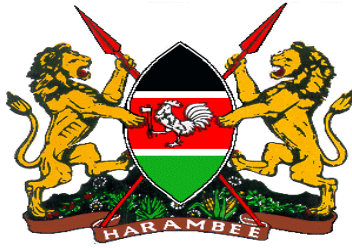


REPUBLIC OF KENYA



COUNTY GOVERNMENT OF BOMET

BOMET MUNICIPALITY

**Draft County Sessional Paper No.... on Integrated Solid Waste Management
(ISWM)
For Bomet Municipality**

November, 2020

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Preface

Foreword Acknowledgements

Glossary or definition of terms

Abbreviation/Acronyms

1.0 INTRODUCTION

1.1 Background

1.2 Rationale

1.3 Benefits

2.0 A FRAMEWORK FOR CHANGE

2.1 Policy framework

2.2 Priorities

2.3 Vision

2.4 Goal

3. THE POLICY INSTRUMENT

3.1 Policy statement

3.2 Guiding principles

3.3 Policy objectives

4. INTEGRATED SOLID WASTE MANAGEMENT

4.1 Introduction

4.2 Waste categories and hierarchy

4.3 Situation analysis

4.4 Strategies and plans

4.5 Legal and institutional framework

5.0 FINANCE AND ECONOMICS

5.1 Introduction

5.2 Costs

5.3 Waste disposal economics

5.4 Investments

5.5 Financing mechanisms

6. STAKEHOLDER PARTICIPATION

6.0 IMPLEMENTATION FRAMEWORK

6.1 Institutional Framework

6.2.1 Responsibility and Accountability

6.2.2 Role of the County Government

6.2.3 Role of the Executive and CEOs/HODs

6.2.4 Role of Sub - County Administrators

6.2.5 Role of stakeholders

6.2.5. Role of private sector

6.2.6 Role of the Financial Institutions/Donors

6.1 Public participation

6.2 Private sector participation

6.3 Public education and awareness

6.4 Capacity building

7.0 ACTION PLAN AND IMPLEMENTATION

7.1 Introduction

7.2 Action plan

7.3 Stakeholder mandates

7.5 Strategies and measures

7.6 Implementation matrix

8. 0 PARALLEL SUPPORT

8.1 Land use and physical planning

8.2 National policies and others

8.3 National and donor support

9. 0 MONITORING AND EVALUATION

9.1 Stakeholder roles

9.2 Monitoring and Evaluation

9.3 Policy review

10. THE WAY FORWARD

Annex I: Steps in Feasibility Studies and Master Plan making process

Annex II: Guidelines for Solid Waste Development Policy

FOREWORD

The County Government of Bomet is over 2 years old since devolution. The County Governments Act, 2012, ushered in a new era of planning in the entire County system of management of its affair. Part XV of the Act stresses the need for each County to develop a County Integrated Development Plan that shall form the basis for all kinds of development in the County.

Every development, however, will bring about tremendous changes/activities to the County; hence increase in incidence of Solid/Liquid (effluent) Waste Generations. This Scenario has necessitated the development of a Solid Waste Management Strategy, hence this policy.

In this regard this policy will assist all the actors in the sector to address the issue of generation and disposal of Solid waste in their day-to-day operations. As the activities continue to grow in the County, a policy to assist in management of urban affairs with regard to generation and disposal of Solid Waste is imperative especially in categorization of wastes.

Wastes will be categorized on the basis of generation; arising from various land uses and developmental activities. This will enable all concerned to play their roles effectively.

The policy will be a basis for future planning and resource mobilization. It will also be a basis for engagement of various stakeholders in Solid Waste Management throughout the County. It will therefore be accompanied by appropriate guidelines to ensure that development activities in the County meet the expectations of the County residents, as well as, ensure clean and conducive environment. In most developing countries across the world, the menace of Solid Waste is real and it has affected their way of living by denying them an opportunity to enjoy a healthy environment. My Government will take necessary steps to address this challenge. This policy forms and presents that basis. It has highlighted a series of approaches that will ensure we deal with Solid Waste at the earliest stage. We need therefore, to be alive to the fact that Solid Waste can otherwise be reused, recycled or reduced to make the approaches advanced in this policy effective.

Our ultimate goal is to have a town that is free of mounds of Solid Waste littering the towns of the County. To achieve this, this policy alone without concerted efforts of all stakeholders, may not amount to much.

In view of this, I wish to call upon all those concerned to cooperate and forge a concerted front to deal with Solid Waste in the County as outlined by this policy.

Finally, I extend my gratitude to those who were involved in coming up with this policy. I look forward to full cooperation to realize the goal of this policy.

**County Executive Committee Member (CECM)
County Government of Bomet**

PREFACE

This policy is one of the key policy frameworks that the County Government has embarked on. It is indeed one of the key milestones that will underscore proper management of Solid Waste in the County.

It has been subjected to a rigorous process, including stakeholders' consultation, and I am sure this will bring about a collaborative spirit and team work in ensuring our towns are clean and free of hazards.

Solid Waste, as has been clearly captured by this policy comes about as a result of economic growth, where all human activities contribute to this. If not well taken care of at the earliest, Solid Waste can prove difficult to manage and it can lead to disastrous consequences. These consequences come in form of pollution to the environment and in some case assume a series of a health hazards, particularly during rainy season.

This policy also elaborates various mechanisms that could be adopted for Solid Waste Management. An integrated approach is critical in achieving desired results. Various programmes, aimed at revenue generation and investment in this policy have also been highlighted.

I wish to therefore record my deepest gratitude to all those who participated in coming up with this policy. It is an opportune time for all those concerned to live up to the guidelines outlined in this policy. When fully implemented, it will yield a better environment in all environs of Bomet County.

My gratitude also goes to my colleagues who gave critical comments towards finalization of this policy. My call is for all of us to cooperate in delivering quality and efficient service to the County citizenry through this policy.

County Executive Committee Member

EXECUTIVE SUMMARY

Article 184 of the constitution of Kenya mandates management of urban areas and cities to County Governments. This was followed by other legislations mainly the enactment of Urban Areas and Cities Act, 2011 which gives effect to this article. The Act provides principles of governance and management and also calls for integrated development planning for which Solid Waste Management Policy (SWMP) will be part of.

The development objective of the SWMP for the County Government of Bomet (CGB) is to improve solid waste management (SWM) services in the County through provision of more efficient, environmentally and socially sound waste management systems. This policy has five thematic areas namely: ***the policy instrument, integrated SWM, finance and economics, stakeholder participation and monitoring and evaluation (M and E).***

This policy sets a clear direction for the department of Public Health and Environment in SWM in terms of providing a *vision, recommending legislation, calling for strategic collaborations, seeking for a master plan and facilitating M and E.*

1.0 INTRODUCTION

In general terms, waste management is the generation, prevention, characterization, monitoring, treatment, handling, reuse and residual disposition of wastes whether liquid or solid. The term usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, the environment or aesthetics.

1.1 Background

Waste management practices are not uniform among countries, counties, regions and sectors. For this reason, the CGB through the Bomet Municipality is developing a policy to address the dynamics of SWM in urban centers within the County.

1.2 Rationale

As cities and towns grow economically, business activities and consumption patterns rise solid waste quantities hence increase correspondingly. Therefore, a comprehensive policy framework is needed for towns and urban areas to link public health, environmental, privatization, decentralization and economic instrument policies to the needs of the solid waste sector so that they are mutually supportive.

1.3 Benefits

With rational and consistent waste management practices there is an opportunity to reap a range of benefits which include; *improvement of economic efficiency, reduction of adverse impacts on health by proper waste management practices, reduction or elimination of adverse impacts on the environment and enhancement of inter-generational social equity.*

2.0 A FRAMEWORK FOR CHANGE

2.1 Policy Framework

A policy framework is the CGB's response to the growing challenges of SWM. It creates a blueprint for planning and supporting economic, spatial and cultural aims, encouraging full stakeholder support and participation, protecting public health and environment and enhancing effective implementation and monitoring.

