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STUDY ON SOLID WASTE MANAGEMENT OPTIONS FOR AFRICA

PROJECT REPORT
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EXECUTIVE SUMMARY

Waste generation, both domestic and industrial, continues to increase world-wide in tandem with growth in consumption. In developed countries, per capita waste generation increased nearly three-fold over the last two decades, reaching a level five to six times higher than that in developing countries. With increases in populations and living standards, waste generation in developing countries is also increasing rapidly, and may double in volume in the current decade. If current trends continue, the world may see a five-fold increase in waste generation by the year 2025. A high proportion of the waste could be recycled by the urban poor generating income for themselves and protecting the environment. There is a need to develop an integrated approach where the public, private and community sectors work together to develop local solutions promoting sustainable solid waste management.

The Sustainable Development and Poverty Reduction Unit (PSDU) of the African Development Bank (ADB) has commissioned a study on solid waste management options for Africa. The study encompasses a literature review of municipal waste management options in African countries and close examination of current waste management practices in the four main African municipalities of Cairo (Egypt), Nairobi (Kenya), Accra (Ghana) and Cape Town (South Africa).

The project's objective is to contribute to the improvement of municipal solid waste (MSW) management systems in Africa, to promote appropriate management policies on national, regional, local and sectorial levels in order to enable the integration of suitable management practices and to guide the African Development Bank's Task Managers in the design of waste management practices or in the integration of waste management concerns into sanitation or urban development projects.

On the Bank's level, the study addresses:

(i) environmental concerns in countries where the Bank provides assistance and has its operations;
(ii) capacity building for environmental management in these countries;
(iii) effective management of the environment portfolio;
(iv) provides a basis for integrating community-based waste management initiatives in urban development projects
(v) endorses the most appropriate waste management options and guides the International Financial Institutions (IFIs), including the ADB, in investment priorities for African countries, and
(vi) contributes to the preparation of Country Environmental Profiles which have been developed by the African Development Bank during the past few years in order to integrate environmental concerns into its overall lending program.

The literature review, presented in Sections 2 to 8, commenced with a general consideration of conceptual approaches to solid waste management in Africa and progressed with a review of individual studies. The review focused on relatively recent publications rather than attempting to carry out a comprehensive historical review. The majority of the studies cover the period 1994-2002.

The specific solid waste management topics covered by the literature survey include: (a) waste generation and characterization; (b) collection/transportation; (c) processing; (d) disposal; and (e) socio-economic and institutional policies of waste management.

Based on the literature data it has been confirmed that urban governments in many African countries are facing serious problems with the management of solid waste. Solutions developed for the North are often not appropriate to contexts in the South. Social relations characterizing primary waste collection in African cities have certain particularities and therefore the potential social impact of changes resulting from the introduction of new waste management methods need to be carefully considered.

A summary of literature findings can be summarized as follows:

(1) Waste characterization data specific to African cities is generally not available, though some regional evaluations have been made.

(2) Usually, the composition of the waste varies depending upon such diverse variables as urbanization, commercial enterprises, manufacturing, and service sector activities.

(3) Primary collection is important for the health of populations since a poor primary collection means exposed waste in the vicinity and an unhealthy environment.

(4) Solid waste management in most countries is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal of municipal solid wastes.

(5) No country has specific waste management legislation, although legislation is being drafted now in some countries.

(6) Usually integrated waste management is not implemented; and very little information is available on composting, controlled sanitary landfills and the recovery of the landfill gas.

(7) Of concern is the current lack of regulatory initiatives to manage waste minimization, with the potential for reducing the hazardous waste problem.

(8) No differentiation is made in the collection of different types of waste, although some municipalities have implemented higher taxes for commercial waste.

(9) The informal sector represents a significant part of the economy, and waste recuperation and recycling is an important economic activity.

(10) Funding for waste management is always inadequate, and real costs are never fully recovered.

(11) Two key alternatives of waste management are currently favored: decentralized approaches and privatization. Privatization in particular is considered a viable option. However, privatization proposals are in many cases hurried, ill thought-out, and often based on developed country models which assume a totally different technical, financial and organizational framework, particularly with regards to primary collection.

(12) Since the privatization of all or parts of many municipal solid waste systems will take place in the coming years, privatization mechanisms should be implemented by involving those who are amongst the poorest and who potentially would be most disadvantaged by such changes.

(13) In order to be successful and sustainable, any future investments in equipment and in technology must be preceded by background studies and surveys of the solid waste management situation to assure that the use of means is best suited to the capabilities of the countries and their people.

(14) Education and communication channels between sectors, especially government and civil society, are considered to be inefficient and inadequate. A lack of a right to know, secrecy and misinformation has also been major contributory factors to poor waste management practices in many African countries.

(15) It has been seen that most community initiatives operate up to the stage of primary collection. Community contributions to small area based organizations, informal payments to municipal sweepers etc. exist because the community needs a regular and reliable primary collection system and does not like to see waste in the immediate vicinity.

(16) On the positive side, the African continent is well-endowed with human and natural resources and civil society is becoming empowered. Political and institutional reforms, although slow, remain the biggest hope for waste management policy change. Political will, sound politics and governance and inter-regional cooperation will determine how waste management resources are allocated and used. A range of initiatives in waste reduction and management are underway - at home, in schools, offices, small and large business, local governments, and public institutions

Detailed review of solid waste management practices in major municipalities is included in this report based on the project consultant visits to Cairo, Nairobi and Accra in October 2000. All four municipalities are important residential, business, commercial and industrial centers in their respective countries. The selected locations of municipalities represent a cross-continental character of the study.

All four municipalities have population of over 1 million. This is summarized in the following table:

Municipality	Country	Location	Population, mln
Cairo	Egypt	North Africa	10.7
Cape Town	South Africa	South Africa	2.7
Nairobi	Kenya	East Africa	2.5
Accra	Ghana	West Africa	1.4

Each of the selected municipalities has its own, unique waste management practices and regulatory framework. Also, the differences exists between municipalities predominant commercial activities. Cairo is an industrialized municipality, Cape Town is a commercial center, Nairobi has a well developed tourist services and Accra is a busy commercial and fishing port.

In each visited city, waste management practices were audited with the assistance of local ADB representatives and commercial officers of the Canadian High Commissions. The project consultant met several municipality officials, representatives of the private sector, non-government organizations (NGOs), Canadian commercial officers and other stakeholders. A list of the interviewed persons is provided in Appendix 1. Also, inspected were specific components of solid waste infrastructure such as dumpsites, composting plants, recovery and recycling centers. A review of waste management practices in Cape Town was completed based on extensively published waste management literature.

Following is a summary of case studies, described further in this publication.

Cairo, Egypt

In Egypt approximately 10 to 15 million tons of solid waste is generated annually with Cairo alone contributing more than 3 million tons. Waste collection and transportation efficiency ranges between 15% and 65%. Approximately one third of solid waste is not collected.

Waste management services have already being privatized in some Egyptian cities. Currently, tenders for integrated solid waste management systems have been launched or are in the pipeline. Already, the Governorate of Alexandria has awarded a 15-year contract to the French firm ONYX Vivendi.

The Governorate of Cairo is divided into four districts and waste management tender documents have been issued for each of the areas. Cairo has well developed, modern composting plants established by the government and rented out to the private sector. There are less than 10 composting plants in Cairo and 25 plants nationwide. Composting plants, designed and equipped by Egyptian companies, have a chance to become a model for other

African countries as a result of their modern design, low cost, high efficiency and satisfactory operation records.

Identified gaps and weaknesses of waste management in Cairo includes:

- Lack of alternative mechanisms for collection of service charges;
- The important role of local companies, NGOs and the informal sector (the Zabbaleen) has not been recognized by the municipal and national governments;
- There is a need for implementation of a long-term and focused sanitation awareness campaign and education in the waste management area; and
- Engineered landfills do not exist at this time.

A large scale innovative and efficient waste recovery, reuse and recycling operation is run by the Zabbaleen, a group of over 50,000 people traditionally involved in the business of waste collection and processing. They recover and/or recycle between 70% and 80% of all collected plastics, metals, glass, paper and other components of the waste stream. In addition, they produce fertilizer in the process of organic waste composting and raise pigs which are fed on garbage on a commercial scale. To support their waste processing operation, the Zabbaleen design and manufacture various types of machinery at their own production facilities. Other African countries could profit from the Zabbaleene experience by importing their know-how and competitively priced waste processing equipment.

Nairobi, Kenya

The current daily rate of solid waste generation in Nairobi is in the range from 800 to 1000 tons. Daily disposal capacity of the Nairobi City Council (the municipality), which is in charge of waste collection, is about 400 tonnes. Waste collected by the municipality on a regular basis amounts to one third and periodic collection deals with the remaining two thirds of waste. Approximately 70% to 80% of solid waste remains uncollected. The Nairobi City Council (NCC) operates 15 to 19 waste collection vehicles daily. There is a high vehicle immobility rate, up to 70%, due to shortage of spare parts and an insufficient operating budget. The municipal staff carries out manual street sweeping. Mechanical street sweeping is not offered at this time.

The private sector is involved in waste collection and disposal in Nairobi. Approximately 50 tons of municipal solid waste is removed daily by such private operators as BINS (Nairobi) Services

Limited and Kenya Refuse Handlers. The companies generate income from collection fees and contracts with the NCC.

Solid waste recovery and recycling is carried out by many of Nairobi's poor who engage in waste picking as a means of income generation. The estimated quantity of recovered and recycled items ranges from 20 to 30 tons per day. The NCC does not operate any transfer station or composting plant where commercial waste recovery / recycling could be implemented.

All solid waste, except medical refuse, is disposed at the Dandora dumpsite. The site is managed by the NCC and is provided with heavy equipment to manage waste disposal. The Dandora site is not fenced and is therefore accessible to scavengers, recovery operators and cattle growers. Waste cover is not implemented and neither is landfill gas recovery or flaring.

Several community based organizations and non-government organizations in Nairobi's low-income areas were found to be undertaking composting as an income generating and environmental management strategy. In cooperation with the UNDP, the Dandora Kuku Womens Group runs compost-making operations. They produce up to 10 tons of compost per year and sell it mainly to urban farmers within the City of Nairobi.

Waste management stakeholders in Nairobi include various NGOs, CBOs, the private sector, the NCC, the Department of Environment and its Cleansing Section, the Ministry of the Environment and Natural Resources, and the Ministry of Local Government.

To improve waste management practices in Nairobi, the Ministry of Local Government has identified the following priority projects:

- Institutional reconstructing and financial reform;
- Introduction of container system with side loaders, dump trucks, etc.;
- Construction of a new sanitary landfill site at Ruai (first stage) and closing the existing dumpsite;
- Construction of a new transfer station; and
- Implementation of the Community Waste Management Project.

The cost of priority projects will be Kshs 2.3 billion (US$30 million).

Accra, Ghana

The average waste quantity generated in Accra in the year 1999 was 1,500 tons per day. Approximately 200 tons of organic waste was directed into Accra’s composting plant and 300 tons was left uncollected. The remaining 1,000 tons was transferred to the Malami dumpsite.

Solid waste collection and disposal in Accra is in the hands of one company, City & Country Waste Limited (CCWL). In 1999, Accra Municipal Assembly (AMA) awarded exclusive

rights for waste management to CCWL, initially for five years, with the possibility of a further five year extension. CCWL subcontracted services to 11 private operators.

Malami is Accra's regional dumpsite which is supervised, well maintained and organized. About 20 employees of CCWL maintain the site, supervise refuse discharge from trucks and the compacting process, organize scavenging activities for up to 50 waste pickers and control vehicle movement. The site will be covered by earth and closed in the near future. An efficient and well managed Malami dumpsite could be used as a demonstration site for landfill/dumpsite managers from other West African countries.

The new, properly designed and constructed landfill will be commissioned prior to the closure of the Malami dumpsite. The new landfill is designed for up to 15 years of operation.

A number of private waste management companies are registered in Accra. They would like to have better access to waste removal services and are apprehensive with the exclusive rights of refuse collection given by AMA to CCWL.

There is an old composting plant in Accra with the processing capacity of 300 tons per day. Because of a limited market demand for compost and deteriorating equipment, the plant is not operating at its full capacity.

No significant waste recovery and reuse activities exist in Accra. Waste pickers are involved in a small-scale recovery and reuse operation. The problem in introducing small-scale resource recovery modules that can contribute to sustainable waste management systems is more a matter of perception than of technology. It requires interdisciplinary co-operation at several levels among various actors, such as municipal and national governments, non-governmental initiators, community representatives, and so on.

To improve waste management in Accra, the National Environmental Sanitation Policy was prepared by the Ministry for Local Government and Rural Development and approved by the Cabinet on April 8, 1999. By adopting the strategic objectives for environmental sanitation it is expected that by the year 2020, all solid waste generated in urban areas will be regularly collected and disposed of in adequately controlled landfills or by other environmentally acceptable means.

Waste collection in Tema (near Accra) is organized within the Urban IV Project financed by the World Bank. In contrary to waste management in Accra, contract awards to the private sector are transparent and executed in an open-bidding process. However, the dumpsite serving Tema is not as well organized and maintained as the one in Accra. As well, maintenance and repair of the waste handling equipment (including trucks) by the Tema Waste Management Department is inferior to the CCWL operations.

Cape Town, South Africa

The total amount of waste accounted for disposal in Cape Town is around two million tons per annum. Estimates of waste quantities per capita can vary considerably across the Metropolitan area, depending on the concentration of commercial activities and the type of community. The major concern is that waste generation rates could rise with economic growth and rising standards of living and quickly exceeds the capacity of existing and planned waste facilities in Cape Town.

It is anticipated that the overall waste generation rate will increase by nearly 20% to 1.98 kg per capita per day over the 30-year planning period, with most of the increase occurring in domestic waste generation.

More than 95% of domestic, trade, industrial and hazardous waste is landfilled, which remains the most widely used method in South Africa and is still the cheapest option. The total amount of available space in existing landfills within the Cape Metropolitan Area (CMA) is estimated to be 19.6 million m^3.

A system of transfer stations is proposed to serve the entire CMA. These stations are designed at locations close to major roads and rail, as well as the collection areas that each station will be serving. A total of 13 transfer stations are anticipated to handle the futures wastes for disposal. Of these, 12 transfer stations will be new.

There are privately owned landfills in South Africa. Many are associated with industrial and hazardous waste. However, a few are owned by private collection services. In general, however, private ownership and/or operation of SWM facilities are rare in South Africa. It is apparent that the most practical means for future landfill development is likely through the private sector. National waste management companies that have the capability to develop such a regional landfill exist.

Recycling of materials from domestic, commercial and industrial wastes, such as metal, plastic, glass, and paper, composting of domestic waste, and the beneficial reuse of wastewater treatment plant sludge account for approximately 24% of the total solid waste stream in Cape Town. Most of the recycling occurs in the industrial sector. Of the total residential and commercial waste stream only an estimated 6.5% of the waste is recycled

Composting is a small-scale activity in South Africa, performed mostly by private entrepreneurs. There is only a limited market for compost material, as the industry is still in a primary stage. Although expansion is taking place in this area, it is not seen as a major waste reduction or resource recovery option. Approximately 41,000 tons per year of collected domestic and commercial solid wastes are composted at several composting facilities in the CMA.

Waste stakeholders in Cape Town include the governments, private sector, NGOs and the general public. The government enacted a legislative body, the Consultative National Environment Policy Process (CONEPP), to address integrated waste management. In addition, the South African Department of Water Affairs and Forestry and the country's

Department of Environmental Affairs and Tourism are jointly involved in the process of developing a comprehensive waste management strategy.

South Africa has a well-developed waste management industry able to serve the needs of the country. A new, modern approach to integrated waste management policy is demonstrated in the White Paper on Integrated Pollution and Waste Management for South Africa. The White Paper serves the following two purposes:

(1) To inform the public of the government's objectives, and how the government intends to achieve them.
(2) To inform government agencies and State organs of these objectives, and their roles in achieving them.

In line with South Africa's objectives of efficient and effective management of the nation's resources, priority is given to prevention. Unlike previous policies that focused predominantly on "end-of-pipe" treatment, the government underscores the importance of preventing pollution to reduce waste generation in the first place and avoiding environmental degradation.

Finally, qualitative evaluation of waste management components at each of the four studied municipalities is summarized in the form of a matrix proposed by the project consultant with an arbitrary marking scale from A to D. The A mark represents a high score and the D mark represents an unsatisfactory performance. The N/A means that data was unavailable to the evaluator.

Component of Waste Management	**Cairo**	**Nairobi**	**Accra**	**Cape Town**
Collection rate	C	D	D	B
Separation at source	B	B	B	C
Recycling	B	D	D	B
Waste pickers / buyers	B	C	C	B
Composting	A	C	C	D
Transfer stations	C	D	D	B
Landfills	D	D	C	C
Privatization	B	C	C	C
Open & competitive bidding	C	C	D	N/A
Public education	C	D	D	B
Legislation	C	C	C	B
Government's priority	C	C	C	B
Overall	**C+**	**C**	**C**	**B-**

The findings, interpretations, and conclusions expressed in this paper are entirely those of the author. The accuracy of the data included in this report is directly related to the accuracy of the reviewed literature and the information given by those contacted during site visits.

Based on the case studies, three SWM models could fit a typical African City at three different community income levels:

- High income community: Cape Town, South Africa;
- Medium income: Nairobi, Kenya; and
- Low income: Tema and Accra, Ghana.

A number of issues must be addressed in preparing solid waste management projects. This includes establishment of an acceptable standard of collection and disposal service delivery, selection of appropriate technology, development of suitably phased action plan, arrangement of institutions (including private sector) for planning and management, arrangement of financial resources, development of regulatory and enforcement framework, provision of public education and participation programs, and incorporation of incentives and disincentives to facilitate project success

Through the provision of a comprehensive and thorough literature review, a detailed analysis of four major African municipalities and the presentation of a SWM project framework with reference to World Bank guidelines, this study should fulfill the task of guiding the ADM Task Manager in the design of waste management projects or the integration of waste management concerns into sanitation or urban development projects.

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ABBREVIATIONS

ADB	African Development Bank
AMA	Accra Metropolitan Authority
ANEN	African NGOs Environment Network
ASG	Apparent Specific Gravity
BUN	Biomass Users Network
CBOs	Community Based Organizations
CCWL	City & Country Waste Limited
CDS	City Development Strategy
CIMEP	Community Involvement in the Management of Environmental Pollution
CMA	Cape Metropolitan Area
CMC	Cape Metropolitan Council
CONEPP	Consultative National Environment Policy Process
DALY	Disability-Adjusted Life Year
DANCED	Danish Cooperation for Environment and Development
DDT	Dichlorodiphenyltrichloroethane
EEAA	Egyptian Environmental Affairs Agency
EHP	Environmental Health Project
EOHSI	Environmental and Occupational Health Sciences Institute
FY	Financial Year
GEF	Global Environment Facility
GHC	Ghanaian Cedis
GHG	Greenhouse Gas
GOE	Government of Egypt
GNP	Gross National Product
HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
IPC&WM	Integrated Pollution Control and Waste Management
ISWM	Integrated Solid Waste Management
IWM	Integrated Waste Management

JECO	Junior Ecological Organization
JICA	Japan International Cooperation Agency
KRH	Kenya Refuse Handlers
Kshs	Kenya Shillings
LAWMA	Lagos Waste Management Authority
LE	Egyptian Pound
LFG	Landfill Gas
MEIP	Metropolitan Environmental Improvement Programme
MELISSA	Managing Environment Locally in Sub-Saharan Africa
MENR	Ministry of the Environment and Natural Resources
MLC	Municipal Local Council
MOLG	Ministry of Local Government
MRF	Materials Recovery Facilities
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
MWM	Municipal Waste Management
MYSA	Mathare Youth Sports Association
NCC	Nairobi City Council
NEAP	National Environment Action Plan
NEDA	Netherlands Directorate for Development Assistance
NEPAD	New Partnership for Africa's Development
NES	National Environmental Secretariat
NGOs	Non-Government Organizations
OESU	Environment and Sustainable Development Unit
PSDU	Sustainable Development and Poverty Reduction Unit
PSP	Private Sector Participation
PWMC	Private Waste Management Contractors
R	South Africa Rand
RDF	Refuse Derived Fuel
SMC	Surat Municipal Corporation
SME	Small and Medium Enterprise

TMA	Tema Municipal Assembly
SWM	Solid Waste Management
TSU	Technical Support Unit
UK	United Kingdom
UMP	Urban Management Programme
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USAID	The United States Agency for International Development
UWEP	Urban Waste Expertise Programme
VALCO	Volta Aluminum Company
WHO	World Health Organization
WMD	Waste Management Department
WTE	Waste-to-Energy
ZEDP	Zabbaleen Environment and Development Program
ZWMA	Zambia Waste Management Association

INTRODUCTION

Sustainable Development and Poverty Reduction Unit (PSDU) of the African Development Bank (ADB) initiated a study on solid waste management option for Africa. The study encompasses literature review concerning municipal waste management options in African countries and close examination of waste management practices in selected major African municipalities including Cairo (Egypt), Nairobi (Kenya), Accra (Ghana) and Cape Town (South Africa).

Until the late 1980s, solid waste management policies and programs in most African cities were formulated and implemented by government agencies without significant public participation. There were many problems in the overall management schemes for solid waste policies. The most often encountered problem was decentralized responsibility for various activities of waste management. Many cities have adopted a management system whereby waste collection was administered under the department of health; disposal was handled by the works' or mechanical engineering department; and the fleet was centrally maintained for all city vehicles by the works or mechanical engineering department. It resulted in placing waste collection at the bottom of the organization tier structure. In some cases there were supervisors assigned to administer the activities of the workers, but there were seldom planners, managers, and field foremen included in the organizational framework. The waste management personnel were so-low in the scheme of the municipal hierarchy that they did not influenced funds allocation for regular replacement and maintenance of equipment. Another aspect of this arrangement of responsibilities was that the department performing the collection (i.e., by street sweeping) was often not responsible for the transfer and disposal. These problems still prevail in some less developed African countries.

However, political and social changes across the continent in 1990s, including the rise of NGOs, have fostered an increased awareness of environmental issues among the public. Urban populations have become more involved in the issues surrounding municipal solid waste (MSW). Resistance to MSW incinerators in countries like Côte d'Ivoire, Senegal, and South Africa reflects an emerging involvement of the public in the debate and policy formation process of SWM. A trend observed in the last decade involves a capacity building transition towards greater national and municipal self-reliance with a priority to accelerate development and promote the use of local knowledge, technology and expertise. Over the past years, many governments have passed legislation to address environmental and human health threats. Regulations aimed at controlling some of the major and most obvious risks have been made public.

However, a number of limitations have become clear:

- Limits of impact management;
- Limited civil society involvement;
- Inadequate integration of environmental media;
- Inadequate integration across government departments;
- Lack of capacity to implement; and
- Inadequate consideration of global environmental issues.

High rate of urbanization in most African countries has made difficult to develop and implement effective MSW management policies. Serious problems have been observed in many countries.

For example, Dakar, home to some 3 million of the 8.5 million Senegalese, produces about 400,000 tonnes of garbage a year, according to official figures (Boubacar, 1996). Discarded paper, fruit skins, old cloth and other wastes have become part of the landscape in this West African town where just about every street is lined with waste and overflowing refuse bins go unemptied for many days. Since 1996, the municipal authorities have signed contracts with about a dozen groups of so called GIEs ('Groupements D'interets Economiques') who, for 1,000 CFA francs (about US$1.80) a tonne, collect the refuse and take it to Mbeubeus. That's the open-air dump northeast of the capital where Dakar's refuse - all of it untreated - is deposited before being sifted through, collected and then re-used by recyclers. The dump, opened in the early 1970s, is located above the main underground reservoir from which much of suburban Dakar gets its potable water. Some four kilometers long and one km wide, it has long exceeded its capacity. After turning a blind eye to this situation for years, the authorities now see it as a serious environmental threat. A few years ago, it was about 15 km from town. Now an expanding Dakar is in the process of swallowing it up and that's the real danger. The Ministry of the Environment and the Protection of Nature it is trying to find ways to solve the problem. The municipality has been toying with the idea of opening a new dump in Thies, 70 km from Dakar, but it is believed that a more viable solution will have to be found for the capital's waste management dilemma.

Population of Lagos, the largest city in Nigeria, increased seven times from 1950 to 1980 with current number of over 10 million (UN, 1997). Majority of residents are poor. They make heavy demand on resources and, at the same time, generate large quantities of solid waste. Total of 4 million tonnes of MSW is generated annually in the city, including approximately half million of untreated industrial waste (IMO, 1995). Port Harcourt, Rivers State, is another Nigerian city with severe MSW problems. Once known as the “Garden City” the place gained a nickname the “Garbage City” because of inadequate collection and disposal practices.

Another example of serious problems with management of solid waste is Lusaka (Zambia) where 90% of the 1,400 tonnes of municipal waste produced daily is left uncontrolled. Private collectors mainly collect waste from industry, commercial premises and private homes on a commercial basis. There are about 53 registered private transporters of waste who collect about 2% of municipal waste in Lusaka town, and about 50% of the waste in the mining towns on the Copperbelt. Community based organisations (CBOs) collect waste from informal settlements where local authorities do not provide a collection service. CBOs account for 100% of all the waste collected in these areas. CBOs account for 100% of all the

waste collected in these areas. Prior to 1990, institutions involved in waste management were the local authorities or councils and ministry of health. These implemented the Public Health Act and the Local Government Act, which provided for street cleaning and sanitation. Local councils were responsible for waste collection and managing of waste disposal sites (Nkansu, 1999).

Some African countries have made efforts to improve solid waste management practices. In August 1998, Department of Environmental Affairs and Tourism of South Africa, with assistance of the Danish Cooperation for Environment and Development (DANCED), developed White Paper on Integrated Pollution and Waste Management for South Africa. The Paper formulates an integrated pollution and waste management system. It presents the concept of Integrated Pollution and Waste Management that government will use in its envisaged national policy on pollution prevention, waste minimization, impact control and remediation. It describes the scope and purpose of this Integrated Pollution and Waste Management policy and delineates the consultative process used in developing this policy. This Draft White Paper on Integrated Pollution and Waste Management for South Africa serves the following two purposes: (1) to inform the public of the government's objectives, and how the government intends to achieve these objectives, and (2) to inform government agencies and State organs of these objectives, and what must be done to achieve these objectives.

In Banjul, The Gambia, National Environment Agency prepared the waste management plan as part of the Environmental Management and Tourism Development Study under the auspices of the Urban Management Project. There are two main objectives of this plan. The first is to develop waste management strategy at waste sources including municipal, commercial and industrial which will significantly improve sanitation in the Greater Banjul Area and other urban, peri-urban and rural areas of the country. The second is to develop and implement system components such as collection, handling, processing, treatment and disposal. They will provide additional energy (incineration) and natural fertilizers (composting) in addition to recovery of commercial materials.

