

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

FACULTY OF BUSINESS AND ECONOMICS
DEPARTMENT OF PUBLIC ADMINISTRATION AND DEVELOPMENT
MANAGEMENT

**SITUATIONAL ANALYSIS OF SOLID AND LIQUID WASTE
MANAGEMENT IN THE CITY OF ADDIS ABABA: THE CASE OF TEN
KEBELES**

YIMENU MEKONNEN

ADVISOR: MEHERET AYENEW (Ph.D)

A THESIS SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES AT ADDIS
ABABA UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF MASTERS IN PUBLIC ADMINISTRATION

JUNE, 2008
Addis Ababa, Ethiopia

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

FACULTY OF BUSINESS AND ECONOMICS
DEPARTMENT OF PUBLIC ADMINISTRATION AND DEVELOPMENT
MANAGEMENT

**SITUATIONAL ANALYSIS OF SOLID AND LIQUID WASTE
MANAGEMENT IN THE CITY OF ADDIS ABABA: THE CASE OF TEN
KEBELES**

YIMENU MEKONNEN ASSERSE

JUNE, 2008
Addis Ababa, Ethiopia

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

FACULTY OF BUSINESS AND ECONOMICS
DEPARTMENT OF PUBLIC ADMINISTRATION AND DEVELOPMENT
MANAGEMENT

SITUATIONAL ANALYSIS OF SOLID AND LIQUID WASTE MANAGEMENT IN
THE CITY OF ADDIS ABABA: THE CASE OF TEN KEBELES

BY
YIMENU MEKONNEN ASSERSE

Approved by Examining Board

Name	Signature	Date
1. <u>Meheret Ayenew (Ph.D)</u> Chairman and Advisor	_____	_____
2. <u>Nega Wubie (Ato)</u> Internal Examiner	_____	_____
3. <u>Solomon Mulugeta (Ph.D)</u> External	_____	_____

Examiner

Acknowledgements

My sincere thanks and recognition goes to my research advisor, Dr. Meheret Ayenew, for his stimulating advice, encouragement and share of his rich experience as well as for his unreserved effort to assist and for providing me with a great research opportunity and allowing me to work at my own pace.

My grateful thanks also goes to the city: Water and Sewerage Authority; Sanitation, Beautification and Parks Development Agency; Roads Authority; Codes Enforcement and Monitoring Agency; Finance and Economic Development Bureau; Civil Service Commission; all authors and researchers cited in the thesis; staff of sample kebeles; sample households; taxi drivers and street children for their willingness and cooperation in providing the necessary data.

I wish to thank all those who in diverse ways have offered assistance and advice during the course of my study and in the preparation of this thesis, especially my friend Bacha Kebede.

I am also greatly indebted to all my family, friends and many other people. I would like to take this opportunity to express my heartfelt thanks to my sponsor, Selam, for her persistent effort, support and contribution to enroll in this program and to pursue my study; for her pray and concern and for her moral and material support that enabled me to complete my graduate studies.

Finally, my humble gratitude goes to the Almighty God for all His wonders He has been doing for me.

TABLE OF CONTENTS

Title	Page
Acknowledgment	i
Table of contents	ii
List of table	vi
Acronyms.....	viii
Symbols	ix
Abstract.....	x

CHAPTER ONE

INTRODUCTION	1
1.1 Background of the Study	1
1.2 Statement of the Problem.....	3
1.3 Objectives of the Study	5
1.4 Significance of the Study	6
1.5 Limitations of the Study	6
1.6 Scope of the Study	6
1.7 Research Methodology	7
1.7.1 Data Collection Techniques and Procedures.....	7
1.7.2 Population and Sample Size	8
1.7.3 Data Analysis	9
1.8 Organization of the Paper	9

CHAPTER TWO

2. LITERATURE REVIEW	10
2.1 The Concepts of Urban Management, Governance And Environmental Management	10
2.2 Fundamentals of Waste Management	11

2.3 Solid Waste Management Approaches	14
2.4 Liquid Waste Management Approaches	17
2.4.1 The Sanitary Crisis	17
2.4.2 Sanitation	18
2.4.3 Drainage.....	19
2.5 Challenges of Waste Management	21
2.5.1 The Waste Problem - Waste Amount and Composition ..	21
2.5.2 Rapid Urbanization, Growth of Urban Population and Inadequate Service Coverage	22
2.5.3 Institutional and Operational Inefficiencies	23
2.6 Strategies and Options for Sound Waste Management.....	23
2.6.1 Waste Reduction	24
2.6.2 Integrated Waste Management Approach.....	26
2.6.3 Landfill	27
2.7 Participation of Different Actors in Municipal Waste Management.	28
2.7.1 Public Awareness and Participation	28
2.7.3 Role of Informal Sector in Waste Management.....	28

CHAPTER THREE

3. BACKGROUND INFORMATION: CITY OF ADDIS ABABA .	30
3.1 Geographical Location and History	30
3.2 Physical Characteristics	31
3.3 Demography	32
3.4 Economy	35
3.5 Employment	35
3.6 Access to and Cost of Basic Services	37
3.6.1 Water supply.....	37
3.6.2 Sanitation	37
3.6.3 Kitchen facilities	38

3.7 Drainage System	39
3.8. Background Information of Sample Kebeles	40
3.8.1 Organization, Power and Functions of a Kebele.....	40
3.8.2 Demographic characteristics	40
3.8.3 Socio-Economic Characteristics of Sample Households .	42

CHAPTER FOUR

4. DESCRIPTION OF WASTE MANAGEMENT AND HOUSEHOLDS RESPONSE REGARDING THE SERVICE	45
4.1 Background of Waste Management in Addis Ababa	45
4.2 Solid Waste Management	45
4.2.1 Characterization of Solid Waste in Addis Ababa	46
4.2.1.1 Sources of Solid Waste	46
4.2.1.2 Types of Solid Wastes.....	46
4.2.1.3 Solid Waste Generation Rate	46
4.2.2 Waste Handling Capacity of the City.....	49
4.3 Liquid Waste Management.....	53
4.3.1 Source of Water Supply for Addis Ababa City.....	54
4.3.2 AAWSA Water Billing System	55
4.4 Waste Handling Capacity of Private Sectors	56
4.5 Households Response Regarding Waste Management.....	58
4.5.1 Characteristics and Composition of Household Waste .	58
4.5.2 Households Waste Storage Devices.....	59
4.5.3 Household's vis-à-vis Site of Communal Containers and disposal agents	60
4.5.4 Waste Reduction at the Households Level.	64
4.5.5 Waste Prevention	67

CHAPTER FIVE

5. DATA ANALYSIS AND DISCUSSION	70
5.1 Solid Waste Collection, Transportation and Disposal.....	70
5.1.1 Status of Solid Waste Collection Service	70
5.1.2 Solid Waste Transportation	71
5.1.2.1 Solid Waste Transportation Coverage	72
5.1.2.2 The Uncollected Part of the Solid Waste.....	76
5.1.2.3 Cost of Solid Waste Transportation	77
5.1.3 Solid Waste Disposal	78
5.2 Liquid Waste Generation, Collection and Disposal	80
5.2.1 Liquid Waste Generation Rate.....	80
5.2.2 Liquid Waste Collection	81
5.2.2.1 The Uncollected Part of the Liquid Waste.....	82
5.2.2.2 Viability of Options to Collect the Uncollected Part of the Liquid Waste	84
5.2.2.3 Storm Water Management	85
5.2.3 Liquid Waste Disposal	86

CHAPTER SIX

6. FINDINGS, CONCLUSION AND RECOMMENDATION ...	87
6.1 Findings	87
6.1.1 Problems of Addis Ababa Waste Management.....	87
6.1.2 Population and Waste	88
6.1.3 Spread of Waste around Communal Containers	89
6.1.4 Effects of Waste.....	90
6.2 Conclusion.....	92
6.3 Recommendation.....	93
References	96
Appendixes	

LIST OF TABLES

Table 3.1: Addis Ababa city area in square kilometer	32
Table 3.2: Population of Addis Ababa city taken at different censuses	33
Table 3.3: Migration to the city by the years 1985, 1995, and 2000	33
Table 3.4: Sub cities: population, area, and population density ...	34
Table 3.5: Employees of AACG by education and sex (2007)	36
Table 3.6: Unemployment rate in the city of Addis Ababa	36
Table 3.7: Sample kebeles with their population and location	40
Table 3.8: Educational status of Sample Households	42
Table 3.9: Respondents age-sex distribution	44
Table 4.1: Waste generated, collected, and disposal coverage	47
Table 4.2: Distribution of containers and trucks by sub cities.....	50
Table 4.3: Number of trips of vehicles and their carrying capacity	51
Table 4.4: Sub cities daily operated vehicles and waste disposal capacity	52
Table 4.5: Share of sub cities-generated and transported waste for 2008.....	53
Table 4.6: Source and amount of water supply	54
Table 4.7: AAWSA monthly billing system	55
Table 4.8: Major Component of Sample Household's Waste	58
Table 4.9: Household's Waste Storage Devices	60

Table 4.10: Household’s Waste Disposal Frequency to Communal containers	60
Table 4.11: Sufficiency of Communal Containers	61
Table 4.12: Household’s Waste Disposal service	62
Table 4.13: Disposal Site of Household Waste	62
Table 4.14: Communal container users and non-users of each kebele	63
Table 4.15: Household items used for sale, exchange and repair .	65
Table 4.16: Households Preparing Coffee Ceremonies	67
Table 4.17: Households Using Green Grass for Coffee Ceremonies	68
Table 4.18: Households who Slaughter Animals at Home	68
Table 4.19: Number of Animals Slaughtered per Annum by the Households	69
Table 4.20: Ways of disposing animal slaughtering waste	69
Table 5.1: Distance of sample Kebeles from the Landfill Site	72
Table 5.2: Number of trips of vehicles, carrying capacity and coverage	75
Table 5.3: Sub cities daily operated vehicles and disposal capacity	75

ACRONYMS

AACG	Addis Ababa City Government
AACMA	Addis Ababa Codes Enforcement and Monitoring Agency
AACSC	Addis Ababa Civil Service Commission
AAEPA	Addis Ababa Environment Protection Agency
AAFEDB	Addis Ababa Finance and Economic Development Bureau
AAHB	Addis Ababa Health Bureau
AAICB	Addis Ababa Information and Culture Bureau
AARA	Addis Ababa Roads Authority
AASBPDA	Addis Ababa Sanitation, Beautification and Parks Development Agency
AAWSA	Addis Ababa Water and Sewerage Authority
CBOs	Community Based Organizations
CSA	Central Statistical Authority
EELPA	Ethiopian Electric Light and Power Authority
EHSD	Environmental Health and Social Service Department
ETC	Ethiopian Telecommunication Corporation
KGs	Kilograms
KMs	Kilometers
NGOs	Non-Governmental Organizations
OAU	Organization of African Unity
SW	Solid Waste
SWM	Solid Waste Management
UNDESA	United Nations Department of Economic and Social Affairs
UNEP	United Nations Environment Program

SYMBOL

÷	Division
M ³	Meter cube
M ²	Meter square
=	Equal to

Abstract

The study was generally intended to examine the current situation of Addis Ababa city solid and liquid waste management service in ten sample kebeles. The objective is to examine the current situation of waste collection, transportation and disposal practice. To attain this objective, data were gathered using primary and secondary sources as well as from field observation. The primary sources were households; taxi drivers; street children; beggars; AASBPDA; AAWSA; AARA; and AACEMA using questionnaire and unstructured interview. The secondary data sources were AASBPDA; AACSC; AAFEDB; AACEMA; previous researches; records and other sources. Data were also obtained from field tour to selected areas. Data obtained is presented, interpreted, analyzed and discussed.

It is found that the city waste disposal system is dumping on land. The public throws and drains waste into open places, drainage system and water bodies, which would be a cause for bad odor, environmental pollution, flooding, potential area for breeding of insects, and the possible spread of diseases. Current waste collection, transportation and disposal practices are unable to keep pace with the waste generation rate. The high rate of urbanization is not backed with corresponding socio-economic development. For instance, the increasing generated waste in the city has not been accompanied by adequate sanitation facilities and management systems. Infrastructural facilities are not sufficient and inadequate access and high cost to basic services. These service deficiencies are accumulated year after year, which cause enormous backlog. The backlog, so vast and interrelated, requires huge capital to ameliorate.

Thus in addition to use available opportunities, it will be better to pay attention and check for: proper allocation and relocation of waste containers; the suitability, proximity and convenience of communal containers to users; timely transportation and safe disposal of waste; proper services of sewage, storm water and solid waste management which are fundamental to the health and welfare of residents.

CHAPTER ONE

1. INTRODUCTION

1.1. Background

Human living and the creation of waste go hand in hand. Waste is a by-product of everyday human living. Thus, the idea of eliminating waste all together is an impractical proposition, and what is realistic is the management of it in an effective manner. Human wellbeing depends on such effective management involving the collection, transfer, recycling, resource recovery and ultimate disposal of waste (Cairncross and Feachem, 1993).

Urbanization and the associated growth of industry and services coupled with rapid population growth, technological developments and mass production has contributed to the increase in volumes and types of waste generated. This growth has brought challenges and problems. One of the problems of urbanization is the amount of solid and liquid waste that is generated at a rate that outstrips the ability of the natural environment to assimilate and municipal authorities to manage (UNDESA, 1999).

Besides, inappropriate collection, transportation and disposal of waste can affect environmental quality and public health, and can constrain future development opportunities. Hence, the primary objective of waste management is to protect the public and the environment from harmful effects of waste.

The city of Addis Ababa is the focus of this study. It is the capital city of Ethiopia; the diplomatic capital of Africa and a seat for various Embassies and international offices. It is also the center for economic and social activities, in which social and infrastructure services are relatively found in a better situation than other towns of the country (AAFEDB, 2007 and AASBPDA, 2008).

The aforementioned aspects of the city coupled with natural growth and migration intensify the rapid increase in population, special expansion and in economic activities. These contributed to the increase in the generation of wastes. Thus, the problem of wastes and its management has become the concern of its residents and the city government.

Therefore, a city with such multi-faceted features has to be given due attention by researchers and practitioners' so as to make a better place to live and work. Addis Ababa City Government (AACG), which is a component of and responsible to the Federal Government, among others, has been given the authority to identify, determine and organize municipal services (AACG Charter, 2003). Currently, AACG provides sanitation, housing, education, health, slaughter services, construction of access road, bridges, parks, recreational centers, and other services.

Among the services delivered by AACG, this study focuses on solid and liquid waste management service. Solid and liquid waste management service is chosen as a topic of the study seeing that it is directly related to environmental sanitation and public health, which are basic to human wellbeing.

1.2. Statement of the Problem

Waste management in the city of Addis Ababa becomes a growing health and environmental concern. Proper management of waste is essential for reducing its adverse effects on human and environment. However, waste management has enormous challenges. Among others the problem in waste collection, transportation and disposal could be cited.

1. Collection: residents of the city generate daily a considerable volume of both solid and liquid waste. The average daily solid waste generation of the city is estimated to be 2,423m³ or 806.84 tones. Of the city solid waste, 71.04 percent (1,721.30m³) is collected per day (AASBPDA, 2008). The situation of the liquid waste seems worse. The daily waste water generation of the city is 169,400m³. However, only 6.27 percent (8,500m³) is collected per day (AAWSA, 2008). The remaining, that is, 28.96 percent of the solid waste and 93.73 percent of the liquid waste is uncollected. Hence, no means for residents than disposing through informal means: disposed on open sites, drainage channels and rivers. This shows that waste collection capacity is quite less in comparison with the volume of generated waste.

2. Transportation: the main challenge in waste transportation is to empty communal containers and pit latrines or septic tanks. The plan is to empty communal containers on average every 2-6 days (AASBPDA, 2008) and to empty pit latrines or septic tanks as and when the need arises (AAWSA, 2008). In practice, however, container clearing frequency takes more than a week period and the housing units are obliged to stay long to clear their pit latrines and septic tanks.

3. Disposal: waste disposal is another problem. There are a number of informal waste disposal sites. This usually happens due to lack of communal containers, remote distance of communal containers and lack of means for waste disposal. There are three formal waste disposal sites, one for solid waste and the other two for liquid waste. All are open dump sites. The formal disposal sites, the communal containers and the uncollected waste scattered here and there (disposed informally) has no cover at all. This may be a threat to human health, surface and ground water. Unsafe waste disposal also cause flooding and create a good ground for breeding of insects. Disposal of waste either in the informal or formal disposal sites are unsafe. Inadequate waste collection, transport and disposal create health and environmental problems.

Recognizing the problem, the city government has taken different initiatives: issue proclamations in order to protect illegal (informal) waste disposal and establishing new organs: Addis Ababa Sanitation, Beautification and Parks Development Agency (AASBPDA) to handle the city solid waste management and Addis Ababa Codes Enforcement and Monitoring Agency (AACEMA) to monitor illegal activity and to follow implementation of codes. AACG issued proclamation number 1, 1994 on Hygiene and Environmental Sanitation; Waste Management Regulation number 13/2004 to prohibit people from disposing waste along roads, rivers, and other sites.

Regardless of the encouraging initiatives of AACG, residents of the city have not been able to limit or stop illegal waste disposal activities. The regulation is repeatedly violated by the community. For instance, according to information from AACEMA, during the period of 6 months, from September 2007 to February 2008; 44,481 households' have violated the regulation and dispose waste illegally. Out of these, 2,921 households were penalized.

This implies that apart from the initiatives taken by the city government, the problem of waste collection, transportation and disposal remains untouched. On the other hand, the initiative of the city government seems inadequate. Hence, the problem seems deep rooted. Adequately identifying all the challenges faced by the city government and the resident is very essential. Therefore, this paper, based on the preceding observation, focuses on the following research questions:-

1. Why waste collection capacity of Addis Ababa city is less in comparison with its waste generation rates?
2. How timely clearing and emptying of pit latrines and of communal containers become the challenge in waste transportation?
3. What are the factors that make the city waste disposal unsafe?

1.3. Objectives of the Study

The general objective of the study is to examine the current situation of waste management services in terms of collection, transportation and disposal practices.

The specific objectives of this study are:

1. to examine the current situation of solid and liquid waste collection, transportation and disposal services in the city of Addis Ababa;
2. to examine waste handling capacity of Addis Ababa City Government;
3. to examine city residents waste management practices;
4. to recommend possible course of action.