2.2 Priorities

The scale and complexity of addressing growing solid waste stream has signaled the need for a policy. Therefore, some of the key priorities include reducing the risk to public health and the environment, establishing institutional arrangements that comprehensively and effectively address solid waste and enhancing opportunities for wider stakeholder collaborations in SWM.

2.3 Vision

The policy sets forth a vision for sustainability of towns and urban areas. A sustainable community that seeks a better quality of life for current and future societies by maintaining nature's ability to function over time. It minimizes waste, prevents pollution, promotes efficiency and develops

resources to revitalize local economies. The waste management system is a component of the infrastructure of a sustainable community.

2.4 Goal

The overall goal of SWM is to collect, treat and dispose of solid wastes generated by all urban population groups in an environmentally and socially satisfactory manner using the most economical means available.

3.0 THE POLICY INSTRUMENT

3.1 Policy Statement

The CGB recognizes solid waste as a resource that should be managed so as to ensure an improved quality of life, promote ecological integrity and encourage economic vitality in a way that facilitates sustainability

3.2 Guiding Principles

A number of overarching principles have informed the formulation of this policy statement and will guide its implementation and include respect and care of the community, life, waste as a resource, performance-based management, sustainability and maintained capacity, enforcement and effective control, regulatory tools, policy integration, legislative initiatives, accountability and stakeholder participation.

3.3 Policy Objectives

This policy sets out the aim of the CGB to gain control over the waste we generate. The policy will lend special *emphasis on waste generators responsibility, private sector initiatives, solid waste hierarchy and government stewardship*

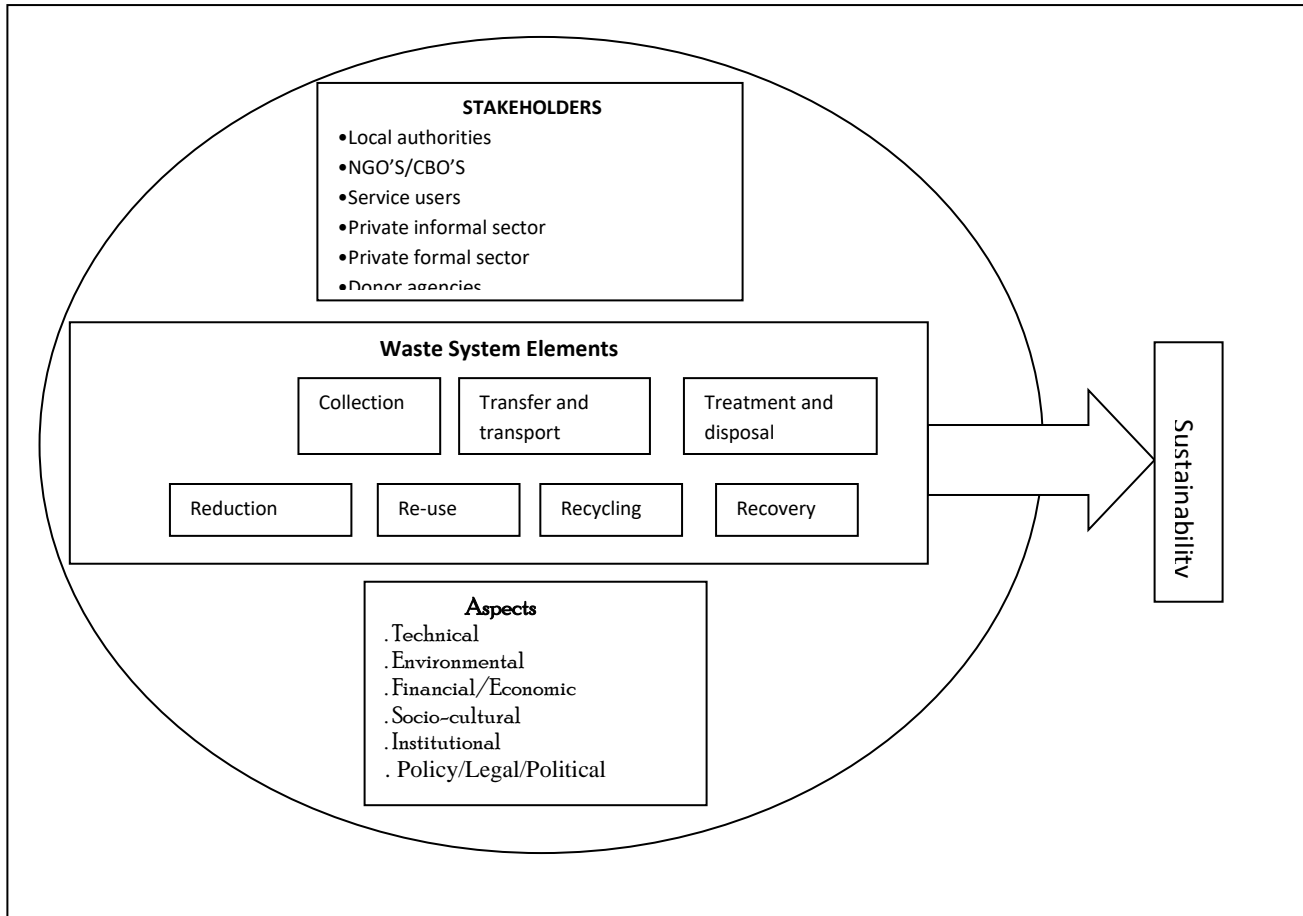
4.0 INTEGRATED SOLID WASTE MANAGEMENT

4.1 Introduction

It has become internationally accepted that the SWM problem should be addressed in a holistic manner, which is commonly referred to as **Integrated Solid Waste Management** (ISWM). ISWM recognizes three important dimensions of SWM. This is also presented in the flow diagram below, labelled as Figure I, which interactions at various levels in integrated solid waste management in the County. The actors/aspects of ISWM include:

- (a) Stakeholders,
- (b) Waste system elements, and
- (c) Sustainability aspects.

