iii Tenemental
iv High-rise

The majority of the commercial sectors, tenemental and industrial properties are situated in the centre of the city. Others lie along the main road networks. The Scottish tenement style of building poses similar problems for waste collection as does that of apartment blocks

Dundee is now working towards restructuring its economic plan in order to establish a new and competitive economic role in the world as its traditional industries have gradually disappeared. In the mid-sixteenth century, Dundee became a centre for wool and linen industries and ranked second in its wealth and prestige after Edinburgh. But the City prosperity came to an end after it was burned to the ground. By the end of the eighteenth century, Dundee regained its prosperity when the jute industries developed with great success. After the second world war, new light engineering developed and this has been followed in more recent times by strong establishment of the electronic sector. Over the past four years, the city centre of Dundee redevelopment resulted an estimate of £55m investment. This success is the implication of Dundee's strength, which are:

- the quality of life it has
- quality of its environment
- Dundee as a regional centre
- supply of skilled labour.

The City of Dundee's first primitive sanitation was formed in 1559. Rubbish was at first carried by householders themselves to the dumping site. As no one was given the task to collect waste at that time, scavengers would collect the rubbish with a small fee being paid to them. Then the task was offered to traders and stall-holders because it is believed that they might find materials that can be re-used for their business. A public functionary handled the work later for the first time. In 1591 a man was appointed by the Council and provided him with a wheelbarrow to carry away the waste and to keep the streets and kirkyard clean.

Being an industrial city in the nineteenth century, waste became an important issue because of the public health implications. In 1842, after a report on sanitary conditions of the labouring population of Great Britain, it was recommended that public authorities undertook the removal of refuse from premises, streets and roads. In 1861, with a staff of 114, Police Commissioners set up Cleansing Department. At that time the staff weekly wage bills were £71.00; where scavengers were paid 12 shillings and 15 shillings for the carters a week for 60 hours work.

6.1.1 Quantity of waste generated by Dundee City council

Total of waste collected by Dundee City Council is as follow :-

Waste currently disposed	Total of waste in tonne
Domestic (bin waste)	44, 000
Domestic (bulky waste)	2, 500
Street sweeping	2, 300
Commercial/Trade*	10, 000
Civic amenity	4, 500

* highly variable

Source: Dundee City Council, 1997)

Amount of waste recycled by Dundee City Council

Recycled material	Total of waste in tonnes
Brown bins (estimate)	1, 750
Other botanical (estimate)	5, 250
Domestic paper (estimate)	4, 000
Commercial/trade paper (estimate)	2. 000
Aluminium	30 - 40
Ferrous metals	600 - 800
Non-ferrous metals	nil
Domestic glass	500
Commercial glass	1, 200

(Source : Dundee City Council, 1997)

6.2 Current Profile of Waste Management in DCC

6.2.1 Dundee City Council Policy on Waste

Dundee City Council (formerly Dundee District City Council) has been nationally recognised as a leader across a number of fronts in the field of waste management

since the early 1990s. It has one of the largest and most successful recycling systems in the UK. Its waste-to-energy plant at the Baldovie site is one of the most advanced of its kind in Europe.

The Council is now involved with a wide range of environmentally friendly, innovative initiatives. However, there is an increasing recognition among central and local government, institutions and industries that the various waste management options and systems should be managed in a more integrated way.

6.2.2 Possible approaches towards implementing an Integrated Policy

Pressures through national and international developments such as landfill tax, producer responsibility, the EC Directives regarding waste will all strengthen the trend towards an Integrated Waste Management Strategy. The Council aims to identify systems which are environmentally and economically sustainable. The possible actions flowing from the Integrated Waste Management Strategy may include the following:

i Produce a clear strategy for waste by the end of 1998, for the period of 1998-2010. Such a strategy to review all aspects of waste, and produce costed and timetable actions on waste streams.

ii This strategy should aim to cover both the waste collected by the Council, and actions on all waste within the city.

iii Take an overview of hazardous waste collection and treatment systems within the city.

iv Develop the principles of BPEO, regional self-sufficiency and proximity.

v Develop the practicalities of waste minimisation schemes with the public.

vi Review competitiveness of Dundee business with regard to waste, particularly waste minimisation in industrial ecology.

vii Develop and use systems for public consultation on waste issues

viii Produce an overview of the compatibility between environmental policy, and the major contracts which the Council has, particularly with regard to waste.

ix Seek to increase the funds flowing into the Council and the city from external sources for example government or EC grants.

x Ensure that development plans and planning policy in general is consistent with the aims of sustainable waste management.

xii Develop a Council-wide policy on purchase of recycled goods.
(Source : Dundee City Council, 1997).

Since Dundee City Council concentrates on its recycling programme as the major element within its waste management activity, the next section outlines the Council's administrative arrangements for material reclamation.

6.2.3 Staff involved in recycling

The number of staff who are fully employed by the Council has increased as the recycling activity has developed. Stated below are number of staff that are involved in the Council recycling programme as in 1996:

1 Recycling Officer

1 Assistant Recycling Officer

1 Composting Officer

1 Materials Reclamation Plant Chargehand

4 Materials Reclamation Plant Operatives

1 Weighbridge/Attendant

5 H.G.V Drivers

9 Refuse Collection Vehicle Loaders

Besides those above, there are also office and operational staff whose work touches on the recycling programme in a marginal way. An evening shift was introduced for the baling process due to the increased amount of recycled waste paper and cardboard coming forward.

6.2.4 Education and the Recycling Scheme

In 1987, the Cleansing Department of the Council employed six persons to create an educational programmes including a teaching programme for young school children with an Anti-Litter Message. The team, which was called 'Keep Dundee Tidy', enlarged their environmental teaching programme to include a wide range of environmental issues relating to reclamation and recycling in general. In 1992, this team was renamed the Dundee Environment Team and continue to teach a wide range of topical environmental issues to school children, youth organisations and clubs and also nursery schools. The Recycling officer also gives talks to adults groups about the recycling processes. The council also receives information on recycling from individuals and organisations that are concerned with environmental issue such as the Friends of Earth, and from other local Authorities. At present, the Cleansing Department has links to the Institute of Waste Management in producing authoritative reports on composting. Members of the Cleansing Department are also in demand to present papers on recycling issues to seminars and conferences.

Dundee City Council has a rolling programme of visits to educational establishments, including primary, junior, senior schools, colleges and universities. In order to create awareness in waste, the programme involved competition on recycling materials and the best school will be awarded. This is also carried into areas where members of the public are keen for information, talks are given to the Guide and Scout movements, women's interest groups and other such groups. Dundee City Council also has a website on the internet which gives details of all the services available within Dundee. Dundee City Council is also approaching

industries, factories and offices, with a view to encourage recycling in office work place by providing information and recycling facilities.

DCC visit each one of 43 schools within the autority's boundary on a yearly basis as well as informing colleges and universities via presentations. The materials reclamation facility and composting site on the outskirts of Dundee are available for educational site visits. Business in the main tend to be stimulated by EU and government legislation "above the line" and by financial and insurance risk levies "below the line"

6.2.5 Publicity

Information publications, for example a series of pamphlets on various aspects of recycling, are produced and distributed in order to help Dundee citizen to understand and to participate in practising recycling as part of their life. Topics involved are:

- Waste Paper and Cardboard Reclamation
- Compost
- Baldovie Materials Reclamation Site (closed since December 1996)
- Aluminium Can "Cash For Cans Scheme"

The introduction of kerbside wheeled bin collection routes is designed to maximise participation by the 'passive' recyclers. An annual Calendar is delivered to the householders to remind participants of the materials they should and could not recycle and details of the collection dates. Participants in this programme receive a new Calendar in December every year. The latest "take-up" achieved by this method is 81.4% of waste paper and 81.2% of compost (Dundee City Council).

6.3 Municipal Solid Waste Practices

6.3.1. Waste Minimisation

The Council's influence on domestic waste minimisation is difficult to assess but the need for minimisation is highlighted in the Environmental Charter (Appendix 2). Within the Council itself, an Environmental Working Group whose

membership is drawn from a broad spectrum of Council Departments actively encourages the reduction of wastes.

Industrial waste producers are encouraged to reduce waste outputs and a system of charging for the disposal of their wastes by weight as a separately identifiable cost is being introduced to highlight the cost benefits of minimising the waste produced.

Because of a lack of specific guidance by Government on the methodology of waste minimisation, the Council is in the best position to effect waste minimisation within the current legislative framework because of its local influence. The creation of the Scottish Environmental Protection Agency (SEPA) may replace some of the Council's regulatory activity but will enhance its role as leader of local good practice.

6.3.2 Re-use

The Council's influence in this kind of treatment is currently minimal but where possible, items which arrive in the waste stream which can be returned for reuse are extracted, collected and returned. Encouragement is given to enterprises, which thrive on the reclamation and resale of clothes, furniture and household goods.

6.3.3 Recycling

The Council has produced an A-Z Guidance Booklet, which is delivered to every household within the Council area.

The Bring-to and Collect systems are two methods used by the Council for the reclamation of its waste material.

i The Collect Systems

There are two commodities of materials, which are collected from domestic properties using the 120 and 140 litre 'wheelie' bins. Waste paper and cardboard are collected from 50, 000 properties. 29, 000 blue bins have been issued and almost 35% of the domestic properties in Dundee are now covered by the scheme.

Green waste for composting is collected from over 12, 000 properties using the 140 litre brown wheeled 'compostainers'. Glass is collected from pubs and clubs throughout the City using green 'wheelie bins' with a capacity from 120 litre to 1,100 litre. There is a separate on-demand collection system for the disposal and recovery of the scrap metal wire-goods which is provided using open vehicles fitted with platform lifts.

ii Bring-to System

Two types of facility provided for the public are:

Materials Reclamation Sites where there are facilities for the reclamation of paper and cardboard, botanical/green waste, glass bottles and jars, aluminium cans, car batteries, scrap metal, clothes and rags, gas bottles and waste engine oil.

Mini Recycling Centres which utilise 1,100 litre capacity wheeled bins. They are located at 35 sites throughout the City and the Council planned to expand to 50 sites in total by the end of the programmes. The wheeled bins are labelled and colour coded for each different material such as paper, green glass, brown glass, clear glass and aluminium cans. These bins are located at the sites where people make regular trips so that no special trips are required. All collected materials are brought to Marchbank Materials Reclamation Plant for baling, bulking, sorting or composting.

6.3.4 Energy Recovery

Since December 1978, the Council has operated a Municipal Incineration Plant at Baldovie as the main treatment for waste disposal. This plant's energy recovery boiler is able to generate 500kW of heat at its maximum operation. Since the implementation of the EC Directive on the Control of Emissions from Municipal Incineration Plant, this Baldovie Plant is closed but an option on reconstruction of an incinerator with heat and power recovery is being followed (Refer to Chapter5)

6.3.5 Landfill and Incineration

The Council landfill site receives mostly waste from the construction and demolition, road sweepings, inert non-incinerable civic amenity wastes, wastes from the Parks Department, occasional emergency domestic refuse disposal and also ash material from incinerator. The Council's present policy with regard to incineration encompasses the need to provide the best environmental options for disposal of wastes and as such the disposal by incineration of special, clinical and low level radioactive wastes is undertaken within strict conditions both upon the selection of suitable wastes and upon operating conditions within the furnaces (Dundee City Council, 1997a).

6.4 Towards An Integrated Policy

Realising that no one method could handle the increasing amount of waste, Dundee City Council is now considering an integrated waste management policy with a full range of waste management options. This includes waste *minimisation, re-use, recycling and recovery whereas disposal* is the last option. The integrated waste management strategy aims to manage all waste in an environmentally and economically sustainable way.

To achieve a fully Integrated Waste Management Strategy, the Dundee City Council has issued (1997) a major policy statement, which is re-produced below as it stands as a model of its kind

Principles of Dundee City Council's Waste Management Policy

The framework for the Council's policy on waste is a clear commitment to sustainable development. This is an explicitly forward looking concept, requiring us to take account of the future consequences of today's decisions in a way that does not forgo potential development for future generations. We need to reduce the amount of waste we generate, and to take greater care of that which we do produce. To do so required actions at levels both above and below that of the City Council - extending from Central Government to action by local people. However

the Council is not powerless: it is important to recognise that whilst the influence of the Council is circumscribed, it is by no means slight.

In the statements that follow, the Council has attempted to take well-recognised, well publicised principles, and make them operational for the Dundee area.