After the 1992 United Nations-sponsored Earth Summit, African governments and Western donors pledged more than $2 billion to a World Bank managed Global Environmental Facility designed for environmental rehabilitation in Africa and elsewhere. But many donors consider African governments too weak to implement such projects effectively. There are also ongoing disagreements between African leaders and Western aid officials regarding the best way to cope with the myriad problems. African governments are often lacking fiscal transparency, according to an August 1994 article in the Washington Post, and many donors doubt that the billions of dollars earmarked for environmental projects in Africa will have much impact in the absence of basic political and economic change. Effective and enforceable environmental policies are difficult to develop and implement in many sub-Saharan countries.

A World Bank supported project in Côte d'Ivoire is developing a set of environmental indicators for use in macroeconomic and sector planning and policymaking. The Ministry of Planning is taking the lead in integrating these indicators into planning activities. The recent trends in environmental indicators will also be central to the dialogue between Côte d'Ivoire

and the international community over forestry and environmental management policies, including waste management.

The Municipal Development Program has been established in Cotonou, Benin, known as Solid Waste Observatory for Western and Central Africa. The Observatory is a tool to collect and disseminate information about the subject. It aims to identify the stakeholders and their strategies, the interaction between the various stakeholders, the modes and means of interventions and their contribution to the improvement of the solid waste management industry. The two main objectives are to master the problems related to solid waste management in African cities and to mobilize the stakeholders promoting their professionalism. Four types of activities are envisioned, being data collection, data analysis, data dissemination and using the data to enhance decision making. The main outcomes of the Observatory are to identify stakeholders and to characterize waste, to develop performance indicators, to promote African expertise and to train stakeholders and undertake action research for enhanced decision-making (Municipal Development Program, Cotonou, Benin).

Based on the available literature concerning waste management practices in Africa, following sections describe waste management strategy in several countries, provide characterization and handling practices of municipal wastes, operation of regional landfills and urban cleansing. Socio-economic, health, legislative and institutional policies of waste management are also reviewed.

WASTE MANAGEMENT STRATEGY

No single solution has been identified that completely answers the question of what to do with solid waste. Every community or region has its own unique profile regarding solid waste. The attitudes of people in different regions of each country vary regarding waste management practice. The diversity of communities and their waste is one reason why no single approach to waste management has been accepted as "the best" method. Since there is no preferred method, every community must create its own "best approach" to dealing with its waste. However, all communities have the same alternatives. The general strategies are reviewed below with reference to Africa.

2.1 Administration

Administration is one of the major weaknesses of waste management systems in Africa. Limited investment and restrictions on raising or directly accessing user fee revenues is another. Any plans to upgrade SWM at the country level would do well to first focus on the administrative and organizational systems on which the service ultimately depends. Provisions must also be made for public feedback and for input from related professional organizations in the planning, evaluation, and upgrading of the system. Cost recovery by municipalities through retained user fees and taxes has shown promise in several cities. Private enterprise may play a role in vastly improving SWM services in Africa. In many cases improvements may be obtained with high labor, low capital alternatives and enabling administrative changes. Cooperatives and community organizations may also play a role in providing SWM services, from pre-collection to recycling and composting.

Generally, administration of waste management in African countries is executed through three levels of responsibility (UNEP-IETC, 1998).

Level A

At the highest level is the Ministry of Environment or its equivalent. In some countries responsibility for SWM rests with the Ministry of Health, the Ministry of Public Works or the Ministry of Planning and Development. The ministry is generally responsible for overseeing SWM at the national level. It controls the allocations for MSW capital investments by city municipal waste authorities. In many cases this ministry is charged with setting standards for SWM based on laws enacted by the legislature. It is also through this ministry that international cooperation in SWM is effected. Often, the central government ministry, such as the Ministry of Environment, is charged with other responsibilities like tourism, wildlife conservation, and land and/or water resources management. These responsibilities generally carry a higher national priority than SWM, since they often directly generate income. When combined with limited staff and budget constraints, SWM may not receive due attention or financial allocation from the ministerial level.

Level B

Under the national ministry are the various municipal agencies responsible for planning and urban affairs in the country's major cities. These generally take the form of district governates, such as the Governate of Cairo, the Communaut Urbaine in Dakar, the Gouvernorat de District in Bamako, and the municipal governments in Ibadan, Accra, and Harare. The planning and design of SWM services is carried out by these agencies. They receive their annual operating budget from the central ministry and usually do not charge a fee for their services. They are generally not empowered to levy taxes. There are some notable exceptions. For example, in Conakry, Guinea and Lagos, Nigeria, municipal agencies raise revenue through direct user fees. The municipal agency is also charged with implementing the SWM plan in its respective city.

Level C

The actual execution of day-to-day SWM operations is carried out by a combination of official municipal workers and fee-based contractors from the private sector. The latter provide collection services as noted earlier. In Cairo, the Zabbaleen operate as a cooperative and use trucks, plastics pelletizers, and rag pullers in their collection and recycling operations. In C⊥te d'Ivoire, Ghana, South Africa and Tanzania, initiatives are underway for private operators to provide MSW collection in all or parts of their major cities. Cooperatives and community groups may also be involved in collection, recycling and composting of MSW. For example, in Cotonou, Benin, community groups participate in the collection process under contracts with the municipal agency.

Waste Management Practices

Waste management practices vary from country to country in Africa. For example, the Government of Comoros endorsed a National Environment Action Plan (NEAP) in August 1994, providing the country with a comprehensive strategy for environmental management and protection as well as a proposal for investment (World Bank, 1995). Four main NEAP strategic priorities provide the operational guidelines for this proposed project:

(i) to collect environmental information that is required for proper environmental management planning and decision-making;
(ii) to strengthen the institutional framework for environmental management and coordination at all levels;
(iii) to provide training for environmental specialists, increase the environmental awareness of the public and bring about effective public participation in environmental management; and
(iv) to preserve and restore the equilibrium of the ecological process, protect biodiversity and promote the rational use of natural resources for the benefit of present and future generations.

Furthermore, NEAP acknowledges that restored economic growth and successful family planning program are the only long run options for relieving pressure on the environment.

In Uganda, environmental policymaking remains largely a function of the central government, but implementation of policies and legislation is passed to the districts. The decentralization process is being supported under the World Bank-financed Environment Management Project, launched in Financial Year 1996 (FY96).

In Accra, the capital of Ghana, the World Bank-facilitated regional MELISSA initiative (Managing Environment Locally in Sub-Saharan Africa), co-financed by the European Union, Sweden, and Norway, carried out its first pilot operation in FY98 to help create the basis for privatizing the management of solid waste.

A number of African countries have been implementing integrated waste management (IWM). It refers to the complementary use of a variety of practices to safely and effectively handles municipal solid waste. The strategy used to develop an integrated waste management system is to identify the level or levels at which the highest values of individual and collective materials can be recovered. The most favorable is reduction, which suggests using less to begin with and reusing more, thereby saving material production, resource cost, and energy. The least desirable is landfilling.

IWM systems follow general hierarchy of waste management, which is shown in Figure 1.

Figure 1. Hierarchy of integrated solid waste management.

For each of the process elements, there is a dependence upon how effective each preceding element has been. This is of great importance when considering each element in the sequence. It can be seen that if there is no effort applied in the prime processes, then the secondary processes such as incineration or landfilling must be capable of accepting and processing all of the components of the waste materials. This not only affects the quantity of municipal solid waste to be processed, it also affects its combustion characteristics, and its composition.

At the present time, integrated waste management (IWM) is getting more recognition than ever. Defined by Tchobanoglous *et al*. (1993), IWM is the selection and application of appropriate techniques, technologies, and management programs to achieve specific waste management objectives and goals. Understanding the inter-relationships among various waste activities makes it possible to create an IWM plan where individual components complement one another.

Although majority of large cities have administered waste management practices of different level of sophistication, in some African countries there is no official solid waste management policy. For example, Cameroon with a population around 14 million of which half is living in towns, does not have door to door solid waste collection program. Solid waste is disposed in the natural streams and rivers, in the surrounding bush or marshland. Traditionally organic waste is also used for feeding domestic animals and as fertilizer in gardening. In many cases, solid waste disposal points are spontaneously created along the most accessible roads around the areas. Depending on the performance of the official collecting system, the disposal points are more or less important. Also times, fire is used to burn heaps of waste. This creates toxic smoke, which is detrimental for health.

Solid waste is disposed in bulk without prior sorting or treatment. Many attempts are made by NGOs, supported by donors, to introduce the presorting of household solid waste into organic and inorganic, reusable and non-reusable waste. They further encourage composting with organic matter and recovery of other forms of solid waste.

In general, the vital needs for the African urban population are zoning of the land, quantitative and qualitative availability of water, availability of energy, good drainage of rainwater, good final disposal of used water, the good final disposal of solid and liquid waste, adequate market place, hygiene and sanitation.

WASTE CHARACTERIZATION

The limited available data suggest that the MSW stream in the typical African city at point of disposal is high in putrescible organic content. However, it is low in percentage of commercially recyclable components and too low in heating value for energy recovery by incineration. Certain wastes may eventually become resources valuable to others once they are removed from the waste stream.

Waste Generation Rates

Worldwide, low income countries have the lowest percentage of urban populations and the lowest waste generation rates, ranging between 0.15 to 0.33 tonnes/person/year. All of the countries that have a GNP per capita less than US $400 produce under 0.25 tonnes/person/year. As GNP increases toward the middle income range, the per capita waste generation rates also increase, ranging from 0.18 to 0.40 tonnes per year.

According to a 1992 report by the Stockholm Environment Institute, residents in Accra, Ghana, generated about 800 tons of solid wastes per day in 1990, with an annual increase of 6%. Most of the waste was organic. There were ashes from fuel wood and charcoal as well as the remains of common foods such as sugar cane, mangoes, and bananas. With little equipment to manage the refuse, garbage was only collected in high-income areas. The rest was dumped in unauthorized dumping sites, primarily along waterways. Associated health problems included high incidences of cholera, diarrhea, and dysentery, especially in children.

The major cities in West Africa produce between 150,000 to 300,000 tons of MSW per year, and waste management absorbs about 50% of the total municipal budget. Only 40% to 60% of this waste is even collected (Paris, 2000).

Waste Composition

Waste composition indicates the components of the waste stream given as a percentage of the total mass or volume. The component categories usually include:

- Compostables (includes food, yard, and wood wastes);
- Paper;
- Plastic;
- Glass;
- Metal; and
- Other (includes ceramics, textiles, leather, rubber, bones, inerts, ashes, coconut husks, bulky wastes, household goods).

As-delivered (wet basis) MSW from Accra, Ibadan, Dakar, Abidjan, and Lusaka shows putrescible organic content ranging from 35-80% (generally toward the higher end of this range); plastic, glass, and metals at less than 10%; and paper with a percentage in the low teens.

To the extent that these figures are approximated, they indicate a waste stream of limited potential commercial value for the recovery of metals, glass, plastic, and paper. However, though the per-capita generation rates of these materials are relatively low, they may be present in sufficient quantities in the MSW streams of densely populated cities to warrant labor-intensive recovery ventures. The high organic content suggests possible value as composting material. However, the viability of these schemes is likely to depend highly on end markets for their products. The low calorific values make the waste stream unsuitable for energy recovery via incineration.

Waste densities and moisture contents are needed to convert data to a common frame of reference for comparison (e.g., from mass to volume and from wet to dry). Usually the higher the percentage of organic matter, the higher the moisture content and the density of the waste stream. Densities in Africa may be expected to fall in the range of 180 to 340 kg/m^3. Compacted MSW, as delivered by collection vehicles with mechanical compactors, can have densities in the range of 180 to 420 kg/m^3, depending on the composition of the waste and the type of compacting equipment. Calorific values are reported to be low.

WASTE HANDLING PRACTICES

Waste handling practices include collection, transfer, reuse, recovery, recycling, composting and incineration. Brief review of waste handling practices based on available literature for Africa is given below.

Waste Reuse

In general, at the household level in low-income peri-urban areas, resource recovery begins with the reuse of plastic bags, bottles, paper, cardboard, and cans for domestic purposes, thereby extending their useful life. The rate of reuse in this instance is high, and these materials enter the waste stream only when they are no longer fit for domestic use. In high-income areas, recovery is carried out by domestic servants and/or wardens. Rather than reusing the materials directly, they sell bottles, plastics, cardboard, and paper to middlemen or commercial centers that pay for these materials. The extent to which these transactions

occur depends on the availability of marketable end uses for the materials. While such industries may be found in some primary cities, they are largely absent in secondary cities and in rural areas. Even in those cases where they are found, they do not consistently stimulate recycling in their host cities.

Glass bottles are usually returned to their point of sale for direct reuse by the beverage industry. A deposit system has maintained a high return rate continent-wide. In the majority of cities, the glass content of the MSW stream would not be sufficient to support a glass recycling industry. Instead, the bottles not used for beverages are diverted from the waste stream and used as containers in homes. Other glass items are discarded with the rest of the MSW stream.

Where there is a market, plastics are recycled by waste pickers, some of whom have modular pelletizers to process the material prior to sale. The material is then sold to local plastic product manufacturers. These plants use granulated or pelletized virgin plastics for the manufacture of packaging material and recoverable utensils and furniture. Waste pickers with rag-pulling equipment shred, clean, and reknit this material as all-purpose utility cloths for resale.

Waste Recovery and Recycling

With few official statistics on MSW generation and recycling to point to continent-wide, it is not possible to generalize about an overall rate of waste recycling in Africa (UNEP-IETC, 1998). As African cities move to upgrade their SWM systems, obtaining waste data will be vital to their design of well-integrated systems.

Waste recycling is often undertaken as a survival strategy when the urban poor are unable to obtain formal employment, and when non-waste resources are scarce or unaffordable (Cointreau and de Kadt, 1991). By reducing the total amount of solid waste headed for the landfill (or left lying to decompose in the streets), recycling and composting are land saving and pollution reducing strategies. Waste re-use also plays a valuable resource conserving role: by recycling materials, further exploitation of scarce natural resources is minimized, thus containing the spreading ecological footprint of the city. Despite these environmentally and socially beneficial aspects of waste recycling, it is not without its negative impacts, which include exploitation by waste buyers and poor health and living conditions for the urban poor who deal in waste picking (Furedy, 1992).

As urban environmental problems worsen in developing countries, non-conventional approaches to urban pressure points like waste management will have to be adopted. The recycling of solid and organic waste is one approach that has positive ramifications in creating informal employment and offering an environmentally sound solution to waste management problems. While there is considerable documentation on innovative community-level waste management schemes in Asian and Latin American cities, little research has been done on the importance of, and potential for, waste re-use in African cities.

Waste Collection

Most major cities in Africa have an established municipal waste collection system. Collection is carried out by human- and animal-drawn carts (wheelbarrows, pushcarts), open-back trucks, compactor trucks, and trailers. Collection rates across the continent range from 20 to 80%. Common feature of the municipalities is that they are ineffective, under-equipped and poorly maintained (often vehicle immobilization rates reach as high as 70%), inadequately funded and poorly staffed. Often collection services are limited to high visibility areas, the wealthy, and businesses willing to pay for this service.

Where collection is performed by non-mechanical means, the volume of material to be collected often exceeds the capacity of the collection system. Because large areas of the cities are inaccessible to large vehicles, precollection is the first step in the waste management chain. Pre-collection is carried out by community groups in some areas not served directly by municipal vehicles. This is often carried out by small communal organizations or micro-enterprises that employ otherwise jobless youths, women, and sometimes even small children. For example, in Cotonou, Benin, such a group is authorized to pre-collect the waste and deposit it in communal bins for later removal by the municipality. Wheelbarrows and donkey carts are often used to transport the waste. Systems were initially funded by local or international NGOs. Collection from skips, a few transfer stations, or door-to-door in high income areas had been modeled on the North American and European systems. However, they typically deteriorated after three to five years because of the unsuitability of the vehicles and lack of maintenance budgets.

Private operators provide service on a fee basis to households and commercial establishments. In Cairo, the Zabbaleen is a group that has traditionally specialized in MSW collection and now operates as a cooperative to perform this service with authorization from the municipal authority. However, though such cooperatives might do much to improve municipal sanitation, they are not common in other African cities. Since the mid-1970s international aid has promoted initiatives to improve the coverage of MSW collection services in Africa. These efforts have focused primarily on vehicular collections only in major cities. In some West African cities, such as Dakar and Cotonou, local initiatives have focused on service to formerly neglected peri-urban areas.

The poorer areas in Africa are the least likely to have any way to safely dispose of their household trash and garbage. In Kampala, Uganda, for example, less than 20% of the population benefits from regular collection of household wastes and less than 20% of the solid wastes generated within the city are collected, according to the International Institute for Environment and Development. This means that organic wastes fill public spaces, backyards, lanes, pathways, and vacant lots, where they attract disease-carrying insects and pests and clog overflowing drainage channels.

The lack of reliable collection service negatively impacts the public health and aesthetics of African cities. As the urban share of the population grows on the continent, this problem is likely to increase. Collection is a key link in the chain of SWM from the point of generation to ultimate disposal. In any initiative to upgrade waste management service, sustainable, contextually appropriate collection should be a major focus of attention.

As reported by Olanrewaju (2000), refuse collection has always been a problematic issue in Lagos, Nigeria. The last military administration made an effort to combat the problem of refuse collection through waste management agency known as the Lagos Waste Management Authority (LAWMA). As LAWMA's performance continued to decline, the post-military Tinubu administration initiated an Operation Drain and Waste Clearing, targeted at removing of heaps of refuse at different locations. Launched in July 1999, the operation has since exhausted millions of naira. The policy was eventually complemented by an innovative Private Sector Participation (PSP) in refuse clearing and collection and now waste is managed by private contractors. Recent surveys of the city shows that most parts of Lagos are nearly refuse free. To achieve government's goal of efficient municipal solid waste management, Governor Tinubu announced the decision of the government to establish a Solid Municipal Waste Management Policy. One of the policy components was to encompass private sector participation in domestic refuse collection via transportation from tenements, markets, motor parks, among others to designated landfill sites. To ensure a success of the programme, the Lagos State Government reeled out modules to govern the operations of the PSP. LAWMA was to assume a subsidiary role.

Waste Transfer

Transfer stations are not common in municipal waste management in African cities. One such facility, operated by the City of Abidjan, C⊥te d'Ivoire, is no longer functional. In almost all cases, the point of disposal of the MSW is located on the perimeter of the city, within easy reach of vehicles and collection crews. The collection vehicles are generally of the 6 - 7 m^3 capacity and go directly from their point of last pickup to the disposal site.

Composting

Composting is a controlled natural process of decomposition of organic waste material. It reduce the cost of waste disposal, minimize nuisance potential, and produce a clean and readily marketable finished product. Composting helps to increase the recovery rate of recyclable materials.

Despite the relative simplicity of composting, its suitability for developing countries, and its compelling economic and environmental benefits, several projects initiated over the past decades have failed due to technical, financial, and institutional reasons such as:

- Inappropriate technology;
- Mechanical breakdown;
- Poor maintenance;
- Lack of operator education and training;
- High operating costs;
- Poor quality feed stock waste;
- Offensive odor emissions;
- Poor marketing plans for the end product;
- Insufficient focus on management; and

- Lack of cooperation from the public, municipal governments and the agriculture sector.

Transfer of solid waste technology, including processes and equipment, is usually from industrialized countries to less developed countries. Often the technology is not directly applicable, as it fails to adequately consider local factors such as the waste characteristics, seasonal variations in climate, lack of technical education and training, cultural attitudes towards solid waste, and the status of waste management in political institutions.

The preference of mechanized composting technology over labor intensive processes is usually inappropriate for developing countries. A lack of trained and educated personnel to control the daily operations results in a low-quality end product and frequent mechanical breakdowns. When a piece of equipment becomes inoperable from misuse or poor maintenance, it is often too expensive and time consuming to purchase and import foreign spare parts.

Many composting facilities are designed to process high-quality waste consisting primarily of organic matter. Often the waste arriving at the composting facility is mixed municipal solid waste which requires more energy to process, causes mechanical breakdowns, and reduces the quality of the final compost. Source separated organic waste is the preferred feedstock since contamination by plastics, glass, metals, and household hazardous materials is minimized. The principle source of heavy metals in MSW is often common domestic products such as batteries (mercury, cadmium, lead, zinc), leather (chromium), paints (chromium, lead, cadmium), plastics (cadmium, lead, nickel), light bulbs (lead), fluorescent lamps (mercury), paper (lead), consumer electronics (lead, cadmium), ceramics (lead, cadmium), cosmetics (cadmium, zinc), and dust from sweeping (de Bertoldi, 1993; Richard *et al*, 1993). In cooler climates the biggest source of contamination is usually coal-ash, mainly from home heating.

Even though the organic content of the MSW in the typical African city may exceed 70% (wet basis), centralized composting, anaerobic digestion, and gas recovery are not significant components of African SWM practice as for now. However, there are backyard composting efforts in Africa. Some non-government organizations promote the practice in Benin, Cameroon, Egypt, Ghana, Kenya, Nigeria, South Africa, and Zimbabwe but the practice does not have a significant impact on SWM at the city level (Hoornweg *et al*, 1999). This may be an overlooked opportunity when the typical African waste stream is high in organic material with potentially high yields of compost.

Two industrial composting plants operated in Dakar, Senegal and Abidjan, C⊥te d'Ivoire during the 1970s. These were financially unsuccessful, plagued by mechanical problems, and ultimately closed. Urban demand for compost has not been established. Additionally, the technology works better with

a well-segregated MSW stream. Yard waste may provide a suitable candidate for composting. However this is likely to be a labor-intensive venture with unproven commercial viability.

In the suburbs of larger South African cities such as Durban, Johannesburg, and Pretoria, there are community composting centers. Residents drop off their garden waste and it is composted and resold for household-sized gardens. In peri-urban areas throughout Africa, NGOs, community based organizations, and economic interest enterprises also promote composting of MSW. These projects are generally highly labor-intensive with a low capital investment. The compost produced is largely for self consumption or for sale to households or businesses such as hotels in the city. In Brazzaville (Congo) peri-urban farmers practice small-scale composting, applying the compost to their fields. There are operating composting systems in Benin and Cameroon. Centralized large scale composting facilities have been recently commissioned in Cairo and other Egyptian cities.

Anaerobic digestion and the recovery of methane are also promoted by several NGOs such as the Biomass Users Network (BUN) in Zimbabwe. However, these systems primarily target rural, agricultural areas and focus on the use of animal wastes rather than MSW.

Community-based composting project was supervised by Peters (1998) in Nairobi, Kenya, in 1994 and 1995. The project was funded by the Canadian International Development Agency (CIDA). Within several of the city's informal settlements, women's groups have started composting organic wastes as means of improving community environmental conditions and generating income through the sale of the compost. The central purpose of the study was to assess the success of these composting projects in meeting their environmental and community development goals. The participatory research techniques employed in the study revealed that significant environmental improvements have been achieved through composting, including improved health, urban agriculture opportunities, better drainage and access within the communities, and the potential to address rural-urban imbalances in resource flows. The composting projects have been less successful in their goal of generating income.

In terms of appropriate roles for NGOs, CBOs (community-based organizations) and local authorities, the research provided evidence that communities were more than willing to provide for themselves urban service like waste management when local authorities were unable to do so. In providing advice, training, and credit to these organizations, NGOs had an important role to play. The resources of local authorities were best employed in regulating, coordinating and advising CBO and NGO efforts in the provision of urban services like waste management.

Incineration

Incineration and waste-to-energy (WTE) presently do not play significant roles in municipal waste management in Africa. High costs relative to other MWM options, a limited infrastructure of human, mechanical and institutional resources, and high content of inerts in the waste stream suggest that incineration is an inappropriate technology for Africa now and

for the foreseeable future. Incineration in Africa would be infeasible if the waste stream is indeed 70% (wet basis) putrescible organic content. Under these conditions, incineration is likely to be an energy-consuming rather than energy-producing option. Characterization of the MSW stream would first be necessary to establish the feasibility of incineration and WTE from MSW in Africa. To date, such city-specific information is largely unavailable for African cities.

One energy recovery plant was recently constructed in Tanzania with foreign assistance. If successful in the long run, this experience would show how safe operations at such a facility can be sustained with local resources. Local capacity to sustain safe and efficient operations at such facilities is a key consideration in weighing the appropriateness of this technology for African cities. These considerations include local technical capacity to maintain and service the facility, the availability of basic spare parts, the scheduled replacement of pollution control equipment, and the effective implementation of a monitoring program to protect public health from plant emissions. The Senegalese have conducted research into refuse-derived fuel (RDF). However, implementation of this system faces the same considerations listed above for incinerator technology in general. The high cost of pre-processing RDF poses an additional obstacle to its safe and cost-effective implementation in Africa. In late 1970s an Italian firm constructed an incineration plant in Lagos, Nigeria. After lengthy commissioning process the plant operated for a short time and was closed due to operation difficulties and lack of spare parts.

There are medical waste incinerators in most African countries. However, many such facilities have no environmental controls and often comprise nothing more than combustion of medical and chemical wastes in an oven or open pit. However, all the major hospitals in South Africa are equipped in incineration units. Johannesburg has five high-tech commercial incineration facilities; one owned by the metropolitan council and four by private waste company Enviroserv. As many hospitals have to deal with HIV/AIDS epidemic there is an urgent need to install medical waste incinerators at all major hospitals in Africa to prevent the spread of AIDS through contaminated medical waste.

LANDFILLS

Worldwide, modern landfills that are properly designed and operated are the most cost-effective and environmentally acceptable means of waste disposal when population density and land availability are not at issue. Because of this, the use of landfills as the primary means of waste disposal is a preferred waste disposal option for Africa.

Landfills are generally sited based on considerations of access to collection vehicles rather than hydrological or public health considerations. This practice ranges from cities in the more arid regions of the North Africa such as Algeria, Libya, and Sudan to those in higher rainfall central countries such as Cameroon and Zaire. The environmental and health consequences for water sources at risk are more significant for the latter cities than the former.

Of all the regions of the world, Africa has the lowest level of investment of World Bank funds in the solid waste sector. Despite a stand-alone solid waste and drainage project in Nigeria in the pre-1988 period, repeating such large investments in the solid waste sector has been contemplated only recently.