Fig. 1: Integrated Sustainable Waste Management

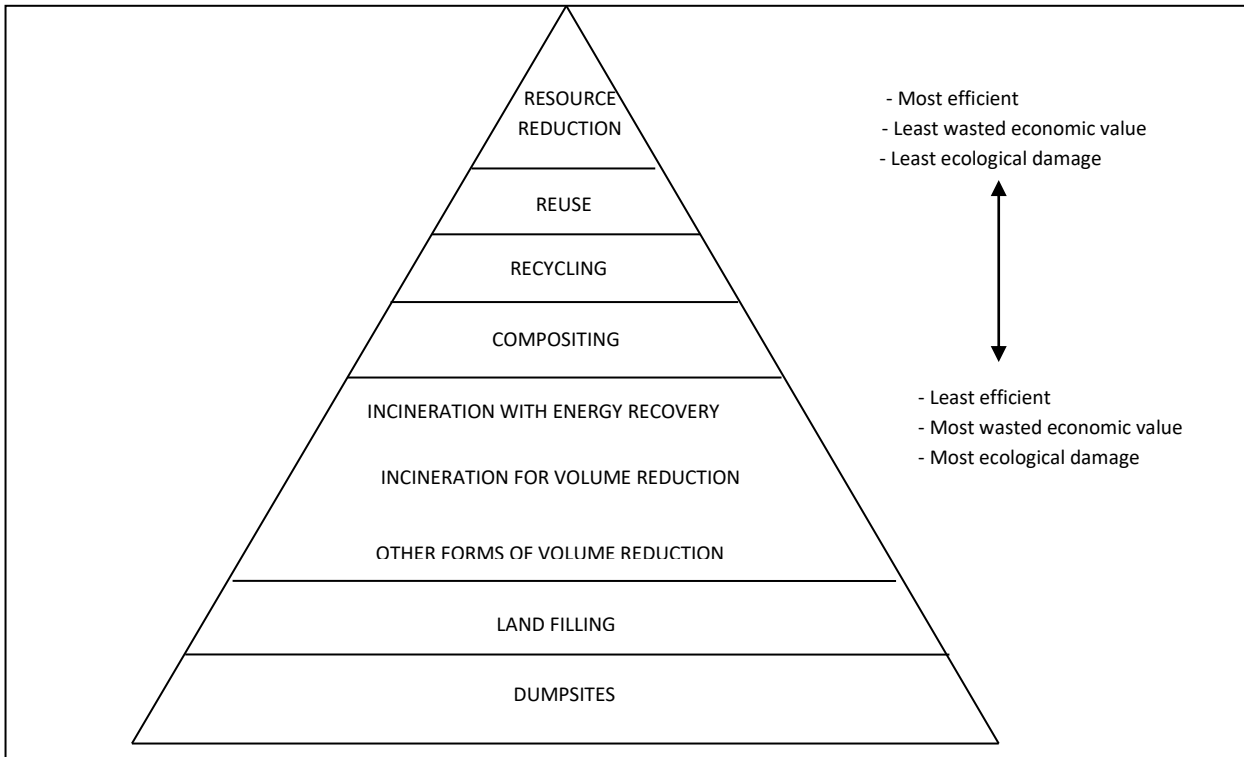


4.2 Waste Categories and Hierarchy

There are various types of solid waste including municipal (residential, Institutional and Commercial), agricultural, and special (health care, household hazardous wastes, sewage sludge). Solid waste generated in towns and urban areas of Bomet County (BC) is predominantly inorganic matters such as paper, plastics, polythene bags and old clothes in addition to organic waste food and vegetable peels. In the context of ISWM, waste is regarded both as a negative and as a useful material providing a potential source of income.

Waste management hierarchy is a tool that policy makers have used to rank waste management options according to their environment benefits. This Policy is based on the hierarchy and seeks to maximize the recovery options and to minimize disposal through open dumping, controlled disposal and land filling. Once possibilities for recovery have been exhausted, plans based on the hierarchy will favor safe disposal, limiting negative impact on the environment and natural resources as much as possible. Figure II below shows the Hierarchy of Solid Waste Management process from the most efficient to the least efficient. This is intended to guide in process selection in order to minimize wastage of scarce resources while managing solid waste in urban centers.

Fig. II: Hierarchy of Solid Waste Management in Bomet County



4.3 Situation Analysis

SWM is one of the most significant environmental problems within towns and urban areas. Its collection, storage, transportation and safe disposal is a major challenge to the town residents and the government. A mound of uncollected waste is still found mainly in the built-up areas, in the commercials, bus parks, markets and residential areas where it is generated. Many of those areas have garbage dumped in the open with the resultant health and environmental consequences. The waste blocks storm drainage system causing flooding during the rainy spells especially in Bomet County, where drainage facilities hardly exist. A closer look at major urban centres within the County reveals that, these facilities are non-PTO existent in built up areas. They need to be built in place to facilitate proper SWM.

The areas mostly affected by poor waste collection services are the CBD, bus parks, markets and low income residential areas. With the growing urban population following increased investments and effects of devolution, it is expected that the quantities of solid wastes will increase. In this regard, dynamic methods and technologies of SWM are paramount.

4.4 Strategies and Plans

Considering the aforementioned challenges in addition to lack of facilities, geographical spread and poor or lack of planning, this policy suggests strategies and plans for implementation which include but not limited to acquisition of facilities including land, carrying out feasibility studies, developing a SWM master plan, stakeholder participation and capacity building and financing mechanisms.

4.5 Legal and Institutional Framework

The County Government will adopt a framework appropriate to achieving the objectives and implementation of the actions identified and will therefore adopt that which establishes among others the authority and structure of SWM, process of formulating and implementing the master plan, timelines and liability provisions, stakeholder participation, social and environmental impact assessments in support of SWM, private sector involvement, research and development, financing options and monitoring and evaluation. This policy suggests legislations to guide SWM in the county and may be called SWM bill 2014 (later Act) to include creation of Green Fund, investment rations in SWM, domestication of Urban Areas and Cities Act, private sector involvement, revenue raising opportunities and performance monitoring and evaluation.

5. 0 FINANCING AND OPTIONS

5.1 Introduction

The long term viability of any SWM service depends, among other things, on the amount, scope and timeliness of finances.

5.2 Costs

Costs associated with SWM are upfront costs (initial investments and expenses), operating costs (operation and maintenance costs, collection and transportation costs, etc), back-end costs (e.g. public awareness costs), remediation costs at inactive sites and contingent costs.

5.3 Waste Disposal Cost Strategies

Strategies on how to reduce SWM costs and increase revenue will be implemented to enhance surplus and sustainability and include purchase of low cost equipments, facility optimization, preventive maintenance, feasibility and marketing studies, community-based initiatives and privatization.

5. 4 Investment and Options

Investments in SWM are both capital and labour intensive. The facilities, equipment and materials required include land, vehicles, waste receptacles, littering pins, incinerators and other SWM tools, equipment and materials. Staff and labour will be required as sanitation inspectors, workers and cleaners. Funds should be allocated to cater for the investment costs through Public, Private Partnerships.

5.5 Financing Mechanisms/System

Monies for financing SWM facilities may come from, among others, allocations from government(s), appropriate fees, fines and charges, contributions from waste generators, donor support in loans and grants, savings from efficiencies, privatization and certifications and permits. This policy proposes creation of Green Fund to include SWM financing.

6.0 STAKEHOLDER PARTICIPATION

6.1 Public Participation

For successful execution of any solid waste project, community participation in collection, community consultation on cost recovery and public participation in setting and design of facilities is inherently essential to sustainability. The general public will be involved in SWM.

6.2 Private Sector Participation

The government will support the participation of the private sector in SWM in three ways namely: involvement of waste generators, participation of waste management service providers and collaboration with environmental non-state actors.

6.3 Public Education and Awareness

Education and awareness also form the foundation of this policy where all stakeholders understand the need for retirement of existing habits so as to embrace new and innovative approaches in SWM. Participatory approach, public awareness programmes and communication and feedbacks will be facilitated throughout SWM process.

6.4 Capacity Building

Implementation of this policy will require broad-based capacity building at the level of county departments, private sector and non-governmental organizations. Key capacity needs will include, but not limited to, staffing requirements, disposal & collection system designs, compliance and enforcement, financing mechanisms, communication and monitoring and evaluation.

7.0 IMPLEMENTATION OF SWM PLAN

7.1 Introduction

The County Government has three key functions with regard to SWM these being maintenance, improvement and regulation. These roles with collaboration among other actors require a master plan for implementation in a decisive and timely manner.

7.3 Implementation Plan

The formulation of an implementation plan (to be contained in the master plan) will start with feasibility studies to understand the present SWM situation in terms of general special features, waste generation to disposal, institutional arrangements, technical systems, social and environmental aspects. The second level will be to document the actual implementation plan with all the necessary aspects of capacity and lastly to execute the plan.

7.4 Role of Stakeholder

Each stakeholder will have a role to play, with the County Government offering stewardship, legislation and part-financing, the private sector investing in SWM and the public participating in plan formulation and implementation. All stakeholders will be responsible in M and E of the policy.

7.5 Strategies and Measures

Policy implementation will be achieved through several strategies and measures which include, but not limited to, legal and institutional framework development, stakeholder participation, technologies and systems applications and financing and cost recovery mechanisms. The policy will consider the appropriateness of each strategy to reflect positively on the dynamic nature of waste issues, priorities at various levels, political support and legal requirements.

7.6 Implementation Matrix

Once the master plan (and thus the implementation plan) has been approved, all strategies and measures will have to be executed. The implementation of this policy shall be coordinated on behalf of County Government by the department responsible for Public Health and Environment with involvement of all stakeholders both the public and private, including development partners, among others. The matrix will contain the description of function, responsibility, period coverage, area of concern, waste quantities, cost of function and suggestions for further improvements.

8.0 SUPPORT MECHANISM

Implementation of SWM policy will follow best industry practices and lessons learnt. It will not only benchmark itself on the inter-county standards but also national and international. The County Government shall involve many actors.

8.1 Land Use and Physical Planning

SWM will be recognized as an integral part of land use and physical development planning where such planning will incorporate the objectives of the policy to include certificate of compliance with SWM practices.