1.4. Significance of the Study

The study will be significant for decision makers to make informed decisions, academicians to conduct further research. It will also help to provoke debate on waste management issues. In the course of this debate better options may be developed. It is hoped that this study will inspire visionaries who are able to translate ideas and theories into new initiatives in the aspects of waste management.

1.5 Limitations of the Study

A plan to make a comparative analysis of waste management between public and private sector becomes very difficult mainly because of shortage and non availability of data on private sectors.

1.6. Scope of the study

The study is limited to solid and liquid waste management. All aspects of solid and liquid waste are vast and needs sufficient time and resource. Hence, this study covers collection, transportation and disposal of solid and liquid waste in the city of Addis Ababa. The study examines the current situation of solid and liquid waste collection, transportation and disposal. However, some presentation and interpretation have been made based on 2003 to 2007 data.

1.7. Research Methodology

Descriptive type of research method is used. In other words, collected data is analyzed descriptively.

1.7.1. Data Collection Techniques and Procedures

Data is collected using three principal sources: primary data, secondary data and observation. These sources used to gather the necessary information that addressed the stated research questions and objectives.

Primary Data: Primary data is collected through questionnaire and unstructured interviews. The questionnaire included both close and open-ended questions. Particularly open-ended questions are used to extract reasons and further explanations. The questionnaires were filled by sample households obtained from the ten kebeles selected on simple random sampling methods. To supplement the data collected through questionnaire, unstructured interview was conducted. The objective of this interview was to solicit ideas and issues, which has not been covered by the questionnaire. Unstructured interview was held with AASBPDA; AAWSA; AARA; AAEPa; AACEA; taxi drivers; street children and beggars.

Secondary data: The study used secondary sources of data. Secondary data was collected via inspection of all available documents and reports of AASBPDA, AACEA; AACSC; publication of AAFEDB; Addis Ababa City Government Charter; and previous researches.

Observation: On top of personal life experiences, field tour to selected areas of the city was carried out. The major area of focus include: 1) landfill site located in Kolfe keraneo sub city; 2) the roadsides, drainage systems and rivers of the sample kebeles. This observation and experiences acquired from just being member of the community help to assess the research questions and objectives.

Data Collection Procedures: Questionnaire was prepared and distributed to households. The questionnaire was translated into Amharic version and distributed to 200 sample households with the help of data collectors. Data collectors were properly trained. Households were briefly told about the purpose of the study and encouraged to cooperate.

On the other hand, interview was conducted with interviewees on the basis of appointment. Data from secondary sources were obtained by getting permission from concerned officials.

1.7.2. Population and Sample Size

The population of the study includes all the 10 sub cities and 99 kebeles of AACG. A sub city has on average 10 kebeles. Since the coverage and quality of providing solid and liquid waste management service is assumed to vary from one sub city to another, a kebele (which is 10 percent) from each sub city is considered to examine the current situation of waste management and to know the magnitude of the problem on a city wide level. One Kebele from each sub city is selected on a simple random sampling technique.

Accordingly, a total of 200 sample households were selected from the ten kebeles, that is, 20 households from each sample kebele. 200 sample sizes are taken considering manageability and with the assumption that it will represent or reflect the current situation of waste management in the each kebele and at a city wide level. Sample households were selected using purposive sampling technique. The sampling frame is obtained from the list of households recorded and kept by respective kebeles.

1.7.3. Data Analysis

The data obtained from primary and secondary sources as well as field observation is presented, interpreted, analyzed and discussed. Tables are interpreted using simple arithmetic procedures such as ratios and percentages.

1.8. Organization of the Paper

The study is organized into six chapters. The first chapter deals with background, statement of the problem, significance, objective, scope, limitations and methodology of the study. In the second chapter, a review of related literature is carried out. The third chapter is about background information of Addis Ababa city and sample households. Description of waste management service and households response regarding the service is presented in the fourth chapter. Chapter five is about data analysis and discussion. The final chapter deals with research findings, conclusion and recommendation.

CHAPTER TWO

2. LITERATURE REVIEW

Waste is created as a result of human activity. It can not be eliminated. The best option is proper management. Human well being, environmental quality and future development depend on its effective management. However, the challenges facing waste management are enormous. To overcome the challenges studies have been conducted and different policies have been issued. In this chapter: the concepts of urban management, governance and environmental management; approaches, fundamentals and challenges of waste management and strategies and options for sound waste management will be reviewed.

2.1. The Concepts of Urban Management, Governance and Environmental Management

The urban management model deals with the development and day-to-day running of cities (Devas and Rakodi, 1993: 43) and includes topics such as public service delivery: education, health, public works and waste management. It is an attempt of using business-like approaches to management and finding better ways of running a city, recognizing the dynamics and uncertainties of development and the need to adapt rules, regulations and working attitudes swiftly to changing circumstances.

In the course of the 1990s, urban management developed into urban governance, which recognizes that the state is only one of the actors involved in running the city and shaping its future development. It is an attempt to broaden the scope of attention and to disconnect it from the

predominance of public management. Urban governance tries to break with the top-down, state-led ideas of running cities to emphasize the role of partnerships and diverse institutional arrangements. Governance includes the whole range of actors within civil society, such as community-based or grass-roots organizations, NGOs, trade unions, religious organizations and businesses sector, both formal and informal, alongside the various branches of government, both national and local (Davev et al., 1997).

Generally, governance can be thought of as a means to establish order among stakeholders. Urban environmental management is based on similar principles as urban management, the most important difference being that urban environmental management looks beyond the city boundaries more, especially in terms of environmental consequences of urban development.

Urban environmental management takes a broader approach of sustainable development. It includes major elements: access to housing and services; healthy working conditions and a healthy living environment; a development pattern that reduces the use of natural resources and does not deplete sinks and hence respects ecosystems and biodiversity; and seeking to include all actors in planning, decision-making and implementation as well as to integrate different sectors of the economy (Davev et al., 1997).

2.2. Fundamentals of Waste Management

In this section concept of waste management, definition of terms, sources of wastes and agencies for waste management will be discussed.

Rand (2000) has defined waste management and concepts of it in aspects of the waste hierarchy. Summary of it is presented as follows.

Sources of waste could be domestic, commercial and industrial. There are agencies that are expected to play a role in the management of the wastes produced by the aforementioned sources. The agencies for waste management are: government, private, community, individual, and local.

Waste is any material/liquid that is thrown away as unwanted. As per physical properties, waste can be categorized as solid and liquid.

A. Solid waste: is any waste other than human excreta, urine & waste water. Solid waste generally includes-house sweeping, kitchen waste, garden waste, agro waste, broken glass, metal, waste paper, plastic, cloths, rubber, waste from markets & shopping areas, hotels, etc. It is the organic and inorganic waste materials produced by households, commercial & industries that have no economic value to the owner. As per biodegradability, solid waste can be classified as:

Biodegradable: are wastes that are completely decomposed by biological processes either in presence or in absence of air. Examples are: kitchen waste, animal dung, agricultural waste etc.

Non-biodegradable: are wastes which cannot be decomposed by biological processes. These are recyclable and non-recyclable.

Recyclable: waste having economic values but destined for disposal can be recovered and reused along with their energy value. Example: plastic, paper, old cloth etc.

Non-recyclable: Waste which do not have economic value of recovery. Example: tetra packs, carbon paper, thermo coal etc.

B. Liquid wastes: those that are generated in, or converted to, a liquid form for disposal. Storm water, wastewater, and flooding are among the liquid wastes.

Black Water: is waste water generated in the toilet. It contains harmful pathogens. *Grey water:* is waste water generated in the kitchen, bathroom and laundry. It may also contain pathogens.

Waste management is the avoidance (not making waste in the first place), minimization (reducing waste, reusing, sorting and recycling), generation (when waste is made), on-site storage (where waste is stored temporarily when it is first produced), collection (how waste is picked up), transport and transfer (how waste is moved), processing and materials recovery (how waste is treated or made useful), and disposal (how waste is finally discarded).

Wherever people live, work or spend their leisure time, they produce waste. The type of waste produced will vary depending on the demographics of the community: whether it is developed or undeveloped, formal or informal, urban or rural, etc. Ones produced by human activity, waste should be given due care so as to reduce its effect on human health and the environment.

Waste management can involve solid, liquid, and gaseous substances with different methods and fields of expertise. The practice differ for developed and developing nations, for urban and rural areas, and for residential, industrial, and commercial producers. Waste management for non-hazardous residential and institutional waste in urban areas is the responsibility of local government authorities.

Waste Management Concepts: There are a number of concepts about waste management, which vary in their usage between countries or regions. Of the most general and widely-used concepts waste hierarchy is one. Waste hierarchy deals with waste prevention, minimization, reuse, recycling, energy recovery, and disposal. They are arranged on their order of importance.

The waste hierarchy refers to the "3 Rs" reduce, reuse and recycle, which classify waste management strategies according to their desirability in terms of waste minimization. The waste hierarchy remains the cornerstone of most waste minimization strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from products and to generate the minimum amount of waste.

Wastes are generated from human activities. Sources could be: domestics, commercial, agriculture, and so on, which require proper handling to reduce its impact on the environment and health. This indicates that there are several phases of waste management right from the stage where it is generated till it reaches its final destination or at a stage where it is no more a threat to the environment.

2.3. Solid Waste Management Approaches

Solid waste management approaches state the rationale for storage; describe storage containers; state the rationale for refuse collection; indicate who has responsibility for refuse collection; identify basic collection systems; discuss methods of treating solid wastes; and evaluate the methods of solid waste disposal.

To this effect Cointreau (1982) has summarized six steps of solid waste management approaches. These are: storage, discharge, collection, transferring, hauling (transportation), and disposal.

Storage: Storages of waste basically divided into separate units and communal storage.

In separate unit storage - wastes are put in either standardized or non-standardized containers. Non-standardized containers could also be either temporary containers such as cartons and plastic bags or permanent containers such as plastic or metal bins. Standardized containers are plastic or metal bins tagged with the addresses of their owner. The size of the containers depends on the weight and density of solid waste, length of storage, and climate of the area which affects the frequency of collection.

In communal storage - containers could be either stationary like four sided masonry structure with a door opening and no roof or portable containers like large steel drums, metal containers that can be lifted by hydraulics, wood or metal trailers for use by tractors, and roll on metal containers to be used by trailer truck bodies.

Discharge: If communal storages are used, citizen can discharge their waste to the containers at any time. But in the case of separate unit storage there should be active participation of the citizen to discharge waste properly. Citizens are required to put their waste at permanent container or bring out their waste according to a specified route and time schedule of the collection vehicle assigned for house-to-house collection.

Collection: human, animal, and engine powered are types of waste collection techniques. In human powered collection technique pushcarts, two wheeled dollies with basket, and pedal tricycles can be used. This technique is particularly useful for narrow walkways, roads with smooth surface, and door-to-door collection in low income areas.

Animals such as horses, mules, donkeys and oxen can be harnessed for waste collection purposes. Animals can be used by saddling containers or letting to pull drawn carts. It is useful for cities with slow moving traffic such as bicycles and tricycles and in areas where there is poor infrastructures such as hilly and narrow roads. In cities with fast moving traffic, waste collection should be early in the morning during low traffic movement.

Engine powered waste collection technique uses tricycles with hydraulic tipping containers mounted on back, tractors pulling wheeled containers or trailers with hydraulically lift containers, and trucks with portable containers. This is useful for cities with expensive labor.

Transferring: It is discharging wastes from smaller pieces of collection equipment to larger container for transportation to the disposal site. If disposal site is close to the collection area, direct haul increase efficiency. However if disposal site is a bit farther, transferring waste to a larger equipment gives time for the collection equipment and the crew to maximize the route and time for provision of collection.

Hauling: Transportation could be either directly from waste collection area or from transferring station to a disposal site. If the landfill is located close to the collocation area and it is economical to haul wastes directly to the landfill, no need to have transfer stations.

Disposal: disposal methods common in developing countries are open dumping. Sanitary landfills require capitals and are expensive for developing countries. In waste disposal, resource recovery options can be used. Due to the high biodegradability and moisture content of wastes in the developing countries, composting, biogas conversions, and methane recovery from landfills is technically feasible.

2.4. Liquid Waste Management Approaches

The discharge of untreated or inadequately treated wastewater from industry and sewage causes pollution or harmful effects to the environment and human health. Wastewater may be defined as any discharge into the environment (effluent or sludge) with or without treatment. Contaminants of concern that are present in wastewater include pathogens, nutrients, heavy metals, suspended solids, biological oxygen demand, and oil and grease (Zurbrugg, 1999). Zurbrugg further elaborates liquid waste management in terms of sanitary crisis, sanitation, and drainage.

2.4.1. The sanitary crisis

The rapid growth of population and urbanization results in an overload on water sources, improper waste disposal, contamination of streams and a long list of service deficiencies. A vicious circle develops in which the generated income is so low that a proper service cannot be improved and the service is so poor because it cannot recover its costs from the users.

The growing out flush of dirty water has major environmental implications, but the urban development planners ignored the drainage and the frequent water treatment. Drain and waste pipes should be of adequate size and be

maintained frequently to prevent clogging and the backflow of sewage and contaminated wastes. Sewage, food particles, and other wastes should not be discharged to the drainage system.

2.4.2. Sanitation

The lack of adequate sanitation contributes to high prevalence of water and sanitation related diseases. Wastewater, human excreta, storm water and flood are causes of pollution. Pit latrines and septic tanks are common sanitation facility in Addis Ababa. Sludge and wastewater collected from them are disposed of to the natural water ways and cause health problems and environmental pollution (Ashenafi, 2001).

The proportion of units that are connected to a 'modern' sewerage system is negligible in Addis Ababa. The system was designed to serve 200,000 residents or 38,462 houses, but only 1,600 units are connected to the system. Not surprisingly, therefore, the liquid waste that is generated by most households in the city either enters the dry pits and septic tanks that are commonly found close to most shelters or simply finds its way to the city's open ditches and streams which have literally become sewers. Most houses in the city do not have toilets. Municipal and private suction trucks are used to collect and dump the contents of the toilets that fill up after months or years of use. As the municipal trucks are not available in sufficient quantity it is not unusual for households to queue up for the service. On the other hand, private operators requesting a much higher service charge. It is common for septic tanks or pit latrines to overflow in poor residential areas that have no or limited access roads. The problem is worse in the case of those septic tanks that fill up quite frequently in areas that are exposed to flood or ground water flow (Theo Van der Loop, 2002).

2.4.3. Drainage

Wastewater, which flows in urban drainage systems are derived from storm water runoff and base flows. The main driving force resulting in storm water runoff in urban drainage systems is rainfall. Pollution of storm water runoff results from the contamination of rainwater through contact with various substances from the time of its origin in the atmosphere until the moment of its discharge into a receiving body of water.

Storm water is rainwater run-off from hard surfaces such as roofs, roads, paths and ground surfaces, as well as the ground water that flows in streams. It receives a range of wastes. All storm water ultimately discharges to the streams and overland.

Storm water issues relate to either: quantity (an excess of which causes flooding) or quality (the pollution in the storm water causes environmental damage). This pollution comes from a number of sources including sewage entering the storm water system such as: heavy metals and hydrocarbons mainly associated with car use and combustion; sediment and silt from erosion and developments and litter.

When it comes to storm water management it is quite clear that Addis Ababa city has a poorly developed drainage system. Out of 990 kilometers asphalted roads only 484 kilometers have got storm drainage lines and from 1,453 kilometers of gravel roads only about 466 kilometers have drainage channels (AARA, 2008).

More often than not unlined channels occur in areas where ground profiles are steep thereby exposing the areas to erosion as a result of high

velocities of flow. On the whole the drainage system of Addis Ababa is sadly underdeveloped by any standard (Theo Van der Loop, 2002).

This being the case, liquid waste has to be properly managed to reduce its impact on health, environment and economic. According to Schubeler (1996) guiding principles for management of such waste are:-

Sustainable development: All members of society are responsible for looking after the environment and for the impact of wastes they produce. A sustainable development approach will be undertaken in making future decisions with consideration given to environmental, economic, social and cultural impacts.

Liquid waste is a resource: This recognizes that there are beneficial reuse opportunities for both sewage and storm water and possibly waste to energy opportunities whilst recognizing that the viability of any systems will need to be explored.

Liquid waste management enables to reduce (source and volume) waste and sustainable disposal.

Reducing Waste: quantities of waste can be reduced at its source and by deploying reused, recycled or recovered after generation.

Sustainable Disposal: All waste is disposed of in an environmentally sustainable manner ensuring the protection of people and ecosystems.

2.5. Challenges of Waste Management

The quantity of waste arising are generally considered to be growing across the globe as a result of increase: in the world's population, industrialization, urbanization, and rising standards of living (UNEP, 1994). There are many factors that vary from place to place and that must be considered in the design of a waste management system (Zurbrugg, 2000). Challenges of waste management such as: waste problem-waste amount and composition, rapid urbanization and growth of urban population, inadequate service coverage, and institutions and operational inefficiencies will be discussed.

2.5.1. The Waste Problem - Waste amount and composition

Domestic waste of industrialized countries has a high content of packaging: made of paper, plastic, glass and metal, and so the waste has a low density. In contrast, wastes of developing countries contain large amounts of inert such as sand, ash, dust, and stones and high moisture levels because of high usage of fresh fruit and vegetables. These factors make the waste very dense (high weight per unit volume). The consequences of this high density are that vehicles and systems that operate well with low-density wastes in industrialized countries are not suitable or reliable when the wastes are heavy. The combination of extra weight, the abrasiveness of the sand and the corrosiveness caused by the water content, can be a cause for rapid deterioration of equipment. If the waste contains a high proportion of moisture, or is mostly inert material, it is not suitable for incineration, and so is the treatment upon is ruled out (Zurbrugg, 2000).

2.5.2. Rapid Urbanization, Growth of Urban Population and Inadequate Service Coverage

Economic growth, population increase and rapid urbanization strain municipal resources to deal with a booming amount of wastes. As addressed by Holmes (1984) higher incomes and economic growth also tend to have an impact on the composition of wastes. Wealthier individuals consume more packaged products, which results in a higher percentage of inorganic materials: metals, plastics, glass, and textiles in the waste stream. Higher volumes of wastes and a changing composition with a higher content of inorganic materials could have a significant impact on human health and the environment. If those additional wastes resulting from growth of population, rapid urbanization and economic growth are not collected, treated and disposed of properly, health and environment will further deteriorate.