The level of investment in the solid waste sector as a fraction of total project costs is also low when compared with other regions. The average investment in the solid waste sub-components in 15 projects in the Africa region is 6.8%, with a high of 27.6% and a low of less than 1%. Nevertheless, some countries in Africa are taking important steps to improve waste disposal practices. Under a World Bank-financed project, Kampala City, Uganda, has constructed a landfill; and under the World Bank's "Urban Environmental Sanitation Project," Ghana has plans to build its first properly sited, designed, and constructed landfills in three of its major cities. Other countries, including Tanzania, Botswana, Namibia, and Rwanda, were selecting sites for new landfills. And, following the specific guidelines and regulations on waste landfills developed in South Africa, Botswana is preparing guidelines and regulations for landfill management.

As a result of the G8 Countries Summit of June 2002 in Kananaskis, Alberta, Canada, new investments in Africa will commence. The G8 leaders met with the Presidents of Algeria, Nigeria, Senegal and South Africa, and the Secretary General of the United Nations, to discuss the challenges faced by Africa and the G8's response to the *New Partnership for Africa's Development* (NEPAD). The Summit adopted *the G8 Africa Action Plan* as a framework for action in support of the NEPAD. It was agreed to each establish enhanced partnerships with African countries whose performance reflects the NEPAD commitments. Although solid waste management has not been specifically singled out, it is expected that because of its direct link with HIV/AIDS control and water supply, municipal waste management will be included in anticipated investments in Africa.

Over the past five years some countries, including Egypt and South Africa, have considered policy changes to promote upgraded landfills for their major cities. These facilities would be classified according to the type of waste they receive, their manner of construction, and their operating procedure. Tunisia has shown leadership in developing a nationwide sanitary landfill program. New guidelines for the construction and operation of landfills were issued in South Africa in 1995. The Environmental Council of Zambia also considers linking improved landfilling to upgraded MSW collection services in its 1995 solid waste plan.

The overwhelming majority of landfills in Africa are open dumps. These facilities are generally located at the perimeter of major urban centers in open lots, wetland areas, or next to surface water sources. Though many municipalities have statutory requirements for the construction and maintenance of landfills these are generally not enforced. In most instances the landfills are owned and operated by the same public

agency that is charged with enforcing the standards. Often a lack of financial and human resources, coupled with absent enabling policies, limit the extent to which landfills can be built, operated, and maintained at minimum standards for sanitary practice.

There is a need for proper administration of operating waste disposal sites. Administration includes site permits and regulatory compliance, worker training and safety, public relations, permitting franchisees, record keeping, accounting, and all other relevant clerical duties. The success of the landfill depends on a strong administration that is committed to adequate financing of the facility, transparency in its operations, and accessibility of information to the public. These factors promote good technical and safety performance of the landfill. Numerous texts provide details on all aspects of landfill operations. Topics range from the selection and use of equipment to the establishment of tipping fees for cost recovery.

Ocean dumping of MSW is banned or restricted by law in most of Africa. This is largely a consequence of restrictions on ocean dumping initially related to hazardous waste under the Lom and Bamako Conventions, as well as the London Dumping Convention of 1972. Even though the practice is largely prohibited across Africa, it still occurs to a significant extent in larger coastal cities. Ocean dumping of sewage sludge beyond the 12-mile limit is still practiced. However, in most of coastal West Africa as well as in South Africa, policy changes are under way to phase out this practice.

The Landfill Gas

In recent years more emphasize has been placed on recuperation of the landfill gas (LFG). Any place where municipal solid waste is dumped or disposed of in large quantities is, in principle, a bioreactor generating leachate and LFG through anaerobic and aerobic decomposition of organic matter. LFG is a powerful greenhouse gas (GHG). When released in an unmanaged fashion, LFG may contribute anywhere from 2 to 4% of total global GHG emissions which are responsible for global warming and ozone depletion.

Uncontrolled landfill gas migration from a site poses a threat not only to the global environment but also to human health and can pollute the local environment. There are two main risks: firstly from explosion or fire caused by build up of landfill methane in buildings near landfill sites, and secondly from asphyxiation, as landfill gas, which is heavier than air, may collect in sewers and manholes. In a well engineered landfill site, gas is not allowed to escape in an uncontrolled manner, it will be contained, collected and preferably treated before being destroyed by flaring or used in an energy recovery project.

If LFG is recovered, it provides a source of energy that can be utilized for several energy producing purposes and thereby generate revenue for the landfill. The theoretical total quantity of LFG generated from 1 ton of biodegradable carbon is 1868 m^3. For commercial recovery of generated LFG, a landfill should receive at least 200 tonnes/day of waste, be designed for a minimum total capacity of 500,000 tonnes, and have a minimum filling height of 10 meters. The waste should not have been deposited for more than 5 -10 years before LFG recovery is attempted.

Though only a few landfills in developing countries currently recover LFG for flaring or energy production, LFG recovery for energy production may have more widespread applications throughout the developing world. The minimum requirements instituted in South Africa offer only limited guidance on landfill gas management. Only two of the landfills in South Africa practiced landfill gas management: the Bisasar Road landfill and the Durban Mobeni landfill. The Bisasar Road landfill had installed an active gas flaring system, which pumped approximately 2,000 m^3 of gas per hour from 24 wells. The gas is flared in a mechanized system. The Durban Mobeni landfill had an active landfill gas management system, comprising 8 wells and a flaring system (Johannessen, 1999).

URBAN CLEANSING

Important components of urban cleansing are street sweeping and waste picking. These are characteristic features of the waste flow related to developing countries not only in Africa but also in Asia and Central/South America.

Street Sweeping

Common waste management practice in main African cities often include street sweeping. It is carried out by a private sector as well as by municipal public works staff. Street sweeping is most often performed manually. In some cities the streets are swept at dawn prior to the opening of the market places and commercial centers and prior to the first pass of the MSW collection service. In other cities sweeping occurs at dusk, with the closing of the market places and commercial centers. The debris is deposited into public waste receptacles along the street and outside the market place. This waste is then removed later for disposal. Collections generally occur at dawn before the commercial centers open and at dusk after these centers have closed for the day. Collections from market places and commercial centers tend to be made in the evening while collections from residential areas and of street sweepings are made at dawn. In the case of markets with stalls assigned to individual vendors, the vendor is generally responsible for sweeping his/her stall and placing the debris at the curb. Municipal street sweepers then clean these common areas and set out the waste for pick up by the collection vehicle.

Waste Picking and Scavenging

Waste picking or scavenging is a process that is well established in developing countries. In fact, scavenging is such a strong part of the waste management system that attempts made to abolish the practice in some cities in Africa have been met with strong resistance. Some scavengers patrol the streets looking for items that can be reused, and are known as "itinerants." Other scavengers conduct their activities at the disposal sites and limit their activities to the collection of one or two materials (e.g., paper, metal objects).

Often scavengers have an agreement with a "middle-man." The middle-man is an individual who:

(1) Has the contacts with the end users.

(2) Can process, prepare, and sell the quantities of materials desired by users.
(3) Provides the scavengers with compensation and, in some cases, a collection vehicle (e.g., a cart or tricycle).

In some locations, the solid waste collection crew conducts its collection activities as well as some scavenging of materials (Diaz, 1999).

In most developing countries, scavenging plays an important role on the economic survival of a number of industries (e.g., steel, pulp and paper). Waste pickers work on dumps and even landfills, while some build squatter colonies on the edges of dumps, sometimes with disastrous consequences.

There is a conflict between the needs of these people and efficient and safe management of a landfill. Experience in developing countries has shown that it is not possible to exclude pickers from landfill sites. Compromises are possible through promoting other options for pickers and buyers. It is preferable that waste picking occur at transfer stations, if in operation, or at the household level. Transfer stations are located closer to the city and are therefore more accessible to pickers. It is also easier to monitor waste picking at transfer stations. In the absence of pickers, landfill operations can proceed without interruption and with a reduced risk of injury to members of the public.

If pickers nevertheless persist at landfills, licensing and cooperation between pickers and municipal staff can help to minimize problems. Allowing pickers access to sanitary facilities, and providing basic health services such as vaccinations for infectious diseases and tetanus, will reduce health problems. This approach has been followed in cities such as Bangkok, Cairo, and Seoul.

WASTE MANAGEMENT AND ENVIRONMENTAL HEALTH

Environmental health refers to those aspects of human health, including quality of life, that are determined by physical, biological, social, and psychosocial factors in the environment. Most causes of disease, injury, and death in developing countries lie outside the purview of the health sector.

The lack of adequate waste collection and disposal systems in developing countries causes public health problems resulting in diseases, which aggravates poverty and leads to negative consequences such as loss of income due to illness, increased spending on health care, and the deprivation of the poor's capability to live in a safer environment (World Bank, 2001).

Africans suffer a higher total burden of disease than their counterparts in other regions, with about 25 percent of the total illnesses attributable to malaria, diarrheal diseases, and respiratory infections (The World Bank Group, Environmental Strategy, Sub-Saharan Africa, www.worldbank.org/ environment). Environment, health, and poverty overlap extensively in Africa because many of the most widespread and debilitating diseases, particularly those that affect the poor disproportionately, stem from environmental conditions or changes.

Solid waste, wastewater and air contaminants from domestic and industrial sources affect hundreds of millions of people in the region, particularly along coastlines, in the largest cities, and in mining areas. While African industries tend to be smaller than in other parts of the world, they are often particularly poorly regulated, and their additive and cumulative impacts can be significant. Waste disposal problems - among them, the lack of suitable disposal facilities for biomedical waste, including disposable syringes and other items used in efforts to stem the HIV/AIDS crisis - are widespread and pose a growing hazard. The loss of medicinal species and indigenous knowledge is of particular significance in Africa because in many countries a large proportion of the population continues to rely on traditional medicine (Lvovsky, 2000).

Disease burden can be expressed in Disability-Adjusted Life Year (DALY), combining the burden due to death and disability in a single index. The use of DALYs as a measure of the burden of disease has provided a consistent basis for systematic comparisons of the cost-effectiveness of alternative interventions designed to improve health. When combined with the results of large-scale epidemiological studies, it enables public-health specialists to identify priorities and focus attention on development programs which have the potential to generate significant improvements in the health status of the poor in the developing world (Murray and Lopez, 1996).

A review of selected studies undertaken by the World Bank to assess the effectiveness of measures outside the health sector in achieving health improvements (preventing the loss of DALYs) estimated that the cost saved per DALY with improved sanitation equals US$120 per DALY (Hughes *et al*, 1999). The World Development Report of 1993 (World Bank, 1993) suggests that interventions yielding a saving of up to US$150 per DALY can be considered cost-effective.

Estimates of the burden of disease caused by inadequate municipal waste management provide an important input to the rational development and evaluation of health and other sector policies which directly manage or influence the determinants of health. Many important environmental health issues fall through the cracks of development agencies because environment and health are both cross-sectoral, and institutions commonly lack clear directives for the multisectoral dimensions of their work. An array of lessons has emerged in the urban sub-sector which point to the value of an integrated approach to environmental health interventions, for example, integrating water supply with municipal waste management, drainage, community education, and hygiene practices (Listorti, 1995).

Uncollected decomposing garbage, which often is responsible for poor drainage, is at the root of the spread of diseases like malaria, tuberculosis, jaundice, enteric diseases and respiratory ailments. In 1994, 62 thousands cases of cholera resulting in over four thousands deaths were reported in Angola, the Democratic Republic of the Congo, Malawi, Mozambique and Tanzania (WHO, 1995). Another 171 thousands cases of dysentery with at least 600 deaths were reported in Malawi, Mozambique and Zimbabwe (Holloway, 1995). Poor drainage in some urban areas contributes to the spread of malaria, which annually kills more that 1.5 million people in Africa (Tavengwa, 1995).

Cases of disease outbreaks due to waste negligence have been observed beyond the African continent. In 1994, pneumonic plague broke out in the city of Surat in the State of Gujarat in India (Ghosh, 2001). The occurrence of the supposedly eradicated disease was attributed to the failure of the Surat Municipal Corporation (SMC) to collect and dispose of the garbage. To control the plague, the SMC launched a short-term action plan, which also included the private sector, comprising collection and disposal of garbage, removal of carcasses, anti-rodent operation and spraying of DDT on pools of stagnant water. Longer-term solutions were implemented in 1995 which involved cleaning up the city on a permanent basis. Later on, the city was divided into 52 sanitary wards, and meticulous ward planning has been completed for garbage collection and disposal. Households and industries were given individual cleanliness instruction, and field employees issued regular instructions and information to householders on how to sort, pack and dispose of garbage. Regular workshops were conducted in the slums of Surat to propagate knowledge on cleanliness and hygiene. At present, garbage is collected on a daily basis and is disposed off in well-maintained landfills with the private contractors handling almost 40% of the garbage. The SMC also strengthened health infrastructures, revived work ethic among health workers and introduced a meticulous disease monitoring system which alerts authorities in the event of a potential epidemic outbreak. Community response has been very positive due to constant interaction with field workers and periodic interaction with senior officials. Regular public meetings are held for health education through poster campaigns, audio and video media.

An important aspect of environmental health is urban air pollution caused by, for example, biomass burning in waste incinerators, the open burning of garbage on the streets and landfill fires, and the re-suspension of particulates due to inadequate road maintenance and lack of street sweeping. The largest component of the costs of air pollution is the result of premature mortality and ill health caused by indoor and outdoor exposure to high levels of pollutants. The projections indicate that about 3.5 million people will die prematurely each year over the next 20 years as a result of indoor and outdoor air pollution. In Sub-Saharan Africa and South Asia (excluding India) most of these deaths will be the result of air pollution (Lvovsky, 2000)

Over the next two decades, the total burden of disease amounts to almost 100 million DALYs per year, equivalent to a loss of slightly more than one year of life over the life span of an average individual. For India and Africa the burden of ill-health caused by air pollution is equivalent to a loss of life of more than 1.5 years (Lvovsky, 2000).

A general guideline on the environmental health is publicized in Health and Environment (April 2000). This guidance should be viewed and eventually adopted as an internal African Bank working document that attempts to synthesize the currently available knowledge and information in the field of healthcare waste management. There is much interest in the health aspect of SWM, but practical information in this rapidly developing field is lacking. WHO and other international and national organizations have released technical guidelines for healthcare facilities and waste management projects, such as Safe Management of Wastes From Health-Care Activities (WHO, 1999). Environmental Health Guidelines for African countries are under development by the Africa Environmental Health team at the World Bank Group.

SOCIO-ECONOMIC, LEGISLATIVE AND INSTITUTIONAL POLICY PRINCIPLES OF WASTE MANAGEMENT

Policy principles are the fundamental premises governments of African countries develop, test and apply in waste management practices. These include decentralization, privatization, decision-making, legislation, regulation and enforcement. Two alternative waste management principles seem to be most appropriate for Africa. They are decentralization and privatization.

Decentralization

Typically, local governments are responsible for the collection and disposal of the wastes generated within their jurisdiction, as well as for the operation and maintenance of their equipment. However, local governments usually lack the authority and resources to provide a satisfactory and economically viable service. Effective and efficient solid waste management depends upon an equitable distribution of responsibilities, authority, and revenue between national government and all local governments. Decentralization is an excellent approach to dealing with solid waste management issues; however, if decentralization is not properly planned and implemented, it will not work and will simply lead to additional bureaucracy.

In West Africa, there is some degree of decentralized waste management. The involvement of micro and small enterprise, youth groups and neighborhood associations in waste collection, freed municipal authorities to grapple with other growing responsibilities of urban management. In Dakar and Bamako about 200 micro and small enterprise groups have been engaged in preliminary collection jobs, and organized themselves into federations to defend their common interest (Obasi, 2000). In Uganda, environmental policymaking remains largely a function of the central government, but implementation of policies and legislation is devolved to the districts. The decentralization process is being supported under the World Bank-financed Environment Management Project, launched in the fiscal year of 1996.

Privatization

Although local or metropolitan governments are typically responsible for local solid waste management, they are not obliged to accomplish the task solely with their own resources. Use of the private sector enhances efficiency and mobilizes private investment but many factors, including cost recovery, efficiency, management, finance, economies of scale, and public accountability, must be analyzed before deciding to do so. The volume also identifies the methods of private sector participation most common to this urban service. The following indicators often assess performance of privatization process:

- The extent of privatization (i.e. government's willingness to exit totally from equity ownership of enterprises);

- Fiscal impacts;
- The efforts made and achievement in broadening ownership;
- The level of foreign direct investment attracted;
- Enterprise post-privatization performance;
- The depth and quality of program design and management;
- Transparency; and
- Government commitment.

Privatization of SWM services is an alternative to the government-managed operation. Considering specifics of African countries it is necessary to address privatization through the involvement of the poor and the most disadvantaged. Compared to developed country models, the African model would require greater involvement of the communities in the process and understanding of the complex interaction between social, economic, legal, technical, and historic factors.

The development of a dynamic small and medium enterprise (SME) sector is an important objective of the Bank as is the development of private financial institutions. In Africa, SMEs account for the majority of private enterprises involving investment of less than US$ 5 million. Considering the importance of this sector in the African economies, the Bank provides assistance to SMEs in the form of direct financial assistance, through lines of credit to financial institutions, and support facilities aimed at providing technical assistance to SMEs. For instance, in Accra the Bank-facilitated regional MELISSA initiative to help create the basis for privatizing the management of solid waste.

Community Participation

Community-based urban waste management involves neighborhood communities, households, community based organizations and small, informal enterprises engaged in collection and disposal, re-use and recycling of waste materials. Women and men, girls and boys are involved in different waste- related activities, partly because of cultural traditions and conventions, partly because of practical interests, such as earning income and maintaining a healthy living environment and partly because of the wish to gain recognition as a worthy community member. Such waste activities range from managing the resources within the household or family to the more formal municipal activities of collection. They include disposal, re-use and recycling; as well comprising community decision making and management and the ways in which individuals, communities and governments arrange and negotiate the diverse interests of the public and private sectors (Scheinberg *et al*, 1999).

Recent research on urban solid waste management in developing countries shows that community participation in waste management yields several benefits, including health and social benefits such as: proper disposal of waste in special bins outside the homes; reduction in the quantity of refuse dumped in rivers, on streets or burned; and reduction of odour generated from uncontrolled dumping of refuse in the neighborhood. Other benefits include empowerment of residents for active participation in municipal affairs, noticeable decline in childhood diseases, increased use of toilets and public lavatories, and a drop in the number of children begging near dumpsites.

The research was based on nine projects established in West Africa and Asia by WASTE, the Netherlands-based Urban Waste Expertise Programme (UWEP), and funded by the Netherlands Directorate for Development Assistance (NEDA) and Ministry of Foreign Affairs. The projects document cases of community and small enterprise participation in the sanitary collection and disposal of urban solid waste, and assist to develop and mobilize local expertise for waste management in developing countries (Obasi, 2000).

Community participation in urban waste disposal means involving key institutional actors in the process, such as micro and small enterprises (MSEs), district committees, non-governmental organizations (NGOs), local authorities and market women associations. Others are traditional rulers, district heads, religious leaders, teachers, politicians and youths.

Community Involvement in the Management of Environmental Pollution (CIMEP) is an innovative approach facilitating community participation and effective governance that focuses on the following:

- How to create trust between government officials and communities;
- How municipalities can provide more efficient services to the underserved neighborhoods of secondary cities;
- Individual and household changes in hygiene behavior;
- How community interventions can be implemented and sustained; and
- How governments can implement decentralization and obtain resources for communities in a transparent manner.

An example of CIMEP is an activity implemented in the Borgou Département in Benin from October 1997 to August 1999 as the Environmental Health Project (EHP) funded by USAID's Bureau for Global Programs (Yacoob *et al,* 1999). Three towns were targeted to achieve the following goals:

- Improve maternal and child health by addressing diarrheal disease risk factors;
- Address diarrheal disease risk factors and related environmental health problems through community-based analysis of the problems and design of solutions;
- Create a relationship of trust, along with improved provision of services, among the national ministries, municipalities, and client communities; and
- Develop a pilot project that would be a model for the region, and share the experience with other countries and donors.

The basic lesson learned from the CIMEP activity was that monitoring and evaluation efforts need to be closely aligned to the level at which the interventions have occurred – either household or communal level. In Benin, the initial direction and baseline survey focused on household indicators and results. However, a decision was reached to focus the microprojects on communal-level improvements before targeting house old behavior change. This decision affected what CIMEP could realistically achieve and what measurable results could be obtained, especially within the two-year time frame and with just one year to implement the microprojects.

Sustainable Waste Management

A multidisciplinary approach is needed to entrench sustainable waste management in developing countries. A sustainable programme is the one that integrates sanitary with social objectives, ensures a profitable project, guarantees reliable service and raises public awareness of its significance. In addition, it must:

- Bring together the private, public and community-based actors and give them well defined responsibilities in the various fields - from preliminary collection to recycling waste;
- Introduce new technologies in order to generate income and jobs; and
- Involve the poorest neighborhoods that are now untouched by urban management and lack basic services.

Grass-roots organizations are increasingly taking on the protection of the environment and health themselves. In Nairobi, Kenya, the 14-year-old African NGOs Environment Network (ANEN) now boasts 430 members from 45 African countries. ANEN works with the United Nations Programme of Action for Africa Recovery and Economic Development and publishes a bimonthly magazine called EcoAfrica.

In addition to a continent-wide organization such as ANEN, specific regions have developed organizations to meet their own environmental needs. For example, the Eastern Africa Environmental Network, also located in Nairobi, is studying toxic waste management, chemical residues in agricultural soils, and population growth.

A non-government professional association in waste management was established in Zambia in May 1995. This is Zambia Waste Management Association (ZWMA). It is a non-governmental organization that aims to promote sound sustainable waste management practices embracing, collection, treatment, handling, storage and disposal of waste materials. ZWMA is sensitizing the stakeholders through workshops and seminars and has held 3 workshops so far focusing on Medical Waste, Hazardous Industrial Waste and Cleaner Production and Waste Minimization. At local level ZWMA is involved in community managed waste management concepts involving local entrepreneurs (waste pickers).

The Role of Women

Recognition of the role women can play in transforming society and building capacity must be recognized in regards to integrated pollution and waste management. An increasing number of women are migrating to urban areas in order to improve their position in the socio-economic system of stratification which limits their ability to participate fully in the rural opportunity system and, to escape traditionally ascribed status, obedience to male relatives, lives of hard physical labour, customary sanctions against unmarried mothers; and to look for husbands because few men remain in rural areas (House-Midamba, 1991). While women lose the security of traditional rural life, they clearly gain a sense of personal freedom, empowerment, and independence from life in the city. Brown (1994) estimates that over half of the population in Nairobi's informal settlements lives in female-headed, single parent households. In terms of employment opportunities, men have more

access to formal sector jobs because they tend to be more highly educated and do not have the child care responsibilities of women. Even in the informal sector, men have more opportunities for the same reasons as above, but they also have better access to credit than women. Women's inability to secure capital and acquire access to credit (because they have been systematically excluded from land ownership which would provide them with collateral) exerts severe and negative repercussions on, for example, Kenyan women's commercial activities.

Usually, women first notice deterioration of environmental conditions, as they are usually associated with responsibility for cleanliness of the home and for the health of the family. They observe a direct impact of the unsanitary conditions such as infectious diseases and childhood diseases, accumulating waste, and lack of sanitation. Since they are responsible for the maintenance of the living space and the health of children, they have a strong sense of civic responsibility and a desire to improve their living conditions and health situation. This is why women seek collective solutions for improving the environment. They are found at the root of many initiatives on health care, waste collection, supply of drinking water, and environmental awareness programs (Bulle, 1999).

The division between the household and community waste stream is defined by the point at which discarded objects pass from the individual property of the household to the community's waste stream. This boundary, also a gender boundary in relation to waste, often defines the limits of women's autonomy and control of waste materials. Urbanization creates systems to manage waste outside of the household, rather than within it, which could involve reusing, burning, burying, composting, feeding to animals, etc. Usually it is the responsibility of women to take the waste to the point at the boundary of the household at which ownership of the waste actually passes from the household to the community or city.

In a number of the African countries underprivileged women are employees of the waste collection services as street sweepers and cart-operators with such physically challenging tasks as handling refuse, covering long distances, and working long hours in addition to the time spent on their domestic tasks. Often they are uneducated individuals facing difficult family circumstances (e.g., divorced mothers with children) so they treat the waste collection employment by a means of surviving and bringing in an income for their family. For example, four women in 10 employed by the municipal waste collection firm "Les Linguères" in Dakar are divorced (Bulle, 1999). They are less hesitant than men when it comes to accepting a job which is underpaid and disrespected by society. As they have little education or are often illiterate, women carry out duties that do nothing to improve their status, such as street sweeping. The women are not involved in decisions about the management of the service they provide because they work long hours and, more importantly, they lack proper training.

In Ouagadougou (Burkina Faso), the community based organization at first only employed men, maintaining that garbage collection was a "typical" man's job. It was only when the high turnover of male collectors began to diminish the effectiveness of the collection service that the organization agreed to employ women. It turned out that women were very reliable employees. These women, from situations of extreme poverty, were bent on doing good work, as they saw this as their only job opportunity, given their lack of employment skills (UWEP, 1998).

An example of community recycling of domestic waste by women comes from the Set-Setal settlement in Dakar, Senegal, which has a population of 45,000 (UN-HABITAT, 2001). Before the initiative involving women began, the municipal services could only collect 35% of the 263 cubic metres of waste produced per day, while 51% of households had no toilet facilities and 76% had no convenient systems to process used waste-water which was consequently poured onto the streets. Unemployment rate for men was 28.6% and 24.1% for women. The settlement had a prevalence of infectious diseases such as typhoid and malaria. This situation was worsen by lack of proponents for urban poverty reduction and absence of skills training for urban women. There were no working relationships between the key partners before the project involving women was initiated. The objectives of the project were to clean up of the urban environment through simple processes ranging from the treatment of waste at home to final elimination or final treatment; generation of income for women through creation of jobs in waste recycling.

The results of their efforts include:

- A regular collection of the waste, and eradication of anarchic dumps thus improving the sanitary and health status of the beneficiaries;
- Generation of income from supplementary activities like waste collection, sale of compost, vegetables and recycled plastic objects;
- Covering the recurrent costs with the financial contribution of the member households. Additional financial sources include a well managed revolving funds scheme, saving banks and credit totally managed by women leading to better co-ordination amongst the different

parties and a greater trust in women from the quarters. The projects translated into municipal savings as the latter did not incur any expenses related to waste management;
- Reinforcement of the managerial capacities and strategic approach of the women through training and exchange visits that allow them to manage the initiative at all levels; and
- Alleviation of the family charges through the employment of jobless youth mostly from female headed households.

The initiative received the Grand Prize Award of the President of the Republic of Senegal. Also, the project was apprised by the Association of Elected Women of Burkina Faso (AFEB). The project has since been replicated in other parts of the country and has been featured as a case study during the USAID International Seminar on the Study of Impact on the Environment.