Principle 1

The Council is committed to a waste framework in which the highest environmental standards are achieved, consistent with economic conditions, and sound science.

Principle 2

The Council's aim in drawing up this policy is to: -

- ***reduce the amount of waste that Dundee produces***
- ***make the best use of waste that is produced***
- ***choose waste management practices, which minimise the risks of immediate and future pollution and damage to human health. In order to achieve these aims, one can rank the different waste management options into a hierarchy which will give a broad indication of their relative environmental benefits and disbenefits***

The Council defines the waste hierarchy as:-

Avoid

Reduce

Re-use

Recycle

Energy Recovery

Dispose

and recognises this hierarchy as a useful management tool in the evaluation of waste management options. Where consistent with the reduction of environmental impact, and consistent with Principle 1 above, the Council will

seek to select as a priority options which are as high up the waste hierarchy as possible.

Principle 3

The Council recognises the value of precautionary principle which has been defined as:-

"Where there are significant risks of damage to the environment, Government will be prepared to take precautionary action to limit the use of potentially dangerous pollutants even where scientific knowledge is not conclusive if the balance of likely costs and benefits justifies it".

This can be paraphrased as 'prevention is better than cure'.

Principle 4

The Council recognises that the waste hierarchy, whilst a useful general guide, will not always produce the most sustainable waste management options. The Council therefore recognises the value of the concept of the Best Practicable Environmental Option (BPEO), and will seek to use this concept to inform its detailed technical evaluations. The Council also recognises the potential of the technique known as Life Cycle Assessment (LCA) and will monitor the application of LCA to waste management decisions.

As Planning Authority, the Council has an important role to play in implementing the principles developed above. The Council will ensure that its development plan and planning policies are consistent with sustainable waste management. In particular, the Council will attempt to operationalise the principles of proximity and regional self sufficiency, which are highlighted below.

Principle 5

The Council recognises the importance of the proximity principle, that is in order to minimise environmental impact, waste should be dealt with as close to the place where it arises as possible. The Council will consider what the principle means for the Dundee area.

Principle 6

The Council recognises the importance of the principle of regional self-sufficiency, in that in determining whether waste facilities in its are adequate, it will seek to consider the amount of waste imported and exported from the region. The Council will seek to operationalise this principle by considering what it means for the Dundee and wider area.

Principle 7

The Council is committed to the provision of high quality waste planning information, both for itself, the citizens of Dundee, and in the wider interest. The Council will co-operate with other agencies in improving the level and quality of data available.

Principle 8

The Council recognises that its citizens have a right to know what the Council is planning in the waste sphere, and the principles and information upon which decisions are based. As far as possible the Council will make available information relating to its waste policy and waste management decisions, and will consult widely on any strategies it is intending to produce.

Principle 9

Where possible, the Council will seek to incorporate environmental criteria into its waste tendering processes and contract documents resulting from the process.

Principle 10

The Council recognises the potentially large impact that waste management decisions can have on the economic development and competitiveness of the City. It will seek to ensure that its waste management decisions reflect both the aims of its economic development plan, and the wider aims stated in the Council's Corporate Plan.

Waste Management Strategy

The Council will produce a formal written strategy for managing waste in the Dundee area, based upon the principles enunciated above.

(Source: Dundee City Council (1997). Report on Integrated Waste Management Strategy for Dundee).

6.5 Conclusion

The collection services provided for household waste and households recycling are provided free of charge. A waste collection service must be provided for households by law and a proportion of the council tax does go part way to the provision of this. Council tax is levied on most households and depends upon the value of the property. For green waste, Dundee City Council has approximately 11000 bins for collecting green waste from households, each house has a bin and places it at the kerbside on given days. This waste is collected by a special vehicle which delivers the contents to the composting site. This is set upon a reclaimed landfill site.

The green waste is shredded and then placed in windrows, these are turned at regular intervals to encourage aerobic digestion of the waste. Once the materials has broken down sufficiently to constitute compost the finished material is passed through a machine which sifts it. The machine is called a "riddler2", it filters the fine material leaving the larger pieces behind. The larger pieces are called "tailings", the tailing are taken to landfill and the good quality material is bagged up for sale to the public at garden centres, some of the material is left in bulk so that members of the public may also purchase in bulk if the wish. Dundee City Council has recently collaborated with the Bank of Scotland to compost shredded old bank notes, and is receiving a bulk load once per month to be composted. With the European Directives imminent on green waste, an increase in the amount of botanical waste collected can be achieved.

The national recycling target was set by the previous government as an aim for the U.K as a whole. The recycling target is a policy target and the Local Authorities

enter into the target voluntarily, although all councils must have a waste strategy. The target is not legislated, it is just a target to try and encourage recycling within Local Authorities to an accepted level by the year 2000. Through recycling initiatives Dundee City has achieved a rate that is higher than the national average, Dundee's current recycling rate overall for 1998/99 is 10.01% (Lee, 1999). Dundee City retains the title of "recycling city". To date no British Local Authority has managed to reach the target of 25% per annum for domestic waste. Dundee City Council is trying hard to reach the target although it may not be by the year 2000. By failing to meet the target, the council will not be penalised by law but the proportion of annual financial support from the central government on waste management will be reduced.

Dundee City Council waste history goes back 400 years ago and has evolved continuously. More up to date, Dundee was recognised for its waste management and recycling achievements as recently as 1991 when it was awarded as Scotland Recycling City. Dundee has recycling rate of 8.1%, whilst this is low by EU standards. The average UK rate is 6%.

In developing its strategy of Integrated Waste Management, the Council hope that it will enhance the competitiveness and attractiveness of Dundee for existing businesses and prospective inward inventors and retain Dundee as the leader in waste management. This approach aligns with the overall aims of its Corporate Plan and Economic Development Plan.

Benefits of this approach as identified by the Council are:

i the production of clear policy aims, backed up by objectives, actions plans and costed proposals.

ii the opportunity to generate a consensus on waste management within the city, and the opportunity to lead current trends, rather than to follow.

iii the application of sound, clear and transparent environmental and economic objectives to waste management

iv the potential to identify environmental improvements or cost savings resulting from systematic appraisal of waste management systems.

(Dundee City Council, 1997)

In order to maintain its services, DCC continue to encourage best possible waste disposal practices in order to protect the environment and use waste as a potential resource. In managing the DCC domestic waste, The council will closely work together with public bodies like SEPA and others to make sure that waste disposal facilities are maintained and under control. Waste disposal practices will be reviewed accordingly, amended and adjusted to make sure that the practices comply with the city's management plan. Within its framework and programme, DCC will try its best to maintain and comply with the guidelines, national legislations and the EU Directives as mentioned above.

CHAPTER 7
POLICY AND IMPLEMENTATION
MALAYSIA CASE STUDIES : KUALA LUMPUR CITY COUNCIL (DBKL) AND PETALING JAYA MUNICIPAL COUNCIL (MPPJ)

7.1 Kuala Lumpur City Council (Dewan Bandaraya Kuala Lumpur - DBKL)

7.1.1 Introduction

Kuala Lumpur is situated midway along the west coast of Peninsular Malaysia, at the conjunction of the Klang and Gombak rivers. It is approximately 35 km from the coast and situated at the centre of the Peninsula's extensive and modern transportation network. Kuala Lumpur (commonly known as KL) is the largest city in the nation with an area of 94 square miles, possessing a population of between 1.6 to 1.8 million people drawn from all of Malaysia's many ethnic groups. It has grown very rapidly in recent years with "skyscraper" office blocks dominating the former traditional townscape of the city centre and leading to an over concentration of office jobs in a small area with the inevitable traffic congestion.

To some citizen, this rapid growth seems to have been gained at the expense of the loss of ancient cultural traditions, but in many ways KL marks the continuation rather than the loss of Malaysia's rich past. KL has long been the commercial centre of South East Asia where businesses and travellers from all over the world come to meet (internet).

7.1.1.1 History

In 1857, a group of eighty-seven Chinese miners led by the Malay chief of Klang, Raja Abdullah, set off from that port city on an expedition up the Klang River in search of tin. After several days of poling upriver, they reached the junction of the Klang and Gombak rivers and the navigable limit for their supply-laden boats.

Prospects in the area were successful, and a large-scale mine was rapidly developed. At the spot where they had disembarked a small trading post was established, marking the beginning of the present-day city of Kuala Lumpur.
Less than two decades later, Kuala Lumpur was chosen as the administrative capital of Selangor's British Resident Frank Swettenham, and the small trading town flourished as a governmental and commercial centre. In 1896, the young city became the capital of the Federated Malay States. As the seat of British administration in the Malay States, Kuala Lumpur inherited from this period of its history an extensive system of roads as well as many fine examples of gracious colonial architecture, both of which are still evident today.

When the Federation of Malaya gained its independence in 1957, Kuala Lumpur was declared the Federal capital. In 1972, it achieved city status. At the same time, it also remained the capital of the state of Selangor, a status it had attained in 1887. On the 1st of February 1974, Kuala Lumpur was officially declared a Federal Territory. Although the two administrative entities retain their close social and commercial ties, Kuala Lumpur is no longer under the jurisdiction of Selangor. This complicates some aspects of strategic planning for the total conurbation of KL and its attached suburbs.

7.1.1.2 Transportation

Kuala Lumpur is served by a modern network of transportation lines, which unlike Singapore is heavily dominated by roads and private car dependency. Railway lines and roads systems link the city to many other parts of the country. Within Kuala Lumpur, buses, mini-buses and taxis have regular services. The city's public transportation system will soon be further augmented by the Light Rail Transit (LRT). Kuala Lumpur is also served by the country's largest seaport, Port Klang.
Kuala Lumpur is the single most important commercial city of Malaysia with an expansion of the urban area and population because of the employment opportunities the city centre offers. The expansion leads to increasing consumption levels, waste generation and traffic congestion The growing number of cars in Kuala Lumpur is expected to increase further, proportionate to the expected

increasing number of KL's population (Mohamad, 1994). Traffic congestion is already affecting the efficiency of economic activity and this includes the systems of waste collection. In addition to the transportation problem, the consequent increasing volume of waste due to increasing urbanisation poses serious problems for disposal because of the limited space remaining for disposal sites.

7.1.2 Administration Structure

In waste management, the federal and state governments of Malaysia are involved direct or indirectly in waste and environmental management but the collection and disposal of solid waste are a local authority responsibility. Dewan Bandaraya Kuala Lumpur (DBKL) is the city council, which is in charge of waste collection and disposal. The Urban Services Department (USD) of DBKL was set up to provide municipal services with the objectives:

i to promote, maintain and sustain the city's' environment

ii to provide solid waste and cleansing services in order to transform Kuala Lumpur into a clean and beautiful city

iii to promote public awareness about the importance of a clean and healthy environment and encourage co-operation with the authority

(Dewan Bandaraya Kuala Lumpur, 1995)

The USD organisation consists of :

- the Cleaning Division,
- the Contract and Supply Division,
- the Waste Administration and Finance Division,
- the Transport and Waste Collection Division,
- the Waste Disposal Division, and
- Research and Development Division.

Details of each division's task are as in Appendix 3. The divisions that are involved with solid waste management are the Transport and Waste Collection Division and

the Waste Disposal Division. The main tasks of both divisions are on sold waste collection and disposal and the management of disposal sites. While waste disposal plan system is under the Research and Development Division. One can see that the administration and job assignment is not well structured.

7.1.3 Waste Policy

The USD of DBKL does not have any specific waste policy as a guideline for them to follow. The Waste Collection and Disposal Section of USD is guided by the commitments mentioned below, for meeting their own objectives. These commitments are :

i to provide a waste collection and handling system that meet the needs of the city dwellers;

ii to provide a system that enables the introduction of recycling and composting;

iii to provide a system that will make a positive reduction of waste;

iv to improve the working conditions and safety of the employees;

v to provide the most efficient and cost effective method of waste collection;

vi to provide a system that maintains a health-conscious community;

vii to modernise the technology in waste - collection and disposal;

(DBKL, 1995)

7.1.4 Quantity of Waste Generation

Data on waste sources and composition are difficult to obtain since DBKL do not do any regular monitoring of waste production. Data is only available through research done by the university and consultants for their studies. The quantity of waste produced in Kuala Lumpur is 3,020 tonnes/day and can be divided according to its sources as in Table 7.1. Hassan, *et. al.*, 1994 of the Universiti Putra Malaysia (UPM) did this survey for their studies.

Table 7.1 Waste Quantity Produced.