8.2 National Policies and Others

Relevant legislations and policies will also lend support to the implementation process. Legislations and policies such as the devolution laws, environmental laws and policies, County Integrated

Development Plan and Medium Term Policy Frameworks among others will integrate issues relating to SWM and draw reference to this policy. International laws, treaties and conventions will also be used to standardize actions aimed at SWM in the county.

9.0 Monitoring and Evaluation Framework

9.1 Stakeholder Roles

This policy places emphasis on the stakeholder roles right from its formulation to implementation. M and E Framework is of no exception as citizens have rights to good service, information and feedback.

9.2 Monitoring and Evaluation Framework

At the national level, M and E is conducted through National Integrated Monitoring and Evaluation System (NIMES) whose aim is to improve the effectiveness and quality of tracking of implementation of various development policies, strategies and programmes. The County and lower levels M and E of projects and programmes are part of this system. This policy will incorporate an M and E framework that contains impact and performance indicators at the County and all other levels below the County Hierarchy.

9.3 Policy Review

This policy will be revisited every year so as to test the success of the vision, goals and objectives targeted during implementations. The M and E will be done against a series of criteria that would effectively measure the level of success so that lessons learnt are documented, modifications needed are addressed and responses to current demands are fulfilled.

10.0 Way Forward

The County Government must develop a sustainable system to manage waste. The policy proposes an approach that places heavy emphasis on waste prevention with the disposal component required for residual waste. Such approaches will be reflected in the master plan that will have been taken through public participation. Furthermore, this policy recommends legislation to institutionalize SWM in the county. The policy calls for wide range of actions that challenges the status quo and demand responsible behavior that would ensure a safer environment for future generations Throughout the County. ***Below are annexes that have been adopted and adapted from Solid Waste Manual prepared by the Government of Kenya for the previous Local Authorities in 2009. (This policy will become effective on the day it is approved and supersedes all previous versions)***

ANNEX I: STEPS IN FEASIBILITY STUDIES AND MASTER PLAN MAKING PROCESS

Solid waste planning is specific to each town or urban area with each planning process being unique for different places. The following steps outline the general process required to develop a Master Plan:

- ✓ Develop a profile of the planning area - Include information on population, number of households, types of business, and estimated growth rate of the tribe. Identifying transportation routes, distance to solid waste landfills and other disposal sites, and infrastructure needs. This information will help when developing cost estimates for waste management activities.
- ✓ Define the solid waste generators within the planning area - Examine the entire residential, commercial, and municipal solid waste generators in the planning area (include homes, governmental buildings, schools, restaurants, health facilities, etc.). Also, determine whether you will need to handle solid waste from the cleanup of illegal dumpsites.
- ✓ Identify existing waste management practices within the planning area - Determine where waste is currently going and how it is being disposed of. Identify any significant amounts of waste entering and leaving the planning area.
- ✓ Conduct a waste assessment/waste audit - characterizing solid waste that requires management in the community is the backbone of the whole planning process. Determining the quantity and composition of waste will allow evaluation of options and estimation of costs.
- ✓ Estimate future waste generation quantities - Estimate using the projected growth information that was gathered in Step 1.
- ✓ Develop waste handling options - once a good picture of the current situation is determined, begin looking at the waste management options available. What percentage of discards could be prevented, reused, reduced, or recycled? Does the administration collect residents' waste, or will members have to take them to a transfer station or disposal facility?
- ✓ Identify existing regional/inter-county programs or infrastructures - determine if there are potential benefits of developing or participating in regional/inter-county programs. Planners and managers usually find that it is beneficial to participate in regional solid waste advisory committees or working groups to gain an understanding of how others are dealing with their challenges.
- ✓ Develop costs for waste handling options - cost estimates should include both capital costs and operation and maintenance costs for each option.
- ✓ Compare options based on criteria defined by the urban area - look to your goals to assist in the development of criteria for comparing options and to prioritize criteria.
- ✓ Obtain approval by your respective town or urban area or other appropriate administrative unit

ANNEX II: WASTE GENERATION, DISCHARGE AND CLASSIFICATION

2.1 Waste Generation

The waste generation is usually represented by waste generation rate-the quantity of waste generated per person per day (kg/day/capital). To establish and monitor the waste generation rate is one essential data to manage the waste. But generally speaking, to know exact data of generation rate is difficult, so it is usually estimated through a random sampling survey. The generation rate is estimated by the average data of the survey result. The waste generations vary with the population, lifestyle, and economical activities of the area and seasonal events. Every urban area should carry out a baseline survey to establish the waste generation and there after monitor it annually.

2.2 Undertaking a Solid Waste Generation Survey

In order to ascertain the nature of solid waste in a town, the following steps will apply while carrying out solid waste generation survey:

2.2.1 Set and Define Objectives:

- ✓ To determine the volume required for on-site storage, transportation, transfer facilities and disposal of solid waste;
- ✓ To identify recycling/resource recovery potential of solid waste;
- ✓ To determine appropriate method of collection and disposal of solid waste; and
- ✓ To estimate the expected life span of a disposal site.
- ✓ To estimate the total cost required in facilitating collection and disposal of solid waste

2.2.2 Anticipated Output:

- ✓ Daily generation rates in Kg/person/day for residential waste and in g/esg./day for commercial waste;
- ✓ Bulk density of solid waste generated in kg/L or in kg/m³; and
- ✓ Composition of solid waste generated in percentage by weight.

2.2.3 Selection Sample Areas:

- ✓ Define several residential areas which represent different socio-economic population groups(e.g. according to ethnic groups and/or income levels: low, middle and high income groups);
- ✓ Select about 100 households for each of the residential areas defined in (1) above.
- ✓ Identify a predominantly business area where a large number of shops and offices are located;
- ✓ Select about 50 shops and offices for the business area defined in (3)above;
- ✓ Alternatively to (3) and (4), further divide the business areas into different categories such as hotels and restaurants , offices, shops and stores, workshops, and for each category select 10-20 samples;
- ✓ Collect the waste generated in the above areas once a day at a fixed time for 8 successive days to allow variation in waste generation over a week. Note that the samples on the first day will be discarded as they may contain waste accumulated from 2 or more days before.

2.2.4 Preparation:

- ✓ Transport of waste-an open (pick -up) truck will be required to transport the waste collected to the dump site where all the measurement will be taken;
- ✓ Workers-a driver and an assistant worker will be required for transportation of the waste. In addition, one or two collection workers will be required for each sample area to collect and load the waste on to the vehicle. At the dump site, two or three workers will be required to measure the weight and volume of waste, and separate it into different categories. A supervisor-cum-data recorder will also be required.
- ✓ Equipment:
 - Plastic bags -8(days) x (No. of households + No. of shops and offices);
 - Weight scale -one or two to weight the waste with an accuracy of 100grams; and
 - Buckets -a) to measure volume of waste; and
-b) to be used as a container for weighing.
 - Plastic sheet -to spread waste over it for sorting; and
 - Gloves -for workers handling the waste.
- ✓ Assignment of numbers to households, shops and offices -for purpose of data recording analysis;
- ✓ Coding of plastic bags by makers- according to the numbers signed to households, shops and offices;
- ✓ Data sheet -tentative examples are given in the annex 8.
- ✓ Survey family size and floor area -the number of persons in each household and the floor area of each shop and office will be recorded in the data sheets;
- ✓ Determination of collection route- the collection route will be recorded on a map;
- ✓ Determination of volume and weight -the volume and weight of a bucket will be measured and recorded; and
- ✓ Give instruction to workers on how they should carry out their work. Distribution of leaflet and plastic bags -a leaflet, which explain the study and requests for cooperation, together with 8 plastic bags will be distributed to each households, shop and office in the sample area.