Waste collection schemes of cities in the developing countries generally serve only a limited part of the urban population, the majority of the people especially in slum areas remaining without waste collection services. These are usually the low-income earners living in poor conditions in urban areas. One of the main causes of inadequate collection services is the lack of financial resources to cope with the increasing amount of generated waste (Zurbrugg, 2000).

Many sources of waste might only be reached by roads or alleys, which might be inaccessible to certain methods of transport because of their width, slope, congestion or surface. This is especially critical in unplanned settlements such as slums or low-income areas and thus largely affects the selection equipment.

In areas that lack refuse collection, usually low income communities, residents tend to either dump their garbage at the nearest vacant lot, public space, stream, river, or simply burn it in their areas. Uncollected waste may accumulate on the streets and block drains and when it rains, it may cause flooding. Wastes can also be carried away by runoff water to rivers, lakes and seas, affecting those ecosystems.

2.5.3. Institutional and Operational Inefficiencies

Institution issues include the current and intended legislation and the extent to which it is enforced. Standards and restrictions may limit the technology options that can be considered. The policy of governments regarding the role of the private sector should also be taken into account. The strength and concerns of trade unions can also have an important influence on what can be done.

Operational inefficiencies are due to inefficient organizational structures and procedures, or deficient management capacity of the institutions involved as well as the use of inappropriate technologies. With regard to the technical system, often the “conventional” collection approach, as developed and used in the industrialized countries, is applied in developing countries: centralized and undiversified, bureaucratic top-down solutions, capital intensive approaches, and the use of the formal sector (UNEP, 1996).

2.6. Strategies and Options for Sound Waste Management

Striving for avoidance of pollution or risk to human beings is impracticable. What is good instead is to adopt various strategies and options to run a sound waste management system.

2.6.1. Waste Reduction/Avoidance

Due to concern over the quantity and toxicity of waste that is being produced; waste reduction/avoidance, which is defined as “the prevention of waste generation”, is placed at the top of waste management hierarchy because it is a “waste avoidance” technique. Waste reduction/avoidance has the potential to conserve resources, save energy and reduce pollutants. In addition, waste reduction/avoidance can also reduce waste collection system costs and reduce the need for new landfills and incinerators. Waste reduction/avoidance includes the design, manufacture, purchase, or use of materials, such as products and packaging, to reduce their quantity and toxicity before they enter the waste management system. This is a strategy that seems simple in concept but has shown promise. However the amount of waste produced, even in developed countries, is often a function of culture and affluence. For example the developed countries have developed, a “throw away culture”. Consumer goods are cheap and packed, which results in significant increases in municipal waste. An emphasis on mass production and the development of cheap consumer goods has caused quality and longevity of goods to be sacrificed, causing people to be more likely to simply throw away and replace items instead of repairing or maintaining them (Zerbock, 2003).

Resource Recovery: Resource recovery, including recycling, composting and combustion is a “waste reuse” technique. The benefits of resource recovery include: conserving natural resources, energy, and landfill space and providing useful products and economic benefits. However, recycling and composting are more than just separation and collection of materials. These materials must be processed and reused in order to have a beneficial effect on reducing the waste stream. Similarly, combustion facilities must

incorporate some form of heat recovery system so that the energy can be utilized. Combustion facilities should also incorporate modern air pollution control systems to reduce air pollution.

Recycling: is the collection and separation of materials from waste and the subsequent processing to produce marketable products. Separating waste materials at the household level occurs almost universally and prevents the most valuable and reusable materials from being discarded. Following in-home retention of valuable material, waste-pickers remove most valuable materials either before garbage enters the waste stream or en route. Even in the more affluent areas of developing cities, often there are found roving buyers of waste materials such as cardboard and glass (UNEP, 1996).

Recycling inorganic materials is often well developed by the activities of the informal sector although such activities are seldom recognized, supported, or promoted by the municipal authorities. Recycling has the advantage of: reducing costs of the disposal facilities, prolonging the site span, and also reducing the environmental impact of disposal sites as the organics are largely to blame for the polluting leach and methane problems.

Composting: It is somewhat more low-technology approach to waste management. Wastes of developing nations would theoretically be ideal for reduction through composting than industrialized nations. For example, in developing nations, the average city's waste stream is over 50 percent organic material. However, composting has not been overwhelmingly successful and widespread in practice throughout the developing world (Hoornweg, et al, 1999). Composting serves as to reduce the amount of waste to be disposed and extending the life of landfills. When done correctly, the end result becomes a useful product, capable of being used at

the household or farm level to augment soil nutrient levels and increase organic matter in the soil and soil stability.

Incineration: is burning of waste at high temperature. Purpose is to reduce the volume of refuse. However; it may not be appropriate for most low-income countries due to high financial start-up and operational capital required to implement its facilities. Incinerators should not be located where prevailing wind patterns would carry emissions over densely settled areas. The use of emissions reduction technology, although expensive, should be mandatory. Incineration volatilizes many compounds potentially harmful to human health: metals, organics, acid gases, nitrogen oxides, carbon monoxide and dust (Rand et al, 2000 and UNEP, 1996).

2.6.2. Integrated Waste Management Approach

Integrated waste management systems incorporate all the policies, programs and technologies that are necessary to manage the waste stream. An integrated approach to waste management considers the principles of sustainable development and waste management hierarchy that must be embraced, coordinated, and implemented at the municipal, community, and institution levels. It also considers regional specific issues and needs and formulates an integrated and appropriate set of solutions unique to each context. The role of government in integrated waste management approach should be three-fold: to develop and enact legislation and policies that promote and ensure protection of the environment, to establish agencies to implement these programs and to regulate waste management practices (Schubeler, 1996 and UNEP, 1996).

2.6.3. Landfill

The final disposal of solid waste is in a landfill. The types are three.

Open dump or open landfill, which is the most common for all developing countries whereby the refuse is simply dumped in low lying areas on open land and wastes are tipped haphazardly.

Semi-controlled or operated landfills are those in which at a designated site, the dumped refuse is compacted and daily topsoil cover is provided to prevent nuisance. Every kind of municipal, industrial or clinical/hospital waste is dumped without segregation and is not engineered to manage the leachate discharge and emissions of landfill gases.

Sanitary landfills: practiced in developed countries. Have facilities for interception of leachate generation and its treatment using a series of ponds and it has arrangements to control gases from waste decomposition.

The difference between landfills and dumps is the level of engineering, planning and administration involved. Open dumps are characterized by lack of engineering measures, no leachate management, no consideration of landfill gas management, and few, if any, operational measures such as registration of users, control of the number of tipping fronts or compaction of waste. Sanitary landfills, on the other hand, are sites where waste is allowed to decompose biologically and chemically (Johannessen, 1999).

Among the three, sanitary land filling is an engineered system which is the best option taking into account the likely environmental impacts by the solid waste with respect to the pollution of air, water and soil. However, sanitary landfill is costly in time of establishment and running its operation.

2.7. Participation of Different Actors in Waste Management

2.7.1. Public Awareness and attitudes

As generators of waste, the public must be aware of the hazards posed by ineffective waste management. Participation by the whole community for waste management program is essential to bring about changes in the management with respect to source segregation, recovery of reusable and recyclables and storage of the waste prior to collection. Public awareness and attitudes to waste can affect the whole waste management. All steps in waste management services depend on public awareness and participation. Thus this is also a crucial issue, which determines the success or failure of a waste management system. Hence government and concerned bodies are expected to play a key role in bringing about this awareness through role play in the municipal waste management programs which in turn creates a sense of ownership among the individuals thus developing keen interest for shouldering responsibilities (Dhussa and Varshney, 2000).

2.7.2. Role of informal sector in waste management

In this sector, there are individuals, families, groups and small enterprises that carry out unregistered and unregulated activities. The waste workers are motivated by the income from the sale of the wastes and work as scavengers, collectors and sweepers despite health hazards. Their contribution to the system is also significant but needs organizational and technical support. This could be achieved by the formation of micro enterprises. Scavenging is unavoidable in the developing countries due to the economic condition of these people and can help in the recovery of the resources for sale to the recycling units (Schubeler, 1996).

Summary

Clean places and streets are essential to live and work. As well, clean water is the most important substance for human existence. Freshwater from rivers, lakes and groundwater are used to irrigate crops, to provide drinking water, and for sanitation purpose.

Be this as it means; all human activity, rapid urbanization and the associated growth of industry and services coupled with rapid population growth are sources and causes to the increase in volumes and types of wastes generated. When waste is produced, it eventually returns to the natural environment-to land, water or air. The environment that receives waste is not able to assimilate it because wastes are dumping faster than nature can degrade and absorb.

This being the case, inadequate management has resulted in the accumulation of waste on open lands, in drains, in rivers and in the living area of many people, causing a trouble and unpleasant-smelling, environmental pollution through leaches from piles (water and soil pollution) and burning of waste (air pollution), blockage of drains, and the spread of diseases. But waste must be disposed in a way that does not have an adverse effect on human health and the environment.

It is, therefore, with the aforesaid idea that this paper will try to focus and examine the current situation of Addis Ababa city solid and liquid waste management service and the findings of which will be discussed in the chapters to come.

CHAPTER THREE

BACKGROUND INFORMATION: CITY OF ADDIS ABABA

3.1 Geographical Location and History

Addis Ababa city has an area of 546.4 km². Modern, multistoried buildings and traditional villas are found in Addis Ababa. Its high elevation gives the city a pleasant climate. Entoto is the mountain range that eclipses the city from the north. Addis Ababa is located at the geographical center of Ethiopia. Its topography is constituted by hills, rivers, and plains. The temperature is fairly constant throughout the year. Average rainfall is 1200 millimeter per year, with the major rains occurring between June and September. Addis Ababa city has a history of 122 years. The site was chosen by Empress Taytu Betul and the city was founded in (Hidar 17, 1879E.C.) 1886 by her husband, Emperor Menelik II (AAFEDB, 2007).

Addis Ababa became the site of many innovations. These included the establishment of the country's first bank- the Bank of Abyssinia founded in 1905; the first hotel established by Taitu in 1908; the first modern school- Menelik II School opened in 1902; the first government hospital- Menelik II hospital and a state owned printing press in 1911. Here too were the erection of the country's first hydroelectric power station on the Akaki river in 1911; and the construction of Addis Ababa Djibouti rail-way that reached Addis Ababa in 1917 (AAICB,2006).

The three nodes for the growth of the city were: the Menilk Palace which served as political center; St George church which served as religious center; and the Arada center which was created between the church and

the palace to serve as a cultural and commercial center. The earlier settlements started to spread out around these centers. Emperor Menilik took further steps that consolidated the urbanization process of the city. Among these: social and economic activities such as schools, hotels, restaurants, banks started to appear and brought about fast growth to the city. The Italian occupation period also saw some new developments: increased construction, the creation of a new location called the Addis Ketema to segregate the indigenous people from the whites and the shifting of the market from Arada to Merkato (AAFEDB, 2007).

The role as a seat of government has helped Addis Ababa to undergo various alterations. It has emerged as a city that has both international and national significance. The international significance is revealed as it serves as seats of various international organizations and embassies. The national significance of the city also comes as it is the major commercial, industrial, education and political center of the country (AAFEDB, 2007). As per the 1994 population and housing census of Ethiopia, the city of Addis Ababa accommodates 27 percent of the total urban population of Ethiopia. Slum areas are found in all corners of the city. Wealthy residences and high buildings are standing in the midst of slum areas.

3.2 Physical Characteristics

The Northern parts of the city are characterized by steep slopes with high mountains, flat topped plateau while the Southern part is less steep. The city is endowed with numerous streams that start from North West and North East running toward the south and draining to the Awash River. The streams are: Kebena, Ginfle, Bantyyiket, Buhe, Kechene and Akaki rivers (AAEPA, 1997).

Table 3.1: Addis Ababa city area in square kilometer

Year	Area of the city	City area growth among the given periods	City growth rate	City Growth rate in percentage
1920	33 km ²	Base year	Base year	Base year
1984	223.6 km ²	190.6 km ²	6.78 times	577.57
1990	518.7 km ²	295.10 km ²	2.32 times	131.97
1994	530.21 km ²	11.51 km ²	1.02 times	2.22
2004	546.4 km ²	16.19 km ²	1.03 times	3.05

Source: extracted from AAEPA, 1997 and AAFEDB, 2007

In reference to table 3.1, the city has shown extensive physical growth over the years. In 1920s the area of the city was 33 km². The area grew to 223.6 km² in 1984 and 518.7 km² in 1990. In 1994 the size of the city was 530.21 km². The present area of the city is 546.4 km². This extensive physical growth of the city has contributed to its rapid urbanization. Since 1991 city area expansion has increased by 27.70km². Emphasis is on vertical expansion not horizontal. To this effect, a number of condominium houses and multi-storey buildings have been constructing.

3.3 Demography

According to the 1994 census, almost all ethnic groups are represented in Addis Ababa due to its position as capital of the country. The major ethnic groups represented are the Amhara (48.3 percent), Oromo (19.2 percent), Gurage (17.5 percent), and Tigray (7.6 percent), while others constitute 7.4 percent of the population. Regarding religion, 82 percent of the population is Orthodox Christian, 3.9 percent Protestants, 12.7 percent Muslims, 0.8 percent Catholics, and 0.6 percent followers of other religions.

Table 3.2: Population of Addis Ababa city taken at different censuses

Year of survey	Size of population	Population increase		Male	Female	Male to Female Ratio
		number	percent			
1961	448,512	-	-	230,180	218,332	105.43
1967	683,530	235,018	34.38	337,350	346,180	97.45
1978	1,167,301	483,771	41.44	553,681	613,620	90.23
1984	1,400,000	232,699	16.62	655,056	744,944	87.93
1994	2,112,737	712,737	33.74	1,002,126	1,110,611	90.23
2003	2,834,267	721,530	25.46	1,396,453	1,437,814	97.12
2004	3,113,023	278,756	8.95	1,522,831	1,590,192	95.76
2005	3,150,692	37,669	1.20	1,470,666	1,680,026	87.54
2006	3,188,362	37,670	1.18	1,563,501	1,624,861	96.22
2007	3,250,140	61,778	1.90	1,579,390	1,670,750	94.53
2008	3,650,889	400,749	10.98	1,753,467	1,897,422	92.41

Source: AAFEDB, 2007 and AASBPDA, 2008

As shown in table 3.2, population of Addis Ababa has been increasing year after year. For instance, the 1984 census put the population of Addis Ababa 1.4 million while the 1994 census recorded 2,112.737 people, which resulted in an increase of 712,737 or 33.74 percent over a decade period. Population has increased due to several factors. According to AAFEDB (2007), the contributing factors for the city population growth are: migration, increase in birth rate and decrease in death rate.

Table 3.3: Migration of people to the city

years	Migration of population in percentage
1985	51.5
1995	46.5
2000	46.9

Source: AAFEDB, 2007

As indicated in table 3.3, migration represents 51.5 percent, 46.5 percent and 46.9 percent of the city population in years 1985, 1995, and 2000. Migration drained rural labor force from agricultural production and created problems of unemployment, congestion of settlement and strains on existing inadequate social and infrastructural services.

According to AAFEDB (2007), average annual growth rate of the city population has been 2.8; 3.5; 4.9; 2.7 and 2.9 percents in the periods 1950-1960, 1960-1970, 1970-1990, 1990-2000 and 2000-2005 respectively.

Table 3.4: Sub cities: population, area, and population density (2008)

Sub city	Size of population	Male	Female	Area in km ²	Population density
Arada	358,611	169,020	189,591	9.98	35,932.97
Addis Ketema	431,399	212,957	218,442	7.77	55,521.11
Lideta	362,554	174,152	188,401	11.56	31,362.8
Kirkos	406,916	194,012	212,905	15.40	26,423.12
Yeka	386,001	179,869	206,132	86.40	4,467.60
Bole	352,833	165,999	186,835	125.24	2,817.26
Akaki Kaliti	239,628	115,770	123,858	130.42	1,837.36
Nifase Silk Lafto	398,129	190,252	207,877	61.21	6,504.31
Kolfe Kerano	339,186	167,807	171,379	66.17	5,125.98
Gullele	375,631	183,629	192,002	32.25	11,647.47
Total	3,650,889	1,753,467	1,897,422	546.40	6681.71

Source: AAFEDB, statistical abstract, 2007

As per table 3.4, high population density is found in Addis Ketma and Arada sub cities while their total area in square kilometer is small as compared to others. Akaki Kalitiie, on the other hand, has less population density. Population density is high in those sub cities found at the center. The average city population density is 6,681.71 inhabitants per square kilometer.

CSA, in its population and housing census of 1994, asserts that density of occupation is inversely related with maintenance of health and privacy of occupants. Infectious disease spread faster in densely populated areas and it is more difficult to evacuate people during disasters and calamities. There are even suggestions that lack of privacy, high noise levels, etc may tend to increase mental illness and maladjustments.

3.4 Economy

Different studies indicate that the economy of the city is predominantly based on the service sector and the private holdings; especially the informal economic activity has a greater contribution. But, the economic activities in Addis Ababa are diverse. According to an official statistics from the Federal Government of Ethiopia, some 119,197 people in the city are engaged in trade and commerce; 113,977 in manufacturing and industry; 80,391 home makers of different variety; 71,186 in civil administration; 50,538 in transport and communication; 42,514 in education, health and social services; 32,685 in hotel and catering services; and 16,602 in agriculture.

3.5 Employment

Employment is a means of getting income. Increased in an unemployed labor force and demand for service is a result of increased population growth.

Table 3.5: Employees of AACG by education and sex (2007)

Education	Total	Male	Female
Unable to read and write	74	43	31
Able to read and write	793	412	381
1-12 grade	14,159	6385	7774
12 grade plus certificate	7780	3937	3843
Diploma	6110	3203	2907
1 st Degree	4239	3255	984
2 nd Degree	220	175	45
3 rd Degree	20	15	5
Unknown	538	195	343
Total	33,933	17620	16313

Source: AACSC, statistical abstracts, 2007

As shown in table 3.5, the city has offered employment for about 33,933 people. These employees are supposed to render basic services for a population of 3,650,889. Out of the total female inhabitants, 0.86 percent (16,313) is employed in the city government. The city government has almost equal number of male (51.93 percent) and female (48.07 percent) employees. But the number of female employees who have diploma and above (38.50 percent) is lower than their counterparts (61.50 percent).