Type of waste generated	Total of waste (tons/day)
1. Household	1010.00
2. Market and commercial	500.00
3. Industrial and construction	1010.00
4. Institutional	120.00
5. Landscaping	150.00
6. Street sweeping	230.00

Source Hassan, *et. al.* 1994

From the table, it will be noted that household waste and industrial and construction waste formed almost 33.3% each of the total of waste being produced. The rest are contributed to by the market and commercial waste, from street sweeping, landscaping and institutional waste which are 16.5%, 7.6%, 4.9% and 3.9% respectively of the total of daily waste generated.

A survey of the solid waste composition by Wahid *et. al.* (1996) is shown in Table 7.2 and indicated that 45.7% of the waste is the highly decomposed materials that contains vegetable residues, poultry residues and other putrescible matter. Following this, is paper and cardboard waste, which constitute 29.9% of the waste composition. Rubber, plastic, metals and aluminium, glass and textile are less than 10% of the fraction of waste composition being produced.

Table 7.2 The Percentage of Waste Composition in Kuala Lumpur area

Waste Composition	Percentage (%)
Highly decomposable material/garbage	45.7
Paper & Cardboard	29.9
Rubber & Plastic	9.0
Bottle/glass	3.9
Metals & aluminium	5.1
Textile	2.1

Waste Composition	Percentage (%)
Miscellaneous	4.3
Moisture content	61.5%
Bulk density (kg/m3)	N/A

Source : Wahid *et. al.* (1996)

N/A : not available.

Waste storage bins vary according to types of residence. High rise buildings and apartments are provided with refuse chutes and 1.5m^3 size of community bins. Housing areas use various types of bins, while the squatter areas are provided by the DBKL with bulky bins, which range in sizes between 14 – 24m^3. Commercial premises, institutional buildings and markets are also provided with bulky bins. Waste from industrial plants, which is collected by the DBKL also, uses bulky bins. Waste is collected using a compactor lorry or an open lorry depending on the storage system. The frequency of waste collection by DBKL is as shown in table 7.3 below:

Table 7.3 Frequency of waste collection

AREAS	FREQUENCY
Commercial areas and shophouses	daily
Hawkers centre	daily
Markets	daily
Binpoints	daily
City hall public housing	daily
Residential area (includes housing estates, condominiums and apartments)	alternate day
Public buildings (school and government offices)	alternate day
Squatter areas	twice a week

(Source : DBKL, 1996)

7.1.5 Current Municipal Solid Waste Practices

7.1.5.1 Waste minimisation/ re-use

Waste minimisation is not yet in practice in the USD. There are no Government guidelines or documents for waste minimisation practices (Suhaimi, 1996) anywhere in Malaysia.

7.1.5.2 Waste Recycling

DBKL has launched a few recycling programmes, which are on an ad-hoc basis. Unfortunately a poor response from the public forced the programmes to be terminated. Recycling activities are now done by DBKL solid waste collection crew, scavengers on the disposal sites and individuals who collect recyclable materials from house to house. These recycling activities ended up with 40% of paper and cardboard being recycled along with 10% of glass and plastics and 40% of aluminium cans. There in no composting activities on its green waste. Most are sent to landfills.

7.1.5.3 Energy from Waste Incineration

Until today, no incineration plant has been built for solid waste treatment in Kuala Lumpur. An incinerator has only been recommended as an alternative to existing methods by a consultant to DBKL, but no further action has been taken.

7.1.5.4 Landfilling

Landfilling of solid waste has been the only way of waste disposal for many years. But the practice of landfill is not sanitary landfilling. For the Kuala Lumpur area, there is only one landfill site of 18.21 hectares owned by the DBKL. All waste collected by the DBKL and private contractors appointed by the DBKL is dumped here and also at a private owned landfill outside the Kuala Lumpur area. The site owned by the DBKL is situated at Jinjang Utara, which is 30-40 km. away from the collection areas and received about 2,000 tonnes of waste everyday. Even though the dumping site is quite far away, there is no transfer station available and all the waste has to be sent directly to the landfills. Through this operation, time and cost of transportation have an impact on the collection and disposal system.

7.1.6 Problems arising

Solid waste management is clearly a major problem that should be solved by the USD soon. Because of the fast development in Kuala Lumpur, planning for solid waste management should be reviewed including methods, technology and the service organisation. Solid waste supply is always increasing and is expected to increase at 8.3 tonnes per month (approximately 100 tonnes per year). Problems also occur, where public knowledge on solid waste management is still very low. Furthermore, there are difficulties in getting waste collection crews and professional private contractors for collection. These are the key problems that should be studied urgently in order to improve the KL solid waste management system. If this the state of waste management in the capital city, it is clear that all other settlements will be at least as bad and probably worse.

7.2 Petaling Jaya Municipal Council (Majlis Perbandaran Petaling Jaya-MPPJ)

7.2.1 Geographical Introduction

Petaling Jaya is situated in the state of Selangor. A suburban township now virtually joined to Kuala Lumpur, it is linked with Shah Alam and Klang in the west by a Federal Highway. This area was first set up in 1952 with an area of 369 hectares at Palmlands Plantation of Jalan Klang Lama. This first phase is now the Seksyen 1 of Petaling Jaya. In 1954, 'Kuasa Tempatan Petaling' was established and after 10 years 6, 000 hectares of land were developed and the area was called the Lembaga Bandaran Petaling Jaya. It was only in 1977 that Majlis Perbandaran Petaling Jaya was established. First it was 16.5 sq. miles but has increased to a current 17.5sq. miles.

Petaling Jaya or well known as PJ, within less than 50 years has been developed as ' successful city'. Its population is around 475, 000 people who are mostly "middle class".

7.2.2 Administration Structure

Urban Services Department (USD) known as Jabatan Perkhidmatan Bandar of Majlis Perbandaran Petaling Jaya(MPPJ) was formed in November 1980 and which is in charge with the solid waste management needs of the MPPJ area.

The existing organisation structure of the USD can be divided into two sections, which are the:

i Executive arm which involve the Yang Dipertua and his officers

ii Legislative arm of municipal council/policy makers.

7.2.2.1 Executive arm

The overall responsibility for the day to day operations and administration of the municipality is the Yang Dipertua, a nominee of the Selangor State Government. The Secretary and another seven Heads of Departments, which integrate to form council decisions, assist the Yang Dipertua. The Departments are:

- Administration
- Treasury
- Engineering
- Health
- Urban Services
- Legal
- Valuation

For managing the solid waste, responsibility is solely under the Urban Services Department. But in order to ensure an efficient solid waste management practice, interaction between all the Departments needs to exist and this is not currently the case.

7.2.2.2 Legislative arm

This council comprises of 24 local councillors who are appointed by The State Government. The legislative arm is responsible for forming the framework of the directional works and policy guidelines related to planning and financial allocation

to meet the development and operational expenditure of the municipality. It gives statutory authority to specific actions and development plans and also makes local by-laws for the Petaling Jaya Municipal Council. In making the policy, the legislative arm functions through 8 sub-committees, which are:

- Finance
- Works and general matters
- Building plans
- Beautification and recreation
- Traffic
- Appeal against assessment
- Appointment and services
- Tenders

All the recommendations or evaluations made by the committees above in respect of policy directives will be endorsed by the full Council before it is implementable.

7.2.3 Waste Policy

The Petaling Jaya Municipal Council has no waste management policy yet. All the activities related to waste management are guided by objectives, which were set up by the USD themselves. These objectives are meant to be met while operating the activities.

7.2.4 Waste Generation

Majlis Perbandaran Petaling Jaya sources of waste vary widely in the different social areas. An estimation of total waste generated in Petaling Jaya area is as shown in Table 7.4 below:

Table 7.4 Estimation of total waste generated in Petaling Jaya (Tonnes/day)

Type of waste generated	Sub-total of waste (tonnes)	Total of waste (tonnes)
1. Residential area		
1.1 Low income	49.0	
1.2 Medium income	86.2	
1.3 High income	34.2	
1.4 Additional income	13.7	
Sub-total		183.1
2. Commercial		
2.1 Shops	28.4	
2.2 Shopping Complex	10.0	
2.3 Hotels	1.6	
2.4 Office complex	2.0	
Sub-total		42.0
3. Industrial		198.0
4. Institutional		9.2
5. Wet markets		4.1
6. Night/agriculture markets		0.8
7. Hawker stalls		0.6
8. Garden waste		30.0
Total		**467.9 tonnes/day**

Source : MPPJ, 1993

From the above table, industrial waste constitutes 42.3% of the total waste generated per day. 39.1% of waste comes from residential area followed by 8.9% from commercial sectors and the rest are from institutional, markets, stalls and garden waste.

The composition of waste generated in this area is given in Table 7.5 below. Putrescibles waste is the main type of waste produced and this types comes mostly from the squatters areas. 27% of the waste is paper, cardboard and paper products, and these waste mostly are from institutionals and commercial sources. Plastic is the third most produced waste and comes from the high and medium income residents. Incombustible materials followed and non-ferrous metals which constitute less than 1% of the waste composition.

From the waste composition, the lifestyles of each group can be determined. Therefore in setting-up the waste management systems it is important to identify the lifestyle of each sources before implementing any action.

7.2.5 Current Municipal Solid Waste Practices

7.2.5.1 Waste Minimisation/Re-use

As in KL, waste minimisation is not yet practised. An industry or individual that practices waste minimisation does so on his or her own initiative. It is not known yet when waste minimisation will be seen as the top priority in the municipality.

7.2.5.2 Waste recycling

A recycling programme was first introduced at Petaling Jaya in December 1990. It started with a joint project between MPPJ and Malaysia Glass Association, which concentrated, only on glass recycling. In 1992, MPPJ expanded its programme, which now also involves paper, plastic, metals, aluminium, rubber and car batteries.

MPPJ recycling programmes include 3 levels of recycling, which are:

i Recycling prior to collection

ii Recycling during collection

iii Recycling at the disposal sites.

Table 7.5 The Average Composition of waste in Petaling Jaya Area

Waste Composition	Residential					Shops	Institutional	Wet markets	Total average
	High income	Medium income	Low income	Squatters	Average				
Paper, cardboard and paper products	20.3	16.0	13.2	11.5	15.3	49.8	58.5	19.8	27.0
Vegetable and putrescibles (food and animal waste)	40.1	45.4	55.6	66.0	51.8	11.0	2.9	34.4	36.5
Rags, jute, hessian and textile, carpets, rugs, leather, etc.	1.6	2.1	4.6	5.5	3.5	4.7	0.9	2.4	3.1
Ferrous metals	2.4	2.8	3.4	3.3	3.0	2.7	1.0	5.1	3.0

continue Table 7.5

Table 7.5 The average composition of waste for Petaling Jaya area.

Waste Composition	**Residential**					**Shops**	**Institutional**	**Wet markets**	**Total average**
	High income	**Medium income**	**Low income**	**Squatters**	**Average**				
Non-ferrous metals	4.4	0.3	0.2	0.0	1.6	0.2	1.0	0.2	0.9
Glass	6.5	4.5	5.6	0.4	4.3	1.2	0.9	2.7	3.1
Plastics	20.4	23.6	16.0	7.8	17.0	17.8	19.1	9.9	16.4
Rubber products	0.0	0.2	0.1	0.6	0.2	12.6	0.2	2.0	2.0
Timber products	4.1	0.5	1.2	4.9	2.7	0.0	15.5	23.0	7.0
Other incombustible, ceramics, etc.	0.2	0.1	0.1	0.0	0.1	0.0	0.0	2.3	0.4
Total	100.0	100.0	100.0	100.0	99.5	100.0	100.0	100.0	99.4

Source : MPPJ, 1992

i Recycling prior to collection

This involves a door-to-door collection by individual purchasers who buy recyclable materials mainly newspapers and bottles . These purchasers use small vans and motorised tricycles. Materials are collected on alternate days or once a week.

ii Recycling during collection

This activity involves the waste collection crews of MPPJ and the private contractors during their collection routes. Recyclable materials, which are sorted out by the crews, are kept in bags and sacks. They are sold to middle-man buyers who eventually sell the materials to manufacturers and other re-users.

iii Recycling at the disposal sites.

At the disposal site, scavengers sort out the recyclable materials. They sort the materials, which were unloaded from the compactors, open collection lorries and also during the spreading of the waste on the site by bulldozers.