2.2.5 Procedures:

- ✓ Collect the plastic bags from houses and shops/offices according to the prescribed collection route. In order to make this collection process efficient, the workers in each sample area may need to collect the bags and place them at a certain location prior to loading them on to the truck;
- ✓ Repeat (1) for each sample area and proceed to the dump site;
- ✓ Weigh each plastic bag and record the weight in the data sheets according to the numbers assigned to households, shops and offices;
- ✓ Select randomly 25 plastic bags from those collected in each sample area and record the households or shops/offices numbers of these bags in the data sheets for volume measurements;
- ✓ Open these plastic bags and empty the contents into the bucket until it becomes full. The bucket will then be emptied and the contents will be spread over the plastic sheet. Repeat this process until all the bags for each sample area are emptied and count the number of bucketful loads, which will be recorded for the volume estimation;
- ✓ Separate the waste on the plastic sheet into different types (e.g. vegetables (putrescible matter), bones, paper, textiles, plastics, grass/leaves/wood, leather/rubber, metals, glass/ceramic, miscellaneous). The separated waste will be put into different buckets for weight measurement.

- ✓ Measure the weight of each type of waste and record it in the data sheet. (Annex 8.);
- ✓ Dump all the waste properly and clean the equipment used; and
- ✓ Repeat (1) to (8) every day for the duration of the study.

2.2.6 Waste Discharge

After waste is generated, people may dispose it off in a number of ways:

- ✓ On-site disposal – burning and/ or burial;
- ✓ On-site composting;
- ✓ Recycling, generally involving individual collectors visiting peoples’ premises (homes, shops etc.) or people selling items directly to middlemen;
- ✓ Discharge for municipality’s collection; and
- ✓ Illegal/open dumping.

The amount of waste discharged for collection is usually represented by waste discharge rate-the quantity of waste discharge for collection per person per day (kg/day/capita). The waste discharge rate is always less than the waste generation rate. The amount of waste discharged for collection also increases with economic growth. However, it is also strongly dependent on local conditions and the relative proportions of waste disposed by other means. The waste discharge rate may be used for SWM planning in similar way to the waste generation rate.

2.2.7 Classification of Waste:

Characteristics of the contents in the solid waste can be classified as either biological, chemical or physical. These parameters are further used to define the nature of the wastes, their appropriate collection, and transportation and disposal methods.

The nature of solid waste can be categorized as hazardous or non-hazardous waste. Municipal waste usually comprise of both the hazardous and non-hazardous waste depending on their level of significance as far as environmental population is concerned. The physical composition of solid waste also varies between different societies and with income, as shown in Table 2.1 below;

Table 2.1(Annex II): Household Waste Composition

Waste Constituent	Lahore	Karachi, Pakistan	Tokyo, Japan	Nairobi
➤ Organic;				54.0
➤ Compostable;				
➤ Food/Kitchen;	30.72	22.84	26.6	
➤ Grass/Wood;and	21.26	-	9.0	6.0
➤ Bones.	1.03	5.5	-	
Total	53.01	28.34	35.6	
Recyclable				
➤ Paper;	2.7	8.41	52.5	14.0
➤ Cardboard;	0.01	8.11	-	
➤ Plastic;	5.63	6.20	6.9	10.0
➤ Glass;	0.70	5.21	0.2	1.5
➤ Metal;	0.32	4.08	0.4	2.0
➤ Textile; and	7.45	8.93	4.0	3.0
➤ Laether.	-	-	-	8.0
Total	16.81	40.94	64.0	

Stone/brick	27.84	8.83	-	
Shoppers	-	6.49	-	
Rubber	-	-	-	1.0
Plastic wrapper	-	8.03	-	
Other	2.35	7.37	0.4	

Source:

1. Lahore data : Solid waste management department, Lahore.;
2. Karachi data: solid waste management, Karachi 2005;
3. Tokyo, Japan from 1999; and
4. Nairobi, JICA report 1988.

In waste classification, **waste bulk density** is used for selecting and sizing garbage storage containers, public bins and collection vehicles and for converting vehicle trips data to tonnages.

Moisture content is used for looking at treatment options, especially composting and incineration. **Carbon-nitrogen ratio** is useful for composting. **Calorific value** is useful for incineration.

Table 2.1 (Annex 1): The Urban Centre Should:-

i.	All Urban Centers should monitor the waste composition and waste bulk density annually
ii.	All medium sized Urban Centres above 50,000 populations should monitor moisture content and carbon-nitrogen ratio annually.
iii.	All large Urban Centres and Towns above 300,000 populations should monitor Calorific value annually.

ANNEX III: WASTE MINIMIZATION

Waste minimization which includes reduction reuse and recycling is the first step of minimizing the environment negative impact and management cost. Reduction of waste basically means reducing waste by not producing it.

To minimize waste amount, it is necessary to enhance the following activities:

- ✓ Not to purchase unnecessary amount – it wastes not only your money but also the precious natural resource;
- ✓ Not to purchase disposal items;
- ✓ Reuse the materials;
- ✓ Purchasing durable, long lasting products;
- ✓ Seeking products and packaging that are as free of toxic substances as possible; and
- ✓ Avoid issuance of carrier polythene bags by always using hand bag.

Recycling is widely practiced throughout the Country and primarily done by the informal sector which recovers paper, carton, plastics, metals, glass and textiles. The waste is frequently scavenged in unsanitary conditions and sold through a chain of middlemen, peddlers, central collection depots and remanufacturing industries.

To achieve the objectives of waste reduction and waste recovery optimization that is safe, efficient and sustainable, local authorities need to consider the following programmes and lines of actions:-

- a) Encourage re-use and recycling at homes and in industry implementation of cleaner production system. Hazardous waste should be collected separately at source. While formal material recovery facilities should also be put in place. This should enable these people to make a living while public health is being protected;
- b) Set up pilot projects for waste segregation at source, for example separate collection of packing materials like plastic and paper/cardboard from schools, universities, segregation of waste into wet (organic) and dry(non-organic) components in a pilot urban areas. An NGO or Private company could be involved in this;
- c) Provide opportunities to formalize the informal sector, e.g. by employing scavengers on the picking lines of composting plants;
- d) Consider the formation of cooperatives among scavengers to engage in kerbside collection of certain types of recyclables. Reserve a separate area at the disposal site for scavengers to search through the newly arrived waste, possibly spreading waste with loaders. Provide scavengers with protective gear and other facilities, as this will increase their efficiency and thus reduce the amount of waste to be disposed at landfills;
- e) Encourage NGOs and private companies to establish community -based segregation at source, separate collection and waste recovery projects. Also encourage small and micro-scale waste recovery enterprises;
- f) Formulation of policies, laws, regulations and by-laws that encourage waste minimization.

Box 3.1(Annex III): The Urban Centres Should:

All Urban Centres should undertake studies on how waste can be minimized and undertake a waste minimization programme involving its residents and other stakeholders.

ANNEX IV: WASTE COLLECTION AND TRANSPORTATION

4.1 Introduction

Existing waste collection and transport systems often cannot handle the amount of waste generated by large cities and towns with growing populations. When this occurs, waste is disposed of in uncontrolled dumps or openly burned. Waste collection rate is estimated around 25-35 percent in Kenya. The type of unmonitored and uncontrolled waste disposal has negative consequences on human health and the environment.

Improvements to waste collection and transport can create jobs. Decrease open dumping and burning, increase appeal for tourism, and significantly improve public health. The process of refuse collection and transport should be thought of as a multiple process, and it is possible to define it in separate phases.

Commercial solid waste collected with skips, large steel containers that are commonly lifted overhead by the collection truck. The size of the skips ranges from 7m³ to 30m³ as the driver of the truck. Does not get out there is a risk of hazardous waste being placed in the skips. The waste therefore should be checked at the disposal site. If hazardous waste is found investigation should be done to identify the source and give warning of impending penalties.

Some commercial premises produce very large quantities of waste that the urban centers may wish require them to make their own arrangement of transporting it to the disposal site. If however the local authority has set adequate charges for solid waste management services it should endeavor to provide the services.