Table 3.6: Unemployment rate in the city of Addis Ababa

Unemployment rate	Above 10 years
2003	32.1
2004	29.1
2005	31.4
2006	28.6

Source: AAFEDB, 2007 cited from CSA, 2006

According to AAFEDB (2007), the city unemployment rate is estimated to be 23 percent by the year 2007/2008.

3.6 Access to and cost of basic services

Despite the government's effort to avail basic services, the rapid urbanization and population growth pose constraint in meeting the demands of the residents of the city. The residents' access to the demands of basic services such as: water, sanitation, transport, drainage and education and health facilities could be seen as follows.

3.6.1 Water supply

According to information from AAWSA (2007), about 88.5 percent of the housing units of the city have pipe line connection to taped water supply, yet 28.6 percent of the housing units experience frequent disruption.

3.6.2 Sanitation

Sanitation is related to the effort to make the city clean and suitable to live and work. Of the total generated solid waste, 25 percent are illegally dumped waste on streets, drainage channels and vacant plots (AAFEDB 2006). Of the total generated liquid waste, only 1 percent is collected. The remaining 99 percent of the liquid waste is left uncollected. This together with the unattended solid waste poses enormous challenge to the environment and human health (CSA, 1994).

Safe and efficient disposal of human waste is one of the measurements of environmental sanitation. Of the 374,742 households': 24.87 percent lack private or shared toilet, 11.99 percent have flush toilets and 63.15 percent have pit latrine. However, from the available toilets 63.15 percents are sub-standard (CSA, 1994). A total of 70 public toilets are available to those who

do not have toilet facilities (AASBPDA, 2007). These public toilets are not evenly distributed and most of them are not accessible by the population. Thus all vacant spaces within the city are common defecation sites.

3.6.3 Kitchen facilities

A kitchen is a room used for cooking of meals. Of the 374,742 households': 26.38 percent have no kitchen facilities at all, 6.19percent have modern kitchen and 67.43 percent have traditional kitchen. However, from the available kitchen, 67.43 percents are below the standard. The traditional kitchen are used to cook meals mainly using firewood, charcoal, cotton seeds, sawdust, leaves as fuel (CSA, 1994).

Kitchen and toilet facilities are almost in a similar status. The number of households who do not have toilet facility is almost equal to those who do not have kitchen facility and the number of households with a sub standard toilet facility is almost equal to those who do have traditional kitchen facility.

To sum up, absence of kitchen and toilet facilities force people to dispose and excrete waste in any open places, drainage systems, riverbanks and green areas. The sub-standard toilets could also be a cause for contamination of groundwater as they may not be cement made or stone paved either in their wall or basement. The traditional kitchens on the other hand produce high quantity of ash, dust and waste water. This increases the volume of solid waste and the discharge of waste water in any available places.

3.7 Drainage System

The storm water drainage system consists of piped and open ditches constructed along both sides of asphalt and gravel roads. Drainage system could be either constructed or excavated natural ditches. Of the total 2,443kms road network, only 950kms (38.88 percent) have drainage facilities, which is quit inadequate. The existing drainage systems are not mostly used for their intended purposes. The open ditches are abused by disposing solid wastes and draining of waste water (AARA, 2008).

To sum up, the high rate of urbanization and its population growth is not backed with corresponding economic development and as a result majority of urban population is poor, surviving below poverty line. The wide spread existence of such poverty is manifested in different forms of socio-economic crises like poor infrastructural facilities, high rate of unemployment, shortage of housing, inadequate access to and high cost to basic services (AAFEDB, report extract, 2006). These all rounded deficiencies are accumulated year after year, which ultimately causes enormous backlog. The backlog, so vast and interrelated, requires huge capital to improve.

In order to alleviate these problems, the city government is expected to mobilize the general public and create the requisite awareness. Besides, the city government has to plan and execute effective and holistic development schemes and guide the urban growth towards achieving sustainable development.

Therefore, based on the factors described above, the chapters to come deal with the different aspects of solid and liquid waste management in the city of Addis Ababa.

3.8 BACKGROUND INFORMATION OF SAMPLE KEBELES

The sample kebeles are within the jurisdiction of AACG. The city government is organized in to 10 sub cities and 99 kebeles. Kebeles have their own organizational structure. They are answerable to their respective sub cities (AACG Charter, 2003).

3.8.1 Organization, Power and Functions of a Kebele

A kebele is a third administrative stratum of the city government and a unit of a sub city. A kebele administration in the city has council, chief executive, standing committee and social courts. A kebele is a center for development and direct popular participation. It is also a location for the delivery of basic services. A kebele is accountable to the resident and to the respective sub city council. A kebele facilitate conditions in order for services to be available within reach of the respective residents. Kebeles are responsible to keep its locality clean (AACG Charter, 2003). The kebele administration has given the power to: penalize dwellers while throwing and draining their waste around the containers, in open spaces, and drainage system; conduct a campaign and clean the area; contact the concerned body to empty the communal containers; and construct latrines for those who do not have such facilities.

3.8.2 Demographic characteristics

According to information from AASBPDA and AAFEDB, population of the sample kebeles is presented in table 3.7. As a whole, the sample kebele has a population of 369,486. Of which, 191,027 are females and 178,459 are males. Total male to female ratio is 93.42 percent. In particular, sample

kebeles from Addis Ketema, Lideta, Nifase Silk Lafto and Gullele sub cities have relatively higher population than others. Akaki Kaliti, Bole, and Kolfe Kerano sub cities have relatively lowest population. Other sub cities (Kirkos and Yeka) have almost equal population. Taking the total population, a kebele has an average population of about 36, 948.

Table 3.7: Sample kebeles with their population and location

Sub city	Sample kebele	Number of household	Population of sample kebele			Location of sample kebeles
			Total	Female	Male	
Arada	09	4991	35,861	19186	16,675	Mosvold
Addis Ketema	15	4273	47,933	25165	22,768	Bus station
Lideta	01	1489	40,284	20746	19,538	Tolosa
Kirkos	18	4195	36,992	20161	16,831	Kasanchs
Yeka	19	3648	35,091	17721	17,370	Kotebe
Bole	03	4075	32,076	16295	15,781	Lasta
Akaki Kaliti	03	3454	29,954	15127	14,827	Garaduba
Nifase Silk Lafto	12	5749	39,813	20265	19,548	Nifassilk
Kolfe Kerano	01	6552	33,919	17129	16,790	Kolfe
Gullele	04	3210	37,563	19232	18,331	Silassie
Total		41636	369,486	191,027	178,459	

Source: Extracted from AASBPDA, 2008; AAFEDB, 2007 and Household survey, 2008.

This study incorporated a sample of 200 households. 20 households from each sample kebele. Of the sample households 43.5 percent (87) are female headed and 56.5 percent (113) are male headed. The survey, therefore, under background information of the sample households tries to incorporate the following points.

3.8.3 Socio-Economic Characteristics of Sample Households

Socio-economic features include both social services and economic activities. The social services include health, education and the like. The economic activities focus on the engagement of people for income generating activities.

Educational status is an indicator of the level of development of a given society. Societies at higher status are usually at a higher level of economic development whereas those at lower educational status are economically poor in relative terms. From this point of view, the educational statuses of the sample households in the study kebeles are explained in table 3.8 as follows.

Table 3.8: Educational status of Sample Households

Level of education	Sex			
	Male		Female	
	Number	Percentage	Number	Percentage
Illiterate	33	29.20	25	28.73
Read and Write	24	21.24	27	31.04
Grade 10/12	31	27.43	19	21.84
Diploma and above	25	22.13	16	18.39
Total	113	100	87	100

Source: Households survey, 2008.

In the study area among the 200 respondents, 58(29 percent) of them are illiterate; 51(25.5 percent) can able to read and write; 50(25 percent) of them have completed grade 10/12; and the remaining 41(20.5 percent) are graduates having diploma and above.

The number of male illiterate (33) is higher than that of female illiterate (25). On the other hand, the number of male who completed grade 10/12 (31) and having diploma and above (25) is by far higher than the number of female who has completed grade 10/12 (19) and having diploma and above (16). The number of those households who can able to read and write is almost equal.

Water connection: Of the sample households, 1.1 percent has piped water inside house, 12.43 percent have private piped water in the compound, 25.67 percent have shared piped water in the compound, 35.33 percent have piped water outside the compound, 10.47 percent get their water from other sources and 15percent are not willing to describe.

Kitchen facilities: Of the sample households, 26 percent has no kitchen facilities at all, 3.5 percent have modern kitchen and 70.5 percent have traditional kitchen. 87.5 percent of the sample households prepare meals mainly using firewood, leaves and cow dung, 3.5 percent use fuel and electricity and are not willing to describe.

Toilet Facility: Of the sample households, 27.47 percent lack private or shared toilet, 9.7 percent have flush toilets, 51 percent have pit latrine and the remaining are not willing to describe. Few of them are connected to the city sewer line.

Occupation: Of the sample households, 30 percent and 23 percent are employees of government and private sectors respectively.19 percent are involved in informal sectors, 13 percent are housewives, 7 percent are students and 8 percent are not willing to describe their occupation.

Respondents' age-sex distribution

In the study kebeles of the city, there are different age groups of population distributed unevenly throughout the survey area. The age sex distribution of the sample households is presented in table 3.9 as follows.

Table 3.9: Respondents age-sex distribution

Respondents age	Sex			
	Male		Female	
	Number	Percentage	Number	Percentage
18 – 30	28	24.78	21	24.14
31 – 45	69	61.06	48	55.17
46 – 60	10	8.85	11	12.64
> 60	6	5.31	7	8.05
Total	113	100	87	100

Source: Households survey, 2008.

As depicted in table 3.9; 162 (81 percent) of the household heads are found between the age of 18 and 45 that is the main reproductive and productive years. Hence, the likelihood of fertility of female increases very high that in turn exacerbates the generation of wastes. But a small segment (18) of the female households are at menopause period (age 46 and above). Thus, the probability of further reproduction capacity of this age group is very low.

To sum up, background information of the sample households from the randomly selected kebeles looks like as presented above. The population of sample kebeles and the necessary services are not compatible. More effort should be exerted by the respective kebele administration to ameliorate the number of service deficiencies.

CHAPTER FOUR

4. DESCRIPTION OF WASTE MANAGEMENT SERVICE AND HOUSEHOLDS RESPONSE REGARDING THE SERVICE

4.1 Background of waste management in Addis Ababa

Waste management in the city of Addis Ababa has almost about a history of 99 years. The municipality of Addis Ababa was established in 1908 with the mandate to follow sanitation activities. 35 and 42 years later, public notice number 25/1944 and 74/1951 regarding solid waste management were enacted. While in 1945, proclamation number 74/1945 was enacted, which empowered the municipality to perform hygienic activities. Later in 1955, sanitary service was placed under EHSD. After 10 years, in 1965 the department selected Repi to be the city's solid waste disposal site. Since then Repi is serving as the main and the only solid waste disposal site. In 1994 the responsibility was shifted to Addis Ababa Health Bureau until the establishment of AASBPDA in 2003. AASBPDA was established with 3 departments, 19 teams (including the 10 teams of the sub cities) and 1,972 employees (AASBPDA, 2008). Currently, city waste is handled by different entities. Solid waste and public toilet is handled by AASBPDA. AAWSA handles liquid waste. Private sectors have been also participating in collection and disposing of waste. Storm water is managed by AARA.

4.2 Solid Waste Management

Characterization of solid waste and waste handling capacity of the city will be presented and interpreted. This helps to have a clear understanding and would serve as a base for the chapters to follow.

4.2.1 Characterization of Solid Waste in Addis Ababa

Solid wastes are characterized by their sources, by the types of wastes produced and by generation rates.

4.2.1.1 Sources of Solid Waste

According to AASBPDA (2008), six sources of solid waste are identified: households (76 percent), commercial institutions (9 percent), street sweeping (6 percent), industry (5 percent), hotel (3 percent) and hospital (1 percent). Household waste covers three fourth of the city's total waste.

4.2.1.2 Types of Solid Wastes

Types of solid wastes are vegetable peelings (4.2 percent), papers (2.5 percent), plastic (2.9 percent), wood (2.3 percent), bone (1.1 percent), textiles (2.4 percent), metals (0.9 percent), glasses (0.5 percent), leaf (15 percent), stone (2.5 percent), and all others (65.8 percent). Of the total, 70 percent is recyclable and 15 percent is non-recyclable (AASBPDA 2008).

4.2.1.3 Solid Waste Generation Rate

Density, volume and weight of solid waste are important to estimate storage requirements and collection frequencies. The generation rate of solid waste is usually given in kgs per person per day and its density in kgs per cubic meter. The density of the city waste is estimated to be 333kg/m³. A high-density waste have high proportions of soil, vegetable matter and moisture whereas a low-density waste is mostly plastic and paper packaging, with low moisture contents (AASBPDA, 2008).

The city solid waste generation rate is 0.221kg/person/day. Based on this, the solid waste produced in 2008 from the city population is *0.221kg/person/day multiplied by 3,650,889 people=806,846.50kg or 806.84tons or 2,423m³ per day*. The amount of solid waste generated per day is, therefore, 806,846.50kg by weight or 2,423m³ by volume. Daily disposal coverage is *0.157kg of 0.221kg, which is 71.04 percent*. Hence, daily collection and disposal of would be 1,721.30m³ (2,423m³ multiplied by 71.04 percent) with 5 trips per day emptying frequency of a vehicle (AASBPDA, 2008). The unattended part of the waste is 701.7m³ per day. Daily disposal coverage of 71.04 percent is not the same as the result in table 4.3, which are 68.74. There is a difference of 2.3 percent. The statement - daily disposal coverage is *0.157kg of 0.221kg* - is a mere declaration of AASBPDA but that of table 4.3 is based on existing capacity.

The city generated solid waste during the last five years has been on average 732,131.8m³. During the period, the amount of waste increases from year to year except in the year 2004.

Table 4.1: Waste generated, collected, and disposal coverage

Year	Generated waste in m ³	Collected waste in m ³	Collection in percentage
2003	686,678	452,192	65
2004	651,136	547,327	84
2005	763,215	623,624	81
2006	772,325	540,266	70
2007	787,305	615,335	78
Total	3,660,659	2,778,744	75.90

Source: AASBPDA, statistical abstracts, 2008

As stated in table 4.1, the city waste generation outstrips its collection and disposal. Waste generated in 2004 was less than that of 2003. However, it was expected that with 2.9 percent population growth per annum (AAFEDB, 2008), waste amount in 2004 should be higher than 2003.

Besides, calculation for daily waste generation does not take in to account Addis Ababa city visitors, international societies residing in the city and investors, which they are believed to generate considerable amount of waste. Hence, daily waste generation rate seems understated.

According to information from AASBPDA (2008), the volume of the city daily waste is determined only considering the number of the city population and waste generation rate. This approach does not give the real quantity of waste, mainly because of two factors.

First, Addis Ababa, as a prime city and capital of Ethiopia, incorporated all ethnic groups, serves as seats of various international organizations and embassies and is relatively the major commercial, industrial, education and political center of the country (AAFEDB, 2007).

The city also entertains city visitors, which include: tourists, traders, interim migrants, relative visitors, students, symposium participants, sport festival attendants, bazaar attendants, etc. Their stay depends on the nature of their business. Some of them may stay: days, weeks, months or years. For instance, Addis Ababa University, Civil Service College, Kotebe Teachers College and Private Colleges accommodate a number of students staying for about four to six years.

City visitors' together sum up and constitute a large part of the population and generate considerable volume of waste. Hence, can significantly increase daily waste generation rate and affect waste collection, transportation and disposal activities. It has also an impact on container to population ratio. The volume of waste depends on their stay and type of activity.

The second point is waste generation rate. City waste generation rate has not always been consistent. According to information from the AAHB, AAFEDB (2007) and AASBPDA (2008), rate has been decreased year after year: from 0.267 to 0.252 in 2003 and to 0.221 in 2004.

AASBPDA present rate (0.221) was taken from a study conducted by Nur Consult in 1994 (cited in Yami, 1999). But during 1994, solid waste was handled by AAHB and the applied waste generation rate was 0.267. Because the rate recommended by Nur Consult was considered low by AAHB. It did not determine the real picture of the city's waste volume. However, 10 years later, in 2004, AASBPDA has been applying the rate, which was considered low to determine solid waste generation volume by the then handler. This being the case, both rates applied by AAHB (0.267) and AASBPDA (0.221) are by far low as compared to that of most African cities of similar status where the solid waste generation rate as estimated by Cointreau (1982) is in the range of 0.4 to 0.6 kg per capita per day for low income countries. Hence, daily solid waste generation rate is understated by number of city visitors and waste generation rate.

4.2.2 Waste Handling Capacity of the City

Once generated, waste has to be properly handled. Among others: equipment, manpower, finance and information are important for proper handling. AASBPDA has 499 containers with 8m³ holding capacity, 1907 dust bins, 72 vehicles and 2,007 employees. There are also 616 Micro and Small Enterprises (MSEs) with a total workforce of 6,614 mainly doing waste collection. Of the 72 vehicles, only 39 (54.17 percent) are engaged in daily operation. The remaining vehicles because of old age, maintenance difficulties, and negligence of drivers are not in operation (AASBPDA, 2008).

Table 4.2: Distribution of containers and trucks by sub cities

Sub city	Size of population	Number of kebeles	Trucks	Container distribution $8m^3$	Container to people ratio $8m^3$	Number of employees
Arada	358,611	10	10	79	4,539	241
Addis Ketema	431,399	9	10	51	8,459	198
Lideta	362,554	9	7	82	4,421	204
Kirkos	406,916	11	9	92	4,423	357
Yeka	386,001	11	5	30	12,867	185
Bole	352,833	11	8	38	9,285	178
Akaki Kaliti	239,628	8	4	25	9,585	102
Nifase Silk Lafto	398,129	10	6	44	9,048	123
Kolfe Kerano	339,186	10	5	33	10,278	129
Gullele	375,631	10	8	25	15,025	177
Total	3,650,889	99	72**	499	7,316	1,894

Source: AAICB, statistical abstract, 2007 and AASBPDA, 2008

Note: * (2,007 minus 1,894) 113 employees are at head office.

**45.83 percent (33) of the available vehicles are not functional.

Table 4.2, among other, depicts container to population ratio. The minimum ratio is 1: 4,421 and the maximum ratio is 1:15,025. Average container to population ratio is 1:7,316. A kebele has on average 5 containers to 36,877 people. This implies that a container is expected to serve 7,375 people.