The existing waste recycling conducted by individuals and small businesses as described above proves to be an effective system to remove recyclables materials from the waste stream (Table 7.6). But this system is not controlled by any authority and also any policy or regulation. Therefore there is no consistence collection by individual purchasers and the price for selling recyclable materials to them is very cheap.

For green or yard waste, the council or its private contractor will collect from householders on certain day. Usually green waste is collected once a week and all will be sent to landfills. This is due to lack of guidance on the importance of using compost and no specific guideline or encouragement from the council in implementing this among the public.

Table 7.6 Quantities of Waste Recycled by Existing System

	Daily Generation (tonnes /day)	Recycled Quantities		Refuse to be disposed	
		tonnes/day	%	tonnes/day	%
Residential	183.1	17.1	9.3	166.0	90.7
Commercial	42.0	1.4	3.3	40.6	96.7
Industrial/ factories	198.0	0.0	0.0	198.0	100.0
Markets (JPB & private contractors)	5.5	0.0	0.0	5.5	100.0
Garden waste (JPB & Private contractors)	30.0	0.0	0.0	30.0	100.0
Institutional	9.2	0.0	0.0	9.2	100.0
Landfill scavengers	0.0	3.0	0.0	3.0	-
Total	467.8	21.5		446.3	
Percent	100.0	4.6		95.4	

(Source : MPPJ, 1993)

From the table above, it can be seen that recycling activities is undertaken mostly by the householders where 9.3% of their waste is recycled. Only 3.3% of commercial waste is recycled and none of the institutional waste is recycled despite it as being the major producer of recyclable materials such as paper products and plastics. Scavenging activities on landfill site contributed 3% of waste being recycled. All theses activities make up 4.6% of waste generated in this area being recycled.

Since MPPJ intended to improve their recycling programme, a survey on Petaling Jaya residents commitment towards the concept of recycling was carried out by

Engineering and Environmental Consultants in 1992. Results of the survey are as Table 7.7 below:

Table 7.7 Results on attitude of residents of Petaling Jaya towards recycling concept.

QUESTIONS ASKED	YES (%)	NO (%)
1. Willingness to participate in a programme to reclaim recyclable materials from solid waste	82.9	17.1
2. Willingness to participate in a programme by separating recyclable materials	85.8	14.2
3. Willingness to assist the programme by taking out separated recyclable materials when vehicles make its round on a specific day	80.4	19.6
4. Willingness to participate in central drop-off site administered by Resident's Associated	43.8	56.2
5. Willingness to participate in curbside collection administered by MPPJ	77.6	22.4
6. Willingness to participate in a recycling programme if there is no payment in cash but would instead in improved facilities through the Resident's Association.	71.6	28.4

Source : MPPJ, 1993

From the result above, a majority of the residents are willing to participate in the recycling programme and preferred the curbside collection method compared to the drop-off system. Resulting from the above survey, in 1996, MPPJ launched their Phase II of the recycling programme in order to expand the recycling activities. At this point, school children and residents were involved. Residents at selected area were provided with recycling bins and drop-off sites were selected to provide the residents with recycling facilities. Recycling companies were also involved in the programme in order to make sure that this programme works.

7.2.5.3 Energy-from-waste Incinerator

At present there is no incinerator plant being built for the treatment of the municipal solid waste. But this has been considered for future waste treatment practice.

7.2.5.4 Landfill

Previously, all waste collected by the MPPJ was sent to its own landfill at Kelana Jaya. The site is about 100 acres, where 80% of its area has been used. Since it has been used, the waste has piled-up to 6-10 metre depth. Waste, which is brought in by the Council or private contractors, is covered with a thin layer of soil. In landfill practice, the Council has a few problems that should be solved. Vehicles, which are loaded with waste, have to travel across the site on exposed crude waste because a proper road for access was not designed on this site. These vehicles which are not designed to be used on landfill often get stuck at the site. This causes vehicles to break down and greatly increases the cost of maintenance. Since the landfill is not well designed it causes fires that give off noxious odours and smoke that causes air pollution. Furthermore, problems of drainage at low-lying areas also occur. The major cause of the problems above is because there is no definite working plan on the dumping, spreading and compacting the waste. The daily plan of working on the site is also not well managed. Today, waste from MPPJ is sent to a private landfill, which is miles away from the Council's area. This private landfill owned by SITA Worldwide is situated at Air Hitam which is 30km away from the previous Kelana Jaya disposal site.

7.2.6 Problems and shortcoming

Even though MPPJ is one of the leading councils in Malaysia, its municipal solid waste management is not yet well managed. In its management, MPPJ is only concentrating on recycling and landfilling as waste management rather than looking at all waste management possibilities which would also involve waste minimisation, re-use, waste-to-energy incineration and composting. Even though recycling has been practised since 1990 at the Petaling Jaya area, not everybody is involved with this programme because it is not well publicised and people that should be involved are not given good guidance to do so. MPPJ should also realise

that, not all materials are suitable to be recycled in terms of their price after sale as well as their uses after being recycled. Therefore, MPPJ should make a thorough study of the advantages of these materials being recycled. If in the future, MPPJ plans to practise recycling as their top priority, a Material Recycling Facility (MRF) should be set up. This is an important infrastructure in making recycling successful as the materials have to be sorted out before being reprocessed. As for the landfill practice, a new landfill site, either private or owned by the Councils should be built. An on-site plan should be worked out and landfill design should be looking at future problems such as air pollution and groundwater pollution so that the landfill can be used for a longer period of time and can be used as agricultural land or a recreational park after it is closed.

7.3 Lesson Learned

Taking an overall view, making waste management work is not just looking at the technologies involved which here are referred to as the hardware technology but also the policy, legislation and management practices, the "software" technology. Several factors were identified on a comparison of MPPJ and DBKL with the situation in DCC, on looking at why both councils in Malaysia fails to manage their waste.

7.3.1 Lack of Government's Commitment and Policy Implications.

It can be seen from both case studies that it is the lack of both external (national level) and internal (local level) guidance, which causes problems for waste management at the municipality level. For example, legal definition of waste in Malaysia is not clearly defined. Under the Environmental Quality Act 1974 (Act127), waste is defined as "any matter prescribed to be a waste and any matter, whether liquid, solid, gaseous, or radioactive, which is discharged, emitted, or deposited in the environment in such volume, composition or manner as to cause an alteration of the environment". With this vague definition, the type of waste is difficult to determine especially to people in charge of waste management, which include waste producers, councils and also private waste collectors. Whereas in the UK in general and DCC specifically ,waste is clearly defined and classified in the law. In the waste policy, DCC is guided with national waste policy following the

Government's commitment towards EC and international policy have clearly outlined their waste management strategy compared to DBKL and most Malaysian's local authorities which failed to do so. Most local authorities in Malaysia are only guided by the objectives and commitments of their scope of job which is also in other words, their work description. These can be seen from both Malaysian case studies case studies in case studies in.

Lack of enforcement from the government level is always an issue. Any national legislation and policy on waste, which does exist, is not well documented. Most of the legislation has been devised to ensure cleanliness, sanitary conditions and public health and is not directly formed for the management of the municipal solid waste. While in Dundee, legislation specifically on waste is well guided and updated. Clear legal definitions of waste and classification of waste (for example controlled waste, non-controlled waste and special waste) are well documented. Furthermore, with national strategies and targets set up by the government, the council is committed to meet the targets. For example 25% of household waste should be recycled by the year 2000. If the council could not achieve the target, they will be penalised by receiving less financial fund from the government. In term of recycling infrastructure, companies involve with recycling activities get certain portion of subsidiary and market price control for recyclable waste. In Malaysia, MPPJ was the first local council to develop recycling activities, which started in 1990. After three year implemented it realised that it was a failure. Then it started again in 1996 but still MPPJ cannot claim the recycling activities introduced a success. The reasons were, there was not target being set up, neither at local level nor at the national level. The commitment and interest from the central government was never experienced. These were among the failure factors.

Under Section 72 and 73 of the *Local Government Act 1976*, local authorities have very wide powers in providing and forcing the use of the services and to regulate matters regarding solid waste. Local authorities have provided waste management services following these powers but little use has been made of the power to make by-laws. The existing by-laws, which are not rigorously drafted, are more directed to the obligations of those who generate waste in order to make sure that there is

proper waste storage, removal and disposal at the landfill site. The by-laws are only for the commercial, industrial and building material waste sources.

As for the general collection and disposal activities, there are no by-laws or other regulations being made because these activities are carried out by the local authorities themselves. Any collection and disposal made by the private contractors for the commercial, industrial and part of the householders are not properly regulated. Compared to DCC, under EPA 1990, collection and disposal of waste are heavily regulated even though these were among local's responsibility. Adding to that, guidelines from central government are also provided.

7.3.2 Lack of Local Authority's commitment.

Government leadership is vital in publicising the importance of good solid waste management by educating the nation as well as supporting any actions taken by the Local Authorities in improving the waste management systems. The Local Authorities need government support in making their programmes work. For example in recycling, government does not control the prices of the recycled materials in order to make these materials valuable. Even worse, in Malaysia, the price of recycled materials especially papers are more expensive compared to virgin paper. When this happen, consumers tend to by virgin papers compared to recycled one. In UK, the recycling infrastructures are subsidised by government and the government controls market price for secondary/recycled materials.

For DBKL and MPPJ, there are no non-statutory guidelines for them to follow in order to manage waste compared to DCC and SAC. For Dundee District Council and South Ayrshire Council, they are guided by guidelines for example the Waste Management Papers, Waste Strategy sets out by the Government and enforcement strategy which is under the Scottish Environmental Protection Agency in Scotland. Further, refereed to the success of the councils in Scotland compared to in Malaysia, the Government has set-up a national non-statutory primary target that should be achieved by all councils where they have to recycle 25% of the municipal waste by the year 2000. countries. Waste minimisation programmes should be guided and supported not only on its method but also financially. The

Project Catalyst implemented in the UK is a good example as it proves to minimise waste and avoid the unnecessary expenditure within the production activities. These can be practiced not only by industries but also by householders, institutions and commercial bodies as well. In limiting the production by waste, economic instruments should also be adopted. This is also an important element in pollution control measure where theoretically economic instruments will have the capacity to regulate pollution according to market mechanisms and therefore facilitate deregulation and reduction in Government involvement (Hassan and Abdul Rahman, 1996). Being a supplement of the direct regulation, economic instruments alone will not work. Thus, economic instruments can only be implemented along with regulations. In Malaysia, there is no economic instruments being used in order to reduce waste generation and disposal. Therefore, Government should learn the important of these instruments in the future.

A municipal integrated solid waste management plan should be formed before action is taken as mentioned inDCC case study earlier. Ad-hoc programmes have proved to be unsuccessful as action taken in management of the waste is not well planned or implemented which happen to DBKL. The next chapters will attempt to present on the outline of the waste strategy for Malaysia and will be structured to take account of the three levels of administration. A solid waste management plan should be based on short-term, medium-term and a long-term planning. Solid waste management should be given the top priority in the local authority administration. When this happens, there will be more allocation for waste treatment.

Effective planning is important to make sure of an appropriate application of technically, economically and socially acceptable technologies. The on-site plan is also important where crews should also be guided and supervised as well as the waste collection route designed. Local authorities should also co-ordinate their waste management activities with the work of related departments such as transport and land-use planning, where these do exist.

In making the Solid Waste Management System work, the public is the most important element because they are the producers and the consumers. The only way to get public involvement is through education. Therefore, it is not only the role of the Government in providing the education, but also the universities through their research and teaching roles. The public here involves the government themselves, the politicians, professional groups, school children and householders. In term of education, public awareness and publicity of council's activities, DBKL has not done any outreach programme to inform and involve public in their activity such as the recycling activity. Compared to DCC, it has its own resource person to conduct environmental awareness programmes, talks and seminars for schools, industries and public. DCC also provide pamphlets to its citizen to inform every single household on recycling activities they conducted. Furthermore infrastrcture on recycling is not well provided by Malaysian council.