4.2 Waste collection

This is referred to as the process whereby scattered pieces that make up solid wastes are gathered together in a temporary control point. Separate phases can be used to define the process of refuse collection. These are:

4.2.1 Premises to Waste Container

The premises to waste container phase does not receive attention in the waste collection system because the efficiencies and conveniences gained here are personal and out communal. It is nevertheless an important phase as it is the beginning point of interaction with the waste generators in the local authority it can also be used to reduce the waste and manage the revenues for solid waste management services. It is also important for residents to put waste in containers to avoid indiscriminate dumping of waste in neighborhood. Facilities to support waste management should for example; waste chutes should be incorporated in building plan.

First residents should be educated to accept that their waste must be placed in an appropriate container to facilitate efficient collection. Effort by urban centers should therefore promote a system where they set the standard of the type of containers that residents can buy on market. There is increasing use of plastics bags, on which the urban centers may wish to provide guidance.

The urban centers may wish to adopt a volume based charge as a way of encouraging reduction of waste at source. In this case the premises owners make a choice of the capacity of container and therefore the fee to pay. If separate at source is desirable the waste containers will have to be of different colours.

4.2.2 Waste Container to Trucks

The concept of backyard and kerbside collection have been mentioned. For safety of the waste collector and security of the residents kerbside collection as opposed to backyard collection is more popular in many urban centres. The premises owner carries the waste to the roadside, often in plastic bag and leaves it there for the collectors to load in the refuse collection vehicle. It should be mentioned that some urban centers use skips, placed at selected places, where residents place their waste. The skips are loaded on the refuse vehicles mechanically.

4.3 Waste Transport

Transportation of wastes is the process of transferring the collected wastes from the generation and collection points to transfer stations, material recovery facilities or final disposal point. Similarly, separate phases can be define this process. These are:-

4.3.1 Truck from Premises to Premises

The refuse vehicle moves from premises to premises collecting waste until it is full or the route is complete. The vehicle should be compacting the waste as it moves. In small urban centers/towns non compacting tractor trailer or side loader truck may be in use. However in large towns it is economical to use refuse vehicle which can compact the waste as it is moves along. An estimate of the number of premises a vehicle can serve in one trip may be done by approximation of the volume of waste per premises per premises and the capacity of the vehicle.

4.3.2 Truck Routing

The routing of a vehicle within its assigned zone is often called micro-routing to distinguish from the large scale problems of routing to the disposal site. The objective in micro-routing is to minimize deadheading, travelling without picking up refuse. The assumption is that if a route can be devised that has the least amount of dead heading as possible it is the most efficient route. The following set rules apply to micro-routing. Some of these are pure commonsensical judgments, and some are useful guidelines for determining overall strategy when preparing a routing model:

- ✓ Routes should not overlap, but should be compact and not be fragmented;
- ✓ The starting point should be as close to the truck garage as possible;
- ✓ Heavily travelled streets should be avoided during rush hours;
- ✓ One way street that cannot be traversed in one line should be looped from the upper end of the street;
- ✓ Dead-end streets should be collected when on the left side of the street;
- ✓ On hills, collection should proceed downhill so that the truck can coast;
- ✓ Clockwise turns around blocks be used whenever possible; and
- ✓ Long, straight paths should be routed before looping clockwise.

These rules can be used to develop effective routes with minor dead-heading.

4.3.3 Truck to Disposal Site

For small town, the macro- finding *macro-routing* in terms of developing the optimal disposal and transport scheme is more complex. The objectives are to minimize the transport cost. A balance

has to be made between having one or more than one disposal site. Consideration will also be given to the need for transfers stations. In which case smaller vehicles will be used in collections from premises to transfer station and large vehicles used from transfer station to disposal site.

The urban centers should have a system of weighing waste as it enters the disposal site or transfer station. It is easy to monitor the waste collection amount. Control the waste and plan the future. Therefore, weighing the waste is an important step in managing the waste.

Taking into account that waste reduction measures could reduce the waste generated by up to 25-35% the urban centers should aim for a waste collection rate of between 65 and 75% of the waste generated in their jurisdiction and transportation of the same to material recovery facility or disposal site.

Box (Annex IV) 4.1: The Urban Centers Should:

1. All urban centres should monitor the collection/disposal amount daily by developing a recording system with or without a weighing mechanism.
2. All large urban centres and towns above 300,000 populations should install weighbridge in each disposal/treatment site and monitor the amount daily.

4.4 Transfer Station

When the waste disposal unit is removed to the collection area. A transfer station is employed. At the transfers' station waste is transferred from smaller collection vehicles to larger transfer vehicles, such as tractor and trailer, a barge, or railroad car.

Transfer stations can be quite simple, or they can be complex facilities. The size of the facility is based on the intended use. With small transfer stations typically relying on a tipping floor where collection vehicles drop their loads. Waste can then be loaded into open-top trailers using a wheel loader. More complex facilities might employ pits for vehicle to drop into.

The decision to build or not to build a transfer station is often an economic decision. If the one way haul distance from the point of full collection vehicle to the discharge point is short, then it is likely that no transfer station is needed. on the other hand , if the discharge point is far away and the collection vehicle will have to be away from its primary role of collecting refuse for too long, then transfer station might be warranted.

It has been demonstrated by other researchers and studies that, longer distances will warrant the construction of a transfer station while shorter hauls will make it uneconomical. The urban centers should therefore as part of the feasibility study carry out cost comparison of the with transfer station and without transfers station options.

4.5 Collection of Recyclable Material

Recyclable materials include:

- ❖ Paper and Paperboard;
- ❖ Glass;
- ❖ Ferrous metal;
- ❖ Aluminum;

- ❖ Other non-ferrous metals;
- ❖ Plastics;
- ❖ Rubber and leather;
- ❖ Textiles;
- ❖ Wood;
- ❖ Food Waste;
- ❖ Yard trimmings;
- ❖ Other materials.

The urban centres should devise innovative methods of identifying recyclable and collecting them in a cost effective way. For example waste paper collectors could be registered and facilitate to collect paper waste from premises to their own cost and a fee to the premises. The urban centres could establish a designated place for glass. A study of the market for recyclables is also important.

4.6 Litter and Street Cleanliness

Litter is a special type of urban centres solid waste (UCSW). It is distinct from other types of UCSW in that it is a solid waste that is not deposited into proper receptacles. Although litter mainly exists in public place, it could be on private premises as well. Litter removal from public places is expensive and requires special effort by the urban centres especially if the entire urban centres area has to be clean. Failure to attend to it will lead to dirty streets, blocked drains, etc.

4.7 Strategy for a Sustainable Waste Collection System

The urban centres as part of its solid waste management action plan should develop a strategy for waste collection with the objective of achieving efficient, and sustainable waste collection systems in its area of jurisdiction the aspects to take into account include:

- a) Set up a system for regular weighing and analysis of wastes generated and collected (quantities, densities, organic content, dry recyclable content, moisture content). These data are essential to determine the most suitable methods of collection, transportation, disposal and treatment;
- b) Develop standard designs for collection and transfer for all areas within the urban centers jurisdiction;
- c) Establish primary collection system in the entire urban centres. A primary collection system means that waste is collected by small vehicles to a transfer point, from where it is collected by larger vehicles to the disposal site (secondary collection system);
- d) Encourage collection of waste in plastic bags, as this reduces loading times for the waste collection crews. However, waste collection in plastic bags needs a fixed timing of the collection services, so that scavengers have minimal access to them;
- e) Encourage door-to-door collection system in high and middle income areas against a cost covering fee. Kerbside, collection, where waste is collected in certain street and at corners, is more appropriate for low income urban areas possibly against a (low)fee;
- f) Competent private collection companies and NGOs should be encouraged to develop community-based collection scheme;
- g) Increase the number of containers and street bin and make their design compatible with collection and transportation systems. The design of containers should reduce unnecessary handling of the waste and make loading of vehicles easier. Containers should be heavy

and/or chained to poles in order to minimize tipping over by scavengers. Their size should be adapted to quantities and densities of waste generated;

- h) Increase the number of containers to collect institutional and industrial waste. Make the frequency of waste collection compatible with waste generation and the nature of the waste. When much organic waste is generated in a particular area like fruit and vegetable markets, collection should be daily or at least every other day to reduce unpleasant odours and the growth of disease vectors;
- i) Improve vehicle selection, taking into account waste quantities and characteristic, the condition of roads and the distance, typically less than 10 km to the disposal site;
- j) Trucks are more appropriate for long haul distances (More than 10 km), as their capital costs are much higher than for tractors. Compactor trucks are appropriate low density waste (typically less than 250kg/m³ to collect i.e. waste that includes much packaging materials, plastic, paper, etc.) which may be the case in major urban cities. In rural and medium towns, where much of the waste consists of organic waste, dust and dirt, which has a high density, compactor trucks, are not suitable;
- k) Establish regional collection system in rural areas, covering several villages and small urban centres;
- l) Establish proper monitoring and supervision mechanisms for waste collection and transportation to ensure reliability and satisfactory operation of the service. Facilitate the work of supervisors by providing those means of transportation and pay them incentives for good performance. Raise salaries and incentives of waste collection workers to increase their motivation and thus increase waste collection efficiency.