Information on the carrying capacity of all containers and number of trips of trucks is also important. Accordingly, carrying capacity of all containers is *499 containers multiplied by $8m^3 = 3,992m^3$ solid wastes*. This implies that the city containers daily solid waste carrying capacity ($3,992m^3$) is greater than the daily generated solid waste ($2,423m^3$). Number of trips of vehicles, their carrying capacity, and generated waste is presented as follows.

Table 4.3: Number of trips of vehicles and their carrying capacity

Vehicle type	Carrying capacity in m ³	Daily average trip	Transported waste by a vehicle in m ³	Number of vehicles		transported waste by all the vehicles and collection coverage		
				Not working	working	Daily m ³	Yearly m ³	Yearly generated 884,395m ³
container (8m ³)	8	5	40	11	17	680	248,200	28.06
compactor (1.1m ³)	15	3+1.5*	67.5	7	7	472.5	172,462.5	19.50
Covered side loader	9	3	27	9	9	243	88,695	10.03
compactor (Heno)	10	3+1.5*	45	6	6	270	98,550	11.14
Total		14	179.5	33	39	1545.5	607,907.5	68.74

Source: AASBPDA, statistical abstracts, 2008

* Daily average trip of a vehicle is 3 trips but has a compaction rate of 1.5 per trip. Compaction rate is the additional carrying capacity of a compactor vehicle.

The total daily operated vehicle numbers, their carrying capacity and daily number of trips made to and from the source and the disposal site is very important to know the city's daily and yearly waste transporting and disposal capacity. Accordingly, based on information from AASBPDA, the city's yearly solid waste transportation and disposal coverage is 68.74 percent. As shown in table 4.3, the city has 39 daily operating vehicles with varying waste disposal trips, the maximum per day being 5 trips.

Table 4.4 and 4.5 are interrelated. One refers the other. The intention is to show sub cities share of daily and yearly generated waste and their transportation and disposal capacity.

Table 4.4: sub cities daily operated vehicles and waste disposal capacity

Sub cities	Number and types of vehicles with waste emptying capacity										
	Number and type of vehicles					Waste disposal capacity in m ³					
	Container	Reno	Side loader	Heno	Total	Container	Reno	Side loader	Heno	Total daily	Total yearly
Arada	2	1	1	1	5	80	67.5	27	45	219.5	80,117.50
Addis Ketema	2	1	0	1	4	80	67.5	0	45	192.5	70,262.50
Lideta	1	1	1	1	4	40	67.5	27	45	179.5	65,517.50
Kirkos	2	1	1	0	4	80	67.5	27	0	174.5	63,692.50
Yeka	2	0	1	1	4	80	0	27	45	152	55,480.00
Bole	2	1	1	0	4	80	67.5	27	0	174.5	63,692.50
Akaki Kaliti	1	0	1	1	3	40	0	27	45	112	40,880.00
Nifase Silk Lafto	2	1	1	0	4	80	67.5	27	0	174.5	63,692.50
Kolfe Kerano	1	0	1	1	3	40	0	27	45	112	40,880.00
Gullele	2	1	1	0	4	80	67.5	27	0	174.5	63,692.50
Total	17	7	9	6	39	680	472.5	243	270	1,665.5	607,907.50

Source: AASBPDA, statistical abstract, 2008

As shown in table 4.4, Arada and Addis Ketema sub cities have relatively better waste transportation and disposal capacity. They do have almost similar number of vehicles but differ in their waste generation rate. Hence, their waste disposal coverage shows little difference as shown in table 4.5.

Yeka, Akaki-Kaliti and Kolfe-Kerano sub-cities on the other hand have relatively low waste transportation and disposal capacity.

Table 4.5: Share of sub cities-generated and transported waste for 2008

Sub city	Size of population	Generated waste		Collected waste		Percentage of yearly collection and disposal
		Daily	Yearly	Daily	Yearly	
Arada	358,611	238.00	86,868.94	219.5	80,117.50	92.23
Addis Ketema	431,399	286.30	104,500.90	192.5	70,262.50	67.24
Lideta	362,554	240.61	87,824.08	179.5	65,517.50	74.60
Kirkos	406,916	270.06	98,570.21	174.5	63,692.50	64.62
Yeka	386,001	256.17	93,503.82	152	55,480.00	59.33
Bole	352,833	234.16	85,469.29	174.5	63,692.50	74.52
Akaki Kaliti	239,628	159.03	58,046.82	112	40,880.00	70.43
Nifase Silk Lafto	398,129	264.22	96,441.67	174.5	63,692.50	66.04
Kolfe Kerano	339,186	225.11	82,163.48	112	40,880.00	49.75
Gullele	375,631	249.29	90,991.82	174.5	63,692.50	70.00
Total	3,650,889	2,422.96	884,381.02	1,665.5	607,907.50	68.74

Source: AASBPDA, statistical abstract, 2008.

4.3 Liquid Waste Management

As mentioned, the city liquid waste is handled by AAWSA. Office of AAWSA is found at 'Megenagna' area, about 6kms from the city center. The request for interview and discussion in view of soliciting primary data has been forwarded to Ato Zeleke Tefera, Central Laboratory Head. The discussion and interview held on 3 April 2008 mainly covers: source of water supply for the city, AAWSA water billing system and liquid waste generation, collection and disposal practices. The interview and discussion made with AAWSA is presented under the aforesaid headings as follows.

4.3.1 Source of Water Supply for Addis Ababa City

The sources of water for the city of Addis Ababa are from dams, wells, ground water and springs. As shown in table 4.6, quantity of water from all these sources is 242,000m³ per day. Of this, 30percent (72,600m³) are non-revenue water. Non-revenue water is the amount of water lost before it reaches to the water reading meter. Therefore, the net water production actually used for consumption or other purpose is 169,400m³ (242,000m³ minus 72,600m³). The main causes for the non-revenue water are system loss (like breakage of machine, leakage) and administrative loss (like counter error, illegal connection, and error in counter reading). Water consumed by AAWSA and the city Fire Birgade is also part of non-revenue water. On the other hand, the total quantity of water demanded by the city is 480,000m³ per day. Water sources, net water production or supply, city water demand and water shortage is presented in table 4.6 as follows.

Table 4.6: Source and amount of water supply

Water Sources	Daily water production in m ³	Percentage of each source from the total	Distance from the city center
Legedadi and Dire dams	165,000	68.18	45km
Gefersa Dam	24.87,000	10.33	18km
Akaki Well	42,000	17.36	18km
Others(ground water and springs)	10,000	4.13	-
Total	242,000	100	-
Non-revenue water: 30percent	(72,600)	30	-
Net water production or supply	169,400	70	-
City water demand	480,000	-	-
Water shortage	(310,600)	-	-

Source: AAWSA, discussion with central laboratory head, 2008

This being the case, water supply coverage of Addis Ababa as compared to its demand is 35.29 percent and this comprises 275,053 housing units and institutions as customers. This, according to housing census result of 1994, accounts for 73.70 percent of the total housing units (374,742) of the city. The unsatisfied demand is 64.71 percent. Some part of the population gets water from wells, bono systems and water vendors. Water vendors are those who sell water for their neighbors and nearby dwellers at a higher rate than they are requested by AAWSA.

4.3.2 AAWSA Water Billing System

AAWSA classify the housing units in to four blocks based on monthly water consumption. Water consumption increases as the block increases from 1 to 4. Tariff increases as consumption increases. The amount of waste water also increases as consumption of water increases.

Table 4.7: AAWSA monthly billing system

Blocks	Housing units	Monthly	
		consumption in m ³	payment per m ³
Block1	Domestic and bono system	0-7	1.75
Block2	Domestic	8-20	3.15
Block3	Domestic	above 20	3.8
Block4	Non- domestic	-	3.8

Source: AAWSA, discussion notes, 2008

As per table 4.7, average monthly payment is Birr 3.15 per m³. Payment depends on consumption, the minimum being Birr 1.75 and the maximum Birr 3.80 per m³ per month. The payment system is designed in such a way that as consumption increases payment per m³ also increases. Block 3 and 4 required to pay a higher rate. Block 3 and 4 subsidize block 1 and 2.

4.4 Waste Handling Capacity of Private Sectors

According to information from AASBPDA (2008) and AAWSA (2008), private sectors in the city of Addis Ababa engage in handling of solid and liquid waste management. There are 616 Micro and Small Enterprises (MSEs) with a total workforce of 6,614. MSEs involve in the city waste collection, transportation and disposal services.

MSEs are authorized by AASBPDA to collect wastes of commercial institutions (9 percent), industry (5 percent), hotel (3 percent) and hospital (1 percent), which is all together 18 percent of the total daily generated solid waste. MSEs require a service charge ranging from 20 to 40 Birr per month. MSEs also render door-to-door waste collection service to households. But owing to lack of recorded data, it is not possible to put how much percentage of the household waste is collected by MSEs. Households are requested to pay service charge within the range of 10 to 20 Birr per household per month. However, majority of the MSEs operate in the middle and high income areas (AASBPDA, 2008).

According to information from AASBPDA (2008), MSEs mainly render waste collection services. They collect solid wastes from the source and dispose it to the nearby communal containers. Few of them (Dynamic, SOS Addis, and Rose sanitary services) collect, transport, and dispose waste from the source to the landfill site, Repi. But, Dynamic, SOS Addis, and Rose sanitary services do not render regular waste transport and disposal services mainly because of lack of capacity. Hence, in addition to lack of recorded data it is very difficult to know how much percentage of the daily generated waste is transported and disposed by MSEs.

Private sectors are also participating in the collection, transportation and disposal of liquid wastes. According to information from AAWSA (2008), there are 18 sucking trucks owned by the private sectors. Out of which only 10 sucking trucks are in a daily operation. But, due to lack of spare part and maintenance difficulty all the 10 trucks do not operate regularly. Of the total daily liquid waste collected, transported and disposed by the sucking trucks, which is 1000m³, one fourth is collected, transported and disposed by the private sectors. For the service they render, private sector requires housing units to pat within the range of 300 to 450 depending on the distance of the pit latrines or septic tanks from the nearby road.

To sum up, 18 percent of the city solid waste generated by commercial institutions, industry, hotel and hospital is collected by MSEs. On the other hand, 25 percent of the daily liquid wastes collected, transported and disposed by the sucking trucks are the share of the private sectors.

4.5 HOUSEHOLDS RESPONSE REGARDING WASTE MANAGEMENT

Households, being the generator of waste and customers of waste management service, are a good source of information. They have experiences about collection, transportation and disposal. The response of the sample households is presented as follows.

4.5.1 Characteristics and Composition of Household Waste

According to the survey, household waste is composed of: leftover and unwanted food; remnants and spoiled vegetables and fruits; ash, dust or sand; grass clippings; bones; paper; plastic and rubber; festal; glass, bottles and ceramics and metals. However, the waste produced from each household generally varies depending on their living conditions. Component

Table 4.8: Major Component of Sample Household's Waste

Types of waste	Number of sample households who generate	Number of sample households who do not generate
Kitchen and laundry	200	-
Food items	200	-
Slaughtering	101	99
Fuel wood (ash)	175	25
Home utensils	110	90
Clothing	95	105
Home sweeping(dust)	175	25
Vegetables and fruits	103	97
Ceremonies	98	102

Source: Household Survey, 2008

The major percentages of household waste as shown in table 4.8 is kitchen and laundry (100 percent); food items (100 percent); ash (87.5 percent); and dust (87.5 percent). Because, most of the sample households prepare meals mainly from raw food items (vegetables, fruits, meat, slaughtered animals) using firewood, leaves, and cow dung. This conforms to the concept discussed in chapter three. As information from CSA indicates, 26.38percent of the housing units have no kitchen facility and 67.43 percent have traditional kitchen mainly using firewood, charcoal, leaves and cow dung. The ash produced from these materials is abundant.

Most houses with traditional kitchen facility also have mud floor as a result generate much dust. Wastes generated from household activities are in a bulk quantity and dominant than wastes produced from other sources. As per the result of the field survey, most kitchen wastes are recyclable.

Density is the other characteristic. Household waste is denser as it constitutes food particles, vegetable items, ash and dust. Moisture content also increases the waste density. These characteristics of wastes help to select the right type of vehicle for transport and disposal.

4.5.2 Households Waste Storage Devices

Households responded differently with regard to waste storage devices. The size, volume and variety of waste storage materials vary from household to household. A household do not always use same personal container to accumulate and dispose waste. The result has shown (table 4.9) that all the sample households use devices to collect waste in their houses.

Table 4.9: Household's Waste Storage Materials

Type of waste collecting material	Number of responses	Percentage
Bucket (solid and liquid waste)	60	30
Sacks	105	52.5
'Festal'	25	12.5
Other materials	10	5
Total	200	100

Source: Household Survey, 2008

Of the sample respondents 60 (30 percent) use buckets; 105 (52.5 percent) use sacks; 25 (12.5 percent) use 'festal' and 10 (5 percent) use other types. These devices serve to collect and transport waste from the house to communal containers.

4.5.3 Household's vis-à-vis Site of Communal Containers and Disposal Agents

Households accumulate daily generated waste and dispose in the nearby communal containers. But, the frequency of waste disposal varies from household to household. The volume of generated waste and the distance of communal containers determine the frequency of household waste disposal.

Table 4.10: Household's Waste Disposal Frequency to Communal containers

Frequency of waste disposal	Number of respondents	Average walking distance of containers	Percentage of responses
Everyday	22	50-200 meters	20
Every 3 days	33	201-600 meters	30
Once in a week	45	601-1000 meters	41
Once in two weeks	9	1001-1500 meters	9
Total	109	-	100

Source: Household Survey, 2008

Of the sample households, 20 percent (22) dispose their waste daily, 30 percent (33) once in 3 days, 41 percent (45) once in a week and 9 percent (9) once in two weeks. These household get containers within the range of 50-200 meters, 201-600 meters, 601-1000 meters and 1001-1500 meters respectively. Sons and daughters of those households who are far from communal containers sometimes complain to carry and dispose wastes. The minimum distance to get communal container is 50 meter and the maximum is 1 and ½ kms.

Sufficiency of containers is another factor that can facilitate waste collection system in the proper manner. Table 4.11 presents the response of sample households regarding sufficiency of containers.

Table 4.11: Sufficiency of Communal Containers

Responses supporting that	Number of respondents	Percentage of respondents
Containers are sufficient	40	20
Containers are not sufficient	160	80
Total	200	100

Source: Household Survey, 2008

Of the respondents, 20 percent (40) support that containers are sufficient while 80 percent (160) of the respondents did not support the sufficiency of communal containers. As clearly presented in table 4.2, the average container to population ratio is 1:7,316. One container is supposed to serve for about 7,316 people or households on average.

Households' response regarding agents of waste disposal is presented in table 4.12.

Table 4.12: Household's Waste Disposal service

Service provider	Number of respondents	Percentage of respondents
Women	140	70
Children	28	14
Non-family members	32	16
Total	200	100

Source: Household Survey, 2008

As shown in table 4.12, 70 percent (140) of households waste is disposed by women; 14 percent (28) is disposed by their children; and 16 percent (32) of the households dispose waste either by cash or in kind payment. Children that used to bring waste to containers, since they are unable to reach the container, they simply dispose the waste near the containers.

The responses of sample households to their waste disposal practice are presented in table 4.13 as follows.

Table 4.13: Disposal Site of Household Waste

Disposal Site	Number of responses	Percentage of responses
Communal containers	109	54.5
Near to road sides	14	7
Open fields	35	17.5
Open ditch	15	7.5
Near by river course	17	8.5
Rivers	10	5
Total	200	100

Source: Household Survey, 2008

Table 4.13 shows that; 54.5 percent (109) use communal containers, 7percent (14) use road side, 17.5 percent (35) use open fields, 7.5 percent (15) use open ditch, 8.5 percent (17) use near by river course, and 5 percent (10) use rivers to dispose their waste. Those who do not use communal containers are 45.5 percent of the sample households. This shows that almost half of the sample households dispose their waste illegally in any available places. Major reasons are the delay in emptying frequency; distant location and shortage of communal containers.

Table 4.14: Communal container users and non-users of each kebele

Sub-city	Sample kebele	Container users		Non-container users	
		number	percentage	Number	Percentage
Arada	09	14	12.84	6	6.59
Addis Ketema	15	16	14.68	4	4.40
Lideta	01	9	8.26	11	12.09
Kirkos	18	11	10.09	9	9.89
Yeka	19	8	7.34	12	13.19
Bole	03	12	11.01	8	8.79
Akaki Kaliti	03	7	6.42	13	14.29
Nifase Silk Lafto	12	8	7.34	12	13.19
Kolfe Kerano	01	9	8.26	11	12.08
Gullele	04	15	13.76	5	5.49
Total		109	100	91	100

Source: Household Survey, 2008

As observed from table 4.14, of the sample households, the highest communal container users are found in sample kebeles of Arada, Addis Ketema, Gullele and Bole sub cities.

To sum up, wastes are generated from different sources: households, commercial institutions, street sweeping, industry, hotel and hospital. Besides, field observation was conducted to know the sources and the current situation of waste management in the city. Hence, major sources of waste from the researcher observation are:

- Pedestrians dropping all sorts of waste while walking. They do not hold wastes either in their bags or pockets.
- Street vendors: food items, cigarettes, vegetables, fruits, soft papers, chewing gums, etc.
- Construction, demolition, renovation and installation activities of government, private, NGOs and individuals.
- Passengers and drivers in any transport throw waste via windows: used soft papers, cover and remnants of vegetables, bus tickets, etc
- Falling or flying of waste from containers and dust bins by the action of wind or dogs, wild or domestic animals while looking for food
- Waste is transported without cover. Wind and scavengers spread the waste all the way to the disposal site.
- Mass celebrations, festivals, sporting activities, bazaars, market places, etc produce waste in abundant and make the area untidy.

4.5.4 Waste Reduction at the Households Level

Sample households involve in selling, exchanging and repairing of used items. They have relations with informal recyclers: Quralyo, Liwatch and Tegagne. Both households and informal recyclers benefit each other. One is the customer of the other. Households and informal recyclers are playing vital role in reducing solid waste from the source.

Households earn income from selling and get new item by exchanging. Informal recyclers also get income by selling to other recyclers. Table 4.15 shows waste handling mechanisms of households and informal recyclers.