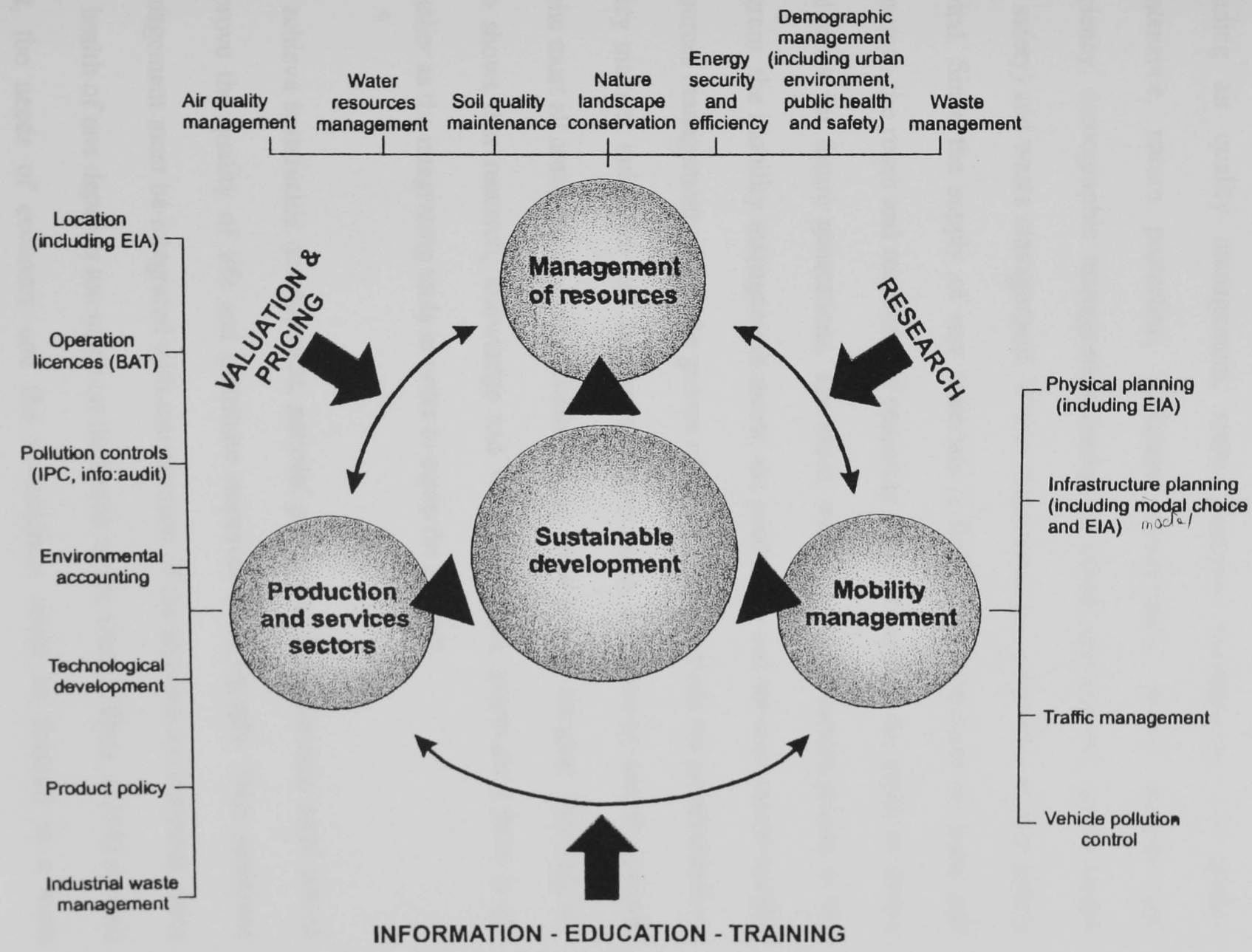
Comparing between both case studies in the UK and Malaysia, government's role is very important. Malaysia have lots to improve in its solid waste management.

CHAPTER 8
DISCUSSION

8.1 Towards A National Goal of Sustainable Development

The continuing degradation of the global environment became a matter of international concern in the 1980s, highlighted by the development of the concept of sustainable development in the Brundtland Report. This report defined Sustainable Development as being "Development that meets the need of the present generation without compromising the ability of the future generation to meet their own needs" (WCED, 1987). This provides for an integrative approach to the planning of all developments. This integration effectively requires a kind of development that balances economic growth with conservation of environmental resources. Further, the principle must be applied to all scales of development from local to global. In many countries throughout the world, sustainable development has been adopted as the guiding principle in their environmental management policies. In the UK for example, the White Paper *This Common Inheritance: Britain's Environmental Strategy* (DoE, 1994) committed the Government to the principle of sustainable development as the guide to effective environmental management. The European Community (Commission of the European Communities, 1993) adopted sustainable development as the theme for the EC Fifth Programme Strategy with emphasis on integration of various sectors (Figure 8.1). Sustainable development is defined by the EC (CEC, 1993) as maintaining the overall quality of life, maintaining access to natural resources and prevention of future environmental degradation.

Figure 8.1: Integration of Various Sectors in Sustainable Development.



(Source; CEC, 1993)

From the interdependence of various sectors and resources, Figure 8.1 is trying to show that in achieving sustainable development, it can not be achieved only by one particular sector or resource, but requires an integrated approach to achieve the goal. This is the responsibility not only of the environmental sector but also all other sectors. The management of resources itself for instance involves various areas including air quality management, water resources management, soil quality maintenance, nature protection, landscape conservation, energy security and efficiency, demographic management (including urban environment, public health and safety) and waste management. Within these areas, the integration of each policy is vital. Since the supply of raw materials is finite, it is important to stress and encourage the reuse and recycling of resources while preventing the depletion of the total stock for future generations. Therefore, within the three sectors shown in the diagram: the mobility management sector, the production and services sector and the resources management sector, the groups of actors, which include the governments as policy makers, industries and institutions representing the economy and the general public must all create an interplay relationship in order to meet the goal. This diagram also shows that research, knowledge and valuation (taxes, grants etc.) have to go together as the integrating tools in order to equip the process.

To achieve sustainable development, national policies and programmes must aim to improve the quality of life and distribute resources more equally. Thus economic management must be integrated with management of the physical environment, since the health of one depends too much on the health of the other. White, (1995) showed that, the needs of economy and the environment could be focused in a more

sustainable way through an environmental management framework as shown in Figure 8.2 below.

Figure 8.2 Environmental Management - An Overall Framework.

Goal	Elements of Goal	Tools Available
Environmentally and economically sustainable environmental management	1. Human and environmental safety	• Human Health Risk Assessment (Occupational and domestic exposure). • Ecological Risk Assessment (Plant-site and consumer releases)
	2. Regulatory compliance	• Manufacturing site management system auditing. • Manufacturing site waste reporting • Material consumption reporting • New chemicals testing and registration • Product and packaging classification and labeling

continue

Goal	Elements of Goal	Tools Available
	3. Efficient resource use and waste management	• Material consumption monitoring and reduction. • Manufacturing site management system auditing • Manufacturing site environmental auditing. • Auditing major and new suppliers • Disposal company auditing • Product Lifecycle Inventory(LCI) • Eco-design • Economic analysis.
	4. Addressing societal concerns (to understand/ anticipation and interaction	**In Understanding/Anticipation** • Opinion surveys • Consumer and market research • Networking
		Interaction • Information through presentations and publications to key audiences • Academic, policy and industry work groups (e.g. think thanks, professional bodies, consultants) • Lobbying to influence future policy and regulations. • Corporate reporting • Specific problem solving with others

(Source : White *et. al.*, 1995, p. 70)

Sustainable environmental management involves health and safety, regulation, resource management (waste is considered as a resource) and human participation. According to White *et. al.*(1995) there is a cycle of commitment among all elements where each has its obligation towards sustainable practices. Technology and

management practices are seen as complementary in the achievement of sustainable development. Technology might be described as the "hardware" of development and management style as the "software".

8.2 Malaysia's Commitment Towards Sustainable Solid Waste Management

This section explains Malaysia's need to form a solid waste management system in the coming future. In a statement delivered by the Minister of Science, Technology and Environment, it stated that in order to improve standard of living and eradicate poverty, a rapid economic growth should be achieved through the national development plans (Yong, 1986). As the economic growth could give pressure on the environment where air pollution, water pollution, solid waste, deforestation and soil erosion are among the elements identified causing environmental degradation. Hence, Malaysia believes that to protect the environment, sustainable development should be the objective in the national development plan.

As part of the world who share the environment for a common future, Malaysia has shown her commitment to a programme of action which was formed and agreed in 1989 during The Commonwealth Heads of Government (CHOGM), the "Langkawi Declaration on the Environment", which supported the concept of sustainable development. Malaysia also realised that sustainable development implies the incorporation of environmental concerns into economic planning and policies (Anon, 1989). In order to achieve this, participation and commitment from all levels of society involving the government, industry and the scientific community, individuals and organisations are essential. Thus an integrated management approach should be

emphasised by Malaysia in order to achieve a sustainable development standard. In decision making, the environmental cost and economic cost should also be taken into account. Following to that, matters pertaining to waste, the environmental and economic impact of waste are the main concerned in forming a municipal solid waste management system in Malaysia.

Cointreau (1982) suggested that solid waste management in developing countries cannot be seen as an isolation. It should be seen as an important issue together with other issues and problems occurred by rapid urbanization. In Malaysia, the impact of development on the environment becoming increasingly visible and many concerned individuals from the government and general public realised that environmental problems were real and required serious attention. With the increase of urban population and industrialization followed by rising prosperity, purchasing power and consumption pattern (Goh, 1991), the amount of waste produced is also increasing. The more waste is produced, the more complex it will be. Without a proper solid waste management it will cause an impact to the environment and people live within.

8.2.1 The political will towards solid waste management.

Government's concern towards environment was first reflected in the enactment of the Environmental Quality Act in 1974. Subsequently 1975, the Department of Environment (DoE) (Malaysia) was set up. In order to provide this body with power for enforcement task, various regulations particularly on pollution were introduced. While DoE is involved with regulation and controls on sources of pollution or polluters, local authorities are responsible on providing public with cleansing services

including waste collection, street sweeping, grass cutting and drain cleansing. Even though this is the most basic function of the local authorities, but due to the unclear and incomplete plan at the local level, satisfaction on this services are not achieved by the public.

Most local authorities' cleansing service departments in Malaysia consume most of their total budget (20 to 80 percent) for their operation of services which to include waste collection and disposal. However, due to the services, which have been delivered with lack of planning and enforcement from both local authority and federal government, it became a non cost-effective service.

Concerned that this deficiency becoming worse, in 1980 a Technical Section was established by the Local Government Division of the Ministry of Housing and Local Government. This section is responsible to provide Local Authorities with services on overall planning and technical advice on any issues related to solid waste management. The *Action Plan for a Beautiful and Clean(ABC)* Malaysia which was prepared by the Technical Section in 1988 become a *de facto* guideline to the States and local authorities for their solid waste management activities. The ABC also required States Government to help their local authorities to prepare regional infrastructure for waste collection and disposal.

8.2.2 Public Disquiet

Waste collection and disposal are the main concern of the general public. Collection efficiency is an important factor in providing effective solid waste management

service. Local councils in Malaysia received most complaints which are related to quality of collection rather than the frequency (refer to Chapter 6). During collection activities, waste collectors: local councils and private contractors are required by local councils' waste collection agreement with the contractors to collect waste using the compactors. But in some cases where private contractors involved in the collection from especially householders, small to medium sized of 1 tonne open lorry are used. Despite the agreement between made between the councils and private contractor stating that they should only use compactors (Majlis Perbandaran Ampang Jaya (MPAJ), 1994), these contractors failed to do so. In most cases, no action is taken against the private contractors, therefore the situation still remains. This happen because of lack of enforcement from the local council and actions taken if any are not stringent. Using an open lorry will cause bad odors and it is likely that waste being carried is blown away during their collection routine. In addition to that, since there is no requirement mad by local councils that waste from residential and commercials are stored in standardized bins, it can be seen that types of storage containers used varies. The containers varied from metal, plastic and rubber waste containers, built-in concrete bins, cardboard boxes, rattan basket as well as plastic bags which are hung on the fences of the premises. While waiting for the routine waste collection, the uncovered waste is exposed emitting odor and at the same time attracting stray dogs and flies. Public who give more attention and effort on this matter by using proper waste storage bins will be dissatisfied with the opposite situation. These situations get worsen as there are insufficient supply of communal bins/skips by the local councils which has lead to illegal waste dumping at improper sites. Furthermore, as a result of poor management of the disposal sites, it has become a nuisance to the people living

nearby due to bad odour, rodents and flies from these disposal sites as majority of the existing disposal sites are not equipped with leachate or gas treatment and no daily covering of the daily waste piles. Somehow, the Not In My Backyard (NIMBY) syndrome in a way is putting pressure to local council to provide better services to the public. Therefore a solid waste management system is needed to overcome these problems for a better healthy life.