The situation often looks different when women engaged in the municipal waste collection are organized in community based groups and as a such they demand the right to appropriate training and, in many cases, they put pressure on the waste collection managers to grant them involvement in decision-making process. There is emergence of cooperatives in many instances to help women organize themselves more efficiently.

Women are partners when it comes to awareness raising and motivating others, thanks to their direct knowledge of the environment, the sanitation issues involved and their ability to settle conflicts in the neighbourhood. The term “community” denotes the distinctive space between household and the public sector where waste management is neither the full responsibility of individual households nor of the municipal waste department. Community denotes neighborhood spaces like streets, public areas and locations for waste facilities such as disposal sites/containers. In the community, citizens are responsible for waste management. No one considers it strange or unfair that women do not get paid for this activity, even when these activities extend beyond the home to community cleaning. Men, on the other hand, tend only to handle waste when they are paid for it, or when it is specific to their activities.

Usually there is a need to investigate which materials are considered suitable for women to recover/reuse and which ones are reserved for men's activities. Women tend not to be permitted access to higher-value materials like metals or paper, but to focus on textiles, plastics and the like. In some societies the materials themselves appear to be gendered. For example, metals are reserved for men, while women work on lower-value glass, plastic and textiles. In general, materials relating to vehicles and machinery appear to be more likely to be recovered by men (Scheinberg *et al.* 1999).

In recent years it has been observed increased ownership of certain waste management sectors by women. In East and West Africa, for example, women are engaged in small scale trading of recycled waste and some women are the recognized head of a junk shop business. Trading of certain components of the waste stream in these countries is socially accepted for women (Muller and Scheinberg, 2002).

However, women traders do face obstacles, as an example from Ghana, where women have an age-long tradition of small and large scale trading. In the bottles trade women can be find deal with sales for reuse. However, their incomes aren't big and their expansion of operations is limited by several factors. Lack of financial support, lack of appropriate markets and the women lack the managerial skills due to lack of education. Also, the women have little access to technology because they are limited to only recovering of the material that can still be used or to retail and warehousing (Nibi, 1998). Yet another factor determining business expansion are the attitudes towards risk and security in business. Research has shown that small scale traders, and especially women, place a high value on a secure and stable income (Everts, 1998). They will not put their present business at risk through expansion, but rather prefer to diversify into small scale different activities. This attitude (or business acumen) has saved an MSE providing a waste removal service in Dar es Salaam from collapse, when they lost their municipal cleaning contract. They had already diversified to the collection, cleaning and sale of recyclables.

Public Education and Training

Until the late 1980s, solid waste management policies and programs in most African cities were formulated and implemented by government agencies without significant public participation. Political and social changes across the continent, including the rise of NGOs, have fostered an increased awareness of environmental issues among the public. Urban populations have become more involved in the issues surrounding MSW. Resistance to MSW incinerators in countries like C⊥te d'Ivoire, Senegal, and South Africa reflects an emerging involvement of the public in the debate and policy formation process of SWM.

The key to changing SWM practice at the consumer level is to make the distinction between public awareness and public education. An informed public can do much to improve the effectiveness of municipal waste management programs. Public agencies engage in this education primarily through initiatives based in the departments of health and education. School children are given instruction in sanitation, which includes reference to the safe handling of human and household wastes. Community service organizations, in collaboration with the health department and international health organizations such as the World Health Organization, conduct training seminars on sanitation for women. Included in these seminars are segments on waste handling.

These efforts reach small segments of the urban population. Their impact is too small to produce the widespread change in attitudes needed to increase public participation in SWM. Broad-based education campaigns would require the initiative of the appropriate SWM authorities. They could work with the health, education, media and other related services, as well as with professional organizations, to educate the public about the SWM system, its programs and their role in it.

Such initiatives are only feasible in an enabling institutional setting. This requires the assignment of an appropriate priority to SWM, the presence of an administrative strategy to meet set management goals, and the marshaling of financial and human resources to

implement all phases of the program. As examples, successful public education campaigns of some note have been carried out in Bamako, Cairo, Cotonou, Dakar, and Johannesburg. In Nigeria, a nationwide public education campaign was conducted under the banner of sanitation. Some of these programs began in the mid-1980s and continue in operation to the present time. In most cases they were undertaken by the district governate for the municipal area in collaboration with community service organizations, the health department, the education department, and the media. The results of these programs ranged from drastic reductions in indiscriminate dumping to community-based MSW pre-collection and street cleaning. The Environmental Council of Zambia promotes periodic public information campaigns on the safe handling of MSW. The health department also trains sanitation workers responsible for monitoring sanitary conditions at the landfill. Other health ministries across Africa also provide similar training for municipal health workers on the MSW detail. In addition, the sanitation or public works departments of major municipal governments often provide some period of probationary training for their new workers. This includes MSW collection truck crews as well as manual and supervisory staff at the landfill.

Human resource development generally focuses on the training of process and operations personnel. Installation of new equipment is often tied with training of operators and maintenance personnel. Some academic departments at universities across Africa provide basic training in the engineering principles of SWM. Also, most countries have sufficient resident personnel to develop and manage effective SWM systems that are appropriate for local conditions and resources. These can be enhanced as the pool of human and other resources grows with time. However, the evolution of SWM systems requires an enabling policy and administrative environment to be successful. Thus, in connection with SWM in Africa, training and human resource development are subordinate issues to institutional and organizational change and to appropriate infrastructure development.

SOLID WASTE MANAGEMENT IN CAIRO, EGYPT

With a population of 7 million, solid waste management in Cairo represents a formidable challenge. A new Egyptian Ministry of State for Environmental Affairs was established in the summer of 1997, an indication of the serious interest of the Egyptian government in solving the country's environmental problems. The new Ministry has been actively taking steps to stop the pollution from industrial and governmental sources into the air, water and land. This sets the stage, from a regulatory standpoint, for significant demand for environmental services and equipment.

Egypt's Environmental Law (Law No. 4 of 1994), whose executive implementing regulations were issued in 1995, requires that all companies in Egypt, both in the public and private sectors, must come into compliance with a number of relatively strict environmental standards. There was an initial grace period of three years for existing companies, but that grace period expired in February 1998, without significant results. Establishments, which are not in compliance with the terms of the law, are facing fines, penalties, and the possibility of being shut down. Economic incentives for the Integrated Solid Waste

Management (ISWM) projects are now in place (Law No. 8) offering low- or no-taxes as well as minimal custom duties on imported equipment and supplies.

In recent years a severe air pollution episode over greater Cairo raised the environmental concerns of the public, the media and decision-makers. The episode was perceived as a result of, and mainly attributed to, open burning of accumulated solid waste. Triggered by this problem, the Government of Egypt launched a fast track programme in 1999 to remove the waste accumulations in priority governorates. Out of the 27 governorates, 11 have been designated as priority governorates in which the solid waste mismanagement problem is to be addressed immediately. Those are characterized as being major governorates with comparatively higher levels of income and economic activities and/or are considered as valuable tourist destinations. Integrated Solid Waste Management projects tender documents for those governorates either have been issued or are in the pipeline requiring solid waste operators with international experience.

The remaining governorates, however, are characterized by a level of income and waste composition that would probably not attract international operators. Nevertheless, solid waste mismanagement is still an issue in those governorates, and would require to be addressed in the near future. As such, appropriate, realistic, and cost effective solid waste management systems need to be developed for those governorates.

With a view to a long-term sustainable solution to the solid waste problem, the Government of Egypt decided to privatize the ISWM activities for 11 priority governorates through contracting international private sector operators.

Taking the lead, the Governorate of Alexandria tendered for its Alexandria General Cleanliness Project. More than 30 national and international firms applied for pre-qualifications, of which eight international firms and consortiums were pre-qualified. The cost of proposals preparation ranged between 0.5 and 1.5 million Egyptian pounds (LE), reflecting the seriousness of bidders in offering a well planned service. On September 3rd, 2000, the winning French firm ONYX (Vivendi Environnement) signed a contract with the Governorate of Alexandria for the general cleanliness and integrated waste management of the City over the next 15 years. The contract, covering the collection and treatment of one million tons per year for a population of 3.5 million inhabitants, comprises:

- Collection of household, commercial, medical and non hazardous industrial waste;
- Cleaning of urban areas and beaches;
- Operation of the 3 existing sorting and composting plants;
- Closure of the 3 existing dumping sites;
- Construction and operation of a new landfill site; and
- Construction and operation of a medical waste incinerator.

The contract, for a total amount of 500 million Euro, started the operational activities after a preparation period of 6 months.

Following the lead of Alexandria, in June 2002 the Governorate of Cairo awarded two major contracts for waste management to two Spanish firms FCC and URBASER. The contracts value is LE115 million annually for a period of 15 years concerning the Eastern and Western zones of Cairo. The contracts comprise collection of wastes from hospitals, houses and streets, waste treatment and disposal at engineered landfills. These contracts will open new business opportunities in waste management, since these companies will have to purchase trucks, collecting garbage vehicles and equipment. Dr. Mamdouh Riad, Egyptian Minister of State for Environmental Affairs and Dr. Abdel Rehim Shehata, Governor of Cairo, declared that in the very near future new contracts will be signed concerning Southern and Northern zones of Cairo (WASTE, 2002).

Municipal solid waste generation in Egypt is estimated at approximately 12.8 million tons per year. The volume of waste generated is expected to increase by 5% per year for the next ten years. MSW in Egypt is characterized by its high organic content: 60% of it is food waste; 17% is inorganic material; 13% is paper; and the rest is metal, cloth, glass, and plastic. Two-thirds of MSW is generated in urban areas.
In addition to municipal refuse, about 1 million tons of industrial non-hazardous solid waste are generated annually, including construction and mining waste. Some sources quote a significantly higher number of 5 million tons per year. Industrial solid waste has a considerable negative aesthetic impact, because it is often dumped along roads and in open desert areas. However, it does not constitute a major threat to public health or the environment if it is not mixed with industrial hazardous waste. Therefore, industrial solid waste is not a high environmental policy priority.

The Government of Egypt (GOE) is undertaking a five-year plan (1997–2002) to raise municipal solid waste collection efficiency in the country with the following targets for collection rates:

- Large cities - 90%
- Governorate capitals - 80%
- Small provincial towns - 70%
- Large villages - 60%

The revenue necessary to implement this plan has been secured from the central government and outside sources. The World Bank has provided Egypt with $40 million for the environmental pollution abatement project; USAID is providing $56 million for the Cairo Improvement Projects, and the U.K. allocated $11 million for supporting the Environmental Assessment and Management Programs.

Waste Generation

The accumulation of waste in Cairo and other Egyptian cities is to a great extent the result of shortages in the equipment and resources available to the authorities. For urban and country dwellers alike, the waste they generate is not only an eyesore but also a serious health hazard. Festering garbage heaps on street corners or on the banks of a canal are common sights, as are the insects and rodents that such refuse breeds.

Studies indicate that the amount of municipal solid waste generated in urban areas of Egypt is in the order of 24,000 tons per day, and in rural areas about 11,000 tons per day (adding up to 35,000 tons nationwide). In general, about half or more of the waste consists of organic materials. Greater Cairo generates thousands of tons of solid waste per day. Estimated average composition of municipal waste in Cairo is shown in Table 9.1 (RCG/Hagler, 1992).

Table 9.1 Composition of Solid Waste in Cairo

Component	Content (% by volume)
General Garbage / Grass	51
Paper	21
Textiles	6
Plastic	9
Metals	6
Glass	6
Other	1

Solid waste is generated by six different sectors, with households generating more than half of total waste. Table 9.2 shows amount of total waste generated by each sector (PDE, 1994).

Table 9.2 Distribution of Municipal Solid Waste in Cairo by Source

Source	Percent of Total Waste
Households	64.3
Street Sweeping / Green Waste	12.3
Commercial	14.9
Industrial	2.3
Educational Institutions	0.9
Hotels	0.7
Hospitals	0.1
Other	4.5

Waste generated by hospitals in Cairo amounts to about 209 tons per day, 20% of which is considered hazardous. Estimates for annual industrial solid waste generation nationwide ranges from 200,000 to one million tons per day, not including non-hazardous wastes from cement, steel and mining. Hazardous wastes generated by Egyptian industries is estimated to be at least 50,000 tons annually.

Construction and demolition waste accumulation in the country vary from one governorate to the other. On average, construction waste accounts for 20% of waste generated in Egypt, by-products from canal and sewage dredging 10%, industrial waste 5%, and miscellaneous waste another five percent. A common sight in downtown Cairo is the dumping of construction and other waste directly on the site of the street, which is then left for a long time as shown in the picture (Figure 9.1) taken at the center of the City.

Figure 9.1 Garbage disposed on the street at downtown Cairo.

Waste Collection and Transfer

Waste collection and transfer for processing and ultimate disposal is perhaps the weakest component of waste management in Egypt, including Cairo. Because of the problem's magnitude, the technical committee of the Ministerial Commission on Solid Waste Management called in 1998 for the adoption of a comprehensive plan for developing a more effective, economically and environmentally sound system for refuse collection and treatment. Nine governorates were initially targeted for major refuse removal programmes: Cairo, Giza, Qalyubiya, Alexandria, Luxor, Aswan, the Red Sea, South Sinai and Gharbiya. The ministerial committee chaired by Minister of State for Environmental Affairs Nadia Makram Ebeid, in coordination with the relevant governors, has conducted a study of the quantities of refuse generated every day in these governorates, the deficit in waste removal capacities and resources, and the quantities of refuse expected to be generated by December 2000. Based on the study, the committee said the waste removal project would cost an estimated Egyptian Pound (LE) 80 million. The project involves two phases. The first, lasting seven months from December 1999 to June 2000, was aimed at eliminating existing tips and assorted debris from the nine governorates. Because it is anticipated that there will be continued shortages in manpower, equipment and resources, the second phase, lasting from July to December 2000, was a transitional period paving the way to the full implementation of the integrated solid waste management project which commenced by the beginning of 2001.

The project provides technical and administrative support to local refuse disposal agencies, seek various channels to help defray costs, promote the establishment of recycling and organic fertilizer projects and furnish dumping sites that meet sanitary and environmental legal provisions. The Social Development Fund allocated LE28 million to the project, while the Ministry of Finance approved an immediate allocation of LE5 million. The committee has also appealed to the Ministry of Planning for an additional LE40 million from its new budget.

Currently, street sweeping in Cairo is done manually. Each sweeper is assigned to a certain area where litter and dust are swept and collected in a cart and then dumped into a street container. In principle, a street sweeper should work eight hours a day, from 6 a.m. to 2 p.m., but in reality a period of five actual working hours is regarded as appropriate, because there are many workers, including women, who do not have sufficient physical strength. The workload differs considerably according to the street condition. Each district is divided into sections that are assigned to a group of sweepers supervised by a section inspector.

Street containers are empted into regular trucks or collected by roll-offs or compactors. There is a problem with timely repair of broken vehicles as spare parts are usually not readily available and often have to be imported. The system is slow and always causes delays in repairs. The funds allocated by the Governorate of Cairo for spare parts and maintenance is beyond what they should be and it is clear that the collection fleet, machinery and equipment are under serviced.

Waste Recovery and Recycling

Egyptians demonstrate behavior patterns that reflect common principles of waste handling. Overall waste recycling in Governorate of Cairo is approximately 70% (Hasez, 2000). Waste recycling in Egypt is currently carried out through the following methods:

At-Source Separation of Organics from Non-Organics At-source separation increases the value of the waste and makes it a more lucrative commodity. The operation is conducted both by households (of a certain income level), commercial enterprises and institutions. The efficient operation of the solid waste system necessitates that it is not left, at any point, in the public domain. Efforts must be made to ensure that it is handled from the source to the next step up through a tightly closed system. Systems which are based on residents bringing their household waste to containers on the street result in unsanitary situations due to people's negative behavior in the public domain such as leaving garbage next to containers instead of inside them, etc.

At-Source Recovery of Non-Organics Egyptians have been recovering non-organics from waste since these items first appeared in solid waste. In fact, they have never considered metals of any kind as waste. Iron and steel have long-established trading centers and routes, as do plastics. Paper, cardboard and animal bones trace their networks to the late forties. Whole towns (Miit Ghamr) and communities (Mokattam/Zabbaleen) have established their economic survival and activities around the recovery and recycling of non-organic waste.

Re-use and Recycling of 80% of Man-made Waste Studies, research and observation demonstrate the practice of re-use and recycling by Egyptians all over

the country and in dealing with all manner of primary elements. Mud is used for bricks, animal troughs, and construction needs (ovens, silos, etc.). Cow dung and organic animal waste is used for fuel in traditional mud ovens. Post-harvest debris is used for roofing, fuel, and bricks.

Trade and Transport of Recovered Non-organics Field observation and research confirm the national aspect of trade in man-made solid waste in Egypt. No longer is it restricted to Cairo, Alexandria and their environs. Trading and manufacturing networks have grown to cover the whole country from Alexandria to Aswan. The industry has spawned its own dealers, its own centers of production and recycling, and its own business culture of credit, trade and finance.

The garbage generation rate in Cairo is 9,000 tonnes per day. About 1/3 of waste is collected and processed by the municipality and formal sector, 1/3 by street collectors and 1/3 by the Zabbaleen. The latter are the most inventive and efficient operators in Cairo. A marginalized group of Coptic Christians in the predominantly Islamic society of Cairo, the Zabbaleen survive through the resource recovery of various waste fractions. They earn their daily income by collecting relatively high-value waste from middle- and high-income areas of the City. Valuable materials, such as plastic and paper are sorted and reprocessed in a large number of micro-enterprises. Since 1980, a business model has been progressively introduced to the traditionally family-based waste management enterprises. The City has been divided into small Zabbaleen franchises, allowing a gradual transformation from informally to formally regulated service delivery. Promotion of recycling and waste related enterprises has led to the creation of over 200 waste related micro-enterprises. Figure 9.2 shows already collected waste in the backyard of the Zabbaleen's suburb of Cairo (Mokattam Garbage Village) where 50,000 people live and process waste in often unsanitary and hazardous conditions.

Figure 9.2 Collected waste at the Zabbaleen's suburb of Cairo.

Following is a brief description of recovery/recycling operations by material operated by the Zabbaleen (Kamel, 1994).

Plastic

Plastic is the most commonly recycled item in garbage. Turns up as food containers, mineral water bottles, black garbage bags, medicine bottles, etc., each is sorted by type like density, colour, etc. Various groups of households specialize in handling the different kinds of plastic. It is sorted by color, washed, cut and crushed. After packing in sacks it is sold to merchants who act as middle-men between the plastic crushers and the manufacturers. Some manufacturing of plastic items takes place in the garbage neighborhood. Example is manufacturing of clothes hangers illustrated in the picture.

Cloth

The microenterprise introduced cloth grinding machines in 1986 which consist of two cogs moving anticlockwise and crushing the cloth into cotton stuffing for mattresses and pillows and the like (see picture). These machines are powered by electric power which is becoming more and more costly every year, especially in view of structural adjustment programs. The crushed cloth makes its way to low income, informal markets and does not conform to high quality control or hygiene standards.

Paper

Although paper was not recycled, it used to be a tedious task to store it in anticipation of the paper merchant's arrival for a sizeable sale. With the expansion of paper compactors, and as a component of the microenterprise scheme, assembling little bits of paper and packing them into large, square bales of paper became a new area of paper recycling which now is one of the main recycled commodity.

Aluminum

A couple of years into the recycling experience, locally designed aluminum smelters began operating in the Zabbaleen neighborhood. The smelters were designed, manufactured and installed manually by the Zabbaleen entrepreneur and required

negligible start-up capital. Negative side effects accompanying the new, unregulated industry and changing recycling practices forced the smelters to stop operation. Currently, collected waste aluminum is compacted in hydraulic presses designed and built by the Zabbaleen and sold on domestic and international markets.

Tin Tin is recovered from aerosol cans after separating the tops. The can part is flattened and tied up in bunches of fifties and hundreds and sold to tin middlemen. Another method involves cleaning of aerosol cans. The end product – clean round, oval, square, rectangular pieces of tin – is sold to manufacturers who used it to make paint cans and a number of other items.

Animal Bones Animal bones are collected, grounded, packed and sold to middlemen who resell them for fertilizer.

Glass This component continued to be sold to manufacturers outside of the community. A glass middleman buys sorted glass from garbage collectors and when the quantity was economically attractive to glass manufacturers it is sold on the international market.

The Zabbaleen collect approximately 1/3 of the total waste in Governorate of Cairo. Other private firms and the municipality of Cairo collect the remaining waste. Of the total waste, 35% is left uncollected.

Composting and Pig Raising

The Zabbaleen additionally raise pigs on the organic material they find in the refuse in so-called *zeribas*, or enclosed courtyards (Figure 9.3).

Figure 9.3 A pig farm at the waste disposal site.

Once or twice a year the *zeribas* are cleaned and the mixture of leftovers and pig manure is carried on donkey carts to the composting plant. Normally, the plant processes 30 tonnes of compost per shift per day. During the season when land is prepared for cultivation (November to February) output is doubled by working two shifts per day. The compost is sold mostly to farmers within a radius of 100/150 km around Cairo, who also cover the transport costs. The operating costs and also part of some welfare projects are paid for from the sale of the compost. Composting facility operated by the Zabbaleen is shown in Figure 9.4.

Figure 9.4 Composting facility operated by the Zabbaleens outside Cairo.

However, not all organic waste reprocessing activities are cost-effective. One of the bottlenecks in organic waste processing is the marketing of end products, among others the marketing of compost. High transportation costs limit the use of compost to the surrounding areas of the City. Urban agriculture could be an option for the application of large amounts of organic waste. Links could be sought with the many urban women who grow and market vegetables. Urban 'greening', that is, supplying green areas (e.g. parks) for the improvement of living conditions, also offers possibilities for the application of compost. So far, these issues have not yet received the attention they deserve and their potential is hardly utilized, due in part to the negative image of urban waste.

There is a conflict between the financial constraints and the ecological advantages of resource recovery of organic waste material. Large-scale composting activities, also in industrialized countries, have shown that environmental benefits are more realistic targets than economic feasibility. The question is whether compost production and organic waste recovery in general should be seen as a way to secure profits or rather as a contribution to social and ecological improvements. Organic waste recovery reduces the overall volume of solid waste that needs to be disposed of in sanitary landfills, thus reducing transportation and disposal costs.

In addition to plants operated by the Zabbaleen, the Cairo municipality recently commissioned a number of composting plants designed and constructed by the former

military factory #999. These plants with capacity of 160 to 1000 tons of waste per day have been rented out to the private sector. Facility operation involves waste receiving, manual segregation of paper, plastics, glass, inorganic components and nonferrous metals. Ferric metals are separated by an electromagnet. Organic material is converted to fertilizer, which is packed and sold to the Egyptian farmers. Approximately 100 tonnes of compost is produced from 320 tonnes of garbage per day.

The following series of photographs shows various stages of operation at the composting plant operated by a private contractor. The plant is on a long-term lease from the Cairo municipality.

Figure 9.5 Delivery of solid waste to the composting plant by rented truck.

Figure 9.6 Waste loading on the conveyer feeding the waste segregation line.

Figure 9.7 The compost turner in action.

Figure 9.8 Compost from waste ready for shipment.

Waste Disposal

Sanitary landfills provide for the environmentally sound disposal of waste which cannot be reduced, recycled, composted, incinerated, or processed in some other manner. A properly designed landfill includes provisions for collecting landfill gas and for its potential use as an energy source. Innovative planning may also facilitate productive use of the landfill property after the landfill is closed.

Egypt currently lacks properly planned, implemented, and operated sanitary landfills. Technical guidelines and alternative specifications and designs must be developed and presented to some of the governorates directing the future sitting, establishment, and operation of sanitary landfills in addition to remediation and closure of existing dumpsites.

At present, no engineered landfills have been in operation in Cairo. Municipal waste is disposed at two main dumpsites in Katamya I and Katamya II, approximately 20 km out of

the City. These sites are supervised by the municipality. There are numerous informal waste stations across the City. Recently tendered projects for four districts of Cairo include engineered landfills as components of integrated solid waste management.

Privatization and Community Participation

In Cairo, a partnership formed by local, national, and international actors has successfully transformed a community through the Zabbaleen Environment and Development Program. Since the program began in 1981, quality of life has improved in a formerly neglected community; thousands of jobs have been created as an improved municipal waste collection and recycling system have been implemented. At the intersection of poverty and the environment, the Zabbaleen Environment and Development program fashioned productive solutions. An example, shown in the enclosed figures, is production of paper and rugs from waste paper and clothing.

Figure 9.9 Manufacturing of recycled paper by members of the Zabbaleen community.

Figure 9.10 Rugs made of recovered fabric produced by the Zabbaleens.

The municipal sanitation force shares management of the waste with a traditional, private-sector collection system run by two historically poor, marginalized social groups, the Wahis and the Zabbaleen. With more than a century in Cairo's garbage trade, the Wahis control the collection routes and contracts with homeowners. The Zabbaleen pick up waste and transport it to their settlement on the City's fringe, where it is sorted and recycled, or used for animal fodder.

A community with little or no organization or power, the Zabbaleen enjoyed few basic services when the program began almost 20 years ago, and suffered from environmental devastation, little economic opportunity, lack of education, and a host of other problems endemic to urban slums. The Zabbaleen Environment and Development Program (ZEDP) has made significant improvement in this community with the backing and investment of partners including the Moqattam Garbage Collectors' Association, known as the Gameya, and numerous governmental and non-governmental organizations. The Zabbaleen design and manufacture various types of equipment for processing of waste plastic. Figure 9.11 shows a machine under construction for manufacturing foil from waste plastic.

The ZEDP had two primary objectives: to improve the living conditions and build the capacity of the Zabbaleen; and to create a more efficient solid waste management system for Cairo. Today, the most visible transformation is the community's physical appearance, resulting from substantial government improvements in community infrastructure. New infrastructure, clean-up projects and the organization of a composting plant are all ZEDP projects which have helped to improve the overall cleanliness of the settlement. In turn, public health has improved, with infant and child mortality decreasing from 240 per thousand in 1979 to 117 per thousand in 1991 (Kamel, 1994).

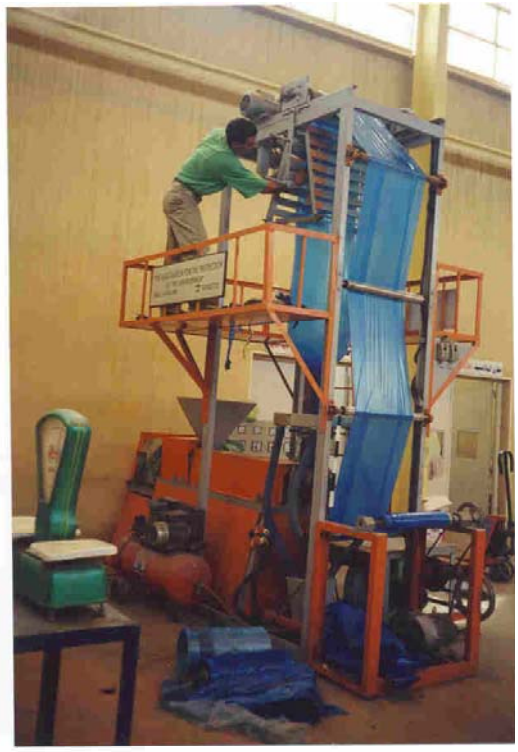


Figure 9.11 Plastic foil manufacturing machine designed and built by the Zabbaleens.