Table 4.15: Household items used for sale, exchange and repair

Items	Number of households	Percentage of items that are commonly		
		Sold to Quralyo	Exchange with Liwatch	Repaired by Tegagne
Bottles and glasses	18			
Cans	10			
Corrugated iron sheet	2			
Total	30	15 %		
Cloth	80			
Shoes	50			
Total	130		65 %	
Metallic Materials	25			
Nonmetallic materials	10			
Umbrella	15			
Total	50			25 %

Source: Household survey, 2008

Note: Each percentage is computed against the total households, which is 200.

As shown in table 4.15; 15, 65 and 25 percents of the households are customers of Quralyo, Liwatch and Tegagne respectively. Of the three, Liwatch have more customers. A household can at a time be customer of Quralyo, Liwatch and Tegagne. These informal recyclers collect and take the used items to the market, mostly to 'Minalesh Tera', to sale for other recyclers. Minalesh Tera is a place found at the heart of Merkato, a largest open market in Africa. The recyclers at Merkato either recycle the items or sale to factories.

A. Quralyo

'Quralyo-ቆራሊዮ' walk in villages near to all the housing units. They repeat the word Quralyo again and again. They use the word to mean any used materials available for sale. Member of a household gets out of home and inform the Quralyo that there are used items for sale. If they agree, Quralyo purchases the used material. It is from the sound Quralyo that their name is derived. Quralyo mostly prefer cans, corrugated iron sheet, used metals, glass and bottles. Every resalable waste which has even the lowest resale value in the market has been bought by them. They collect most of the recyclable waste from the households and sell it to 'Merkato'.

B. Liwach

The name 'Liwach-ሊዋቅ' represents those informal recyclers engaged in collecting recyclable materials in exchange with new materials. Liwachs give new household utensils (plastic, glass, coffee and tea cups, etc) in exchange to recyclable materials. Liwach commonly collect old wears and shoes. Liwachs take these recyclable materials mostly to Merkato and Kolfie. These materials get repaired and avail for sale in the form of second hand.

C. Tegagne

Tegagne represents repairers. Repairers walk around the housing units by repeating the sound 'yemitegen eqa yalew-የሚጠገን አቃ ያለው'. Tegagnes therefore repair utensils of those households who are waiting their service.

To sum up, informal recyclers play an important role in reducing solid waste items at the source which otherwise could be disposed. The items collected by the informal recyclers, table 4.15, are non-biodegradable and can not be used for compost. The proportion of non-biodegradable items of the city is low, 15 percent (AASBPDA, 2008). Repairing and exchanging also helps to reduce disposable waste and prevents entrance of additional items to the household. The judgment made from the questionnaire survey and field observation shows that there is a positive contribution of the recyclable waste buying businessmen.

4.5.5 Waste Prevention

The generation of waste in the households can also be reduced by preventing some materials which later could be otherwise a waste. Different types of ceremonies are prepared by the households among which coffee ceremony is the most common one.

Table 4.16: Households Preparing Coffee Ceremonies

Households	Number of respondents	Percentage of respondents
Prepare coffee ceremony	170	85
Do not prepare coffee ceremony	30	15
Total	200	100

Source: Household Survey, 2008

Of all the households, 85 percent (170) have a coffee ceremony in their homes at three days interval. Most households use green grass for the ceremony. Table 4.17 presents number of households using green grass for coffee ceremony.

Table 4.17: Households Using Green Grass for Coffee Ceremonies

Households	Number of respondents	Percentage of respondents
Using grass	98	49
Do not use grass	102	51
Total	200	100

Source: Household Survey, 2008

Of the respondents, 49 percent (98) of the households use grass for coffee ceremony and 51 percent (102) do not use grass for coffee ceremony. The grass turns to waste. It could be prevented either by abandoning or replacing by other durable grass like materials such as plastic. However, all the households in the sample survey use green grass for holidays.

Sample households slaughter animals (ox, cow, sheep, goat, hen) at home. From the sample households, 49.5 percent (99) do not slaughter animals and 50.5 percent (101) mentioned that they practice animal slaughtering at home, commonly during holidays. On average they slaughter four times per annum.

Table 4.18: Households who Slaughter Animals at Home

Households who	Number of respondents	Percentage of respondents
Slaughter animals	101	50.5
Do not slaughter animals	99	49.5
Total	200	100

Source: Household Survey, 2008

Table 4.19, computed based on table 4.18 and household survey of 2008, shows number of slaughtered animals per annum.

Table 4.19: Number of Animals Slaughtered per Annum by the Households

Number of slaughtered animals	Number of respondents	Percentage of respondents
1 - 5	96	95.05
6 - 10	5	4.95
Total	101	100

Source: Computed from table 4.13 and household Survey, 2008

Animal slaughtering generate wastes like unwanted flesh, blood and undigested materials.

Table 4.20: Ways of disposing animal slaughtering waste

Means of waste disposing	Number of households	Percentage
Communal Containers	25	24.75
Micro Enterprises	10	9.9
Septic tanks	12	11.9
Open space	24	23.76
Open ditches	17	16.83
Streams	13	12.86
Total	101	100

Source: Household Survey, 2008

As shown in table 4.20, only one fourth of the households who slaughter animals at home dispose the waste in the communal container. Informal waste disposal of animal slaughtering waste in open space, open ditch and streams accounts for 53.46 percent (54) of the total respondents.

CHAPTER FIVE

5. DATA ANALYSIS AND DISCUSSION

5.1 Solid Waste Collection, Transportation and Disposal

5.1.1 Status of Solid Waste Collection Service

Sample households (table 4.11) and interviewed officials and experts indicated that the existing containers in city do not match with the increasing population (table 3.2) and the volume of generated solid waste (chapter 4, sub heading 4.2.1.3). Containers to population ratio are not proportional. Container to population ratio is 1:7,316 (table 4.2). This ratio does not include number of city visitors, international community residing in the city and investors (chapter 4, sub heading 4.2.1.3). A container is supposed to serve 7,316 people. A kebele with an average population of 36,878 ($3,650,889 \div 99$ kebeles) is served by 5 containers ($499 \text{ containers} \div 99 \text{ kebeles}$). If all the population uses containers for waste collection, a single container will be shared by 7,316 people. This figure is 2.8 times higher than recommend by NUPI (a container for 2,000 people) as cited in Yami (1999). This implies that waste collection service does not reach the entire population. Hence, residents are required to travel more to dispose waste (table 4.10). From the sample households, 50 percent travel from 601 meters to 1 and $\frac{1}{2}$ kms to get the nearby container. The settlement pattern of Addis Ababa is also a spreading out; consisting of predominantly villa houses. People need to travel long distance to get and use containers: minimum 50meter and maximum 1 and $\frac{1}{2}$ kms.

Local and international standards set to control the location of containers show that distance between containers should not exceed 200 meters (UNHCS, cited in Yami, 1999). This requires 200 containers per square km. However, this is not true for Addis Ababa where residents are obliged to travel more than 200 meters (table 4.10) and containers are not sufficient (table 4.2 and 4.11). Yami also pointed out the shortage of containers. For instance, in 1998, NUPI (cited in Yami, 1999) recommended a total of 616 containers. But, today after 10 years, with a considerable increase in population and volume of waste, the number of containers is still 499.

Besides, the selection of sites for placement of collection containers is not appropriate, hence does not facilitate collection. Containers are usually placed along main roads for ease of access. Population size is not given due consideration. However, lack of free space and unwillingness of inhabitants are some of the problems to place a container.

5.1.2 Solid Waste Transportation

Transportation of waste is directly from transferring stations. Waste containers are lifted hydraulically and mounted on back of the collection truck. Volumes of waste that can be transported each day depend upon:-

- The limited number of vehicles and their working condition;
- The road conditions for access (e.g. paved, unpaved, steep, narrow);
- The traffic conditions (example: slow, congested or rapid and clear);
- The high volume of waste produced per day;
- The settlement pattern.

5.1.2.1 Solid Waste Transportation Coverage

Information from AAHB and AASBPDA reveals that waste collection coverage has increased from 38 percent in 1993 to 40 percent in 1994, 53.9 percent in 1996, and 65 percent in 2002. After 5 years (in 2007) collection reached 78 percent. On the other hand, the amount of generated waste increased by 12.78 percent and the working capacity of vehicles decreased during 2003 to 2007. Owing to this, the current working capacity of vehicles is 54.17 percent (chapter 4, sub-heading 4.2.2).

Table 5.1: Distance of Sample Kebeles from the Landfill Site

Sub city	Sample kebele	Location of sample kebeles	Distance of sample kebeles
Arada	09	Mosvold	14km
Addis Ketema	15	Bus station	10km
Lideta	01	Tolosa	8km
Kirkos	18	Kasanchs	17km
Yeka	19	Kotebe	23km
Bole	03	Lasta	20km
Akaki Kaliti	03	Garaduba	15km
Nifase Silk Lafto	12	Nifassilk	10km
Kolfe Kerano	01	Kolfe	8km
Gullele	04	Silassie	18km
Total			145km **
Average			14.5km

Source: AASBPDA, 2008 and city taxi drivers.

*Distance from the city center to landfill site is 13kms (AASBPDA, 2008).

**Kilometers are obtained from discussion with taxi drivers.

***Distance of sample kebeles from the land fill site is obtained 13km minus or plus distance of sample kebeles from the city center.

Taking the city center (Minilik II square) as a point of reference:-

a. Three sample kebeles are located between the city center and the landfill site: (15) Addis Ketema, (01) Lideta and (01) Kolfe Kerano. The distance from the city center to the kebeles location is estimated and deducted from 13km, distance from the city center to Repi.

b. Five sample kebeles are located between the city center and the landfill site: (09) Arada, (18) Kirkos, (19) Yeka, (03) Bole and (04) Gullele. The distance from city center to kebeles is estimated and added to 13km.

c. (03) Akaki Kaliti is located 17km from the city center. Its location is, however, nearer to the landfill site than the city center, which is 15km.

d. (12) Nifase Silk Lafto is located 5km from the city center on the way to Akaki Kaliti. But its distance to landfill site is greater than the distance to the city center, which is 10km.

To sum up, all the sample kebeles do not found at equal distance to the landfill site. Accordingly, refuse carrying vehicle trip to and from the landfill and the source also vary. It seems that those sample kebeles located near to the landfill site will have more trip per vehicle per day and kebeles found at longer distance will have fewer trips per vehicle per day. However, taking in to account intervening variables like quantity of waste, vehicle condition, employee efficiency, etc, it is better to consider the average distance, 14.5km as a point of reference to deal with transportation, disposal, etc.

Of the total vehicles, only 39 or 54.17 percent are operational. The remaining vehicles; because of old age, maintenance difficulties, negligence of drivers and frequent accidents; are not in operation. The average age of the vehicles is also more than 11 years.

Majority of the vehicles, that is 26 of the 39 (table 5.2), carry a single container (8m^3 or 9m^3) at a time. Hence, most trips are made to and from the source and disposal site only for single container. Working time is 8 hours per day (6:00PM to 2: PM) and 7 days in a week. However, normal start up of operation on average is 1:00AM. Reason is unpunctuality. It is a norm that almost all vehicles start operation one hour behind schedule. Given the slow and congested traffic condition, round trip travel distance, low speed of the vehicle-because of old age, efficiency of employees and time for loading unloading; a vehicle on average needs 2 hours to cover a round trip, which is 29kms (table 5.1) to dispose waste at Repi.

Hence, waste collection trucks can not make many round trips per day between the sources and the disposal site. Besides, drivers and assistants took half hour rest for tea from 4:00 to 4:30AM and one hour for lunch from 6:00AM to 1:00PM.

As a result, a total of 2 and $\frac{1}{2}$ hours are not making use of mainly because of lateness, tea break and lunch hour. Net working hours is 5 and $\frac{1}{2}$ hours (8 hours minus 2 and $\frac{1}{2}$ hours). Net working hour and the time spent per single trip is important to know the daily total trips of a vehicle. This further helps to know the actual capacity of the city solid waste collection and transportation coverage. In line with this, a vehicle on average can make 2.75 trips ($5 \text{ and } \frac{1}{2} \div 2$ hours per trip) per day. Let us approximate and make 3 trips per day.

The vehicles can transport $1,393.50\text{m}^3$ of waste per day (table 5.2). The daily transported and disposed waste is 57.51 percent. Hence, AASBPDA assumption of waste emptying frequency of 5 trips per vehicle per day and daily collection and disposal capacity of $1,721.30\text{m}^3$ (chapter 4, sub heading 4.2.1.3) or 71.04 percent is not acceptable.

Table 5.2: Number of trips of vehicles, carrying capacity and coverage

Vehicle type	Number of working vehicles	Carrying capacity in m ³	Daily average trip	transported waste		
				daily	yearly	collection coverage of vehicles from 884,395m ^{3*}
Container(8m ³)	17	8	3	408	148,920	16.84
Compactor(1.1m ³)	7	15	3+1.5**	472.5	172,463	19.50
side loader	9	9	3	243	88,695	10.03
compactor-Heno	6	10	3+1.5**	270	98,550	11.14
Total	39	42	15	1,393.5	508,628	57.51

Source: AASBPDA, statistical abstracts, 2008

* 884,395m³ is yearly-generated waste (2,423m³ multiplied by 365days).

** A vehicle has a compaction rate of 1.5 per trip.

Table 5.3: sub cities daily operated vehicles and waste disposal capacity

Sub city	population	Number of vehicles	Yearly generated waste in m ³	Yearly collected waste in m ³	Percentage of yearly waste disposal
Arada	358,611	5	86,868.94	68,437.50	78.78
Addis Ketema	431,399	4	104,500.90	58,582.50	56.06
Lideta	362,554	4	87,824.08	59,677.50	67.95
Kirkos	406,916	4	98,570.21	52,012.50	52.77
Yeka	386,001	4	93,503.82	43,800.00	46.84
Bole	352,833	4	85,469.29	52,012.50	60.86
Akaki Kaliti	239,628	3	58,046.82	35,040.00	60.37
Nifase Silk Lafto	398,129	4	96,441.67	52,012.50	53.93
Kolfe Kerano	339,186	3	82,163.48	18,615.00	22.66
Gullele	375,631	4	90,991.82	68,437.50	75.21
Total	3,650,889	39	884,381.02	508,627.50	57.51

Source: Table 4.3 and table 5.1 and 5.2.

Arada and Gullele sub cities have better waste transportation and disposal capacity. Their waste collection and disposal performance is equal but Gullele has more waste than Arada due to its high population. Hence, their waste disposal coverage shows little difference. Kolfe-Kerano is the least performer; its disposal is less than one fourth of the generated waste.

5.1.2.2 The uncollected part of the solid waste

The unattended part of the solid waste is 42.49 percent or 1,029.5m³ per day (2,423m³ minus 1,393.5m³). This figure is close to half of the daily generated waste. This much waste is dumped illegally in any open places, drainage systems and streams. From the sample households, 91 of them dispose their household waste illegally (Table 4.13 and 4.14). This in turn could cause health problems and environmental pollution. The concerned bodies seem to be failing to take preventive measures. Therefore, option has to be designed to collect the uncollected part of the waste.

One of the options to collect the unattended part of the current solid waste is to purchase additional vehicles and allocate more containers. Let us assume to purchase new container vehicles of compatible type and 8m³ capacity. Given the growing traffic congestion, traveling distance, and time for loading unloading; the new vehicle on average is expected to cover a round trip within 1 and ½ hours. Hence, based on net working hours of 5 and ½, a new vehicle on average could make 3.67 trips (5 and ½ ÷ 1 and ½ hours per trip) per day. Let us approximate and make 4 trips per day. Hence, with a capacity of 8m³ and 4 trips per day, a new vehicle can collect 32m³ (4trips multiplied by 8m³ per single trip) per day. This gives a base to calculate the number of vehicles required to dispose the whole uncollected waste.

Accordingly, the number of vehicles needed to collect the current daily-unattended solid waste is 32 ($1,029.5\text{m}^3 \div 32\text{m}^3$). These could help the AASBPDA to raise its disposal capacity from 57.51 to 100 percent. However, these vehicles require running cost, driver and assistants and initial purchase capital. The major issue is in fact the purchase cost. *It requires huge amount of capital; Birr 16,000,000 (32 vehicles multiplied by 500,000Birr) to purchase.*

5.1.2.3 Cost of Solid Waste Transportation

Solid waste collection, transportation and disposal are tiresome, time consuming and requires huge amount of money to handle. As mentioned repeatedly, majority of the vehicles carry a single container. Most trips are made to and from collection site and the source only for a single container. This entails huge finance for fuel, manpower and overhead costs, which are not proportional to transport a single container for disposal in round trip of about 29kms (table 5.1) from the source. Hence, solid waste transportation and disposal practice seems inefficient and uneconomical.

As per an informal discussion with container vehicle driver, the available vehicles because of old age consume one liter diesel in each 2 and $\frac{1}{2}$ kms. The price of one liter diesel is 6.90Birr. To dispose waste of a single container a vehicle on average covers 29.4kms. Hence, the cost of diesel is 80.04 Birr ($29\text{kms} \div 2.5\text{kms}$ multiplied by 6.90Birr). A vehicle per day requires Birr 240.12 (Birr 80.04 multiplied by 3 trips per day). *The 39 vehicles require Birr 9,364.68 (39 vehicles multiplied by Birr 240.12) and Birr 3,418,108.20 (Birr 9,364.68 multiplied by 365 days) per day and per year respectively.* This cost coupled with other costs (like oil, grease, tyre, etc) and employees salary escalate the total sum.

Waste handling service is not free. But, only those housing units who are a customer of AAWSA are required to pay 5 percent of their monthly water consumption. AAWSA collects the amount on behalf of AASBPDA. The collected fee as explained by AASBPDA is not enough to cover cost of collecting, transporting and disposal of solid waste.

5.1.3 Solid Waste Disposal

Interview and discussion with the landfill expert at office and in the landfill site coupled with personal observation is summarized as follows. The final stage in solid waste management is disposal. Wastes from different sources (though not totally) are collected, transported and disposed.

The city landfill is the type of open dumps. In conformity with Johannessen (1999) view, the refuse is simply dumped in low lying areas on open land and tipped haphazardly. The site is found in Kolfe keraneo sub city and supervised by AASBPDA. It is located along the Ayer Tena – Kality section of the ring road. Its purpose is to dump all types of solid wastes. Its location is in the South-West direction at a distance of 13 km from the heart of the city. The landfill, 43, has been giving service since 1965. It is known by the name Repi or 'Koshe'. Its total area is 20.8 hectars. Site selection was not considering the engineering aspect, slope and soil type.