8.2.3 Regulation on solid waste

As mentioned earlier, specific regulations and law on solid waste management does not exist. Environmental Bill in Malaysia is still on the preparation stage under the Ministry of Housing and Local Government (The Star, 1997) and not yet approved. This scenario shows that Malaysia realised the importance of a regulatory framework in achieving sustainable environmental standard. The importance of regulation for an effective solid waste management system is written and highlighted by other authors such as Bartone and Bernstein, 1993, Jorgensen, 994 and Cointreau, 1982. First of all, a statutory definition of waste in general needs to be formed and established. Even though, hazardous waste and special waste definition have been used (DoE, 1994), municipal solid waste is not included. Classification on types of waste could be different among countries, for example, differences in the classification of solid waste in the UK and Japan. In Malaysia, because of different life style and custom, there are also differences in its waste composition from other countries, therefore it is important to have a standard classification and definition among all states before regulation is set up. Advantage of having a standard waste classification are easier for

data gathering and monitoring purposes and from the data priority action on solid waste management can be taken.

In order to provide the public with efficient service and facilities on solid waste issues, regulations and procedures should be established at the federal, state and local level. In the United States for example, its Federal Government is responsible in basic legislation and regulatory requirements (OECDa) and provide financial help on dealing with waste management programmes. State government and local authorities could pass by-laws that are more detail especially on municipal solid waste storage, collection, transportation and disposal according to their need and environment. It is also important to set up the standard storage bins for household, commercial and industrial solid waste. For waste collection, only certain trucks that are suitable for waste collection should be required either waste is collected by local councils or by private sectors. For waste that is not for recycling purposes, compactors should be used to avoid waste being blown away or waste odour experienced by the public. Compactor also could maximise the amount of waste collected. In the other hand, size of the vehicle used for collection is better to match the size and type of the local condition (Bartone and Bernstein, 1993). Emphasis should also be made on the vehicle maintenance services. This study reveals that broken vehicles and vehicles which are not used are being left in garages because of insufficient number of workers or drivers. In author's opinion, this is not a cost-effective practice, if an inter-department linkages exist among local authorities or other waste collection bodies, these expensive vehicles could be used by other local authority for their area. This is where an integration between departments could play an important role.

A survey carried out by DBKL (DBKL, 1994) revealed that the frequency of waste collection from households, commercial, institutional and industrial premises is satisfying and does not has much complaints. Therefore the waste collectors' party should maintain this. JAICA (1990) suggested that in providing an effective and cost-benefit on waste collection, the route planning of the trucks should be taken into account. In cases where disposal site is located far away, the uneconomical journey takeplace would contribute to pollution as what is happening in Malaysia. Therefore a transfer station should be considered. Advantage of having a transfer station is the time consumed could be minimised especially for waste collected from city centre with traffic congestion problem as in Kuala Lumpur and Petaling Jaya areas. Recycling activities could also be done here. At present, most disposal sites in Malaysia are multi-disposal system, looking at future prospect, this practice should be abolished. If multi-disposal is to continue, Malaysia will facing problem in the future which may cause groundwater pollution by leachate, fire burning and degrading the quality of land. Therefore a piece of legislation regarding this matter must be established. In Europe, with the Landfill Directive coming in force, multi-disposal will not be allowed and waste will be treated before sending to landfills.

Since Malaysia is still at the early stage in forming solid waste legislation, it is important that all aspects concerning solid waste management implication is taken into account. This is to provide regulations which is few in number, clear, easy to understand, equal and have a significant economical and physical effects

8.2.4 Enforcement

In Malaysia, enforcement is not given a serious attention by local councils/authorities. Due to this, the number of enforcement officer available is not sufficient. For certain cases, enforcement duty which was done by a Health Officer found to be not efficient. In Ampang Jaya municipal council for example, there is only one Control Officer cum Health Inspector who is in charge of enforcement. He has to cover the Ampang Jaya Municipal area that hold around 400, 000 population (MPAJ, 1993). The same problems occur in the case studies presented earlier. In the UK, the enforcement come from the regulatory body that is called the Environment Agency. In Germany, organisations are formed by the Landers (equivalent to State Government) to co-ordinate in the implementation and enforcement of waste management. Malaysia should learned that enforcement body should be formed in order to monitor waste management issues which includes the solid waste problems. The advantage of having a committee which comprises of agencies either government or non-government agencies to 'police" and enforcing waste management legislation and practices should be seen as an important option for Malaysia to consider seriously. In the US, a strong rules and regulations enforcement is the basis of their waste management successes to date (OECD, 1996).

8.2.5 Solid Waste Planning.

Another finding of this research is that the most decision making in solid waste management by the Local Authorities/Local Councils is mostly done based on ad-hoc basis which has led to a non-strategic practices for solid waste management. Out of 145 Local Authorities in Malaysia, only two municipalities have a master plan for

their solid waste operations, whereas others are on ad-hoc basis. Ineffective of local authorities planning is also caused by non-formal existence on data collection neither on municipal solid waste collection, generation nor on its composition. Data are acquired only when there are studies conducted on certain local authorities by interested parties or by private consultant when required by the local authority itself. Therefore any waste future projection and target to set up are impossible to implement by the federal or local government.

Local authorities/councils' boundaries is also one of the important element for an effective MSWM system. Since the regional infrastructure and population density have influence on MSWM system, it is suggested that a population size between 200 - 250, 000 is an optimum size for optimum service and economically feasible. Furthermore, as the environment of solid waste changes rapidly, planning system should also be made in various period of time. In these planning, future possible changes for in life styles, environmental pressures, technical advancement and public awareness should be considered and evaluated. In order to plan, it is appropriate to use the period of time as suggested by JICA (1990):

i Immediate plan (0 to 1 year)

ii Short-term plan (1 to 2-3 years)

iii Medium-term plan (2-3 to 5 years)

iv Long-term plan (5 to 10 years)

These planning terms are also to ensure that any local authority/council will not be pressured by the federal or state government when certain target is imposed by the government in reducing waste. This scene is now experienced by Local Authorities in

the UK where the Government set its secondary target to recycle or compost 25% of it household waste by the year 2000. Reports from various sources and interviews conducted found that most council believe that it is impossible for them to reach the target where reasons varies from the falling price of papers and other recyclable materials to lack of government support in providing financial assistance and recycled material treatment plant.

8.2.6 Economic perspective on MSWM system

Economic instruments have been adopted in many countries primarily developed ones in introducing more flexible, efficient and cost-effective action to control pollution. The commonly economic instruments used are classified as :

i charges and taxes

Three types of charges, which are the : i) User charges impose on amount of waste collected or treated. This charges cover the direct costs not the actual costs of waste activities which include costs on environmental damages. ii) Disposal charges or known as the "tipping fees" according to amount of waste disposed to landfill. In the UK, landfill tax was introduced in October 1996 where waste sent to landfill are charged according to type of the waste. iii) Product charges where non-returnable containers, plastic bags and other non-reusable products are charged.

ii deposit-refund system

This system is imposed on consumers to encourage recycling and prevent pollution. The system is in taxes, charges and fees form. iii marketable permits

It is an environmental quotas on pollution level refereed to as credits, allowances or marketable permits.

iv subsidies, grants, loans and other forms of financial support.

Provided by the government, these form of financial support is used to support local authorities or state government in development and implementing solid waste activities.

At national or international level, "charges" and "taxes" are used in various perception. In Malaysia, the so called economic instruments systems are used not for reducing waste but only to cover the waste management costs. Among them are: municipal tax, license fees from trades, industries and businesses, service charge on waste collection and grants from federal and state government. Since Malaysia is at an early stage, oversight and achievement of this system in industrial countries should be learned and practised where appropriate.

8.2.7 Policy on solid waste management for Malaysia

From the data surveyed and information received on municipal solid waste management (MSWM) in Malaysia among the important findings revealed that lack of management and planning arrangement from Federal Government to local authorities/councils, regulatory body, industries and public who acted as the actors and players. In designing a solid waste management system, all physical, technical, legal, institutional, financial, environmental and sociocultural aspects of MSWM should be considered and taken into account (Bartone and Bernstein, 1993).

The case studies also reveal that, in the MSWM there is no clear policy for effective strategy at the government or local authority level for MSWM in Malaysia. Currently there are two types of policy adopted in managing municipal solid waste which are

the command-and-control and economic instrument. A research by Hassan and Abdul Rahman (1996) showed that the regulatory instrument on municipal solid waste available passed by the Federal Constitution has no specific reference to solid waste management or waste issues. Related waste regulations have no statutory definition on solid waste, and the waste producer and regulator often interchangeably use the term "waste" and "refuse" without clear understanding. Most laws related to local authority's task concerned only on cleanliness, sanitary conditions and public health. Under Section 72 and 73 of the Local Government Act 1976, local authorities are given the power to provide and making enforcement on waste management services. They are also given power to make by-laws but little effort was made. Existing by-laws are mainly focus on proper storage of waste generated, removal and disposal of commercial, industrial and building material waste at disposal sites. In the case where private companies involve with the collection, the system itself is not properly regulated too. Concern on environmental impact of landfill are mentioned via the Environmental Impact Assessment Regulations, 1989 of the Environmental Quality Act, 1974

Looking at the leadership role on solid waste management in Malaysia at present, municipal solid waste is under the responsibility of the Economic-Planning Unit of the Local Government and Housing Ministry. Whereas the Department of Environment of the Ministry of Environment and Science is responsible on issues regarding pollution. Successful single leadership role has been practiced notably in the United States, Japan, United Kingdom and Germany of Environment of Japan, Department of Environment in the United Kingdom and in Germany.

Besides statutory guideline, the Federal government should also provide non-statutory guidance on solid waste management. In the UK for example, its 30 volumes of Waste Management Paper (WMP) provide technical guidance and data presentation on waste management. Published by the DoE (now known as Department of Environment, Transport and Region (DETR)), WMP covers topics such as: options of waste, recycling and landfilling (WMP no. 1, WMP no. 28, WMP no. 26 etc.). The Royal Commission on Environmental Pollution of the UK, a standing body appointed by the government to advice on pollution of the environment at national and international level (Barron, 1996) through their reports. For example, report related to waste are the 11th Report on Managing Waste: the Duty of care (1985), 12th Report on Best Practicable Environmental Option (BPEO) (1986)and the 17th Report on Incineration (1990). In Scotland, the State Government or known as Scottish Office has published guidelines on planning and waste management (NPPG 10, 1996) where it emphasises on the development plans important roles in the management and disposal of waste. Because of their commitment on sustainable development, the NPPG 10 supplies information on how to achieve sustainable development through waste management. As stated in its objective in achieving sustainable development, the NPPG10 requires that waste management framework adopted should applies the principles of sustainable development. This includes 'the proximity principle' which applies when providing waste disposal facilities where it would be as close as possible to the point of waste production, the 'regional self sufficiency' on the Structure Plan area, 'the precautionary principle' in avoiding any potential of environmental

damage, the 'polluter pays principle' and 'the best practical environmental option' in providing waste treatment that is least damage to the environment.

If Malaysia would like to have a uniform, cost-effective and an acceptable solid waste management system by the public these guidelines are vital and should be provided by the Federal government not only for waste operators but also for general public as part of their education and knowledge information.

Rookwood (1996) proposed that a single independence body should be established by statue where waste is concerned. This body is responsible in preparing and revising government environmental policies - a set of national objectives for waste and recycling, pollution and non-renewable resources. These objectives incorporate the standard of environmental performance, limits on environmental capacity and requirements for environmental impact assessment as environmental measuring tool.

For the Federal Government, it is vital for them to provide a national waste policy to make sure that a more sustainable approach to waste management is achieved by those involved in waste generation and its management. In the UK, Scotland is now setting a policy framework, where the Scottish Environmental Protection Agency (SEPA) is responsible for developing the waste strategy under Section 92 and Schedule 12 of the Environment Act 1995(SEPA, 1997). In promoting the solid waste issues, state government could adapt the national waste strategy and formed a link with land-use planners as well as transportation network. As for the local government, councils can form a plan on SWM System and deliver them to the general public. In maintaining and facilitating, the federal government could provide grants, research

and development (R&D) group and most important is knowledge guidance on how to implement the SWM and the important of having a management system. For example the National Planning Policy Guideline (NPPG)provided by the Scottish Office of Scotland on Planning and Waste Management provide guidelines on existing policy and law on waste management.