ANNEX V: MATERIAL SEPARATION

As seen the bulk of solid waste generated from industry, households, etc. within a community is a complex mixture of different materials with very difficult properties and potential for reuse. Some materials are in a form that can be recycled directly while others need considerable further treatment before they can be utilized. Most modern waste management system therefore involve separation of the materials are delivered. Physical treatment of the waste materials to improve sorting efficiency and reduce storage and transport costs is typically part of the waste treatment.

5.2 Separation at the Source

Re-use of solid waste material fractions is strongly dependent upon the quality of the materials. Source separation is typically used for materials that are easily recognizable and easily recyclable. If a fraction of materials is contaminated with other types of materials it is more difficult to re-use as the contaminants may hamper further processing or decrease the quality of the final product made from the materials. Separation of the materials at their source of generation can prevent contamination altogether as the materials are never mixed and result in material fractions of much higher quality and purity than can be achieved by separation once the wastes have been mixed together.

Urban centres therefore need emphasis much on waste separation at source by investing much on public awareness. Source separation should always be considered in situations where the objective is to improve recycling and quality of waste materials. With the use of source separation it is possible to generate a large number of material fractions with a high level of purity, which gives a very high potential for recycling of the materials.

As source separation requires the participation of the citizens in the community it is important that the desired fractions can be clearly identified such that the risk of wrongly sorted materials kept at a minimum. A high level of information is required to educate the citizens in how to separate their wastes. Source separation typically also requires more equipment such as special container systems for sorting and collection vehicles with special rooms for the sorted materials.

Source separation systems have the potential of generating higher income when selling the sorted materials therefore it can be a source of returns on capital invested in SWM. Urban center need to help the public on spending more time. Their own wastes urban centre practice the decision of what fractions in which to sort the wastes is always trade-off between the costs in terms of equipment use and time spent the possibility of wrongly sorted materials in the fraction, and the economic gain from marketing the materials.

These materials include different types of paper, glass, plastic; aluminum cans organic wastes (food, garden) and metals. Other types of waste that are separated in some cases are furniture, house wares and other items that can be reused directly, in some case construction waste and similar materials may also be separated urban center need to establish by laws requiring that construction and demolition companies sort there for recycling.

5.3 Source Separation Systems

Types of source separation systems are based on different levels of citizen involvement and equipments. Some general types of source separation systems include:

5.3.1 Special Container System

This system is typically based on a set of different containers in which to deposit the different waste fractions located at the source. Such container system would of course be different depending on the type of source, which could be either single homes, apartment complexes or industries. At single homes the sorting system could be a set of plastic boxes in which the waste s are sorted manually.

At apartment complexes with a central container system in the basement (or equivalent) and waste deposit hatches at each floor, separation could be done installing mechanical distribution system that will deposit the waste into the appropriate container. The container could be selected electronically at a panel near the deposit hath before depositing the waste. Systems where the waste are sorted in to plastic bags of different colors and then deposited in the same container can also render successful service.

The advantage of these types of systems is they require the least amount effort from the citizens and typically result in fractions of very high purity. Because they ease to use more wastes will be separated instead of ending up in the fraction of non-recyclable materials and therefore greater quantities of material can be recycled. These systems also makes it possible to collect all the waste fractions at the same time minimizing the amount of driving needed for collection and reducing transport costs. This means that there is no need to store waste materials at the source for longer periods. A major disadvantage is that the equipment costs for containers etc. are often high, as a large number of container systems are typically needed.

5.3.2 Communal Containers

The use of communal containers requires that the citizens bring their sorted waste materials to the containers. The container are typically located in a public place such as shopping Areas, parking lots or other public areas where people tend to pass by often.

An optimum location that people pass by on their way to or from work or while shopping will minimize the extra effort required for depositing the waste and result in increased quantities of sorted materials. Communal container is typically used for waste fraction such as paper, glass, metal, and aluminum cans. Often the containers are designed are designed such that it is difficult to deposit other types of materials than those desired.

Communal containers separation system is less expensive to operate; as equipment require rents and collection frequency is significantly lower. However they are not suitable for sorting biodegradable waste fractions as these will start to decompose with sanitary problems as a result. These types of wastes should therefore be collected at the source using the separated system.

The disadvantages of communal containers is that more effort is required of the users, as they have to bring their wastes to the containers. The quantities of waste materials collected are therefore often lower than for systems with container at the source. The quantities of waste materials collected are therefore often lower than for systems with container at the source. The quantities collected per container is variable kin the early stages of implementation of this system after which

it shows a slowly increasing trend. The initial variability will likely occur because the citizens in the community are not familiar with the separation system and it takes some time before they develop a routine for delivering the materials. Additional citizens becoming aware of the system, possibly because they see more containers in the streets or hear about it from other users etc. and therefore feel obligated to use the system explains the slowly increasing trend at later stages.

5.3.3 Recycling Stations

These are recovery or recycling facilities typically equipped with containers for collecting many different sorts of waste materials. The stations are usually connected to waste processing facilities such as an incinerator or composting facility and it is often possible to buy processed waste product such as compost at the recycling stations.

Users have to deliver their wastes to the station themselves. Recycling stations are used for delivery of construction or park and garden waste or other types of large waste items that are not easily handled by the public waste collection system. Urban centers should promote, subsidize, contract or empower persons or companies that have large quantities of wastes to employ this separation system.

5.3.4 Efficiency of Source Separation Systems

Efficiency of source separation systems depends strongly on the user-friendliness of the system. In general will and high level of service and information results in high levels of separated waste quantities. Source separation system is sometimes characterized by their selectively.

The selectively depends mainly upon a good level of information about how to use the separation and what materials to sort whereas the participation factor in general depends upon how easy the source separation system is to use for the participants.

The separated materials will always contain some small fraction of unwanted materials (Contaminants) due to error in the separation process. These contaminants can cause difficulties during further treatment of the materials and can therefore reduce the value the value of the separated material.

5.3.5 Central Separation

Here, wastes are generally sorted at a central location where they are delivered after collection. Mechanical equipment are used to sort the commingled waste and only in special case is should manual separation be used due to problem with dust, bacteria and toxic substances obtained contained in wastes. Central separation should be primarily mechanical because of the high risk of exposure by the workers to pathogens or hazardous materials contained in the wastes but manual separation can only be considered only special cases where the waste consist of dry materials such as paper, cardboard and plastics.

5.3.6 Mechanical Separation

Like dividing bulk waste into types and categories of material based on their recyclability and chemical composition, a stream of water materials can be divided into two or more sub-streams based on the physically properties of the particles in the stream. Mixed waste is normally sorted in to the following fractions: combustibles, rocks etc, magnetic metals, other metals, a fine fraction and

a rest fraction. Mechanical separation can also be applied to source separated wastes to generate more fractions of materials. Techniques for separating wastes mechanically include;

Screening- It is an efficient method for removing smaller particles such as dirt, small pieces of demolition wastes ash, etc from the main waste stream. The method less efficient for separating materials such as glass or paper from the waste stream. Screening can also in special cases be used to separate other types of materials as different types often consist of particles of different sizes.