Health and environmental benefits initiated in the ZEDP have had wider effects in greater Cairo. The Route Extension Project, funded by the NGO, Oxfam, brought 8,000 more homes into the Zabbaleen collection system, helping to create a much cleaner City overall. Recycling programs born of the ZEDP have significantly reduced the environmental burden of waste disposal. The ZEDP composting plant mentioned above now produces fertilizer that is free of chemicals and harmful contaminants.

The economic benefits are also numerous. Household income has increased twenty fold over the past ten years. Recycling activities and projects have created a diversified urban economy and additional income. Women and children have been relieved of the long and arduous process of sorting, and are free to engage in various other income-generating, educational and recreational activities.

Nuweiba Waste Management Pilot Program

The solid waste management program being implemented in Nuweiba, is intended as a pilot project for the whole of Sinai, is also modeled on an earlier, successful scheme in Moqattam, a suburb of Cairo. Nuweiba was selected for the pilot project

because there was already a strong NGO, namely Ghamrawy's Hemaya. From the local point of view, Nuweiba's solid waste problem is intolerable and has to be solved. Ghamrawy had originally intended to set up a primarily environmental organization, but he was forced to broaden Hemaya's mandate after developers set up their own environmental NGO to circumvent his interference with their plans. Ghamrawy has become a defender of social development.

The government's Social Fund for Development provided money for the first year of the project. It has a good chance of success because the project has such government support as the Ministry of the Environment, the Governor of Sinai, and local municipalities.

Environmentalists hope that the Nuweiba project will eventually expand to become a nationwide program. Several sites around the country have already been earmarked for similar arrangements. Solutions through solid waste management constitute a first step towards addressing environmental degradation in the region, which will lead to sustainable tourism development if properly implemented.

The aim of the project is to design and implement an effective and sustainable solid waste management system in South Sinai that would address garbage separation, collection, transport, disposal, recovery, recycling and sanitary treatment. Also, to engage the stakeholders in a partnership that would bring the people, the municipalities, the investors, the private sector, NGO's and the Egyptian Environmental Affairs Agency (EEAA) together to create a financially viable enterprise and a clean environment in the Sinai. Based on the Mokattam garbage village experience, Hilton Hotels in Sharm El Sheikh, Nuweiba, Taba and Hurghada have launched and maintain their on-site garbage at-source separation project.

Figure 9.12 Waste sorting line at the Nuweiba project place.

The Nuweiba project has operated a transfer station since November 1998. It is built on land rented from the municipality of Nuweiba to Hemaya. The local NGO is operating the station. Exclusively non-organic waste arrives at the station and is loaded on a central conveyor belt where workers sort it to its different components: paper, cardboard, plastic, glass, and metals (Figure 9.12). Each material is then channeled to its specific processing room. Certain types of plastic are granulated; and paper, cardboard and metals get compacted, each in a separate machine. The processed/separated product is stored for sale to recycling industries in the Greater Cairo area through the Mokattam recyclers.

During peak tourist seasons, Nuweiba generates around eight tons of garbage per day. The Hemaya NGO managed to sign garbage collection contracts with close to thirty hotels and cafeterias in Nuweiba. The project employs ten workers for collection and transfer station operation. In addition, the project rents trucks owned by Bedouin drivers to help out in the collection. The station currently generates sufficient average monthly revenues to support its operation. As more users recognize the importance of the service and sign up by paying fees, the station will generate income which will be directed toward beautifying the town of Nuweiba, and expanding the required workforce in order to provide better service.

SOLID WASTE MANAGEMENT IN NAIROBI, KENYA

Nairobi, the capital City of Kenya, is situated at an elevation of about 1,660 m in the highlands of the southern part of the country. The City is Kenya's principal economic, administrative, and cultural center and is one of the largest and fastest growing cities in Africa with a population over 2.2 million. Manufacturing includes processed food, textiles, clothing, building materials, and communications and transportation equipment. The City also has a large tourist industry. The population ratio of high, middle and low income (including surrounding area) is 23.3%, 26.7% and 50.0%, respectively (NCC, 1992*)*. The number of shops except restaurants is 39,900 and that of restaurants, 5,600 (NCC, 1993). The number of markets is 34. The total length of roads to be swept is around 1,430 km.

The provision of basic urban services has not kept pace with the rapid growth of the City. The vast majority of the urban poor do not have access to such services, which are inadequate and not properly maintained. Whereas the urban population has doubled in size during the past decade, infrastructural development has proceeded far more slowly. The result has been an ever-widening gap between the need for and the supply of essential services. Revenue is collected primarily from property taxes (80%), and also from fees (4%), rents (15%), and other sources, but is not adequate to finance urban services (MI, 1993).

Urban sprawl is associated with a rapidly deteriorating quality of life, with particularly adverse impacts on the urban poor who have the poorest access to the

existing facilities. Most affected are housing, water supply, municipal waste, sewerage, and transport. Access to infrastructure has been dependent on income levels rather than population density, with higher standards of provision in high-income areas than in high-density, low-income areas.

Nairobi developed a reputation for a good standard of living and, therefore, attracted migrants from around the nation. An acute housing shortage developed. Homeless people resorted to squatting on unoccupied land or renting land from private owners and building houses. Tiny shacks proliferated on empty land throughout the City. Over time, the use of permanent building materials and the development of rooms for rent became widespread. These housing areas are characterized by: overcrowding and high densities; small one- and two-room dwelling units; poor sanitation and lack of other communal facilities; lack of adequate support infrastructure; buildings in poor structural condition and constructed of temporary and semi-permanent materials; and a high degree of tenure insecurity. In Nairobi, the main zones of poor housing are in the Dagoretti, Langata (Kibera), Kasarani, and Makadara divisions. Informal settlements occupy is 6% of the residential area but accommodate approximately 55% of the City's population, adding up to 750,000 people (as of 1994). The households in these informal areas have poor access to communal and infrastructure services such as water, sanitation, and solid waste disposal, and are thus exposed to ill-health and disease. Frequent demolitions of temporary dwellings destroy the lives and housing of Nairobi's poor. The shelter problem is intensified by the exorbitantly high rents for single rooms.

Streets covered with garbage, often with smoldering fire, can be commonly seen especially in the poor neighborhoods as illustrated in Figure 10.1.

Figure 10.1 Typical view of a site street in downtown Nairobi.

Nairobi has experienced the negative effects of industrialization and overpopulation on its environment. It has become increasingly necessary to find efficient waste

management systems to deal with the increase in garbage generated proportionally with the increase in the City population.

Waste Generation

The most recent survey of waste generation and composition in Nairobi was conducted in 1997 by a local consultant under the supervision of the Japan International Cooperation Agency (JICA, 1998). The survey was conducted in a residential area, residential/commercial mixed area, markets and roads. The residential area was further subdivided into high-, middle- and low-income areas. The waste generation rate per capita in residential area is shown in Table 10.1.

Table 10.1 Waste Generation of Each Generation Source in Nairobi

Income Class	Unit	Value (kg/day)
Mixed (restaurant)	shop	6.79
Mixed (others)	shop	1.39
High income	household	3.84
Middle income	household	3.34
Low income	household	2.72
Surrounding area	household	3.07
Markets	market	2,425
Roads	1 km	48.3

The results of waste generation surveys are summarized as follows:

- In mixed areas, waste generation of restaurants is 6.79 kg/day and this value is more than 4 times as that of others.

- In residential areas, the generation rate of high, middle, low and the surrounding area is 0.654, 0.595, 0.565 and 0.537 kg/capita/day, respectively, and this value is in proportion to the level of income.

- The waste generation of markets and roads is about 2,400 kg/market/day and 50 kg/km/day, respectively.

The total waste amount generated in Nairobi City at present is estimated at 1,530 t/day and is shown in Table 10.2.

Table 10.2 Total Amount of Waste Generation in Nairobi

Description	Weight per Unit (kg)			Total Number			Total Weight (t)			
	Person	Shops	/ km	Population	Shops	Length	House	Shops	Road	Total
Mixed (res)		6.79			5,600			38		38
Mixed (others)		1.39			39,900			56		56
High income	0.654			511,000			334			334
Middle income	0.595			585,000			348			348
Low income*	0.551			1,095,000			603			603
Markets		2,425			34			82		82
Roads			48.3			1,430				69
Total				2,191,000			1,285	176	69	1,530

* Low income includes surrounding areas

The Apparent Specific Gravity (ASG) of solid waste is an important tool required to assess the total mass and volume of waste generated in Nairobi. The value of ASG is between 0.23 (roads) to 0.38 (markets) with the average value of 0.28.

The quantity of waste generation by component (weight and percentage) is shown in Table 10.3.

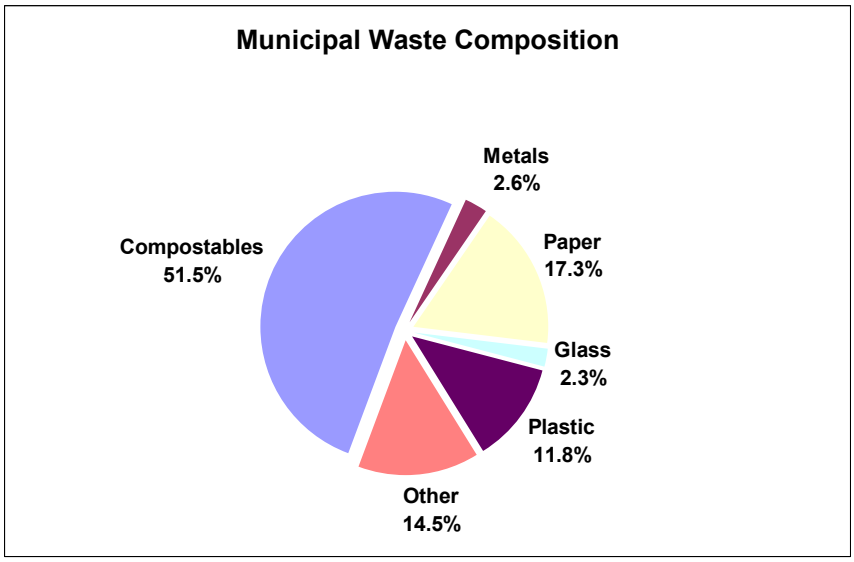
Table 10.3 Weight and Percentage of Total Waste in Niarobi

Constituent		Total (t/day)	Percentage (%)
Food Waste		734	51.5
Paper	Recyclable	206	14.5
	Others	41	2.8
	Subtotal	247	17.3
Textile		38	2.7
Plastic	Container	67	4.7
	Others	102	7.1
	Subtotal	169	11.8
Grass/Wood		96	6.7
Leather		13	0.9
Rubber		21	1.5
Combustibles Sub-Total		***1,317***	***92.4***
Glass	Container	21	1.5
	Others	11	0.8
	Subtotal	32	2.3
Metal	Container	25	1.7
	Others	13	0.9
	Subtotal	38	2.6
Any other		38	2.7
Non-combustibles Sub-Total		***109***	***7.6***
Total*		***1,426***	***100.0***

* Total weight of waste is calculated by subtracting self-disposal waste amount from the total waste generation amount, i.e., 1,530 – 104 (self-disposal amount) = 1,426 t/day

When considering waste combustion it is important to know its calorific value. The JICA study showed that the calorific value of the mixed waste is the highest because the rate of paper is the highest and that of compost is extremely low due to decomposition of organic material. The weighted calorific value of total waste generated in Nairobi City is around 1,000 cal/g.

Waste composition (in percent) estimated by Nairobi City Council (NCC), Environment Department, is shown in the following chart (NCC, 2000).



Approximate rate of waste generation in Nairobi is 1,600 tons per day. Households generate 50%, institutes 20%, schools 20%, industries 20% and ports less than 5%. The NNC Solid Waste Management Questionnaire is provided in Appendix 2.

Waste Collection and Transfer

The collection and disposal of solid wastes in Nairobi has become increasingly infrequent. It is estimated that in 1994, 800 to 1,000 tons of refuse were generated per day, out of which fewer than 200 tonnes were collected. Solid waste generation rate given by NCC is 1,580 tons per day (NCC, 2000). Waste collection services are provided only sporadically to low-income areas because of poor accessibility and very high waste generation which cannot be handled with available vehicles and equipment. Other problems encountered by the NCC Environmental Department include inadequate financing, lack of recognition of the importance of satisfactory and effective waste management by the policy makers, and inadequate training of managers. Some private companies now operate disposing about 50 tonnes of municipal waste monthly. Privatizing waste collection has been

considered as a possible remedial measure. As Nairobi grows and the volume of refuse increases, the NCC is planning to promote reclamation, re-use, and recycling of materials as a way of reducing the problems. Such activities would create employment for a section of the population as well as being a source of raw materials.

In the year 2000, waste collected by municipality on a regular basis amounted to 1/3 and periodic collection dealt with 2/3 of waste. Approximately 70% to 80% of solid waste remained uncollected (personal communication: S.W. Opiyo, NCC, Oct. 2, 2000). The municipality operated 15 to 19 waste collection vehicles daily. There was a high vehicle immobility rate, up to 70%, due to shortage of spare parts and insufficient operating budget. The municipal employees carried out manual street sweeping. Mechanical street sweeping was not offered at that time.

A number of private sector firms have been commissioned by the NCC to collect and transfer solid waste within the City of Nairobi. BINS (Nairobi) Services Ltd has been in the garbage collection business since 1989. The company was started by a group of entrepreneurs who recognized that the City Council was no longer in a position to carry out its obligations and decided to fill the gap in the provision of garbage collection and disposal services. In October 2000, BINS had a fleet of 16 trucks ranging from two to eight tons and employed 105 people. BINS offers waste collection and disposal to residential customers, residential blocks / compounds, industrial / commercial and special services such as one time removal of a large volume of garbage. The fees depend on volume, collection frequency, and other factors. For example, amount charged for 10 kg plastic bag is 50 Kenya shillings (Kshs) (personal communication: Peter Shewan, BINS, Oct. 4, 2000).

Another company offering solid waste services is Kenya Refuse Handlers (KRH). The company specializes in:

- Environmental and waste management;
- Provision of sanitary bins; and
- General cleaning in municipalities, schools, hotels, industrial & commercial establishments and homes.

Established in 1987 and registered in 1992, the company invested in professional staff and equipment. KRH carried out major cleaning services for the City of Nairobi from 1997 to 1999. In addition to waste services, the company has been engaged in educating the general public on waste management through awareness campaigns and in encouraging user participation (personal communication: Elizabeth Ongoro, KRH, Nairobi, Oct. 9, 2000). KRH assets includes 10 garbage compactor trucks, four tipper trucks, two “Kuka” trucks, three bean vehicles, 2,200 street orderlies / trolleys, and numerous, different types of refuse containers with different capacities.

Only upper-income residents and businesses are able to afford the monthly garbage collection fee. Neither company ventures into the informal settlements since they are unable to collect fees from residents.

Waste Recovery and Recycling

The NCC has been disposing municipal solid waste at Dandora dumpsite without intermediate treatment. Solid waste recovery and recycling is carried out by many of Nairobi's poor who engage in waste picking as a means of income generation. In 1992, scavengers collected approximately 20 tonnes of the 800 to 1,000 tonnes generated daily in Nairobi (Syagga, 1992). In the year 2000, this figure could be 50% higher considering the increase in population and commercial activity since 1992. Waste pickers jump the garbage trucks before they unload to secure immediate access to fresh garbage, which they sort out while looking for recoverable materials (Figure 10.2).

Figure 10.2 Waste pickers on a truck approaching Dandora dumpsite.

Waste pickers are usually long-term residents of Nairobi. The estimated population of scavengers is around 600, and they operate as an organized group. It is not a job for recent migrants since detailed information as to where to find the garbage is needed and one must have linkages to the market to enable one to sell the recovered material. The most popular items scavenged, in order of preference, include paper, scrap metal, and bottles. Other materials identified included bones and plastics. Scavengers sell daily collections to middlemen who in turn sell them onto industries.

Composting

Organic wastes are not usually scavenged by waste pickers. Some of the larger restaurants and hotels also sell their scraps to farmers to be used as pig feed. Organic wastes are also important to the urban agriculture sector as all sorts of livestock, including goats, chickens and the occasional cow, feed on top of waste heaps.

Urban agriculture exists throughout the City on both private and public land. The growing of crops in urban areas is an important survival strategy for the urban poor (especially for those without rural land holdings) as it reduces the amount of income expended on food. It was estimated that one-third of urban households in Nairobi grew crops (Freeman, 1991). A study on urban agriculture by the Mazingira Institute estimates that three quarters of urban farmers consumed all that they produced. Urban agriculture generates demand for fertilizer produced at the small scale waste composting facilities.

In October 2000, Nairobi municipality did not operated any commercial composting plant. According to NCC officials, there was no demand for compost produced at the plants, which rendered commercial composting unfeasible.

However, several community based organizations (CBOs) and non government organizations (NGOs) in Nairobi's low-income areas were found to be undertaking composting as an income generating and environmental management strategy. One half of the solid waste generated in Nairobi consists of organic matter. For households alone, it is estimated that three-quarters of the waste is organic material. There are composting groups in Nairobi's low-income areas, which are supported by a number of local NGOs. These composting groups were established by the NGOs through existing community-based organizations, usually women's savings or church groups. Three local NGOs (Uvumbuzi Club, Undugu Society of Kenya, and the Foundation for Sustainable Development in Africa) have provided support and training to approximately 12 CBOs doing composting in several of Nairobi's low-income areas.

The Dandora Kuku Women’s Group runs compost-making operations. Their motto is “Jua Kali for Industrialization”. The operation is included in the UNDP program “Partners in Progress”. A wall poster of the group at their Dandora office is shown in Figure 10.3.

Figure 10.3 Wall poster of Dandora Kuku Women Group.

The amount of compost produced is less than 10 tons per year. It is sold to the urban agriculture sector in Nairobi. A photograph of one of the composting sheds is given in Figure 10.4.

Figure 10.4 Household composting facility at Dandora suburb of Nairobi.

The benefits of compost-making are not limited to mitigating the waste problems of urban areas. The interviews with composting group members suggested that composting could have a positive impact on Kenya's rural areas. Evidence from Kenya indicates that urban-learned skills are extremely important to rural development, especially since most urban residents maintain strong links with their rural homes. Many composting group members identified composting skills as valuable to their farming activities "back home." Those with rural farms intended to use the urban-produced compost in rural crop production.

Waste Disposal

Dandora is the only open dumpsite in Nairobi. It is supervised by the NCC which provides heavy equipment, such as compactors and bulldozers, to distribute garbage in a controlled

manner. Approximately 30% of the City garbage, excluding medical waste, is dumped at Dandora. Access roads to the disposal place are in poor condition as shown in Figure 10.5. During rainy season trucks are often unable to clear the road and as a result dump garbage at random locations.

Figure 10.5 Access road to Dandora dumpsite.

The site is 7.5 km to the southeast of the centre of Nairobi. It is filled with approximately 1.3 million m^3 waste at present. Since sufficient funds are unavailable, a proper landfill operation to prevent secondary pollution is yet to be created. The site is open and accessible to people and animals (Figure 10.6).

Figure 10.6 View of Dandora dumpsite.

There is a high risk of contamination, both bacterial and chemical, which may affect the health of scavengers and neighboring residents living in close proximity to the site as documented in Figure 10.7.

Figure 10.7 Proximity of residences at Dandora dumpsite.

Long-term waste management planning by NCC includes the construction of a new, engineered 40 ha landfill at Ruai. The estimated total capital cost is Kshs 1,969 million (US$33 million), with collection and transportation costs will be Kshs 4,282 million (JICA, 1998).

Some stakeholders in the City of Nairobi consider incineration as a feasible solid waste management option. Reecon, Renewable Energy Engineering Contractors, has developed the business plan for a multiphase, integrated approach to wastewater treatment, solid waste collection and incineration. They propose to apply energy recovered from waste incineration for the wastewater purification and recycling. Phase I involves setting up incineration plans at three new transfer stations within Nairobi. After removal of inorganic and compostable components the remaining waste will have the desired calorific value to support self-combustion. The incinerators will be equipped with air pollution control systems such as bag filters, cyclones and scrubbers. The approximate cost of Phase I is Kshs 23 million. Phase II will involve energy recovery and power generation. Wastewater treatment for recycling will be addressed in Phase III of the system. Reecon has developed a pilot scale incinerator which operates in four main stages of incineration such as waste heating, combustion, pirolysis and afterburning. All stages are taking place in one unit. An incinerator prototype and several Reecon employees are shown in Figure 10.8.

Figure 10.8 Prototype of waste incinerator developed by Reecon Contractors.

The company is looking for investment capital in order to test the full scale unit and implement Phase I. NCC is interested in implementing the project.

Waste Stakeholders in Nairobi

Waste management stakeholders include non government organizations, community based organizations, the Nairobi City Council (NCC) and its Environment Department, the Ministry of the Environment and Natural Resources (MENR), the Ministry of Local Government (MOLG) and the private sector.

Community Sector

The community sector needs to be included in waste management efforts as both private and public sector actors are unable to provide waste services to low-income areas of the City. The involvement of the community sector is viewed as an effective way of increasing access of the poor to urban services, including waste management. In Nairobi, organizations in the community sector, such as charitable organizations, ethnic associations, professional "support" NGOs, welfare societies, village committees, self-help groups, and security committees are already providing many of these services:

In Nairobi, many NGOs have a strong presence in the City's informal settlements. They play an important role in providing education, health care, and many other urban services. The strength of the NGOs is their recognition that solutions to urban problems are not isolated, but interconnected. This recognition is reflected in the integrated approach they are taking to environmental management and community development.

The NCC does not have an official policy on community involvement in waste management, but does participate actively in several community clean-up programs. Most publicized are the Mathare Youth Sports Association and the Clean-Up Nairobi Campaign (CUN). The Mathare Youth Sports Association (MYSA) began in 1987 as a small self-help initiative combining community responsibility with sports (football). Community responsibility is promoted through clean-ups carried out once a week in the various villages comprising the Mathare Valley informal settlement in Nairobi. Garbage is collected and removed and drainage ditches are cleared with the aid of the NCC personnel and equipment.

The Clean Up Nairobi Campaign, founded in 1992, was a coalition of Nairobi residents who came together to solve the City's waste problem with a hands-on approach. Activities were planned in coordination with the NCC - much the same as the MYSA activities. The coalition was also looking into promoting waste reduction and composting. However, Clean Up Nairobi has recently collapsed due to management difficulties, including difficulties coordinating with and getting support from the NCC and a lack of ability to devote the time necessary to get the campaign active.

The Nairobi City Council

The Council, headed by a Mayor who is assisted by the Deputy Mayor, is comprised of 73 councilors, 55 of which are popularly elected and 18 of which are nominated by the Minister of Local Government. Each elected councilor represents one of the City’s 55 wards and one of the nominated councilors serves as the Provincial Commissioner of Nairobi. The NCC approves the appointments of the Mayor and the Deputy Mayor.

The Nairobi City Council has the primary duty of care for the provision and regulation of solid waste management (SWM) services to the City of Nairobi. NCC’s major objectives towards solid waste management are to:

- Improve public cleanliness in order to keep public places aesthetically acceptable;
- Improve public health; and
- Protect the environment.

These objectives are achieved by ensuring the proper storage, collection, transportation, safe treatment and disposal of solid waste.

Under the Public Health Act and the Local Government Act and its By-laws, the NCC might appear to have, by implication but not expressly, responsibility for all types of solid waste in Nairobi, i.e., municipal, hospital and industrial waste.

The NCC's main responsibilities towards SWM are to:

- Formulate and implement SWM policies;
- Provide services for the collection, transportation, treatment and disposal of solid waste;
- Regulate and monitor the activities of all generators of solid waste;
- Regulate and monitor private companies engaged in solid waste activities;
- Formulate and enforce laws and regulations relating to SWM; and
- Coordinate with other departments within NCC, donor agencies, NGO's and other government organizations involved in SWM.

The Department of Environment

The NCC delivers SWM services through the Department of Environment (DOE) which is one of its administrative departments. The DOE is solely responsible for the delivery of these services through its Cleansing Section. The DOE also manages Nairobi's City parks through its Parks Section. As a department of NCC, the operations of DOE are regulated by the Local Government Act and its bylaws.

The DOE is divided into the Administration Section and two operational sections, the Cleansing Section and the Parks Section. The Department is headed by the Director of Environment who is assisted by the Deputy Director.

The main responsibilities of the Department towards solid waste management are to:

- Implement NCC's SWM policies formulated by the Council's Environmental Committee;
- Maintain public cleanliness, protect public health and the environment, and keep public places aesthetically acceptable by providing services for the collection, transportation, treatment and disposal of solid waste;
- To regulate and monitor the activities of all generators of solid waste;
- To regulate and monitor private companies engaged in solid waste activities;
- To formulate and enforce laws and regulations relating to SWM; and

- To coordinate with other departments within NCC, donor agencies, NGO's and other government organizations involved in SWM.

Institutional Responsibility for Solid Waste Management (SWM) at the National Level

At the national level the main responsibility for SWM lies with the Ministry of the Environment and Natural Resources (MENR) and the Ministry of Local Government (MOLG). As for Nairobi City, the institutional and organizational arrangements at the national level have become deficient due to the remarkable increase of solid waste, and some important SWM responsibilities at the national level seem to necessitate urgent improvement.
These responsibilities may be summarized as:

- Policy formulation and planning for SWM;
- Preparation of a comprehensive national law on SWM;
- Formulation of national standards or guidelines on SWM, including policies covering private sector involvement;
- Issuance of permits and licenses to solid waste operators, e.g., permit for landfill sites or waste transportation; and
- Monitoring of activities of solid waste generators or operators.

Furthermore, the present coordination and linkages among institutions involved in SWM such as the coordination of policy, planning and legislation through the Inter-ministerial Committee on the Environmental chaired by the National Environmental Secretariat (NES) may have to be augmented.