For the State governments in Malaysia, it is important for them to adopt the "NPPG" at state level and monitor the performance of the local government. In assisting the local government, public could set up organisation of local community in improving and delivering the message to improve waste management practice. In this matter public education through publicity and training are important so that government's objective to improve waste management activities could be achieved.

Therefore policy of local authorities on waste monitoring should be emphasised in optimising the collection, treatment and disposal of municipal solid waste. Any complaints received from public regarding municipal solid waste problems should be recorded and looked into regularly where this will be included in the strategy to optimise the municipal solid waste services.

To set up a national waste policy and guidelines, an integrated approach and commitment should be introduced in Malaysia. Looking at the problem arise, failure to understand of own responsibility is among the main reason why waste management issues cannot be solved until today.

8.3 Integrated Waste Management System

8.3.1 The Role of the Government

According to Bernstein and Bartone (1993), inefficiency in solid waste management in developing countries is commonly caused by inefficient institutional arrangement of the municipal government, which supports the finding of this study. The government should consider waste management issues as one of the top priority concern and it is important for the institution to create an interactive process and waste should be treated as a resource. A National waste policy and strategy on solid waste management that create co-operation and integration responsibility among governments, planning developers and public should be established.

8.3.2 Institutional Structure.

According to Bernstein and Bartone (1993), inefficiency in SWMS in developing countries is commonly caused by inefficient institutional arrangement of the municipal government. Top priority concern amongst the institutions is to create an interactive process on solid waste management issue, where waste is treated as a resource. The institutional involved are the Federal Government, State Government and Local Government where their roles are to provide the services and be closest to the public and stakeholders. A fully integrated system will require the clarification of working links between all three levels of government i.e. Federal, State and Local. A plan for better integration will require preparation of the laws and regulations, design of service delivery arrangements and arrangements for financial assistance. The gaps among the institutions should also be removed.

Although the issue that usually looked into in Malaysia is principally on waste disposal, now it should be realised that in considering a MSW system, waste generation problem should also be included. Therefore, an effective system is to have an integrated system which incorporate waste minimisation, recycling processes, waste-to-energy incineration and ultimate waste disposal. In Malaysia, its initial identification on prioritised waste type and waste treatment should be emphasised. For an immediate to short term planning, recycling of waste material could be the best option because it has been practised in Malaysia since 1990 among the households and institutions as well as school children. Improvement can be made through national publicity rather than just effort made by local authorities. Studies on waste recovery in Bombay (Beukering, 1997) through a simulation model demonstrated that Western system is not necessarily cost-effective to be practised in developing countries. Reasons are because informal recovery that involves independent waste buyers and scavengers proved to be more cost-effective and environmentally optimal. Inspite of its limited capital investment, this informal system creates employment. The advantage of the western policy is only on the creation of income distribution. A lot more to be done in improving recycling activities in Malaysia. The introduction of economic instruments to encourage recycling can be an example. It could be better if waste recycling system and economic instruments are imposed on certain wastes such as paper and cardboard, glass bottles or aluminium cans for a start.. This depends on which of these waste will have an invariable pricing in a long term. In the past, failure of recycling programme implemented by some local authorities/councils in Malaysia in term of lack of public participation are because public are not well informed and do

not understand the important of recycling as well as less commitment given by state and federal government (Suhaimi, 1996) (Saiful Bahli, 1996).

More than 90% of municipal solid waste goes to landfill in Malaysia since the past 20 years. According to Hassan (1992), through a comprehensive technological-economic evaluation, landfill is the most cost-effective waste treatment in Malaysia. A proper sanitary landfill social cost (direct cost plus environmental damages cost) is around RM35/tonne, RM500/tonne for incineration whereas for composting is RM216/tonne. Though problems on landfill are leachate and landfill gases, these could be controlled by technologies available. But this studies strongly recommended that for a long term planning, landfill should be seen as the last option and it is the matter to change the attitude of the regulator, producers and consumers that play an important role in choosing landfill as either the last resort or top of the hierarchy. If Malaysia's government intention to bring in more industries and tourism in the development of the economy, prediction on waste produced should be identified for future waste disposal planning. Because in SWM system, theory and practice is significantly diverge, it is important for Malaysia to learn the experiences from other countries in developing its SWM system. Turner, K. (1992) stated that failures on waste management in the UK in the past were caused by

i) information failure

Lack of single data which is national, comprehensive and up to date. It is said that lack of projection on amount of waste will cause difficulties for planning and economical SWM system.

ii) Lack of "systems" thinking

Systems selected for waste are diverse and confusing for the waste producers.

iii)Institutional failure

Before a decentralised body was set up (i.e. Environmental Agency for England and Wales and SEPA for Scotland), division on waste collection, disposal, licensing and policy making has contributed to the inconsistency in standard of SWM system.

iv) Lack of economic cost-benefit thinking

Lack of use on economic instrument on SWM system.

From the policy and strategy discussed above, Malaysia has lot to do to improve its SWM system. Nevertheless, with the involvement from all the parties mentioned above this could be achieved in the near future.

8.4 Structuring Public Administration to Deliver Sustainable Waste Management

In broad terms, administrative decision making takes place at three levels of geographic scale, which dictate in turn the level of detail and the quantity of policy input, as distinct from design elements, within the decision process. Broad policies for the whole nation are made for the long-term guidance of the whole national territory. As these policies move towards the stage of actual implementation, they must be "geared down" to sub area of the nation (or regions). No national territory is homogeneous and the social and economic character will also vary accordingly. National policies need to be adjusted in detail to fit regional variations. Beyond the regional level the local authority level presents further and still more details variations

to which the policy must adapt in order to be effectively implemented on the ground. Whatever the policy field, the effectiveness of its delivery will depend on

1. the exercise of political will in the cause-hence the importance of positive leadership from central government
2. the availability of professionals with management and technical skills - hence the need to institute a nation wide programme of professional mid career environmental education
3. a clear system of public accountability - hence the need to ensure that institutions are in place for effective public participation

In Malaysia, the organizational structure of government will need to adapt to something like this in co-ordinating model to deliver on its stated ideals of promoting sustainable development. Cross-departmental linkages at all levels will require to be fostered. Among the professionals, the ability to think up and down the scale levels as well as laterally within ones own level will need to become standard working practice among both officials and politicians. Furthermore all levels and departments will need to be open to public involvement in the shaping of decisions. Subsequently, mechanisms for public involvement will need to be put in place if they do not already exist. The disciplinary boundaries between professions and administrative groups will need to become more permeable.

In summary, the broad policy fields, which are essential to a co-ordinated national drive for sustainable waste management in Malaysia, are

- Socio Economic policy (to set the targets for the economy and a vision for improving the life of the people)
- Resources policy (including waste-waste as a resource) to enable sustainable use to be made of the nations resources
- Spatial land use planning , to make sure that new development is located so as to optimize both economic use and social conservation values
- Education planning - to ensure that an informed electorate supports governmental efforts and participate directly at local level in implementing sustainable waste management and an environmentally educated group of professionals who will turn policy into action.

key element in resource policy making. It is now time to elaborate a national strategy for solid waste management using the principles set out above.

Current approaches to solid waste management in Malaysia face serious difficulties arising from the lack of

- a holistic overview of the nature of the problem from which an integrated policy might emerge
- an institutional structure suited to implementing the co-ordinated action which such a policy would require.

Bartone, C. R. and Bernstein, J. D., 1993, emphasise that in designing a solid waste management system, it is critical that all physical, technical, legal, institutional, financial, environmental and sociocultural aspects should be considered and drawn together into single integrated policy. In order to improve the solid waste management system, the role of the central government is key since it can set the framework for

action at all lower scale levels as well as across departmental boundaries within any one level.

In adopting the Agenda 21, it is important that Malaysia outlined the elements of policy statement as guidelines to be adopted. First, should be the integrated relationship. This includes the public, policies and instruments integration and a round-table approach. The next step is to form an integrated policy between the public, government and other institution so that each sector have an objective to achieve which will bring them to a sustainable practices. This integration will develop a partnership of responsibility not only among the public, government and other institutions but also within the different levels of government, which was mentioned earlier. Information on environment and continuous improvement on the environment should be the key subjects of this framework.

Although policy may come from the national level, it is clear that regional adaptation and operational implementation of the policy will require to be organized in an integrated way down through all the levels of administration. This is the duty of the national government. In order to provide the public in Malaysia with efficient service and facilities on solid waste issues, regulations and procedures should be established at the federal, state and local level. Another aspect of administration which should be kept in mind in regard to a waste management policy, is the paramount need to co-ordinate the waste policy with parallel policies relating to the management of the nation's infrastructure i.e. land use and transportation. The form and location of urban

development has a direct impact upon any plans for the cost-effective management of waste.

In meeting the government policies and programmes on solid waste management successfully, this can be achieved through individual and community action at home and at work (Ham, R.K., 1992). For example, a designed recycling programme, without any participation and willingness, the programme will not be successful. This is what happen in Malaysia, whenever the local authorities implement a project on recycling, the participation from general public is always not satisfying and end up with termination of the programme. In this matter education is the most important tool in making the programmes successful. Education mentioned here involve all level of public with different method of approach such as environmental awareness and education especially for school level and public in general, staff training on environmental awareness for industries, institutions and politician and developed from here is the co-ordination and partnership among public.

Today environmental education is seen as an important tool in achieving sustainable environmental management. It is becoming a multi disciplinary curriculum venture among organization (Forbes, J. 1998). Furthermore, environmental education aims to involve people from all level to participate in forming the policy and plan for a harmonious result in the management of the environment. In public involvement, various segments of public with different level of involvement based on differences in their roles, technical expertise and their willingness to commit the time and energy are very important towards the success of the environmental management. According to

USEPA (1990), a way to picture levels of involvement is to visualize several "orbits" of activity revolving around the decision-makers. The public involves are classified as the professionals with technical expertise, member of groups or businesses who will not choose to participate in environmental programs unless influence by leaders or top management, the active citizen and general public.

As mentioned earlier, an integrated responsibility approach is vital in tackling the waste problem. Thus educational strategy should change from being a single topic approach to a more holistic method. The kind of education should suit all level of public which include the decision makers, the professionals, the workers in business and institutions and general public of all ages. According to Forbes, J. (1998), any national policy on waste management will be so interwoven with national policies on the environment in general, that publicising and educating about waste is most properly designed within a national policy on environmental education. which local populations may depend (e.g. fishing); all urban development must have planning permission and must conform to statutory land use plans which will be made by the regional and local authorities and which will work to national planning guidelines.

Environmental education should be a key element in all levels of education. It need not be a separate subject but should be a method of approach to which all learning can be related. All students should be encouraged to understand the total inter relationship between human activity and the health of the nations natural environment.

8.5 Waste Privatisation in Malaysia: Its Implications and Challenges

A variety of constraints placed a burden on state and local authorities to plan and maintain effective waste management system, including infrastructural, financial. operational, and technical recourses. Therefore in the Government's Privatisation Master Plan, solid waste management was earmarked as one of the areas for privatisation. This privatisation programme demonstrated the transfer of activities and functions that were traditionally with the Government to the private sector. This privatization concept is hoped to provide opportunities to the private sectors to conceptualize and develop new projects as well as expand this existing project, thus will enhance economic growth. Private sectors are hoped to provide an integrated, efficient and effective technologically advanced system that enhances environmental quality through waste minimisation and resource recovery. The Malaysian Government through its Economic Planning Unit (EPU) invited local and foreign companies to participate in this privatisation project in 1994. Through this bidding, four consortia were selected. Each consortium is incharge of one region : Northern (consists of Perak, Kedah, Penang and Perlis), Southern (Johor, Negeri Sembilan, Malacca), Central region (consists states of Pahang, Selangor, Kuala Lumpur, Kelantan and Trengganu) and East Malaysia region which includes Sabah, Sarawak and Labuan. In solid waste management privatisation, Malaysia was split in four regions to four different companies because of the inadequacies resulting from private monopoly of Malaysia's sewerage services.

According to Kamariah (1995), challenges in privatisation of solid waste management involved waste management hierarchy, participation and integration. Public

perception and participation in waste either mange by local authorities or private companies remains generally negative due to the poor performance and slow implementation of services. In public's view, privatisation is expected to bring forth a positive result with improved management and responsibility overnight, but the Indah Water Konsortium (IWK), the sewerage system privatisation situation has soured the transition and created scpetisim among public and officials responsible. Therefore, media environmental education play an important role in creating and promoting awareness of the total concept of waste management, so that they know their respective roles.