The landfill has no: buffer zone, leachate treatment, fence, office, toilet, shower, and electricity and telephone services. On average the site is visited 117 times per day (table 4.20) by trucks to unload wastes. Wastes are emptied haphazardly and without segregation. The total daily unload solid waste on average is 1,393.5m³. The amount of solid waste dumped to date is 11.6 million m³.

Three dozers and a compactor are assigned to spread and compact the daily dumped waste. The main reason is to reduce the amount of waste and to get free space for ease movement of waste unloading trucks. The landfill is getting full. It has reached a level where it can no longer be used for waste disposal. It is partly surrounded by residents and institutions. The waste is not provided topsoil cover, which prevents nuisance. Other techniques like decomposition, incineration and recycling are not used.

As stated in the literature, an aerobic decomposition of organic solid waste produces what is termed as landfill gas which constitutes of methane and carbon dioxide and sometimes toxic gases. This is true of Repi, where the gases generated from the landfill sets the waste on fire. Besides, the scavengers, to segregate recyclable materials, purposely set fire. On the process toxic liquid substance is produced, which will pose a risk to human health and contaminate surrounding area and water bodies.

Though not supported by detail studies, according to the landfill expert, the gas produced could be methane. It has fire or explosive nature and the liquid part is Licheate which escapes from the landfill due to failure of the piping system. The amount increases following heavy rain.

AASBPDA has been attempting to completely abandon Repi and to build a sanitary landfill. To this effect, AASBPDA had pondered four sites for comparison so as to select the best that fulfills both technical and administrative requirements of a sanitary landfill. Accordingly, a place called Arabsa located at Bole area with an area of 76 hectare was chosen. At present they are waiting the opinions of the AACG Environment and Protection Agency. The French Government show green light to cover some part of the project cost.

It must be noted that the city solid waste management encompasses collection, transportation and disposal of wastes. Considerable amount of the solid waste generated remain uncollected. The uncollected waste is mostly thrown on streets, open places, drainage systems and streams. This endangers the health and well being of residents. Furthermore, the present solid waste management practice used by AASBPDA involves no recycling or resource recovery. There is no effort towards the systematic recycling of waste, except by the Quralyo, Liwatch and Tegagne. Scavengers also involve in the recycling process. However, they spread the waste around communal containers and increasing the health risks and environmental hazards.

5.2 Liquid Waste Generation, Collection and Disposal

5.2.1 Liquid Waste Generation Rate

Water is one of the basic resources and among others used for drinking, cooking, cleanses clothes and kitchen utensils, for shower and toilet flushing. Some part of this water content remains in our body, food items, etc while a large percentage is converted in to waste in the form of urine, waste water, etc. As mentioned, total net daily water production is $169,400\text{m}^3$. The amount of daily waste water according to Head of Central Laboratory is '80 percent of the daily net water production'. Hence, the city waste water is $169,400\text{m}^3$ multiplied by 80 percent= $135,520\text{m}^3$ per day. Had the city water demand ($480,000\text{m}^3$) been satisfied, the daily generated liquid waste amount would have been raised to $384,000\text{m}^3$ ($480,000\text{m}^3$ multiplied by 80 percent).

5.2.2 Liquid Waste Collection

AAWSA uses two ways to collect liquid waste: sewerage line and sucking truck. The city sewer line daily collects $7,500m^3$ liquid waste. This accounts for 5.53 percent of the daily generated waste water.

The proportion of housing units connected to a 'modern' sewerage system is very minimal. According to AAWSA, only 2,818 housing units have access to the city sewer system. This accounts for 0.75 percent of the total housing units. The system was originally designed to serve for 200,000 residents or 38,462 houses, of which only 2,818 housing units are currently connected to the system. If all 38,462 houses are connected, the sewerage system will have a capacity to connect 10.26 percent of the housing units.

The other means of collecting the city liquid waste is using sucking trucks of different holding capacity. The collection amount using the sucking trucks on average is $1000m^3$ per day, which is 0.74 percent of the total daily generated liquid waste. The trucks are 99 in number. Of which 34 belongs to Federal Police, Ministry of Defense, Education, Abattoirs Enterprise, NGOs and the private sectors. The remaining 65 trucks belong to AAWSA, but due to old age and maintenance difficulty, only 45 of them are operational.

AAWSA has four liquid waste transfer stations: kechene, Abakoran and around the palace areas. The $3m^3$ and $7.5m^3$ holding capacity trucks are mainly deployed to suck liquid waste from housing units and to empty at one of the transfer stations. Trucks with holding capacity of $14m^3$ and $16m^3$ are mainly assigned to transport liquid wastes from the transfer stations to either one of the disposal sites in the city: Kotebe or Akakai. The total daily collected liquid waste is very minimal. It is about 6.27 percent.

Cost of Liquid Waste Collection: The available suction trucks collect and dispose the contents of the pit latrines or septic tanks of the housing units per request. Service payment system correlates with monthly water consumption amount (table 4.4). Block one pays fixed tariff, Birr 69. The other blocks treated differently. They pay the initial Birr 69 plus Birr 387 (456-69) on monthly basis with a charge of 0.55 cents per m³. This is just to cover the total running cost of a sucking truck, which is Birr 456. There is application of subsidy like in the case of monthly water billing system. The other blocks subsidize block one.

5.2.2.1 The Uncollected Part of the Liquid Waste

The uncollected part of the liquid waste, which accounts for 93.73 percent of the total waste, has not provided some sort of collection and disposal. It is left uncollected. This part of the liquid waste either enters the dry pits and septic tanks or simply finds its way to the city's open ditches and streams. City residents practice the following as a means of disposal.

A. Direct Defecation

Nearly a quarter of the housing units in Addis Ababa city have no toilet facilities (CSA, 1994). Hence, do not have access to sanitary facilities in their home. There are also a number of people who are homeless: street children and others. Both the former and the later don't have option other than defecating in any open spaces and river basins. Differently, however, the later mostly found and execrate their waste, wash their face and foot and rarely prepare their food in places where most of the people are gathering for social, economical, religious and other activities.

The researcher field observation and interview with street children and beggars in the street, taxi terminals and market places of Kazanches, Arat killo, Piazza, Arada Giorgis, Atiklet Tera, and Merkato areas confirmed that they have no option than defecating in any available places. Most of them know the availability of public toilets but do not use due to lack of money.

The other problem is that public toilets are not evenly distributed and most of them are not accessible by the population who need them. For instance, the public toilet at piazza in front of Abyssinia Bank is not accessible to a person at Arat Kilo. Thus as observed, any available vacant places are common defecation sites.

As a consequence, available open places and streams are serving as open defecating sites and the city streams receive all wastes washed by rain or run off through out their course in the city. The river basin, particularly in the dry season, is widely used for defecation and its surface is smeared with human excreta. The bad smell out of it is also disgust to visitors. In some places getting a free space to walk nearby the river basin is quit difficult. This is because of accrual of human excreta. The situation of human excreta in the river basin represents an unhygienic and aesthetic loss to the city. This coupled with the abundant disposal of solid wastes make the streams to serve as an open sewer and open landfill site to the city.

B. Direct Connections to the Rivers and Drainage Systems

Only 2,818 from 374,742 housing units have access to city sewer system. The remaining, 371,924 housing units, have no sewer line connection. The sucking trucks are not enough to cover these housing units. Hence, residents of the city have no means to dispose the liquid waste. Instead

residents connect housing units either to the river system, if they are near, or to the drainage systems to dispose the sewage and other liquid waste.

Besides, it is common for septic tanks or pit latrines to overflow in poor residential areas that have no or limited access roads for sucking trucks. The problem is worse in those septic tanks that fill up quite frequently in areas that are exposed to flood.

5.2.2.2 Viability of Options to Collect the Uncollected Part of the Liquid Waste

To collect the unattended part of the liquid waste, AAWSA has two options, that is, either to construct additional sewerage system to connect all the housing units or purchase additional sucking trucks. But, both options are difficult to operate. Each requires huge capital.

Constructing additional sewerage systems entails huge amount of capital. Given the city topography, raising cost of construction materials and labor, the option tends to be impractical. The housing units that are in the inner city are not also convenient for sewer line establishment. The topography and early unplanned settlement further complicates the work. Furthermore, expansion and upgrading activities could also have their own impact.

The second option is purchasing of additional sucking trucks. It also entails huge amount of capital. Let us assume to purchase trucks with a holding capacity of 16m^3 . The uncollected liquid waste amount is $127,020\text{m}^3$ ($135,520\text{m}^3$ minus $8,500\text{m}^3$). With a net working hour of 5 and $\frac{1}{2}$ (as stated in sub heading 6.1.1.3.1) and the time for loading unloading, a new vehicle on average can make two trips per day. Hence, with a capacity of 16m^3 and

two trips per day a new vehicle can collect 32m^3 (2 trips multiplied by 16m^3) per day. This gives a base to calculate the number of sucking trucks required to dispose the whole uncollected liquid waste. Accordingly, the number of trucks needed to collect the current daily unattended liquid waste is 3,969 ($127,020\text{m}^3$ divided by 32m^3). These further demands running cost and follow up. Parking place could also be another problem. The major problem is capital. One truck with 16m^3 holding capacity is about 1,300,000Birr. All trucks require *3,969 multiplied by 1,300,000 = 5,159,700,000 Birr*. This seems insupportable as a viable option.

To sum up, the viability of the two options seems to be less practical, mainly owing to financial problem.

5.2.2.3 Storm Water Management

The city road network is 2,443kms: 990 are asphalt roads and the remaining gravel. Of the total road network 950kms (38.89 percent) have drainage facility (AARA, 2008). The remaining 61.11 percent of the road network have no way to drain the storm water. Rainy season is from June to September. Of this rain, only a small part is collected and drained by a drainage system. The greater amounts of the rainfall have no way than to drain in any ground carrying anything in its way. This may cause flood, deterioration of roads and other damages. The roads which the drainage system do not function properly also face severe deterioration from run off. Hence, some drainage system needs clearing and construction correction mainly inlets.

Besides, roads are cut by different infrastructure providing institutions like ETC and AAWSA. Some of the internal roads are not properly accessed.

Uncovered ditches are not properly used. Solid waste has been thrown on it and serves as draining of wastewater. Open manholes become a good place for disposal of solid waste. The drainage channels and inlets are also frequently blocked by refuse. As a result, streets are damaged by runoff and it is usual for any one of the several streams that cross the city in a north-south direction to swell and cause damage following heavy rains.

The rainfall in the city is collected by open ditches and street inlets connected to a drainage system consisting of underground drainage pipes which drain the run-off to the nearby river basin. The pipes are actually in bad condition, the street inlets are clogged with garbage and they are partly blocked by asphalt maintenance works. Hence, during the rainy seasons a greater part of the run-off is flowed in to streets, stored into the low-lying parts of the run-off basin and blocks the traffic in this area.

5.2.3 Liquid waste Disposal

The collected liquid waste is disposed at either Kotebe or Akakai disposal sites. The basements of the disposal sites have been covered and compacted with clay soil so as to prevent infiltration that pollutes the ground water. The liquid waste is dried in the drying beds with the help of sun and air. The dry part of the waste has been accumulating to be used as fertilizer. The problem is the existence of hazardous elements within the liquid waste: needle, blade, nail, etc.

Effort has not yet been exerted to separate the hazardous elements. Reason is lack of appropriate technology. The accumulated part of the waste is subject to rain and sun. Easily washed by rain and spread to the surrounding environs. Hence, become a cause for pollution.

CHAPTER SIX

6. RESEARCH FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.1 RESEARCH FINDINGS

6.1.1 Problems of Addis Ababa City Waste Management

Different researchers argue that the problems of the city waste management dated back to the time of its establishment. During that time there was hardly any thought of waste management. According to information from AASBPDA, waste was disposed haphazardly. Settlement was not in a planned manner. Haphazard waste disposal and unplanned settlement grew up and become a problem until this time. Rural area sanitation culture, open field system and haphazard waste disposal, come together with migrants and create problem in waste collection, transportation and disposal.

The culture of rural sanitation seems to continue mainly due to rural urban migration. Population growth, shortage and lack of sanitation facility aggravate the problem. Although this has been prevailing since 1886 (AAFEDB, 2007), it was not a problem until recent times because nature's own treatment process took care of these problems.

But, today both population and quantity of waste increases. The natural processes are slow and can take care of only a limited amounts and specific kinds of wastes because wastes are dumping faster than the assimilation capacity of nature. All these are going to cause serious threat to our ecosystem (Syed, 2006).

The problem has been accumulating and becomes a serious agenda of the city. It is common for housing units to queue up for service, especially for emptying their pit latrine and septic tanks. In addition, because of limited access or no roads, septic tanks or pit latrines sometimes overflow in poor and congested residential areas. The problem is worse in the case of those pit latrines or septic tanks that fill up quite frequently in areas that are exposed to flood.

6.1.2 Population and waste

Population dynamics have significant influence on the volume of generated waste and its proper handling. The population of the city, as clearly discussed in chapter three, is rapidly increasing mainly because of migration. The population of the city has grown from 448,512 in 1961 to 2,112,737 in 1994 and presently it reached at 3,650,889 (table 3.2).

It is quite clear that a number of people visit the city from regional states and other countries of the world on a daily basis. Purpose of the visit ranges and depends on the issue of each visitor. Some of the visitors stay behind after close of business for days, weeks or months.

The increase in population growth and number of city visitors implies increases in waste generation. This is not proportionately accompanied by increase in basic sanitation facilities.

According to Syed (2006), population increase is accompanied by greater consumption and rising level of waste. This increases volumes of waste and its environmental impacts. This is the situation in the city of Addis Ababa.

6.1.3 Spread of Waste around Communal Containers

There is no trend amongst the residents to throw waste in a sack directly into the containers. People have a small waste bag in their houses. They bring to empty in the communal containers and take back for storage at later times. Because of this, the waste instead of being placed inside the containers falls partly outside. The waste spreads around the containers. This makes the area around the containers dirty. People find it inconvenient to get close to the container. They try to throw the waste being away from the container. In doing this, the waste spreads than being placed inside the container. This increases the waste spread around the container.

Scavengers often spread the waste in search of resalable material and food items. According to an explanation of AASBPDA landfill expert and field observation; scavengers are available around communal containers in the city wide level and in the landfill site.

Stray animals like cat, dog and other night animals spread the waste in search of food. Stray animals are attracted due to the smell of the waste which contains vegetables and food waste.

Dustbins are fixed on poles of ETC and EELPA to serve as a waste collection material for the pedestrians. However, waste is often thrown outside due to lack of capacity, partial bottom dustbin detachment and public insensitivity.

The preceding situation becomes worse in the rainy season as the spread waste mixed with mud and water. Since containers are open at the top, waste is directly exposed to rain. The waste spreads out when the container becomes full, thus polluting the surrounding area. The water that does not have any outlet forms annoying odor and increase the weight.

Illegal waste disposal in open drains frequently blocked drainage systems. This becomes real problems and the situation worsens in the rainy season. The accumulated waste in turn creates ideal breeding conditions for insects which can be a cause for any disease outbreak.

Inappropriateness of the system: As per NUPI recommendation, the desired walking distance to waste container sites should not exceed 200meter from the housing units. This encourages household members to bring their waste to the communal containers. A large majority of households in the city live away from accessible roads. For such households, the walking distance to get a communal container sometimes reach 1 to 1.5km. It seems, therefore, unrealistic to expect anyone to carry the waste over such a distance.

The vehicles used for transporting waste in the city come from developed countries, where the waste characteristics and infrastructures are different from what is found in the city. It is not surprising, therefore, that the vehicle does not work efficiently.

6.1.4 Effects of Waste

The sight and smell of inadequately managed and uncollected waste constitute a major discomfort to residents, visitors and the environment. For instance, pollution of water increases the technical difficulty and cost of providing pure water. The polluted environment also causes serious health impact with high social and economic costs to ameliorate. Flooding causes damage to public infrastructure and private property.

A. Impact on the Environment

The disposal site (Repi), the communal containers, and uncollected waste has no cover at all. The disposal site is not covered by soil. Communal containers are open at the top and illegally dumped waste has no cover at all. This creates adverse aesthetic impacts on the environment.

The waste, which contains high amount of plastic bags, ash and dust are blown by the wind. This windblown waste makes the area unsafe and creates unpleasant conditions in the environment. The wastes make the city very untidy and unhygienic. The situation in the disposal site is horrific. This is because of the presence of leachate, stinking odor, insects, flies, etc. These and other factors make people to avoid the environment. Hence, it might create an impact on the value of the houses near and around the site.

B. Pollution and Flooding

Waste in the environment constitute high potential for the spread of infections through run offs during rains and contamination of underground water. According to AASBPDA landfill expert, serious leachate generations occur at Repi especially after heavy rainfall. Leachate, which obviously contains pathogens, is a direct risk to human health and a source of contamination to groundwater.

The illegally dumped wastes to open places, green areas, open ditches, open manholes and riverbanks clogged water ways which result in heavy flooding and loss of property during rainy seasons. Heavy flooding mainly occurred due to accumulation of waste in streams and drainage systems.

C. Health and Social Effects

Smooth flow of water is affected by illegal waste dumping in rivers and drainage systems. This creates stagnant water, which serve as breeding grounds for insects. These insects carry transmittable diseases.

According to the explanation of the landfill expert of AASBPDA, during the dry season high temperature coupled with the disposal site condition; facilitate decomposition rates and degradation of organic components of the waste. The process produces landfill gases. The gas is harmful and has stinking odors. This harmful and stinking odor spread to the surrounding residences and institutions. This, undoubtedly, affects health and social life of the surrounding inhabitants.

6.2. CONCLUSION

The haphazard waste disposal and settlement pattern in the early age of the city; the rural sanitation culture; the growing number of city population and number of city visitors; the high volume of waste produced per day; insufficient number of toilet facility and drainage system; negligible sewerage system connection; the spreading out settlement pattern of the city; shortage of communal containers and their inconvenient placement; lower number of trips made by vehicles per day and non-existence of sanitary landfill and treatment plants make waste collection, transportation and disposal very challenging in the city of Addis Ababa. The current waste collection, transportation and disposal system and capacity are not matching with the growing waste generation rate.