SOLID WASTE MANAGEMENT IN ACCRA, GHANA

Accra is the capital and the largest City of Ghana, situated on the Gulf of Guinea. The City is an important commercial, manufacturing and communication center. Accra has a population of 1.4 million, which is growing at an estimated rate of four percent, and occupies around two percent of the total land area of Ghana. Accra is the site of an international airport and focus of the country's railroad system, including a link to nearby Tema, which since 1962 has served as the City's deepwater port. Industries include vehicle and appliance assembly, petroleum refinery and other manufacturing facilities. Natural hazards, which Accra faces, include erosion and flooding, while man-made hazards include indiscriminate disposal of all kinds of solid waste, noise pollution and discrepancies in both refuse and human waste management.

Accra is generally unplanned and characterized by overcrowding, substandard housing, and inadequate sanitation as well as other municipal services, especially in

low-income areas. The poor throughout the metropolis tend to be concentrated in core indigenous settlements and in migrant residential areas, which are economically depressed, high-density neighborhoods. Accra has prepared two master plans, one in 1944 and another in 1958. Some of the provisions of the 1958 Master Plan are now being implemented, for example the construction of the main Independence Avenue and the Accra-Tema Motorway Extension.

Critical environment development issues in Accra include:

- Obsolete infrastructure, over-densification and poor housing stock in low-income residential areas;
- Inadequate solid waste management;
- Inadequate sanitation in the high density residential areas plus a general lack of infrastructure and services in the fast-growing urban fringe;
- Decay of the City's Korle Lagoon due to pollution from streams feeding the lagoon;
- Overcrowded and unsanitary markets, truck and bus depots;
- Traffic congestion and vehicular/pedestrian conflicts;
- Land degradation from sand-winning and quarrying;
- Poor drainage contributing to flooding of residential areas; and
- Shoreline erosion.

Solid waste management is an essential factor contributing to the health, productivity and welfare of the people of Ghana. It is identified in Ghana's programme of economic and social development set out in "Vision 2020" as a key element underlying health and human development. The Government's National Environmental Action Plan also places a high priority on environmental sanitation, as well as the establishment and implementation of environmental health standards.

Waste Generation

The estimation of total waste quantities and quantities per capita is required for planning efforts and the estimation of investment needs. According to Accra municipality officials the average waste quantity generated in Accra is 1,500 tons per day (personal communication: Ben Laryea, Waste Management Department, AMA, Accra, Oct. 26, 2000). Approximately 200 tons of organic waste is directed into Accra's composting plant and 300 tons is left uncollected. The remaining 1,000 tons is transferred to the Malami dumpsite.

Accra is divided into five administrative districts. Within these districts the City is arbitrarily divided into three zones populated by high-, medium- and low-income groups. Solid waste composition is strongly correlated to income levels and economic productivity of each group. Table 11.1 shows waste characteristics for low, middle and high income groups. Within the high income class, there is a

greater content of organic components and packaging material such as paper and a lower content of inert or residue. The low income group utilizes solid fuels for cooking, resulting in ash addition to inert / residue waste content.

Table 11.1 Composition and Attributes of Municipal Solid Waste in Accra

Components	Zones			*Mean*
	High Class, Low Density	Medium Class, Medium Density	Low Class, High Density	
Organics				
percent	72	61	49	60
kg/person-day	0.323	0.233	0.087	0.214
MJ/kg	16.54	17.02	14.4	16.00
Total Carbon,%	45	46	40	44
Paper & Cardboard				
percent	10	7	8	8
kg/person-day	0.043	0.027	0.014	0.028
MJ/kg	17.50	16.28	16.73	16.84
Total Carbon,%	47	46	46	46
Plastics & Rubber				
percent	6	9	9	8
kg/person-day	0.027	0.035	0.016	0.026
MJ/kg	-	-	-	-
Total Carbon,%	-	-	-	-
Metals				
percent	2	4	4	3
kg/person-day	0.011	0.014	0.007	0.011
MJ/kg	-	-	-	-
Total Carbon,%	-	-	-	-
Glass				
percent	1	2	2	2
kg/person-day	0.005	0.007	0.004	0.005
MJ/kg	-	-	-	-
Total Carbon,%	-	-	-	-
Textiles				
percent	2	3	8	4
kg/person-day	0.008	0.011	0.015	0.011
MJ/kg	16.82	17.30	19.23	17.78
Total Carbon,%	46	48	56	50
Inerts or Residue				
percent	5	12	17	11
kg/person-day	0.024	0.045	0.030	0.033
MJ/kg	-	-	-	-
Total Carbon,%	-	-	-	-

Components	Zones			*Mean*
	High Class, Low Density	**Medium Class, Medium Density**	**Low Class, High Density**	
Miscellaneous				
percent	2	2	3	2
kg/person-day	0.011	0.008	0.005	0.008
MJ/kg	-	-	-	-
Total Carbon,%	-	-	-	-

Further solid waste quantification for each zone is presented in Tables 11.2 and 11.3.

Table 11.2 Waste Characteristics in the Accra Metropolis

Parameter	Zones			Mean or Total
	High Class, Low Density	Medium Class, Medium Density	Low Class, High Density	
Population (thousand)	136.5	1,764.0	1,599.5	3,500
Weight waste/person/day (kg)	0.462	0.380	0.285	0.47
Weight waste/year (10^3 tons)	23.0	244.7	166.5	480.7
Volume waste/person/day (liters)	1.2	1.3	0.5	1.0
Volume waste/year (10^3 m^3)	59.9	837.5	292.2	1,278.4
Moisture content (%)	62	47	40	50
Bulk density (kg/m^3)	530	410	540	474

It can be seen that an individual in the high income group generates more waste than in the other two groups, almost twice as much as that in the low income group. However, most of waste in Accra comes from the middle class group.

Table 11.3 Quantification of Waste Categories

Parameter	Zone			Mean
	High Class, Low Density	Medium Class, Medium Density	Low Class, High Density	
Population (thousand)	136.5	1,764.0	1,599.5	3,500.0
Compostables/year (10^3 tons)	19.72	203.44	80.72	363.06
Non-compostables/year (10^3 tons)	2.56	41.27	2.19	52.60
Combustibles/year (10^3 tons)	20.45	198.33	73.78	357.94
Non-combustibles/year (10^3 tons)	2.19	46.39	30.32	73.05
Gross energy of combustibles/year (GJ)	0.346	3.286	1.297	6.443

As shown in Table 11.3, considerable waste quantity is available for composting, over 360,000 tones per year. A similar quantity of waste is classified as combustible with total energy of combustion equal to 6.443 giga Joule (6.443×10^9 J). This amount of energy could produce substantial power if combusted in the waste-to-energy incineration plant. However, high content of ash and sand (up to 35%) could hinder the combustion process and generate a large quantity of ash.

Waste Collection and Transfer

Solid waste collection is a problem in Accra where at least 42% of people practice open waste disposal. The 300,000 tons of solid waste collected per year alone represent only 60% of waste generated.
Solid waste collection in Accra involves removal of waste from neighborhoods and transport to a discharge point, which is the Malami dumpsite. This is the most expensive part of the solid waste management system in Accra, requiring over 70% of the total solid waste management budget. Main cost components includes equipment capital cost, running costs of fuel, spare parts, tires, etc. Labor cost constitutes a much smaller amount that of equipment.

City & Country Waste Limited (CCWL) is the newly appointed waste management company for Accra. It is determined to make the metropolis cleaner and safer to aid good health by the end of the first decade of the new millennium. The inventory of CCWL equipment includes 52 compactor trucks, 15 roll on/off trucks, two bulldozers, a tanker truck, a tipper truck, a refuse compactor, and a weight bridge at the entrance to the landfill. The company has technical expertise to ensure the smooth running of waste management (*Ghanaian Chronicle,* November 10, 1999).

CCWL has optimized the cost of collection by analyzing the following factors: roads accessibility, road conditions, traffic speeds, distance of collection zones to disposal site, interest rates on capital, and cooperation from residents with collection containers and schedules

The most common collection vehicles are open tipper trucks and rear-loading compaction trucks for door-to-door service where the residents use household garbage bins which total 20,000 across Accra. Container hoist trucks, such as skip and arm roll trucks, are also in use for communal service to inaccessible areas or those where residents are too poor to procure and use household dustbins. In these places, large waste disposal containers are accessible for residents without charge. When the container is full, it is taken to the disposal site and replaced by the empty one. In some places containers are picked up as often as three times per day. A typical area container in south part of Accra is shown in Figure 11.1.

Figure 11.1 Waste disposal container on a street of Accra.

Different sizes of containers are also in use. Figure 11.2 shows smaller containers awaiting discharge at the dumpsite.

Figure 11.2 Garbage containers at Accra's dumpsite.

Garbage collection vehicles used in Accra discharging their load at the dumpsite are shown in Figure 11.3.

Figure 11.3 Garbage vehicles used in Accra.

The CCWL waste collection territory covers an area 35 km in diameter. Approximately 250 employees work 8 hour or 11 hour shifts. The first shift starts at 2 a.m. or 4 a.m. This depends on traffic and density of population. The average speed of a garbage truck is 20 miles/hour. CCWL subcontract a part of waste collection and disposal operation to 11 private operators who use their own equipment.

As stated by the General Director of CCWL (personal communication: Jacques Marquis, Accra, Oct. 23, 2000), collection and treatment/disposal of about 80% of the solid waste generated in Accra could be achieve by implementing the following:

- Introduction of a central container collection system in low-class residential areas;
- Introduction of appropriate systems for collection and treatment of hospital waste;
- Rehabilitation and operation of a compost plant and introduction of decentralized composting system; and
- Site selection, construction and operation of sanitary landfill sites.

Some of the above is already in the implementation phase.

Waste Recovery and Recycling

For various reasons, informal resource recovery, either by micro-entrepreneurs or by communities, has not received the support it deserves. In Accra and Tema, where unregulated dumping is the cheapest means of waste disposal, activities in this field are poorly stimulated and supported by local governments. Municipal policies undermine small-scale recovery activities.

In Accra, waste pickers sort through refuse from incoming garbage trucks, before and immediately after unloading. They often prevent the compactor from leveling and compressing the newly disposed waste. Picked items are stored on side of the road until sold to the recyclable waste buyer. Recovered items awaiting sale are shown in Figure 11.4.

Figure 11.4 View of waste items salvaged at the dumpsite in Accra.

City & Country Waste Limited recycles plastic waste, which is not biodegradable and therefore harmful to the environment. As a component of the company's national clean-up campaign under which CCWL, together with the metropolitan assemblies, provides for collection of used plastic containers for recycling.

Basically, there is only a limited proportion of recoverable material in the waste stream in Accra. The material is kept away from the waste at the household level where such items as empty bottles, plastic containers, metal cans, etc, are salvaged and kept for domestic use. They are additionally collected on site and sold for a small profit to the middleman who occasionally collects recyclables.

Composting

Accra Metropolitan Authority (AMA) operates the Teshie Nongua composting plant which has an operational capacity of 200 tons per day. The plant has been in operation since 1974. Existing equipment, such as the compost turner and screening unit, have been in operation for almost 30 years. As a consequence of its age it breaks down frequently; this negatively impacting the production capacity. A private company has been subcontracted to collect compostable waste in the City specifically for this composting plant. There is demand for fertilizer produced at the plant and more compost could be sold, if it was made available. AMA intends to build a new composting plant if receives the financial means.

Through the support of the German government, financially self-sustainable co-composting of pumped septage and municipal solid waste was implemented in Accra. The compost plant consisted of a simple windrow turning operation, followed by screening. The mixture composted was 50% solid waste and 50% treated human waste sludge. The windrow piles for composting were turned every six weeks, for a period of about eight months. Turning was done by payloader and screening of compost product by sieving drums. The compost quality was analyzed and considered excellent in terms of its nutrient content (0.48% nitrogen, 0.97% phosphate, and 0.46% potassium). Farmers using Accra's compost were able to reduce their fertilizer input by 50 to 80% and still obtain the same crop yields. The cost of the product was US$9.2 per cubic meter of compost. With 50 kg plastic bag priced at US$1.10, full cost recovery was achieved. The savings in land cost was about US$1 / m^3 of solid waste converted to compost (Meinel, 1996).

Waste Disposal

A semi-controlled dump is the first stage in the country's efforts to upgrade landfills. Controlled dumps operate with some form of inspection and recording of incoming waste, the practice of extensive waste compaction, tipping front control and the application of soil cover. Operated dumps, however, implement only limited measures to mitigate other environmental impacts.

The Malami dumpsite is the only open, semi-controlled solid waste disposal facility in Accra. The dumping section of the site is shown in Figure 11.5.

Figure 11.5 View of the solid waste disposal site for Accra.

The site is served by approximately 20 employees of CCWL who supervise and participate in landfill operation. All garbage trucks must enter and leave the site through the weight bridge. They are billed based on the weight of waste discharged at the dumpsite. The weight bridge at the Malami dumpsite is shown in Figure 11.6.

Figure 11.6 The weight bridge at the Malami dumpsite.

After entering the dumpsite, trucks are directed by the site supervisor to the discharge point. Disposed waste is sifted by scavengers (Figure 11.7) and then leveled and compacted by the refuse compactor shown in Figure 11.8.

Figure 11.7 Waste pickers at Malami dumpsite.

Figure 11.8 Refuse compactor at work.

The Malami dumpsite is located close to the residential area, which is illustrated in Figure 11.9.

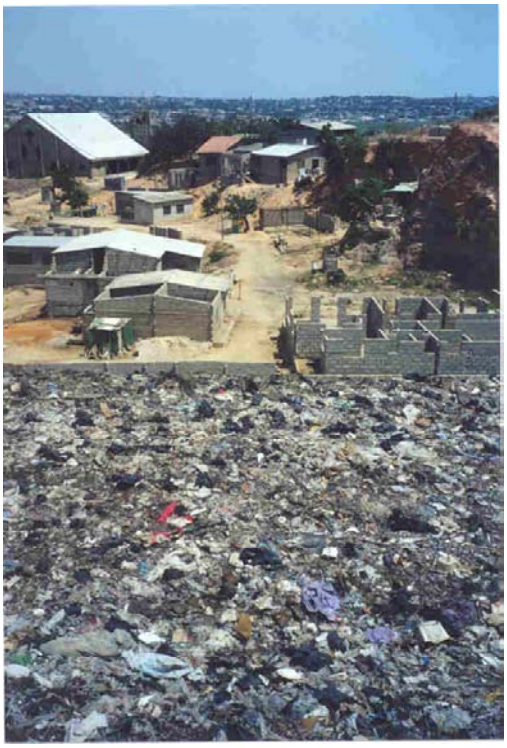


Figure 11.9 Construction of residences next to the dumpsite.

Malami dumpsite practices unmanaged contaminant release and does not take into account environmental cautionary measures such as leachate and landfill gas management. This is especially relevant during the rainy season in West Africa. There is a possibility of groundwater contamination at dumpsite areas where many houses have been constructed. The dumpsite has reached its maximum capacity and will be closed in the near future.

As the City grows and produces more waste and as its solid waste collection system becomes more efficient, the environmental impact from open dumps has become increasingly intolerable. The conversion of open or operated dumps to engineered landfills and sanitary landfills is an essential step to avoid future costs from present mismanagement.

A new Kwabenya landfill serving the Accra municipality will be commissioned in one or two years. It will be a properly designed engineered landfill located at a former borrow pit, 15 km from the City center. The landfill area will be six km^2 with the operational capacity of 1000 tons of waste per day. The £7 million investment has been provided by the United Kingdom.

Waste Stakeholders in Accra

Waste stakeholders in Accra include the national government, international organizations, the municipal government, informal sector and private firms.

At a national level, the Environmental Protection Council (EPC) was established in 1974 as an institutional framework for the country's environmental management. At the time, without a coherent national environmental policy, attempts to address Ghana's critical environmental problems were largely fruitless. In the late 1980s, with the help of the World Bank and USAID, Ghana developed a National Environmental Action Plan to deal with six key environmental areas, including waste management.

At the beginning of the eighties, the management of solid and liquid wastes in Accra had collapsed and the common practice of uncontrolled dumping of wastes posed considerable health and environmental risks to the citizens. In response, the Waste Management Department (WMD) under the Accra Metropolitan Assembly was established in 1984 and since 1985 has been supported by German Financial and Technical Cooperation. The WMD is authorized to raise and retain revenues through direct user charges.

Strengthening of the organizational structure and overall performance of the Waste Management Division has been achieved by introduction of strategic planning and privatization and organizational development and training measures.

International involvement includes the Accra Sustainable Programme which is funded and supported by the United Nations Development Programme (UNDP) and the United Nations Centre for Human Settlements (Habitat). Other partners include:

- Denmark (Danish Technological Institute)
- DANIDA - financial support
- UNICEF - support to Working Group
- PACIPE – investment
- UMP - funding mini consultation

The Accra Sustainable Programme is implemented by the Accra Metropolitan Assembly in collaboration with the Ministry of Local Government and the Asiedu Keteke Sub-metro Council, with the assistance of the following local partners:

- The Ministry of Works and Housing
- The Town and Country Planning Department
- The Mines Department
- The Waste Management Department

- The Greater Accra Regional Administration
- Ghana Water Company Ltd.
- NGOS, CBOs and research institutions

Accra has experienced several efforts that have sought to integrate environmental issues with urban development. The Accra Structure Plan process, initiated in 1988 and terminated several years later, included a review of environmental conditions in the City. In 1991, urban environmental data was collected and an environmental profile of the City prepared with assistance from the Urban Management Program (UMP). That same year, urban environmental consultations and a town meeting were held with assistance from Canadian donors and the UMP. These initiatives were not, however, designed to be part of a more complete EPM process.

In 1994, the Government of Ghana and UNCHS/UNEP Sustainable Cities Programme signed a project document for the execution of the Accra Sustainable Programme (ASP). The key implementing agencies are the Ministry of Local Government and Rural Development and the Accra Metropolitan Authority. A technical support unit is located within the Town and Country Planning Department, a decentralized group within the Metropolitan Authority.

To identify and prioritize urban environmental issues, a one-week long City Consultation was held in Accra in May 1995. The objectives of the consultation were to:

- Review and elaborate on the City's most pressing environmental issues, as identified in an environmental profile;
- Bring together major stakeholders to jointly agree on a participatory planning process;
- Identify two priority issues for action plan development; and
- Agree on an appropriate institutional structure for the ASP.

Prior to the consultation, a series of individual meetings were held to build commitment and the environmental profile was distributed to form the basis of discussion. Over 150 stakeholders participated in the consultation, coming from central government, metropolitan government, traditional authorities, Parliament, the private sector, NGOs, CBOs, international agencies, and academic/research institutes. During the five-day consultation, two priority issues were discussed (degradation of the Korle Lagoon and inadequate sanitation), an appropriate institutional framework was devised for the ASP, and consensus was summarized in an "Accra Declaration."

Strategy development and action planning is proceeding through the formation of working groups (WGs). The Coordinating Working Group is responsible for bringing together all the strategies and action plans prepared by the Working Groups in order to remove areas of overlap and conflicts. Through this process all

the WGs are made aware of what is happening in each group. The memberships of the Groups are drawn from a wide section of stakeholders. These include the Accra Metropolitan Assembly (AMA) and its decentralized departments, technical departments, chiefs, NGOs and CBOs. The Technical Support Unit (TSU) supports the Working Groups by visiting them, taking part in the discussions, and giving advice.

To help the government in solid waste management, the private sector has organized the Association of Private Waste Management Contractors (PWMC). The PWMC identified lack of data on refuse collection, poor enforcement of bylaws, luck of dumpsite monitoring and night operations.

Privatization and Community Participation

In recent times, and in view of the trend towards private sector participation in the environmental sector, certain aspects (e.g. billing and collection, waste disposal) have been contracted out to the private sector. The activities of these private entities are being monitored to see how well they fare as part of the commercial measures to reduce waste burden and to improve the waste collection ratio.

Privatization of waste management may be formally arranged as:

- Zonal franchise for a minimum of five years with a private company for all or partial waste collection and dumping;
- Zonal contracts for one year plus unlimited renewals of one year each for residential solid waste collection;
- City-wide contract for 15 years plus two renewals of three years each with one private company for collection, transfer and disposal of residential, commercial and institutional solid waste;
- Neighborhood contracts with cooperatives and economic groups for solid waste pre-collection; and
- Establishment of household subscription with private small-scale enterprises for solid waste pre-collection and collection.

Privatization typically involves one or more of the following activities:

- Provision of vehicles or heavy equipment – by lease/rental agreement;
- Pre-collection of residential solid waste;
- Collection of construction/demolition waste;
- Collection of industrial wastes from factories;
- Collection and disposal of infectious medical wastes from hospital – by private subscription with private hospitals;
- Sweeping or cleaning of streets or open areas;

- Repair of City solid waste equipment – by service contract or an as-needed basis with small workshops;
- Conversion of waste to compost – by service contract or concession;
- Operation of a City disposal site; and
- Collection of user charges or waste taxes - by concession with bill collection agents, water authority, or electrical utility.

Accra's experience with privatized (franchise) waste management dated back to 1994 when the City awarded a five-year franchise for collecting wastes from several neighborhoods to one private company, while continuing to provide government service in other neighborhoods. The company's owner had been a sales agent for heavy vehicles, including refuse collection vehicles, and thus had experience in equipment specification, operation and maintenance. A number of waste management companies were involved in collection and disposal as sub-contractors.

In 1999, Accra Metropolitan Assembly (AMA) awarded a City-wide contract to City & Country Waste Limited (CCWL), a consortium of Ghanaian and Canadian firms. The fixed fee contract is for five years plus two renewals of two-year and three-year each for collection, transfer and disposal of residential, commercial and institutional solid waste. Waste collection vehicles and refuse compactors owned by AMA were taken over by CCWL on leasing arrangement.

Several other waste management companies operate in Accra. These include Gee Waste Limited, Merhill Limited and Dar Al-Handasah.

The main constraint in community participation in solid waste management is the lack of adequate awareness campaigns to educate the populace of the implications of improper solid and liquid waste disposal within the City and in the peri-urban settlements, as well as communities living along the stretch of the Densu River. Some attempts have been made by Ghana's Environmental Protection Agency (EPA) to undertake a public awareness campaign, but once again, fund limitations have been the main constraint and there is an urgent need to change the public attitude to water resources conservation and protection. To increase public awareness, the Ministry of Local Government and Rural Development declared National Environmental Sanitation Day once every year on a date fixed by the Government.

An example of community participation in waste management is the Junior Ecological Organization (JECO). This is a youth-oriented non-profit organization whose main aim and vision is the promotion of environmental regeneration and sustainability, education, and poverty alleviation. JECO's approach is to stimulate the interest of youth in environmental issues. Children form a large proportion of the population and so are directly affected by environmental issues, especially

sanitation. If they were taught their role and the proper way to handle waste, significant progress in solving the problem would be achieved. Recycling and reusing, which have always been practiced informally due mainly to poverty (such as reusing old bottles and scavenging), must be introduced as classroom activities that could then be implemented at home and in communities.

JECO's initial projects include the School Environmental Education Program, started initially with the formation of environmental clubs for children in schools and communities. These clubs use hands-on activities such as drama, radio programs, newsletters, and litterbug campaigns at local functions and programs, to promote recycling and source-reduction.

As a follow up to these activities, the Environmental and Occupational Health Sciences Institute (EOHSI) at Rutgers University is embarking on a collaboration with JECO to develop an environmental education curriculum on solid waste management for ten-year old students in Ghana. The goal of the project is to use this integrated and interdisciplinary curriculum as a pilot in selected elementary schools in Accra. Teachers in these schools are given all the materials and are trained in solid and liquid waste management and on how to develop stimulating methods of instruction. The teachers have been involved with environmental clubs set up by JECO and have realized that the existing curriculum does not sufficiently address solid waste management. The teachers have reported an increased interest by the ten-year olds, but have also expressed a need for more time and commitment for the activities, which they feel should be scheduled as extracurricular activities.

Awareness of the nexus between urban poverty and the environment has become a primary concern in Accra. Many of the worst features of urban poverty are environmental, such as inadequate access to safe water, poor waste management practices, contaminated food, and insect infestation.

Waste Management in Tema, Ghana

Tema is a City and port in southeastern Ghana. It lies along the Gulf of Guinea (Atlantic Ocean), 18 miles (29 km) east of Accra. Tema was chosen for construction of a deepwater harbour in 1951 for its proximity to the Volta and Accra rivers, its local supplies of construction materials for breakwaters, and its deep offshore waters that minimize dredging. Opened formally in 1962, Tema's harbour encloses 410 acres (166 hectares) of sea and is Africa's largest man-made harbour.

The government acquired 64 square miles (166 km^2) of land north of the harbour and entrusted it to the Tema Development Corporation (1952). The "New Town" that was subsequently built on the site was planned as an industrial-residential complex. There was a large influx of population beginning in the 1960s owing to

the new employment opportunities, but the corporation was unable to construct housing and provide other services to meet the needs of this migration. The result was the creation of a large slum area consisting of shacks near Tema in an area called Ashiaman. The slum area has persisted despite building projects undertaken by the Tema Municipal Council. However, overall Tema is better planned than Accra, with clearly defined residential, industrial and recreational areas. The current population is around 450,000 of which about 410,000 benefit from organized collection by Tema Municipal Assembly (TMA). The remaining 40,000 resort to refuse dumps. The service area is 396 km^2.

With a high level of industrialization and the operation of a busy harbour, Tema municipality faces a difficult task in efficiently and effectively managing its solid waste. Manufacturing companies, like Volta Aluminum Company (VALCO) and Tema Steel Works, generate an annual total of 3,720 m^3 of waste from sludge refractors and ashes from metal production. Ghana Cement (Ghacem) generates 800 m^3 of cement ashes, dust and sludge annually (Botwe, 2000).

Organized waste collection and disposal commenced in the Tema Municipality in December 1990 when contracts were awarded to six contractors to collect waste from six sub-zones (personal communication: Willy Vordoagu, Tema Municipal Assembly, Oct. 24, 2000). In 1995, new terms of reference were developed and new contracts awarded.

In 1998, with the supporting budget of US$89 million for five cities in Ghana, Tema started preparation for the Urban IV Environmental Sanitation Project. The project started in July 2000. Under this program, Accra's Waste Management Department (WMD) with its 150 employees serves the indigenous area of Tema while eight private operators serve the rest of the area. The private sector secured contracts totaling 89 million Ghanaian cedis (GHC) in an open bidding competition. The service area incorporates approximately 44,000 households. The WDM contractor removes 800 tons per month of the industrial waste. Private operators use their own equipment, such as compactor trucks and roll on/off trucks. WMD leases two roll on/off trucks to contractors. The Environmental Health Division and Solid waste Management Unit are monitoring performance of private operators. When the service is inadequate, financial penalties are imposed. The department operates the workshop where waste collection equipment is repaired. As seen in Figure 11.10, the shop is in a state of disarray.

Figure 11.10 Tema municipal workshop.