This is also the situation of the lesson learned from the failure of IWK national Sewerage system privatisation. In the author's view, there are two main things that cause the failure of this privatisation: first is lack of public awareness on the importance of a sewerage treatment plant and second because of lack of understanding. Therefore public are not willing to pay for their sewerage system bill though IWK had imposed a very low monthly payment which ranges from RM2.00 to RM8.00 per month depending on the size of the house. Therefore for the solid waste management, they have taken a step not to privatised the solid waste management system at national level, in-fact it was divided into four regions and taken over by four different private companies. Private companies involved with solid waste should in the first place introduce to public the important of having good waste management system and to develop awareness regarding this issue. This will involves publicity, education at all level and also the introduction of a systematic economic instrument in order to make sure that public pay for the services they get.

In Malaysia, the Government has selected to privatise the sewerage services which was under the Local Authorities because it was considered to be the quickest and most effective solution, since this service is facing severe problem of massive scale of investment, expertise and manpower skills under local authority. In December 1993, a concession agreement was signed awarding a 28 years concession to a private company, Indah Water Konsortium (IWK) and sewerage management was handed over to IWK in stages beginning April 1994. After almost 6 years of privatization, it was taken over by the government because its privatization was seen as a failure. This failure is actually caused by various elements among which are:

- unclear and incomplete role of the various players

The concession company took on an all encompassing role, with far reaching responsibilities and risks, while ownership and authority remained with the Government. Some of the role of the Government, its agencies, the concession company and the customer were not clearly defined, and were not in consonance with one another. The concession company struggled with a sewerage system which it had inherited in a dilapidated condition, and faced pressure from the regulators. Angry customers refused to pay the tariff. Added to that, state Government had to relied on in obtaining land for sludge and sewage treatment facilities, while regulators enforced on standard performance to be achieved, even while the problem were being settled. To overcome public dissatisfaction on the service, the government has taken an action by lowering the service payment, where this situation further compounding the problem of the concession company.

- Customer acceptance
- People in Malaysia in general have a poor understanding of environmental issues. Majority of the public do not know what sewerage management is all about. Because of lack of understanding, the public do not care of the dangers and risks of pollution, ecological damage and public health hazards that can result from poor sewerage management.
- resistance to tariff

people had either never paid directly for sewerage services or had paid highly subsidized rates. Public are comparing the charges they have to pay before and after the privatization. Due to tariff problem, public resistance and non-payment, as well as Government's decision to cut the tariff, rates, IWK's income has been badly affected.

- financial problem

Due to the problem on the tariff, public resistance and non-payment, as well as the Government decision to cut tariff rates, the IWK's income has badly affected. Furthermore, the expenditure on operation, refurbishment and capital projects has far outstripped even the most conservative estimates. This has upset the balance in the financial model assumed at the outset of the privatisation exercise, and has affected IWK's ability to perform to its optimum capability.

- Manpower and skills

Lack of expertise in this field. Not only in technology field but also in the management of the services.

Looking at the failure of the sewerage privatisation in Malaysia, the waste privatisation has a lot to improved especially in getting publics, commitment and trust

that the waste privatisation is able to provide better service. Public will be the limiting factor for the success of the waste company because they are the source of income in operating and maintaining the services and the "long life" of the waste companies involved. Therefore a study on the mechanism of the best way of getting the revenue from the public need to be conducted by the government and the company in supporting their services.

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APPENDIX 1

Harmonising Waste Classification Systems

The harmonisation of waste classification systems is crucial for developing comparable waste control systems across European countries. In particular there is a need to harmonise and cross-reference the existing list of waste, which require control under international and regional conventions. Attempts to harmonise definitions and establish an international waste classification system are currently being undertaken by international organisations as summarized below:

3.1.1 The International Waste Identification Code

Developed by the OECD in 1988, the International Waste Identification Code (IWIC) (OECD Council Decision C(88)90Final) provides a uniform classification system to describe waste considered to be hazardous. Different approaches are used to describe waste as follow:

i. the reasons why the material is intended for disposal
ii. disposal operations
iii. generic types of potentially hazardous wastes
iv. their constituents
v. the hazardous characteristics
vi. the activities generating them

The IWIC provides a coded list for each of these approaches which together allow a ' cradle-to-grave' card index to be produced. In this way, any batch of waste undergoing transfrontier movement can be described.

3.1.2 The core list of hazardous waste

During the last decade, the emergence of international agreements on controlling the transfrontier movement of hazardous waste prompted national governments to recognise the need for a common list of waste, specifying the characteristics, which make them hazardous. OECD countries adopted a core list of 17 generic waste types and 27 constituents in 1988. The 45 categories of waste to be controlled by the Basle Convention (2989) on the Control of Transboundary Movement of Hazardous Waste and their Disposal correspond to a large extent to the OECD core list.

3.1.3 Green, amber and red list

OECD countries have also adopted a classification system for waste designated for recovery operations. This distinguishes wastes in terms of the 'green', 'amber' and 'red' lists, depending on the level of control, which applies for their transfrontier movement. These lists have been introduces into EC Council Regulation 93/259/EEC on the supervision and control of shipments of waste.

3.1.4 The European Waste Catalogue

The initiative to create a general nomenclature for waste has been undertaken by the European Commission to develop a European Waste Catalogue (EWC). The EWC has been developed and approved (EC Decision 94/3/EC) in compliance with EC Council Directive on waste 75/442/EEC as amended by EC Directive 91/156/EEC (Framework Directive), which requires a common reference list of waste to be established across the EU Member States. Its implementation will provide a common basis for cross-referencing national lists, and facilitate the implementation of EU waste management policies. The catalogue is not meant to replace national classification schemes or to follow strictly a single approach. Instead it should allow EU Member States to harmonise waste control systems and reporting on waste. The system classifies waste according to sources, processes and waste streams, providing the basis for producing comparable and compatible statistics on waste in EU Member States. The EU and UNECE are co-operating towards extending the catalogue to all European countries.

Source: EEA, 1995

APPENDIX 2

THE ENVIRONMENTAL CHARTER
A DECLARATION OF INTENT

AS SCOTLAND'S RECYCLING CITY, THE CITY OF DUNDEE DISTRICT COUNCIL (NOW KNOWN AS DUNDEE CITY COUNCIL) IS IN A UNIQUE POSITION TO PROMOTE CARE FOR THE ENVIRONMENT THROUGH PARTNERSHIP, LEADRERSHIP AND INFLUENCE.

THE CITY OF DUNDEE DISTRICT COUNCIL (NOW KNOWN AS DUNDEE CITY COUNCIL) IS COMMITTED TO:
THE CONSERVATION OF THE EARTH'S FINITE RESOURCES BY

- active development of policies and programmes to conserve energy
- continued development of policies and programmes which conserve materials and resources through efficient and effective use and recycling
- use of machinery, appliances and practices which are the most energy efficient and which minimise environmental pollution.

- **THE PROTECTION AND MAINTENANCE OF THE ENVIRONMENT BY THIS LOCAL AUTHORITY BY** Development of policies and strategies which monitor and minimise pollution.
- Providing the public with information and advice concerning the disposal of potentially harmful materials.
- Minimising damage to the environment through minimal use of approved chemicals and pesticides.

THE PROMOTION OF ENVIRONMENTAL APPRECIATION LOCALLY, NATIONALLY AND AROUND THE WORLD BY

- Instituting within the Council, staff development and education programmes to raise awareness of this Authority's environmental policies.
- Promoting and participating in education programmes and, in partnership with Tayside Regional Council, providing the public with information and advice.
- Promoting partnership between appropriate environmental, scientific and community groups for exchange of information.

THE CO-ORDINATION AND MANAGEMENT OF THE COUNCIL'S POLICIES, DECISIONS NAD ACTIONS TO ENSURE ENVIRONMENTAL AWARENESS BY

- Setting up an Environmental Advisory Group which will co-ordinate, manage and develop the Environmental Charter and resulting policies and information
- Instructing Chief Officers to prepare and implement action plans reflecting the Environmental Charter
- Monitoring the environmental performance and impact of the Authority
- Instructing Chief Officers to include an assessment of environmental considerations in all appropriate committee reports

THE ENHANCEMENT OF THE LOCAL ENVIRONMENT BY

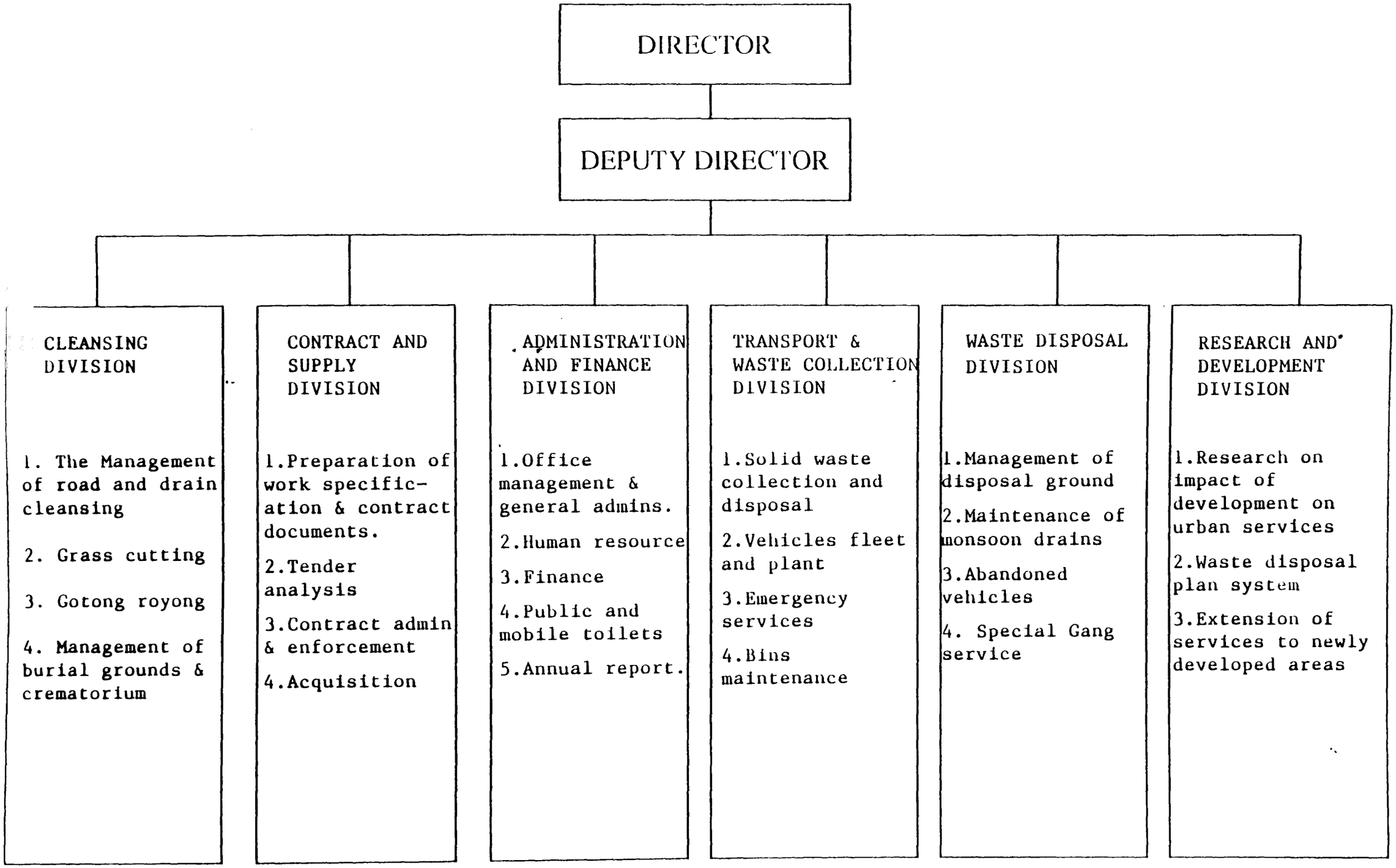
- The continued development and enhancement of the built and natural environment through the planning processes of this Local Authority
- The adoption as policy of a "Nature Conservation Strategy for Dundee" to protect and enhance Dundee's wildlife and to promote its adoption in the statutory local plan.

Thomas Mitchell JP
Lord Provost of Dundee

Magnus Magnusson, KBE

APPENDIX 3

Organisation Chart of Urban Services Department (USD)



(Source: DBKL, 1996).