Separation Based on Shape- The method is appropriate for separating waste fractions such as bricks, metal pipes, wooden beams, cardboard sheets etc. are associated with a specific shape and /or size.

5.4 Waste Materials Recovery Facilities (MRF)

This is a facility purposely designed to receive, sort and bail recyclable materials from collected urban solid waste. The processed materials can be marketed to clients as raw materials for production or otherwise.

Urban centres need to procure strategic partners for the provision of sustainable and reliable MRFs within their region. These partners would be mandated to provide waste recycling services which includes:

- ✓ Receiving and processing all recyclable delivered in the facility from the generation points within the urban centers jurisdiction;
- ✓ Construct a modern facility characterized by latest technologies and labour balances;
- ✓ Provide sustainable and appropriate waste materials recovery alternatives the best suit specific regions within the urban centers;
- ✓ Set appropriate fees for operations within the facility;
- ✓ Provide appropriate staff to carry out operation within the facility. The operators should maintain accurate records on various categories of waste materials processed at the facility including residue waste;
- ✓ Provide security measures within the locality of the facility to guarantee environmental protection; and
- ✓ Transport the residue waste from the facility to the final disposal points i.e. landfill.

ANNEX VI: FINAL DISPOSAL

6.1.1 Introduction

Finally disposal site is basically the place of neither reusable nor recyclable. But actually there are many valuable wastes and it attracts a lot of scavengers/waste pickers to recover the valuable wastes. Some items decompose very quickly (e.g. food/kitchen waste), while some take a long time (e.g. plastics -over 100 years) and others are hazardous or toxic (e.g. Batteries (Lead and Zinc), tube lights (Mercury)). Hence, it is very important to practice good final disposal of waste for our sake and the sake of our children, grandchildren and other children. For further detail, refer standard guidelines on solid waste disposal and landfill establishments.

6.2 Land-filling

The following are various types of landfills that may be considered for Bomet County urban centers:

6.2.1 Types of Landfilling Structures

Landsite fill have been classified into five types, based on the microbial environments existing in the landfill layers, as follows:

- i. Anaerobic Landfill;
- ii. Anaerobic Sanitary Landfill;
- iii. Improved Anaerobic Sanitary Landfill;
- iv. Semi-aerobic (Sanitary)Landfill; and
- v. Aerobic (Sanitary) Landfill.

6.2.2 Levels of Landfill

The level of improvement of sanitary landfill system can be achieved in four stages, namely:

- i. Level I : Controlled Tipping;
- ii. Level II : Sanitary Landfill with a bound and daily cover soil;
- iii. Level III: Sanitary Landfill with leachate recirculation; and
- iv. Level IV: Sanitary Landfill with leachate treatment and/or energy recovery.

In improving sanitary landfill system, it is more efficient if the works are carried out after having first determined the level of improvement to be achieved. This decision should be made after considering the site conditions at the proposed landfill site, the financial capability and the level of technology required for the improvement to be carried out by urban centres. The level of sanitary landfill system, its target, etc.

It is more realistic at the moment to improve a sanitary landfill system in stages. It is also important that at the same time to consider the need to achieve a balances urban infrastructure improvement and aspects of urban environmental preservation.

Based on the above mentioned, the primary target of the improvement plan for sanitary landfill system should be at level III. The implementation programme should contain a plan for continuous upgrading of the system in link with the financial and technical capability of the urban centre so that level IV may be obtained as early as possible.

Box (Annex VI) 6.1 The Urban Centers Should:

i.	All urban centre should do target at Level I
ii.	All medium urban centres above 500,000 population at planning horizon should do target at level II
iii.	All large urban centres and cities above 300,000 population at planning horizon should do target at level III.

6.3 Incineration

Municipal solid waste incineration plants are among the most expensive solid waste management options since they require highly skilled personnel and carefully maintenance. For these reasons incineration tends to be a good choice only when other simpler and less expensive choices are not available. However, it is an efficient way to reduce the waste volume and demand for landfill space. Incineration plants are located close to the points of generation thus reducing transportation costs.

6.4 Plant Ownership and Operation

An urban centres intending to invest on an incineration plant, must first undertake feasibility studies before implementation. It is important first to involve the public throughout the project cycle through awareness campaigns in the mass media and public hearings on major decisions with a direct community impact. Public participation beyond what is recommended for urban planning and environmental impacts assessment may be useful in dissolving public resistance to the project. To prepare an appropriate incineration project, an elaborate institutional framework and organization need to established. The project organization will develop appropriate agreement regarding capital investment, waste supply, energy sale, residue disposal as well as the necessary environmental impacts assessment.

Urban centers need to establish regulations on specific waste generators especially those generating hazardous waste e.g. medical, grease and fuel wastes etc. to invest on private incinerators with well recruited and trained staff for efficient operation in the incinerator.

6.5 Strategy for a Sustainable Waste Disposal and Treatment System

The urban center as part of its waste management action plan should develop a strategy for waste collection with the objectives of achieving sanitary disposal sites with reduced pollution to the environmental the aspects to take in to account include:

6.5.1 Disposal

- a) Introduce controlled tipping practices at disposal sites to remove mal-odours, litter and other nuisance and to minimize the problem of flies and vermin. Use construction waste and sand as a top layer. Ensure the working equipment such as bulldozers is available at the disposal sites to level the waste. There should be sanitary landfill with leachate treatment facility;
- b) Select new disposal sites to replace disposal sites that are close to full or that are improperly located. Before granting an approval for establishment of sanitary landfill site, the project proponent should undertake and Environmental Impact Assessment identifying potential damage of the disposal site to soil, water and air, and to suggest mitigation measures which should be implemented;

- c) Identify possible regional disposal sites in view of the scarcity of available land in adjoining cities;
- d) Improve the working conditions of scavengers on disposal sites, because this will improve their health and it increase the life of the disposal site and waste recovery levels;
- e) Give the rights to waste recovery to a waste dealer who pays the urban monthly fee and has exclusive access to the recovered materials picked by the scavengers. Funds raised in this way can be used to maintain and operate the site;
- f) Incineration is not considered an option for the treatment of urban waste due to its high operating and maintenance costs and the low calorific value of waste, but it is the recommended solution for the treatment of clinical and industrial hazardous waste; and
- g) Carry out environmental impact audits for existing disposal sites.

6.5.2 Composting

- a) Composting is only feasible and appropriate, when quantities of waste and organic content of the waste are high enough, and when there is a market for its product (compost and dry recyclable). This makes composting plants not suitable for areas where much of the waste consists of dirt or dust;
- b) Carry out feasibility and marketing studies for both organic and inorganic materials before any composting plant or recovery unit is installed. Study the prevailing rate of waste recovery, as this has a major influence on the amount of raw material available to the composting plant thus on its output and revenue;
- c) Select proper disposal sites, when new composting plants are being planned. Composting plants are only a partial solution to the waste problem, as non-compostable waste and reject still need to be disposed of;
- d) Investigate opportunities for co-composting with animal waste and/or dried sewage sludge to solve two problems in one time. This will increase the nutritional value of the compost and the moisture content of the raw materials;
- e) Introduce segregation at source of organic waste and separate collection in pilot areas, as this will improve the quality of compost and of dry recyclable, and thus their quality and price. This needs adequate awareness-raising efforts and possibly incentives for the communities involved. Depending on its success it could be extended to other areas;
- f) Avoid mixing of urban waste with infectious clinical and industrial waste, especially when waste is collected for composting, as this endangers the life of workers at the picking belt and the quality of the compost; and
- g) Develop maintenance programme. Design training programmes for staff of composting plants to improve their technical, management and marketing skills. Encourage private to develop and maintain composting plants.

6.6 Target Level of Landfill

The introduction of an advanced sanitary landfill system requires a large amount of capital investment. Taking into consideration of the size of the urban centres annual budget and financial situation, we can expect various problems with regards to funding for the sanitary landfill system.

ANNEX VII: IMPLEMENTATION FLOW-CHART

Fig. III: Implementation Flow-chart of Bomet County Solid Waste Management Policy