The Tema municipal dumpsite is located in Kpone, 15 km from the City. This is an old borrow pit from which gravel had been removed over the years and now is reclaimed with refuse. It occupies an area of 6 km^2. The Kpone site has been operating for 15 years and is scheduled to close in the year 2015. Any salvageable items are removed from waste by 20 to 30 scavengers operating at the site. Disposed refuse is compacted but no soil cover is applied. The dumpsite is shown in Figure 11.11.

Figure 11.11 Tema regional dumpsite in Kpone.

Figure 11.11 shows the smoldering garbage ignited by landfill methane gas generated from the decomposting organic matter. A strong odor of decomposing organic waste, flies and windblown litter are present at the dumpsite and its surroundings.

Total monthly removal of municipal waste in Tema is estimated to be 10,000 tons. Industrial establishments are responsible to dispose waste in their own terms. Ghana Ports and Harbour Authority handle ships and port waste.

No waste transfer station operates in Tema. Waste recovery and recycling of metals, glass and certain types of plastics are carried out, on a small scale, by waste pickers.

SOLID WASTE MANAGEMENT IN CAPE TOWN, SOUTH AFRICA

Cape Town is located in the South Western Cape region of South Africa and is distinguished by its unique natural, cultural and physical characteristics. The Cape Town Municipal Area has a population of 3.4 million and an expected population of 4.4 million by the year 2010 (CIA, 1999). About 1.3 million people presently in the Cape Metropolitan Area (CMA) are capable of working. Of these, approximately 850,000 people are employed in the formal sector. Cape Town has a strong commercial and financial base with a number of large international corporations locating their head offices in the City. It is also one of the continent's leading cities of learning. High-tech businesses are one of the fastest growing segments of the economy. Manufacturing industries are the major employers with clothing textiles and food products being the major contributors.

An increasing amount of waste is generated in the CMA as a result of rapid rate of urbanization and industrialization. Urban waste arises from domestic activities, commerce and trade, secondary industrial operations and littering. It includes sewage sludge, domestic refuse, non-hazardous industrial waste and commercial waste.

Waste Quantities and Characterization

Estimates of waste quantities per capita can vary considerably across Cape Town, depending on the concentration of commercial activities and the type of community. The major concern is that waste generation rates could rise with economic growth and rising standards of living and quickly exceed the capacity of existing and planned waste disposal facilities in Cape Town. As the Cape Town's economy is now dependent on revenue from local and foreign tourists to a total of 10 billion rand (R) a year, the City cannot allow the degradation of its environment resulting from overloading by garbage (Yeld, 2000).

The total amount of waste in 1997 that was accounted for by disposal location in Cape Town was 2,050,800 tons per annum and by source was 1,735,400 tons per annum. Although these figures are somewhat different caused by inadequacy in the survey and the sampling process, they are remarkably close, yielding a high degree of confidence in accounting for the waste quantities (CMC, 1998).

Current waste generation rates were determined on a per capita basis (in kilograms per capita per day, or kg/c/d) for domestic waste by level of living: 0.35 for informal settlements, 0.73 for low to middle income and 1.3 for upper middle to high income. The population-weighted average of these domestic waste generation rates is 0.83 kg/c/d. Current waste generation rates were also determined for commercial and industrial wastes on a per capita basis: 0.37 kg/c/d and 0.46 kg/c/d, respectively. This yields a current total waste generation rate of 1.66 kg/c/d (ibid.).

Waste generation rates generally increase over time. It is anticipated that the overall waste generation rate will increase by nearly 20% to 1.98 kg/c/d over the 30-year planning period, with most of the increase occurring in domestic waste generation.

The domestic waste stream from more affluent areas and informal settlements, e.g. squatter camps of Cape Town, is roughly made up as shown in Figure 12.1 (CMC, 1999).

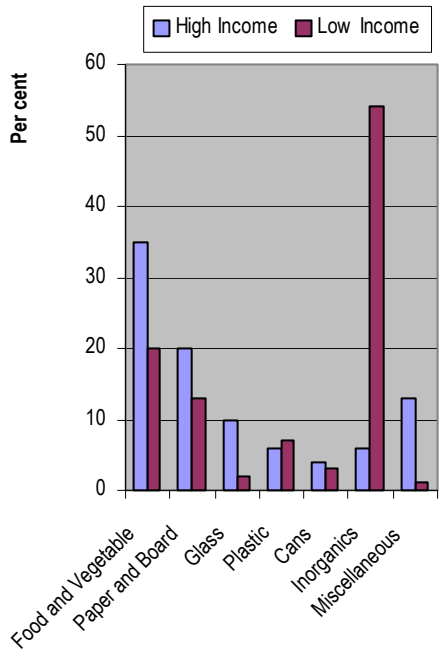


Figure 12.1 The domestic waste composition in Cape Town Municipality.

Table 12.1 presents data on 1998 waste quantities generation rates (tons per day) in Cape Town Municipality (ibid.).

Table 12.1 Cape Town Waste Quantities by Material in 1998 (tons per day)

Material	Quantity, tpd

Organics	614
Plastic	367
Paper	345
Glass	141
Metals	134
Textiles	93
Timber	64
Other	212
Total	**1,970**

Based on the analysis of waste characterization given in Table 12.1, nearly 30% of the residential and commercial waste stream by weight consists of organic waste such as kitchen and garden waste, nearly 20% consists of plastic and 20% consists of paper and cardboard. These three components account for approximately 70% of the residential and commercial waste stream, with glass, metal, textiles and timber accounting for more than 20% by weight.

Waste characteristics, or the individual components that make up a waste stream, vary from season to season and location to location. This makes it difficult to determine exact quantities of individual components in the waste stream.

Waste Collection and Transfer

Collection of solid waste in the Cape Metropolitan Area (CMA) is a responsibility of the Municipal Local Councils (MLC's). Collection is performed largely at curbside throughout the CMA by means of compacting collection trucks. Collection is conducted either directly by the municipality or contracted through private waste haulers. The collection policies vary across the CMA depending on the local municipality. Each of the present six MLC's would like to introduce a uniform policy for the CMA in the wake of the recent reorganization of former municipalities, local areas, and areas that were previously under the jurisdiction of the former Regional Services Council.

Generally, mixed waste and garden refuse is collected using black bags or standard-size bins, with some of the informal areas being served by skips. Because many of the existing disposal sites are relatively close to the points of waste generation, most of the waste that is collected is hauled directly to a nearby landfill site for disposal.

There is only one large transfer station, the Athlone Refuse Transfer Station, which deals strictly with a portion of Cape Town's waste. Unsorted waste from the Athlone is baled and hauled by rail to the Cape Municipal Council's landfill at Vissershok. In 1997, there were only two other small transfer stations in operation in the CMA, one at Somerset West and one at Simon's Town, each formerly owned

by their respective former municipalities and still serving them (Parsons & Associates, 1997).

The need for transfer stations will increase significantly as landfills are closed and waste is diverted to other landfills. As long as the landfills are located relatively near the disposal sites, transfer stations are not needed. As the remaining open existing landfills become remote from collection areas, transfer stations will be necessary to control hauling costs. Such transfer stations must serve both the short-term need as a drop-off and transport point for interim disposal at an existing open landfill, served by either road or rail, and the long-term need as a drop-off and transport point for long-term disposal at a regional landfill, served by rail. In essence these new transfer facilities must be the part of the long-term solution, but designed to be adaptable to the most feasible interim solution.

A system of transfer stations is proposed to serve the entire CMA. These stations are designed at locations close to major roads and rail, and the collection areas that each station will be serving. A total of thirteen transfer stations are anticipated to handle the futures waste for disposal. Of these, 12 transfer stations will be new. The only existing transfer station to remain, as part of the long-term plan, would be the rehabilitated Athlone Refuse Transfer Station. The significant issues that were evaluated include appropriate sizing, service by road or rail, and whether or not to compact the waste for transport. The most cost-effective concept is for larger transfer stations with modular designs (up to a nominal capacity of 800 tons/day) equipped with compactors and served by rail (CMC, 1998).

Waste Recovery and Recycling

The primary reason for the high recycling rate of industrial waste materials is because it is profitable. In South Africa, the three major materials that are recycled in the industrial sector are metal, paper and glass. A deposit system is used to encourage the return of bottles and tin and aluminum cans. In addition, specially marked receiving containers are placed at “Greens Depots” for the drop off of bottles and cans. The country has a sizeable tin mining and processing industry, with a demand for the recycled material. Aluminum is processed for use in beverage containers.

The recycling of residential and commercial waste that takes place in the CMA is done largely in an informal way, meaning there is no underlying policy, mandate or programs that are led by any levels of government. One notable exception is the recovery of waste materials at the Bellville composting facility. Recycling of materials from the residential and commercial waste stream is driven by poverty and as a means of survival. The retrieval of recyclable material from waste occurs on a fairly large scale, but is often unorganized and conducted in unsafe and unhealthy conditions, and through means that are not necessarily environmentally sound. The industry response to the use of recycled materials as a "raw material" is

greater than any movement towards recycling being incorporated as part of the everyday lifestyle.

Recycling of materials from domestic, commercial and industrial wastes, such as metal, plastic, glass, and paper, composting of domestic waste, and the beneficial reuse of wastewater treatment plant sludge accounts for approximately 24% of the total solid waste stream in Cape Town. Most of the recycling occurs in the industrial sector. Of the total residential and commercial waste stream only an estimated 6.5% of the waste is recycled. With significant mandates and programs in place for recycling, a recycling rate of 20 to 25% of the domestic and commercial waste is expected to be achievable by the year 2030 (CMC, 1998).

Based on information available in Cape Metropolitan Council's (CMC) report on recycled quantities of paper, glass, metal, plastic and garden waste, and the total quantities of each of these materials in the waste stream, the estimated recycling rates of various materials in 1977 was as shown in Table 12.2 (Parsons & Associates, 1997).

Table 12.2 Cape Town Recycling Rate by Material in 1997

Material	Recycling Rate,%
Paper	10
Glass	7.5
Metals	45
Plastics	6
Organics	0
Total all material	**6.5%**

Cape Town requires a policy that mandates recycling to prevent recoverable materials from taking up precious landfill space. An appropriate approach would be to establish goals and policies for recycling with source separation as a long-term objective. In the interim, more effective materials recovery may be achieved through the use of mixed waste materials recovery facilities (MRF's), and increasing the number of drop-off/buy-back centers currently in place. This would provide the benefits of recovering recyclable materials as a resource, and at least equally importantly, can reduce overall disposal costs. The most cost-effective means of implementing mixed waste MRF's is to incorporate them into the transfer station facility. What is envisioned are simple manual sorting lines, where workers sort recyclable materials from a conveyor that is passing from the tipping area to the area where containers are loaded. Example of the MRF's sorting line is shown in Figure 12.2.

Figure 12.2 Waste recovery sorting line.

At the MRF waste is loaded onto conveyors that pass through sorting lines where workers sort waste removing glass, plastic and paper. The only mechanized sorting is an electromagnet for removing ferrous metals. In the transfer stations that are coupled with MRF's, there is a tipping floor for receiving waste and loading the conveyors for sorting, and a collection/storage area for waste leaving the conveyors to be loaded into the hoppers feeding the compactors. All that passes through and is not removed is then loaded into containers and shipped to the landfill. The recovered materials are temporarily stored for shipment to recycled materials brokers and ultimately industries that use the materials.

In the past, a number of capital intensive recycling plants have operated unsuccessfully in South Africa, e.g. Robinson Deep's Waste Flow Plant in Johannesburg and the Resource Recycling Plant in Randburg. A labour-intensive initiative, Durban's Tempo Recycling operation, also failed. The failures have been attributed to a number of factors including - the commercial value of the waste stream was overestimated, the economy had experienced a down swing at the time that the project was launched, and the informal pickers had removed the recyclable materials from the waste stream at source, i.e. before it reached the site.

Composting

Composting is a small-scale activity in South Africa, and performed mostly by private entrepreneurs. Composting is not seen as a viable waste disposal option. There is only a limited market for compost, as the industry is still in a primary stage. Although expansion is taking place in this area, it is not seen as a major waste reduction or resource recovery option.

Approximately 41,000 tons per year of collected domestic and commercial solid wastes are composted at several composting facilities in the CMA. Over 80% of the composting occurs at two facilities located in Bellville and Parow (Radnor), with

the remainder occurring at the Mitchell's Plain facility adjacent to the Swartklip disposal site.

Waste Disposal

In Africa, landfilling is the most appropriate solution for disposal of waste materials that otherwise cannot either be prevented from entering, or be recovered from, the stream of waste that is generated by residences, businesses and industry. Modern landfills that are properly designed and operated are the most cost-effective and environmentally acceptable means of waste disposal when population density and land availability are not at issue. South Africa's abundant land resources and transportation infrastructure make landfilling the most economical means of waste disposal.

More than 95% of domestic, trade, industrial and hazardous waste is landfilled, and this remains the most widely used method in South Africa and still the cheapest option. There are approximately 1,200 landfills, mostly owned and operated by municipalities. Many of these are located on sites such as abandoned quarries and ravines. Only 214 (18%) sites have licenses and are duly permitted. A large part of the current problem with management of solid waste appears to be due not so much to a lack of legislation, but in the oversight and lack of enforcement of existing laws and regulations (Johannessen & Boyer, 1999). Currently, to obtain a landfill permit one must receive approval from the direct oversight agency, the Department of Water Affairs and Forestry, the Department of Health and the Department of Environmental Affairs and Tourism.

Though only a few landfills in developing countries currently recover the landfill gas (LFG) for flaring or energy production, LFG recovery for energy production may have more widespread applications throughout the developing world. The minimum requirements instituted in South Africa offer only limited guidance on landfill gas management. There is no landfill gas management in the CMA.

The Cape Metropolitan Area is faced with declining capacity for solid waste disposal at existing landfills. The most appropriate solution for waste disposal for the CMA therefore includes the short-term continued use of existing landfills, and the long-term use of large regional landfills to be developed. However, it will be difficult to find an acceptable site for a new landfill that would comply with the latest regulations within the Cape Town area (Johannessen & Boyer, 1999).

In South Africa, as in the rest of the African continent, most of the existing landfills are unlined and unfenced. Operating practices generally do not include compaction or the application of daily cover. This may reflect the absence of appropriate equipment or other resources to carry out these practices. Additionally, large numbers of waste pickers may scour the landfills for materials of economic or

personal value. The returns from the sale of these materials go to the waste pickers, and not to the agency operating the facility.

Within the CMA, there are presently six public landfills owned by CMC: Vissershok, Coastal Park, Swartklip, Bellville South, Brackenfell, and Faure. One privately-owned landfill, Vissershok Waste Management Facility, is owned by EnviroServ and Wasteman. All of the other landfills receive only general waste for disposal. There is also a medical waste incinerator adjacent to the landfills at Vissershok. Limited facilities for garden refuse and building rubble disposal are scattered across the CMA.

The two landfills at Vissershok are permitted for and receive general and hazardous waste for disposal. One is privately operated and the other run by the CMC with a collective available space of 13 million m^3 (Figure 12.3). These facilities have lifespans reaching to the year 2010 and 2027 respectively. Low-level and intermediate-level nuclear waste generated by Koeberg Nuclear Power Station amounts to 1,560m^3 per annum and is stored at the Koeberg disposal site.

Figure 12.3

The current quantity of commercial waste is more difficult to define and estimate than industrial waste. For the years that the CMC owned and operated the Swartklip, Coastal Park and Vissershok landfills, it was estimated that approximately 25% of the total waste received was from commercial sources (source: *Cape Argus*, November 2, 2000). Quantities of total and commercial waste disposed at different landfills are illustrated in Table 12.3 (Johannessen & Boyer, 1999).

Table 12.3 Waste Quantities Disposed at the Cape Town's Landfills (tons per annum)

Disposal Location	Total Waste, tons	Commercial Waste,%	Commercial Waste, tons

Athlone RTS	164,871	25	41,200
Bellville South	32,344	25	82,300
Brackenfell	78,743	25	19,700
Coastal Park	221,796	25	55,500
Faure	165,568	25	41,400
Swartklip	185,316	25	46,300
Vissershok CMC	162,816	25	40,700
Vissershok WMF	0	N/A	N/A
Solids	228,960	25	57,200
Liquids	52,800	0	0
Garden Refuse / Building Rubble	25,500	100	25,500
Total	**1,318,714**	**-**	**409,800**

The total amount of available disposal space in existing landfills within the CMA is estimated to be 19.6 million m^3. The required amount of space over the 30-year planning period will far exceed this existing capacity. All of the existing landfills will close at some time during the planning period. The most urgent need is for landfill capacity to replace that presently associated with the Swartklip and Faure landfills, which are the first landfills expected to close. The waste presently being disposed at those landfills must be diverted to the remaining open landfills until new sites are developed. Acceptable sites for new landfills that can both comply with the latest regulations and provide sufficient capacity will not be found within the CMA. That situation has focused attention on the development of one or more regional landfills outside the CMA. It is estimated that between 1% and 2% of domestic waste is hazardous (ibid.).

The standard of waste disposal in South Africa has improved in the metropolitan areas but continues to be low in the smaller local authorities that do not have the benefit of metropolitan support structures. The collective experience of developed countries suggests that the acceptance of very stringent waste disposal regulations is a necessity because the cost of poor disposal is frequently much higher than anticipated. Furthermore, the poor standards that are supposedly affordable now merely postpone the cost that must inevitably be borne by the economy at some

time in the future. The planning of future disposal sites in South Africa must receive a substantially higher priority with all of the stakeholders.

Waste Stakeholders in Cape Town

Waste stakeholders in Cape Town include the governments, private sector, NGOs and the general public.

At the government level, a legislative body, the Consultative National Environment Policy Process (CONEPP), has been enacted to address integrated waste management. In addition, the South African Department of Water Affairs and Forestry and the country's Department of Environmental Affairs and Tourism announced jointly that they are currently in the process of developing a comprehensive waste management strategy. The two departments are focusing on developing an Integrated Pollution Control and Waste Management (IPC&WM) program for South Africa (Halsted, 1999).

The IP&WM is a subsidiary and supporting program to the national environmental management policy, which identifies the Department of Environmental Affairs and Tourism as the lead agent for the environment. As such, the Department took overall responsibility for integrated pollution and waste management in South Africa. It is the policy of the Department of Environmental Affairs and Tourism to encourage all stakeholders, such as other government departments, business and industry, Iabour, environmental and public interest groups, along with other members of civil society, to participate in the discussion, design and implementation of new policies and programs. Organized efforts such as these set South Africa apart from many of its neighbors.

Non-governmental organizations have been instrumental in driving the growth of environmental awareness and in advancing the IP&WM policy. Therefore, the government acknowledges their role by:

- Recognizing their status as stakeholders in integrated pollution and waste management issues;
- Ensuring full access to information to enable them to participate from a base of knowledge and expertise;
- Facilitating their involvement in national and international processes in integrated pollution and waste management capacity-building; and
- Creating channels to address grievances.

In order to ensure that non-governmental organizations take part, the lead agent developed mechanisms and capacity building to address their grievances, and involved them in decision-making and enforcement.

Recognizing the value and potential of a well-informed and committed citizenry for effecting positive change, the Department of Environmental Affairs and Tourism encourages meaningful public involvement in integrated pollution and waste management issues. Public participation in the regulatory process has been expanding using consensus-based approaches and negotiated rule making.

Pollution and waste management is not the exclusive preserve of the government. The private sector and civil society have crucial roles to play. The fostering of partnerships between government and the private sector is a prerequisite in order for sustainable and effective pollution and waste management to take place. Similarly, the spirit of partnerships and co-operative governance between organs of state is equally important due to the crosscutting nature of pollution and waste management.

Privatization

There are privately owned landfills in South Africa. Many are associated with industrial and hazardous waste. However, a few are owned by private collection services. In general, private ownership and/or operation of SWM facilities are rare in Africa. It is apparent that the most practical means for future landfill development is likely through the private sector. There are national waste management companies that have the capability to develop regional landfills.

Countrywide there are now well over 100 operators, varying in size from mainly small firms of one man operators up to a few large firms of which only two have a national presence. These operators have mainly limited themselves to collection, transport and ‘recycling’ operations and only a handful have ventured into establishing and operating landfill sites. This is primarily due to the start-up cost, operational expense needed to manage landfill sites, and the risk factor.

The local authorities have followed a similar pattern and while most are active in the collection, transport and disposal of non-hazardous wastes, only Cape Town and Uitenhage have ventured into the disposal of hazardous wastes and then only on a limited scale. Today, there exists a wide distribution of private companies with the ability to transport wastes and there are six hazardous landfill sites in Cape Town; Port Elizabeth; Durban (2); Springs and Pretoria which are owned and operated by the private sector.

Besides for the profit motive, the most significant drivers of the development of a private waste industry is the existence and enforcement of legislation. Up until the end of the 1980’s legislation was fragmented, very limited and spread amongst some 33 Acts of Parliament. Enforcement was generally of a poor standard by few inspectors with limited knowledge and powers, who generally focused only a single aspect of the law and ignored the balance of transgressions.

Hazardous landfills were issued with a 'consent' permit, which was based on overseas (mainly UK) practice and on the assumption that suitable legislation would be similar in content. Since the promulgation of the Environmental Conservation Act No 73 in 1989 there has been a more concerted attempt by the authorities to bring about better legislation for waste generation, transportation and disposal, culminating in the draft National Waste Management Strategy recently published.

The private sector has much to offer the waste industry since it has many advantages over local and provincial authorities, namely:

- Flexibility in areas of operation;
- Flexibility in choice and range of equipment;
- Flexibility in pay packages and ability to attract the best qualified staff;
- Ability to raise capital;
- Ability to reward employees;
- Economies of scale; and
- General ability to operate more efficiently.

On the other hand, the private sector is constrained by a number of issues, including:

- Resistance by trade unions to the contracting out of services,
- "double standards" allowing for local authorities to operate at lower than legal requirements,
- Empire building by local authorities,
- Bylaws restricting certain categories of work for exclusively the local authorities,
- Poor legislation, and
- Lack of and inconsistent enforcement of legislation.

All of these results in high investment requirement coupled with the high risk of few guarantees for a level playing field.

White Paper on Environmental Management Policy for South Africa

The waste management strategy for South Africa has been recently formulated in an important document titled The White Paper on Environmental Management Policy for South Africa (Notice No. 227 of 2000, Government Gazette, Vol.417, No.20978, 17 March 2000).

The White Paper's section on Integrated Pollution and Waste Management outlines the government's new thinking in relation to pollution and waste management. In line with international trends and South Africa's objectives of efficient and effective management of the nation's resources, priority is given in this new approach to prevention. Unlike previous policies that focused predominantly on so called "end-of-pipe" treatment, the White Paper underscores the importance of preventing pollution and waste and avoiding environmental degradation.

Effective mechanisms to deal with unavoidable waste will remain necessary, but much greater attention will be directed to the introduction of preventative strategies aimed at waste minimization and pollution prevention. Ever increasing urban and industrial development throughout the world is leading to levels of pollution which seriously threaten the natural resources.

The Reconstruction and Development Programme included in the White Paper highlights the sub-optimal use of natural resources, and unacceptably high levels of air and water pollution as one of the major problem areas regarding the environment. Although South Africa has extensive environmental, pollution and waste management legislation, responsibility for its implementation is scattered over a number of departments and institutions. The fragmented and uncoordinated way pollution and waste is currently being dealt with, as well as the insufficient resources to implement and monitor existing legislation, contributes largely to the unacceptably high levels of pollution and waste in South Africa. The White Paper will implement co-operative governance as envisaged in the Constitution. The current fragmentation, duplication and lack of co-ordination will be eliminated. The White Paper on Integrated Pollution and Waste Management will result in a review of all existing legislation and the preparation of a single piece of legislation dealing with all waste and pollution matters.

The White Paper makes clear that all members of society contribute to waste generation and should therefore be part of the solution to the problem. Mechanisms to increase individuals' and groups' awareness of, and role in, waste management will be explored as part of the national strategies on pollution and waste. All sectors of civil society, in particular the following, have a role to play in integrated pollution and waste management:

- Organized labour;
- Community-based organizations;
- Non-governmental organizations, and
- Business, industry and mining.

The White Paper proposes a number of tools to implement the objectives of the policy it sets out. The most significant of these is a legislative programme that will culminate in new pollution and waste legislation. This proposed legislation,

amongst other things, will address current legislative gaps, and clarify and allocate responsibilities within government for pollution and waste management. The importance of drafting such legislation in a manner that continues to build on the participation of all stakeholders who were involved in the development of this White Paper is emphasized.

In terms of the National Environmental Management Act, the Minister of Environmental Affairs and Tourism will establish a National Environmental Advisory Forum with subcommittees to advise him on environmental issues. A subcommittee for pollution and waste management will be established as a subordinate body to the proposed National Environmental Advisory Forums. Similar structures will be established to advise the Members of the Executive Council (MECS) at provincial level.

The Polokwane Declaration

The current status and the future development of waste management practices in South Africa within the frame of sustainable development was a subject of the meeting of representatives of national, provincial and local government, civil society and the business community (the Parties) at Polokwane in the Northern Province in September 2001. The meeting formulated waste management strategy and adopted policy matters for South Africa which includes:

- To reaffirm a commitment to the Integrated Pollution and Waste Management Policy, the National Waste Management Strategy and the principles of waste minimization, reuse and recycling for sustainable development.

- Implementation of a waste management system which contributes to sustainable development and a measurable improvement in the quality of life by means of energy recovery and waste reduction.

- To reduce waste generation by 50% and disposal by 25% by the year 2012, and to work towards zero waste by 2022.

- The Parties expressed concern about environmental degradation, which has significant economic and social impact. On behalf of all South Africans the Parties recommitted to the objectives of the integrated pollution and waste management policy, emphasized the essential role of effective management of waste in sustainable development and the protection of human health and the environment, and pledged action to undertake initiatives that will promote appropriate and efficient use of natural resources, and the protection of human resources and the environment.

With the White Paper and the Polkowane Declaration, South Africa has committed to implementation of the advanced, integrated solid waste management which, if executed as planned, should enhanced environmental protection, recover valuable materials and reduce the rate of waste generation.

~~13.~~synopsis OF STUDY FINDINGS IN RELATION TO THE BANK'S MUNICIPAL WASTE MANAGEMENT POLICIES

A literature review of waste management practices and case studies have formed the basis for the integrated waste management initiatives in the African Development Bank's urban development projects. It is advantageous to synthesize study findings in relation to the Bank Group's (BG's) strategies to alleviate SWM's problems in its client countries.

The overall objective of the solid waste management project is to establish sustainable systems which meet the needs of all citizens, including the poor. To develop sustainable and effective waste management programs, strategic objectives and strategic issues have to be identified. Highlights of the conceptual framework for solid waste management projects incorporating strategic objectives and strategic issues presented by Schübeler (1996) is shown in Table 13.1.