6.3 Recommendations

As it can be seen from data analysis and discussion part of the paper; proper waste collection, transportation and disposal could be facilitated by taking in to account several factors. To increase waste management service coverage and improve the service, it is better for the city government to emphasize on the under mentioned aspects.

6.3.1 Generation: consideration of the number of city visitors, international communities residing in the city and investors would help to know the actual quantity of daily-generated waste. Knowing the actual daily waste quantity for collection, transportation and disposal helps to set the storage requirements and collection frequencies.

6.3.2 Collection: the previous and existing waste collection rate of Addis Ababa city is very low. Especially, liquid waste collection rate is no more below 7 percent. Adequate number of workers and equipment (containers, vehicles, dust bins, etc), proper location of containers and accessible road conditions are the basic once for proper waste collection. It is better to distribute containers in a way that considers: the distribution of the population; the rate of solid waste generation, and the optimum distance that beneficiaries travel.

a. Container Placement: identification of areas which do not have container within a convenient distance facilitates waste collection and transportation. It is also important to know as to what is a convenient distance for people from their places to the container. This would serve as a guideline to decide the maximum distance that should be considered while planning for proposing new waste containers or relocating the existing once.

b. Increase the number of containers: containers are the major equipment used for solid waste collection. Container to population ratio is 1:7,316. The number of containers is not enough and not evenly distributed. About 42.49 percent of the solid waste left uncollected. This necessitates the provision of additional containers and distribute in an evenly manner. Besides, dust bins play a pivotal role in collecting pedestrians waste.

c. Increase sewerage system coverage: the capacity of existing sewerage system is only 5.53 percent of the total daily generated waste. Additional sewerage system construction helps to minimize the existing problem.

d. Increase drainage system coverage: storm water drainage coverage of the city is 38.89 percent. Even the existing drainage system, due to illegal waste disposal, does not properly function. Additional drainage line construction and raising community awareness to stop illegal waste disposal helps to minimize the problem.

6.3.3 Transportation: available vehicles should be properly maintained and kept. Besides, good and accessible road conditions and rapid and clear traffic conditions facilitate the rate of daily trip.

a. Increase number of vehicles: solid waste collection vehicles and liquid waste sucking trucks are small in number. As a result, small proportions of the generated waste are transported and disposed. The vehicles render service for long time, hence maintenance become difficult. Increase the number of both solid and liquid waste transporting vehicles could help to improve and raise the existing waste transporting coverage.

6.3.4 Disposal: It is better to provide the landfill top soil cover, freely access to a bulldozer on a regular basis, improved access roads in multiple directions, office facility, controlled access of waste picking by scavengers, drainage for storm water evacuation and fence. Some radius of a buffer zone helps to avoid construction of buildings and the danger of emissions of landfill gas. Water, electricity and communication utilities are also very essential. These can significantly prolong the life span of the landfill and reduce the negative environmental impacts. Moreover, the workers should also be provided with gloves, masks, uniforms, and periodic medical checkups. Effective monitoring and evaluation should also back the process.

Meanwhile, sanitary landfill site is needed. The new site selection and its development must be based on sound scientific criteria and incorporate community input especially in site selection. A site's design and development must use sound engineering principles.

Mobilization of the general public and creation of the requisite awareness helps to minimize or alleviate the existing problems. Besides, planning and effective execution of holistic development schemes and guide the urban growth towards achieving sustainable development helps a lot to alleviate the existing problems.

6.3.5 Further study: research on the city waste condition and solid waste generation rate would help to further identify the drawbacks.

-----*The end*-----

REFERENCES

BOOKS, PUBLICATIONS AND ARTICLES

- AAWSA (2002), *Problems and Prospects of Water Supply in Addis Ababa*, AADIPO, Addis Ababa, Ethiopia.
- Addis Ababa Civil Service Commission report February, 2008 (AACSC) Addis Ababa, Ethiopia.
- Addis Ababa Codes Enforcement and Monitoring Agency February, 2008 (AACEMA) Addis Ababa, Ethiopia.
- Addis Ababa Finance and Economic Development Bureau August, 2008 (AAFEDB) Addis Ababa, Ethiopia.
- Addis Ababa Roads Authority February, 2008 (AARA) Addis Ababa, Ethiopia.
- Addis Ababa Sanitation Beautification and Parks Development Agency January, 2008 (AASBPDA) Addis Ababa, Ethiopia.
- Addis Ababa Water and Sewerage Authority April, 2008 (AAWSA) Addis Ababa, Ethiopia.
- Ashenafi Gossaye (2001), *Inner-City Renewal in Addis Ababa: The Impact of Resettlement on the Socio-Economic and Housing Situation of Low-Income Residents*, Dr.Ing Thesis, Norwegian University of Science and Technology, 2001.
- Brown, L. and Jacobson, J. (1987), *The Future of Urbanization: Facing the Ecological and Economic Constraints*, World watch Paper 77. Washington, DC: World watch Institute.
- Cairncross, S. and Feachem, R.G. (1993), *Environmental Health Engineering in the Tropics: An Introductory edition*, John Wiley & sons, UK.
- Central Statistical Authority (1997), *The 1994 Population and Housing Census of Ethiopia: Results at country level*, Volume I-statistical report Addis Ababa, Ethiopia.
- Cointreau, S. (1982), *Environmental Management of Solid Wastes in Developing Countries*, Washington, DC: The World Bank, 1982.
- CSA (1994), *Population and Housing Census of Ethiopia April, 1996*. Addis Ababa, Ethiopia.

- Davy, K.et.al (1997), *Urban Management: the Challenge of Growth*, Hong Kong: Avebury.
- Davy,N. and C. Rakodi, eds. (1993), *Managing Fast Growing Cities: New Approaches to Urban Planning and Managing in the Developing World*, Longman, Harlow.
- Dhussa A.K and Varshney A.K (200), *Bio Energy News*, 'Energy Recovery from Municipal Solid Waste - Potential and Possibility', UNDP, Vol.4, No. 1, 2000.
- Holmes, J. (1984), *Solid Waste Management Decisions in Developing Countries*, In Holmes, J. (ed.) *Managing Solid Wastes in Developing Countries*. New York: John Wiley & Sons.
- Hoornweg, D., Thomas, L. and Otten, L. (1999). *Composting and Its Applicability in Developing Countries*, *Urban Waste Management Working Paper Series 8*. Washington, DC: World Bank.
- Johannessen, L.M. (1999), *Observations of solid waste landfills in developing countries: Africa, Asia and Latin America*, *Urban and Local Government Working Paper Series No. 3*, The World Bank, Washington, DC.
- Odegi-Awuondo, C. (1994), *Economics of Garbage Collection: A Survival Strategy for Nairobi's Urban Poor*, in C. Odegi-Awuondo et al. (eds.), *Masters of Survival*. Nairobi: Basic Books Kenya, 45-62.
- Rand, T., Haukohl, J. and Marxen, U. (2000), *Municipal Solid Waste Incineration, A Decision Maker's Guide*, Washington, DC: The International Bank for Reconstruction and Development, World Bank.
- Schubeler, P. (1996), *Conceptual Framework for Municipal Solid Waste Management in Low-Income Countries*, United Nations Development Program, UMP Working Paper Series no. 9. St. Gallen, Switzerland: SKAT.
- Syed.S (2006), *Solid and Liquid Waste Management*, King Abdulaziz City for Science and Technology, Saudi Arabia.
- Theo Van der Loop (Ed) (2002), *Local Democracy and Decentralization in Ethiopia*, UN Habitat, published by Department of Regional and Local Studies, University of Addis Ababa.
- UNEP (1996), Newsletter and Technical Publications, *Municipal Solid Waste Management Sound Practices Overview of the Sound Practices Section* Michigan Technology Center.

- UNEP Environmental Data Report, (1994), *GEMS Monitoring and Assessment Research Centre*, London UK in co-operation with the World Institute, Washington DC, UK Department of the Environment, London.
- UNEP. (1996), *International Source Book on Environmentally Sound Technologies for Municipal Solid Waste Management*, UNEP Technical Publication 6, Nov. 1996.
- United Nations (1999), *Solid Waste Management and Sewage Related Issues, working paper, 1999*, the United Nations Department of Economic and Social Affairs (DESA), Washington, DC.
- World Bank (AGR) Report 1996: World Bank Publication.
- Yami Birke, (1999), *Solid Waste Management in Ethiopia*, 25th WEDC Conference Addis Ababa, Ethiopia.
- Zerbock, O. (2003), *Urban Solid Waste Management, Waste Reduction in Developing Countries*.
- Zurbrugg, C.(1999), *The Challenge of Solid Waste Disposal in Developing Countries*, SANDEC News, EAWAG, No. 4, 1999.

PROCLAMATIONS AND LEGISLATIONS

- Addis Ababa City Government (2003) "*Solid Waste Management Policy of Addis Ababa City Government (AACG)*", NEGARI GAZETA 2nd Year No. 29, Addis Ababa.
- Addis Ababa City Government (2004) "*Waste Management Collection and Disposal Regulation of Addis Ababa City Government (AACG)*", NEGARI GAZETA 2nd Year No. 29, Addis Ababa.
- Federal Democratic Republic of Ethiopia (1995) "*Addis Ababa City Government Revised Charter*", NEGARIT GAZETA 9th Year No. 86, Addis Ababa.
- Federal Democratic Republic of Ethiopia (1995) "*Proclamation of the Constitution of Federal Democratic Republic of Ethiopia (FDRE)*", NEGARIT GAZETA 1st Year No. 4, Berhanana Selem Printing Press Addis Ababa.

Addis Ababa University
School of Graduate Studies

Faculty of Business and Economics
Department of Public Administration and Development Management

Subject: Research questionnaire

Dear respondent, this questionnaire is designed to examine the current situation of waste management in the city of Addis Ababa and thereby aim to suggest possible solution. The study is basically used for academics purpose. And hence, your responses are very vital for the success of the study. Therefore, please answer the questions attached herewith honestly. I thank you for your cooperation in advance. Finally, I would like to ensure that your responses remain confidential. Do not write your name.

Regards,

Yimenu Mekonnen

Questionnaire to be filled by the sample households

Please circle one or more of the choices given in the list

1. Sex

- A. Male
- B. Female

2. Address

- A. sub city
- B. kebele

3. Number of family member(s) of the household

- A. 1
- B. 2
- C. 3 and above

4. Age of household heads

- A. 18-30
- B. 31-45
- C. 45-60
- D. Above 60

5. Educational level

- A. Illiterate
- B. Read and write
- B. Grade 10/12
- D. Diploma and above

- 6.** Do you have employment?
- A. Yes
 - B. No
- 7.** If the answer is yes to question number 6, in what organizations you are working for?
- A. Government
 - B. Private sector
 - C. Involve in informal sector
 - D. Housewives
 - E. Student
- 8.** The type of house(standard or condition) you are living in
- A. Soil floor and corrugated iron wall
 - B. Soil floor and 'Cheka' wall
 - C. Cemented floor and 'Cheka' wall
 - D. Cemented floor and blocket wall
- 9.** Does the house have toilet facility?
- A. Yes
 - B. No
- 10.** If the answer is yes to question number 9, please indicate the standard of the toilet
- A. Wooden floor, 'Cheka' wall and corrugated iron roof
 - B. Cemented floor, Ceramic wall and corrugated iron roof

- 11.** If the answer is yes again to question number 9, what is the type of the toilet?
- A. Dry pit latrine
 - B. Septic tank systems (flush toilet)
- 12.** If the answer is no to question number 9, in what way do you use to urinate and excrete?
- A. In group toilets
 - B. Open fields
 - C. Near to road sides
 - D. Near by river course
 - E. Other (please specify) _____
- 13.** Do you have a bathroom in your house?
- A. Yes
 - B. No
- 14.** If the answer is yes to question number 13, where the waste water, including other liquid waste, drains?
- A. To the open ditch at the side of the street
 - B. To drainage system
 - C. To any open field
 - D. Other (please specify) _____
- 15.** Do you regularly empty and clean the toilet when it fills?
- A. Yes
 - B. No

16. If the answer is yes to question number 15, who is your service provider?

- A. Government
- B. Private
- C. Other (please specify) _____

17. If the answer is no to question number 15, what do you think is the basic reason? Please clearly state

18. What type of materials do you use for cooking?

- A. Firewood/leaves
- B. Charcoal
- C. Fuel
- D. Other (please specify) _____

19. What type and components of wastes are generated in your household?

- A. Kitchen, laundry and Bathroom waste waters
- B. Food items and slaughtering by product
- C. Ash and dust
- D. Clothing
- E. Home utensils
- F. Plastics
- G. Paper, packaging materials
- H. Leather, rubber, metal
- I. Other (please specify) _____

20. What materials do you use for waste collection?

A. Bucket for waste water and solid waste

B. Basket (Bamboo or Plastic)

C. Sack

D. Festal

E. Other (please specify) _____

21. Is there any possibility to minimize or reduce the amount of waste your household is generating currently?

A. Yes

B. No

22. If the answer is yes to question number 21, what are the possibilities of reducing the waste?

23. Is communal container for waste disposing system available in your vicinity?

A. Yes

B. No

24. If the answer is yes to question number 23, does there enough or sufficient communal containers?

A. Yes

B. No

- 25.** If the answer is no to question number 24, what is the reason?
- A. Lack of communal containers
 - B. Lack of commitment
- 26.** If the answer is yes again to question number 23, do you use the communal container regularly?
- A. Yes
 - B. No
- 27.** How often do you dispose waste of your household?
- A. Everyday
 - B. Every 2 days
 - C. Every 3 days
 - D. Once in a week
- 28.** How far is the communal container from your house?
- A. 50 to 200 meters
 - B. 201 to 600 meters
 - C. 601 to 1000 meters
 - D. 1001 to 1500 meters
 - E. Above 1500 meters
- 29.** If the answer is no to question number 23, what other means do you use to dispose your household waste?
- A. Dump or drain on the road side
 - B. Dump or drain on open field
 - C. Dump or drain in sewers
 - D. Throw or drain into the river which flows in the vicinity

- 30.** Is there any possibility to minimize the amount of waste your household is generating currently?
- A. Yes
 - B. No
- 31.** Does the placement of communal containers encourage people to use the service than disposing in other places?
- A. Yes
 - B. No
- 32.** The private sector waste collection service in comparison to the government is
- A. Costly but fast and efficient
 - C. Cost is compensated by prompt and efficient service
 - D. Government service is by far good
- 33.** Who disposes your household waste to the container?
- A. Myself
 - B. Children
 - C. Non-family members
- 34.** Communal containers are emptied:-
- A. Daily
 - B. Two days
 - C. Three days
 - D. One week
 - E. More than a week time

- 35.** Where do you drop your waste if containers are full or not emptied timely?
- A. Dispose in the road side
 - B. Dispose around or near to full container
 - C. Dispose to the open ditch
 - D. Other (please specify) _____
- 36.** Do you get waste collection service from MSEs?
- A. Yes
 - B. No
- 37.** If the answer is yes to question number 36, how often the MSEs collect waste from your house?
- A. Weekly
 - B. Twice a week
 - C. Other (please specify) _____
- 38.** How much monthly payment do you pay for the service?
- Birr _____
- 39.** For what purposes do you use the solid waste in home more frequently?
- A. Exchanging with 'Liwatch'
 - B. Get repaired by 'Tegagne' or repairers
 - C. Selling for 'Quralyo'
- 40.** Do you have Quralyo as your client?
- A. Yes
 - B. No

- 41.** If the answer is yes to question number 40, what type of materials do you sale for Quralyo?
- A. Used shoe
 - B. Packaging items (cans, plastics, cartons)
 - C. Used metallic home appliances and glasses
 - D. Other (please specify) _____
- 42.** Do you exchange used materials with Liwatch?
- A. Yes
 - B. No
- 43.** If the answer is yes to question number 42, what type of materials do you exchange with Liwatch?
- A. Used shoe
 - B. Used cloths
 - C. Other (please specify) _____
- 44.** Do you use repairers to repairer materials at home?
- A. Yes
 - B. No
- 45.** If the answer is yes to question number 44, what type of materials do you repair?
- A. Used metallic & other home appliances
 - B. Plastic containers
 - C. Umbrellas
- 46.** Do you prepare coffee ceremony at home?
- A. Yes
 - B. No

- 47.** If the answer is yes to question number 46, do you use green grass for coffee ceremony?
- A. Yes
 - B. No
- 48.** Do you slaughter animals at home?
- C. Yes
 - D. No
- 49.** If the answer is yes to question number 48, how many animals do you slaughter per annum?
- C. 1-5
 - D. 6-10
- 50.** If the answer is yes again to question number 48, where do you dispose waste of slaughtering animals?
- A. Communal Containers
 - B. Micro Enterprises
 - C. Septic tanks
 - D. Open space
 - E. Open ditches
 - F. Streams
- 51.** Do you know the establishment of sanitation and beautification committee in your kebele?
- A. Yes
 - B. No

52. If the answer is yes to question number 51, do you participate as part of or in support of the committee?

- A. Yes
- B. No

53. If the answer is yes again to question number 51, what do you do with the committee?

- A. Campaigning
- B. Protecting illegal waste dumping
- C. Educating the kebele residents

54. Do you believe that waste management service rendered by the city is satisfactory?

- A. Yes
- B. No

55. If the answer is no to question number 47, please briefly state below what should be done to improve the service?

Appendix II

ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES

FACULTY OF BUSINESS AND ECONOMICS
DEPARTMENT OF PUBLIC ADMINISTRATION AND DEVELOPMENT
MANAGEMENT

Situational Analysis of Solid and Liquid Waste Management in the City of Addis Ababa: The Case of Ten Kebeles

Interview guide

1. What are the strengths and weaknesses of waste collection, transportation and disposal system in the city of Addis Ababa? Are there constraining or challenging factors that impede waste collection, transportation and disposal system?
2. What initiatives have been taken by your good office to minimize or rectify the challenges and to improve waste collection, transportation and disposal practices?
3. What opportunities are there for proper waste collection, transportation and disposal activities?
4. What do you recommend to ameliorate waste collection, transportation and disposal practices of the city?

DECLARATION

I, the undersigned, declare that this thesis is my original work and has not been presented for a degree in any other university, and that all source of materials used for the thesis have been duly acknowledged.

Declared by:

Name : Yimenu Mekonnen Asserse

Signature : _____

Date : _____

Confirmed by Advisor:

Name : Meheret Ayenew (Ph.D)

Signature : _____

Date : _____

Place and date of Submission: _____