Table 13.1 Overview of the Conceptual Framework for SWM

Strategic Objectives					
Political	**Institutional**	**Social**	**Financial**	**Economic**	**Technical**
Determine MSWM goals and priorities	Devolve responsibility *and* authority for MSWM to local governments	Orient MSWM to the real needs of people, including the poor, women & children	Establish practical and transparent cost accounting and budgeting systems	Promote economic productivity & development through adequate MSWM service	Achieve low life-cycle cost of waste management facilities and equipment
Define clear roles and jurisdiction for MSWM	Establish effective municipal institutions for MSWM	Encourage proper waste handling patterns by the population	Mobilise adequate capital investment resources	Environmentally sound waste collection, recovery and disposal	Technology that facilitates user and private sector collaboration
Establish an effective legal and regulatory framework	Introduce appropriate management methods, procedures and service targets	Raise people's awareness of MSWM problems and priorities	Raise sufficient revenues for recurring expenses —ensure adequate O&M	Ensure long-term economic effectiveness of MSWM systems	Ensure that technical systems effectively limit environmental pollution
	Build municipal capacity for MSWM	Mobilise community participation in local waste management	Improve the efficiency and reduce costs of MSWM service	Promote waste minimisation and material efficiency	
	Increase efficiency and through private sector involvement	Protect health and socio-economic security of waste workers		Generate employment and incomes in waste management	
	Extend lower cost MSWM service through community participation				
Strategic Issues					
Relative priority of collection services in relation to safe waste disposal	Optimal distribution of functions and responsibilities?	Adaptation of waste management services to the needs of poor households and women	Failing incentive of local institutions to use available cost accounting methods	Trade-off between low-cost waste service and environmental protection	Coherence of technical systems in spite of differing requirements and decision makers
Priority attributed to waste minimisation —reduction and recovery	Devolution of MSWM responsibility in spite of limited local government capacity	Effectiveness of awareness building or direct community involvement	Use of collected revenues for the intended MSWM purposes	Control of industrial and hazardous waste in spite of small, scattered sources	Estimation of life-cycle costs of technical alternatives
Meeting the service needs of irregular and illegal settlements	Involving local governments in system planning and development	Equity of MSWM service access to the poor	Incorporating incentives for cost reduction and efficiency	Trade-off between efficiency of waste service and employment creation	Appropriate standards for sanitary landfill design and operations
Mix of instruments for waste management: regulations, incentives and/or motivations	Responsiveness of waste management to real needs and demands	Collaboration with and support of informal waste workers			
Contribution of ESAs to MSWM policy formulation	Raising the professional standing of waste managers				

~~13.1~~Bank Group's Policies on Solid Waste Management

During the last ten years waste management has evolved as an important component of environmental control. It has attracted increasing attention from bilateral and multilateral development agencies due to the mounting urgency of urban environmental problems – identified, for example, in Agenda 21, Chapters 7 and 21 – and an increasing concern for capacity building at the level of municipal management (Schubeler, 1996).

The Bank Group (BG) has supported several programs and partnerships to help build mechanisms for consensus building, for consultation among a range of stakeholders, and for the coordination of cross-sectoral policies and measures. The Urban Management Programme (UMP) sponsored by the World Bank, the United Nations Development Programme (UNDP), and the United Nations Centre for Human Settlements (Habitat), supports case studies, research, and partnership activities in order to assist cities and towns in developing countries. The Metropolitan Environmental Improvement Programme (MEIP), established by the UNDP and the Bank and supported by several donors, has assisted several Asian and African cities to find and implement practical solutions for rapidly growing environmental problems. The MELISSA program, developed by the World Bank's Africa Region, supports and facilitates the improvement of the local environment through partnership development and knowledge management.

The BG has financed a wide range of projects in various member countries administered by Water and Sanitation, Urban Development, and Water Resources Management sectors. The solid waste management sub-sector has played a secondary role in the BG's fiscal policy. Nevertheless, the BG recognizes that solid waste disposal, especially in urban areas, is necessary to ensure health and the quality of life (ADB, 1989). The BG encourages member countries to incorporate provisions for the collection and disposal of solid waste in water supply and sanitation projects.

Solid waste management is a key responsibility of many City governments and has been an area of BG's assistance in the form of analytical work and urban investment for many years. The Strategic Solid Waste Management Program has generated a range of practical and analytical tools for planning, and there have been investments for waste management activities across the Bank's regional vice presidencies. The latter investments often address waste collection and disposal problems but now increasingly support more comprehensive approaches to waste management.

In the years since the UN Conference on Environment and Development in 1992, the Global Environment Facility (GEF) has emerged as a facilitator and a funding mechanism for integrating global concerns into the development process. The GEF currently covers four focal areas: biodiversity, climate change, international waters, and the ozone layer.

Recently, the WBG defined in its Urban and Local Government Strategy the "livable" City as defined in terms of a healthy and dignified living environment (World Bank, 2000). The livable City requires addressing the sources of environmental degradation, enabling access to basic shelter and environmental services for the urban poor, and reducing the vulnerability of poor people to environmental hazards. The strategy proposes an agenda for working with both national and local governments to develop cities that are livable, well governed and managed, and financially sustainable. Where environmental problems are identified as priorities, an urban environmental management strategy can be developed, leading to issue-specific action plans such as solid waste management. This can be done within the City Development Strategy (CDS), A common approach for achieving this objective is laid out in *Toward Environmental Strategies for Cities* (Bartone *at al*., 1994).

The overall goals of the Bank Group's (BG's) municipal refuse management projects are to:

- Improve and safeguard the public health and welfare;
- Reduce waste generation;
- Increase resource recovery and reuse; and
- Protect environmental quality.

Specific objectives of solid waste projects are compatible with objectives staged for other sectors serving basic needs of the urban public:

- Providinge universal access to an acceptable level of service;
- Building an institutional arrangement which has the capability to perform continuous planning of solid waste systems to conform with the continuously changing urban setting;
- Supplying the institution with the equipment, facilities and skilled personnel to administer and perform waste management to an acceptable service delivery standard; and
- Developing a system of generating financial resources to meet operating, maintenance and depreciation costs of existing systems, as well as the investment costs for expanded or improved systems.

These goals and objectives are to be pursued within the framework of developing a solid waste project. Outside this framework, municipal projects themselves may

help to address MSWM. For example, with-in the context of a water supply and drainage project, a solid waste component may be vital to the realization of the projected health benefits assessed for the improved water supply and drainage. In additionAlso, for increased drainage and sewage (attributable to increased water use) to flow freely, refuse collection must be adequate to maintain open drains and sewers. Another example: within urban development projects there are low-cost loans and basic infrastructure are provided as incentives for low-income neighborhood residents to upgrade their area.

At present, solid waste is viewed as a source of valuable materials for compost manufacturing, recovery of metals, glass, paper, high density plastics, methane generation, etc. On the other hand, some types of solid waste such as those being toxic, infectious, hazardous and industrial are particularly dangerous to the public and the surrounding environment. Complicity of waste management and its exponential increase in its quantity calls for full recognition of the SWM importance in BG's financing of urban projects.

13.2Integrating Solid Waste Management Initiatives in the African Development Bank's Urban Development Projects

The African Development Bank Group's mission is to fight poverty in Africa with lasting results, which is inextricably inescapably linked to environmental protection and improved management of renewable natural resources. African livelihoods and national economies rely mainly on agriculture and on extraction of mineral and biological resources, and there are few alternatives or options to compensate when these are lost. In both rural and urban settings, it is the poor who are most affected by the loss of natural resources and the deterioration of environmental services and who are most at risk from natural disasters that can be aggravated by environmental degradation. Currently in Africa the natural resource base is steadily deteriorating, with some of the world's highest rates of soil degradation and with loss of forests, rangelands, wetlands, and fish and wildlife populations.

Mainstreaming the environment into the Bank's overall operations remains an important challenge. Reviews of efforts to integrate the environment into countries' economic development programs have provided important lessons, including:

- The need for longer time frames to support institutional development and environmental action;
- The need for institutional capacity building in order to take into account the changing roles of government, civil society, and the private sector;

- The need to continue the environmental assessment (EA) process into the implementation phase by strengthening the implementers' capacity to carry out environmental management plans and by monitoring impacts;
- The risk of isolating the environmental agenda from overall development priorities by "sectoralizing" it through isolated environmental planning processes, programs, and funds;
- The risk of creating a "supply-driven" mentality by imposing external conditionalities rather than building local constituencies; and
- The risk of creating overly ambitious and ultimately ineffective institutions by providing temporary external funding at levels that cannot be sustained.

The analysis of BG's currently deficient policies pertaining to solid waste management calls for upgrading SWM to the sectoral level. The SWM have to be integrated into the Bank's Operations Manual. As well, issues of waste management have not been clearly addressed within the strategic plans of the BG. For example, ADB's Three-Year Strategic Plan and Work Programme (OESU, 1999) does not bring up SWM in Training and Capacity Building nor in Operational Activities. It is the study consultant's view that the PSDU is understaffed so that the Bank's missions do not have enough resources ~~or~~ and that mission duration is inadequate to appropriately address SWM problems. The Bank's water and sanitation experts traditionally have not incorporated SWM in the TORs for preparation of missions, with the one exception of OCDS (Malawi: Integrated Water Supply and Sanitation) ~~that has~~which included a TOR for SWM.

A study of SWM practices in Cairo, Nairobi and Accra described in this report concludes that the SWM subsector is handled not at a line-ministry level but it is within the responsibility of a local governments in virtually ~~in~~ all of the instances. Local governments consume between 20% and 50% of municipal budgets. MSW is a complex task that depends as much upon organization and cooperation between households, communities, private enterprises and municipal authorities as it does upon the selection and implementation of suitable technical solutions for waste collection, transfer, recycling, composting and disposal. The various needs of providing service may be handled under one cleansing agency or a combination of agencies, i.e., public works, mechanical engineering, and health. In either case, the responsibilities fall within so-called line agencies of urban management and not within peripheral agencies created for special needs, i.e.~~,~~ housing or transportation. An attempt to improve the institutional and financial capability of the urban management entities providing cleansing services inherently involves some effort of improving the overall urban management system.

The potential for spin-off benefits to municipal administrations derived from solid waste management improvements is particularly applicable to the financial aspects. As revealed during project visits to Accra and Cairo, money for providing collection, transfer and disposal of refuse usually comes from the general municipal

revenues. Direct user charges for refuse service are not common for two reasons: residents see refuse service as a basic need which the municipality has a responsibility to meet within its general directive, and there are no viable means of shutting off service to a resident who doesn't pay his bills. In those few instances where direct charges are levied, and are collected in an efficient and effective manner, the bills are tied in with provision of service which can be curtailed upon lack of payment: i.e. water supply. Therefore, provision of financial arrangements which support a solid waste activity almost invariably involve the following:

- Reviewing the municipal tar [?]assessment activities;
- Reviewing the projection of municipal needs and the subsequent planning of revenue generation;
- Reviewing adequacy of the municipal accounting system; and
- Reviewing the municipality's approach to planning and providing allocations of revenue resources to the various needs of the urban area.

Performance of these reviews, coupled with recommendations to improve each of these activities within municipal financial management, is essential to the success of the solid waste projects and provides benefits indirectly applicable to the success of urban development projects.

Based on the case studies described in this report, three SWM models could fit a typical African City at three different community income levels:

- High income community: Cape Town, South Africa
- Medium income: Nairobi, Kenya
- Low income: Tema and Accra, Ghana

To achieve sustainable and effective waste management, development strategies must extend beyond purely technical considerations in formulating specific objectives and implementing appropriate measures with regard to political, institutional, social, economic and technical aspects of SWM. The PSDU might opt for adopting relevant sections of existing publications such as *A Project Guide for Environmental Management of Urban Solid Wastes in Developing Countries* (Cointreau, 1982), *Conceptual Framework for Municipal Solid Waste Management in Low-Income Countries* (Schubeler, 1996), and other relevant documents, including a 2001 issue of CD ROM titled *Strategic Planning Guide for Municipal Solid Waste Management* prepared by David Wilson, Andrew Whiteman and Angela Tormin, Environmental Resources Management for the Collaborative Working Group. The CD ROM can be ordered on line at http://www.worldbank.org/infoshop/. The Guide's purpose is to provide comprehensive information, supporting methodologies and tools to assist the development of Strategic MSWM Plans at the local and regional level. The primary target audiences are~~is~~ municipalities and regional authorities in developing

countries and economies in transition, but much of the material in the Planning Guide will also be relevant and of use to all countries.

~~13.3~~Project Guide Framework for Solid Waste Management

The solid waste management project guide is useful in project preparation, appraisal and implementation of Bank-financed solid waste projects or in the process of integration of waste management concepts into sanitation or urban development projects.

The World Bank has had many different types of solid waste projects. Most of these have been components of larger projects, but some have been separately developed and implemented. A solid waste management project cycle usually include six basic components, or any combination of the following:

- Identification
- Preparation
- Appraisal
- Negotiation
- Implementation and supervision
- Evaluation

In general, the ADB Task Managers are ~~staff is~~ well familiar with the project cycle ~~because~~ since ~~of~~ the above components are commonly used in most of the Bank projects. However, they are some specifics pertaining to SWM projects. They are described in the World Bank Technical Paper No. 5 (Cointreau, 1982) which is enclosed as Appendix 3.

A number of issues must be addressed in preparing solid waste management projects. This includes establishment of an acceptable standard of collection and disposal service delivery, selection of appropriate technology, development of suitably phased action plan, arrangement of institutions (including private sector) for planning and management, arrangement of financial resources, development of regulatory and enforcement framework, provision of public education and participation programs, and incorporation of incentives and disincentives to facilitate project success (Cointreau, 1982). Technical components which have to be addressed in project preparation include:

- Estimation of waste quantities per capita and overall;
- Prediction of waste characteristics which is strongly related to income levels and economic productivity;

- Planning of pre-collection services, usually some type of door-to-door activity;
- Collection and transport to a discharge point;
- Assessment of the potential for resource recovery of materials and energy;
- Disposal means at controlled landfills or other facilities; and
- Identification ~~for~~ of equipment and facilities ~~needs required~~ requirements for collection, transfer and disposal.

Preparation and appraisal of a SWM project can be ~~done~~ implemented by PSDU staff or by a solid waste specialist. In any case Terms of Reference should be available to assure that all the tasks will be addressed. Sample Terms of Reference for preparation and appraisal stages for the consultant are~~is~~ shown in Appendix 4.

One of the most important components of project preparation is collection of qualitative and quantitative waste data. This task can be completed with aid of the waste management questionnaire which has been developed for the ADB during the early stage of the project. A copy of the questionnaire is provided in Appendix 5. In addition, more comprehensive data collection and financial analysis worksheets used by World Bank project officers ~~is~~ are enclosed in Appendix 6 (source: The World Bank Urban Development Technical Paper No. 5).

It is concluded that every project for solid waste management is unique, hence it is difficult to develop a specific project guide which would ~~fit all~~be applicable for all projects. In some cases the SWM may involve resource recovery or design and construction of composting facilities, in others there might be a need for waste collection vehicles or for the design and implementation of an integrated waste management system. Consequently, the level of effort and financial requirements varies from one project to other. ~~By providing comprehensive literature review, detailed analyses of four main African municipalities and presenting project guide framework for SWM projects with reference to World Bank guidelines, this study fulfill the task of guiding the ADB Task Manager in designing of waste management projects or in the integration of waste management concerns into sanitation or urban development projects.~~
Through the provision of a comprehensive and thorough literature review, a detailed analysis of four major African municipalities and the presentation of a SWM project framework with reference to World Bank guidelines, this study should fulfill the task of guiding the ADM Task Manager in the design of waste management projects or the integration of waste management concerns into sanitation or urban development projects.

CONCLUSIONS

The specific solid waste management topics covered by the literature survey include: (a) waste generation and characterization; (b) collection/transportation; (c) processing; (d) disposal; and (e) socio-economic and institutional policy of waste management.

Available literature and bibliographies have been assessed as far as possible relative to: (a) geographical area and time period covered; (b) conceptual approach; (c) type of data used; (d) methodological approach; and (e) main substantive findings.

It should be emphasized that existing waste data, including both generation rates and composition, should be considered with a degree of caution due to global inconsistencies in definitions of common terms and methodologies. In most low and middle income countries, the reliability of solid waste data is further reduced by large seasonal weather variations, incomplete waste collection and disposal and a lack of weigh scales at landfill sites to record waste quantities. For example, significant level of waste is disposed directly by the generator by burning or throwing in waterways and low lying areas.

General conclusions based on the available literature reviewed in this report are summarized as follows:

(1) Solid waste management in most developing countries is characterized by inefficient collection methods, insufficient coverage of the collection system and improper disposal of municipal solid wastes.

(2) No country has specific waste management legislation, although legislation is being drafted now in some countries.

(3) Usually integrated waste management is not implemented; very little information is available on composting, controlled sanitary landfills and the recovery of the landfill gas.

(4) No differentiation is made in the collection of different types of waste, although some municipalities have implemented higher taxes for commercial waste.

(5) The informal sector represents a significant part of the economy, and waste recuperation and recycling is an important economic activity.

(6) Investment for waste management is always inadequate, and real costs are never fully recovered.

(7) Two key alternatives of waste management are currently favored: decentralized approaches and privatization. Privatization in particular is considered a viable option for urban, high-income, formal settlements.

(8) In order to be successful and sustainable, any future investments in equipment and in technology must be preceded by background studies and surveys of the solid waste management situation to assure that the use of means is best suited to the capabilities of the countries and their people.

(9) Education and communication channels between sectors, especially government and civil society, are considered to be inefficient and inadequate. A lack of a right to know, secrecy and misinformation have also been major contributory factors to poor waste management practices in many African countries.

Of concern is the current lack of regulatory initiatives to manage waste minimization, with the potential for reducing the hazardous waste problem.

In Egypt approximately 10 to 15 million tons of solid waste is generated annually with Cairo contributing more than 3 million tons. Waste collection and transportation efficiency ranges between 15% and 65%. In Cairo approximately 1/3 of solid waste is not collected.

Gaps and weaknesses of waste management in Cairo include:

- Alternative mechanisms for collection of service charges are not yet in place yet and available financial resources are not known;
- Appropriate final treatment and disposal facilities, especially landfills, do not exist;
- Lack of full recognition by authorities of the important role of local companies, NGOs and the informal sector (the Zabbaleen);
- Long-term and focused awareness campaign has not been implemented; and
- Technology transfer programme to support co-manufacturing of solid waste technologies yet to be introduced.

Waste management services have already being privatized. Currently, the Governorate of Cairo has tendered for integrated solid waste management systems for two districts and has already awarded two major contracts for integrated waste management in two other districts of Cairo. The Governorate of Alexandria has contracted an international firm for 15-year waste management services.

Intensive, innovative and efficient waste recovery, reuse and recycling operation is run by the Zabbaleen, a group of over 50,000 people traditionally involved in the

business waste collection and processing. They recover/recycle up to 80% of waste. African countries could profit from the Zabbaleen experience by importing their know-how and waste processing equipment to improve low cost waste management practices.

Cairo has well developed, modern composting plants set up by the government and rented out to the private sector. By the year 2000, there were less than 10 composting plants in Cairo and 25 plants nationwide. It is expected that in the next year 25 new composting plants will be commissioned. Foreseen capacity of some of them will be as high as 1,000 tons per day. Egyptian composting plants have a chance to become a model for other African countries because of their modern design, low cost, high efficiency and satisfactory operation records.

In Nairobi, the capital city of Kenya, daily rate of solid waste generation is approximately 1,600 tons. Waste collected by the municipality on a regular basis amounts to 1/3 and periodic collection deals with the remaining 2/3 of waste. Approximately 70% to 80% of solid waste remains uncollected. The municipality operates 15 to 19 waste collection vehicles daily. There is a high vehicle immobility rate, up to 70%, due to shortage of spare parts and an insufficient operating budget. The municipal staff carries out manual street sweeping. Mechanical street sweeping is not offered at this time.

The private sector is involved in waste collection and disposal. Approximately 50 tons of municipal solid waste is removed daily by private operators such as BINS (Nairobi) Services Ltd. and Kenya Refuse Handlers. The companies generate income from collection fees and contracts with the NCC.

Solid waste recovery and recycling is carried out by many of Nairobi's poor who engage in waste picking as a means of income generation. The estimated quantity of recovered and recycled items ranges from 20 to 30 tons per day. The NCC does not operate any transfer station or composting plant where commercial waste recovery / recycling could be implemented.

All solid waste, except medical refuse, is disposed at the Dandora dumpsite. The site is managed by the NCC and provided with heavy equipment to manage waste disposal. The Dandora site is not fenced and is therefore accessible to scavengers, recovery operators and cattle growers. Waste cover is not implemented and neither is landfill gas recovery or flaring.

Waste management stakeholders in Nairobi include various NGOs, CBOs, the private sector, the NCC, the Department of Environment and its Cleansing Section, the Ministry of the Environment and Natural Resources, and the Ministry of Local Government.

In August 1998, the NCC identified following priority waste projects:

- Institutional reconstructing and financial reform;
- Construction of a new workshop at Kaloleni;
- Introduction of container system with side loaders, dump trucks, etc.;
- Construction of a new sanitary landfill site at Ruai (first stage);
- Procurement of heavy equipment for the new landfill;
- Closing of the existing dumpsite at Dandora;
- Implementation of the Community Waste Management Project; and
- Construction of waste transfer station.

The cost of priority projects will be Kshs 2.3 billion (US$30 million). In the case that the revenue necessary to implement the projects will be insufficient due to financial constrains, some of the projects may have to be deferred to the next implementation stage.

Accra, the largest City in Ghana, has a population of 1.4 million, which is growing at an estimated rate of four percent, and occupies around two percent of the total land area of Ghana. Accra is divided into five administrative districts. Within these districts the City is arbitrarily divided into three zones populated by high-, medium- and low-income groups. Solid waste composition is strongly correlated to income levels and economic productivity of each group. Within the high income class, there is a greater content of organic components and packaging material such as paper and a lower content of inert or residue. The low income group utilizes solid fuels for cooking, resulting in ash addition to inert / residue waste content. According to Accra municipality officials, the average waste quantity generated in Accra is 1,500 tons per day. Approximately 200 tons of organic waste is directed into Accra's composting plant and 300 tons is left uncollected. The remaining 1,000 tons is transferred to the Malami dumpsite.

Solid waste collection and disposal in Accra is in the hands of one company, City & Country Waste Limited (CCWL). In 1999, Accra Municipal Assembly (AMA) awarded exclusive right for waste management to CCWL, initially for five years, with possibility of extension for another five years. CCWL subcontracted services to 11 private operators.

The CCWL provides a good service to their fleet of waste collection and transportation vehicles. The company dispatches over 20,000 household containers and over 600 large waste bins and containers, which are empted on a regular basis or when they are full.
Accra's regional, supervised Malami dumpsite is well maintained and organized. About 20 employees of CCWL maintain the site, supervise refuse discharge from trucks and the compacting process, organize scavenging activities for up to 50 waste pickers and control vehicle movement. It is anticipated that the site will be

covered by earth and closed in the near future. The new, properly designed and constructed landfill will be commissioned prior to the closure the Malami dumpsite. The new landfill is designed for up to 15 years of operation.

There is an old composting plant in Accra with the processing capacity of 300 tons per day. Because of a limited market demand for compost and deteriorating equipment, the plant is not operating at its full capacity.

No significant waste recovery and reuse activities exist in Accra. Waste pickers are involved in a small-scale recovery and reuse operation. The problem in introducing small-scale resource recovery modules that can contribute to sustainable waste management systems is more a matter of perception than of technology.

Waste collection in Tema, industrial City and port located near Accra, is organized within the Urban IV Project financed by the World Bank. In contrary to waste management in Accra, contract awards to the private sector are transparent and executed in an open-bidding process. However, the dumpsite serving Tema is not as well organized and maintained as the one in Accra. As well, maintenance and repair of the waste handling equipment (including trucks) by Tema Waste Management Department is inferior to the CCWL operations.

The problems of solid waste management in Accra and Tema cannot be treated in isolation - they are inseparably linked with municipal policy on waste management, effluents from the informal sector, sanitation, education and involvement of the public. The issues underlying urban environmental degradation are more managerial than physical, e.g. lack of co-ordination, and inadequate technical and financial capacity. However, new institutions are not needed but rather a new approach of consultations and permanent coordinating arrangements as embodied in the Accra Sustainable Programme. Existing environmental problems are also exacerbated by Accra's spatial and population growth resulting in a focus on unplanned settlements.

Relatively advanced solid waste management system is operational in Cape Town, South Africa, with a population of 3.4 million. The total amount of waste accounted for disposal in Cape Town is around 2 million tons per annum. The major concern is that waste generation rates could rise with economic growth and rising standards of living and quickly exceeds the capacity of existing and planned waste facilities in Cape Town. It is anticipated that the overall waste generation rate will increase by nearly 20% to 1.98 kg/capita/day over the 30-year planning period, with most of the increase occurring in domestic waste generation.

More than 95% of domestic, trade, industrial and hazardous waste is landfilled, which remains the most widely used method in South Africa and is still the cheapest option. The total amount of available space in existing landfills within the

CMA is estimated to be 19.6 million m^3. There are privately owned landfills in South Africa. Many are associated with industrial and hazardous waste. However, a few are owned by private collection services. In general, however, private ownership and/or operation of SWM facilities are rare in Africa. It is apparent that the most practical means for future landfill development is likely through the private sector. National waste management companies that have the capability to develop such a regional landfill exist.

A system of transfer stations is proposed to serve the entire CMA. These stations are designed at locations close to major roads and rail, and the collection areas that each station will be serving. A total of 13 transfer stations are anticipated to handle the futures wastes for disposal. Of these, 12 transfer stations will be new.

Recycling of materials from domestic, commercial and industrial wastes, such as metal, plastic, glass, and paper, composting of domestic waste, and the beneficial reuse of wastewater treatment plant sludge account for approximately ¼ of the total solid waste stream in Cape Town. Most of the recycling occurs in the industrial sector.

Waste stakeholders in Cape Town include the governments, private sector, NGOs and the general public. The government enacted a legislative body, the Consultative National Environment Policy Process (CONEPP), to address integrated waste management. In addition, the South African Department of Water Affairs and Forestry and the country's Department of Environmental Affairs and Tourism are jointly involved in the process of developing a comprehensive waste management strategy.

South Africa has a well developed waste management industry able to serve the needs of the country. A new, modern approach to integrated waste management policy is demonstrated in the White Paper on Integrated Pollution and Waste Management for South Africa and in the Polkowane Declaration. The last commits South Africans to reduce waste generation by 50% and disposal by 25% by the year 2012, and to work towards zero waste by 2022.

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