ASSESSING WATER SUPPLY AND DEMAND MANAGEMENT IN INDUSTRIES AND COMMERCIAL ENTERPRISES IN ATHI RIVER TOWN, MACHAKOS COUNTY

BY

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DECLARATION

This project is my original work and has not been submitted for a degree or any other award in any University

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APPROVAL

We confirm that the work in this research project was carried out by the candidate under our supervision

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DEDICATION

To the memory of my loving parents

Mr. and Mrs. Odongo

God is faithful, he has done it again!

ACKNOWLEDGMENT

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ABSTRACT

Water is an integral part of many industrial processes and increasing demand for water for industrial uses will result from increasing economic activity.The water resources upon which industrial growth depends are under increasing stress and almost no economy will be spared the negative consequences of unsustainable use of this scarce resource. This study was designed to assess how industries and commercial enterprises in Athi River Town are managing water as a resource. It reviewed the existing policy, legal and institutional framework for water supply and demand management. It also assessed the current water supply and demand situation in industries and commercial enterprises. Further, it examined the current water demand management strategies applied by industries and commercial enterprises to use water efficiently. In carrying out the study, questionnaires and interview schedules were used to collect the data. Data was then analysed descriptively using SPSS software and the results presented using measures of central tendency. The study found out that the legal, policy and institutional framework governing industrial water supply and demand management is not so effective and therefore needing sectoral review. Some of the problems within the institutional framework include lack of effective collaboration and public private partnerships towards sustainable water management. The study also found out that piped water is the main source of water for industrial and commercial enterprises at 83% followed by borehole at 60%. The application of water demand management was at 80%, this is an indicator of the importance the business community gives to the management of water as a resource. However the study also established that the application of complex and effective water demand management strategies is low. The most applied water demand management strategy was metering and sub-metering at 79% whereas the least applied was use of reclaimed water at 21%.This was attributed to factors such as lack of support, information and technology. The study came up with various recommendations including: proper policy formulations and implementation of water demand strategies, implementing water reuse practices, providing incentives for recycling and reclaiming water and providing preferential water tariffs for key industries.

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ACRONYMS AND ABBREVIATIONS

ABIWSI	African Beverage Industries Water Saving Initiative
CETRAD	Centre for training and integrated research in ASAL
CSD	Commission for Sustainable Development
DDP	District Development Plan
DEAP	District Environmental Action Plan
EAPC	East Africa Portland Cement
ECA	Economic Commission for Africa
EMCA	Environmental Management and Coordination Act
EPZ	Export Processing Zone
EPZA	Export Processing Zone Authority
FAO	Food and Agricultural Organisation
GDP	Gross Domestic Product
GWP	Global Water Partnership
ICT	Information Communication Technology
IWRM	Integrated Water Resources Management
KIRDI	Kenya Industrial Research Development Institute
KMC	Kenya Meat Commission
KNBS	Kenya National Bureau of Statistics
MAVWASCO	Mavoko Water and Sewerage Company
MIDA	Malaysian Industrial Development Authority
MDG	Millennium Development Goals

MOEWNR	Ministry of Environment, Water and Natural Resources
MOIED	Ministry of Industrialisation and Enterprise Development
NCSE	National Council for Small Enterprises
NCST	National Council for Science and Technology
NEMA	National Environmental Management Authority
NESC	National Economic and Social Council
UNEP	United Nations Environmental Programme
UNESCO	United Nations Education Scientific and Cultural Organisation
WBCSD	World Business Council for Sustainable Development
WDM	Water Demand Management
WRMA	Water Resources Management Authority
WSB	Water Services Boards
WSPs	Water Service Providers
WSRB	Water Services Regulatory Board
WSTF	Water Services Trust Fund

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Water is an essential resource for the development of any country and its unavailability is the most limiting factor for socio-economic progress and advancement (Waswa et al, 2007).As asserted by commonwealth (1991) the availability of adequate quantities of water is the basic prerequisite for most socio-economic development-agriculture, industry, aquaculture, navigation, power generation amongst others.CSD(2005) argues that water and economy are inextricably linked and therefore a country's overall development strategy and macroeconomic policies affect demand and investment in water-related activities.

Use of water may be broadly classified into three consumption categories: agricultural, industrial and domestic. While there is substantial literature dealing with the agricultural and domestic uses of water, relatively few have systematically analyzed industrial water use especially in the context of developing countries. (Kumar, 2008)

According to WBCSD (2005), business activity ranging from industrialization to services such as tourism and entertainment continues to expand rapidly. This expansion requires increased water services including both supply and sanitation, which can lead to more pressure on water resources and natural ecosystems. Commonwealth (1991) asserts that growing cities are able to satisfy their water needs only at an increasing cost and with greater environmental damage. Waswa et al (2007) argues that material derived from nature for industrial processes are not used as efficiently as would be possible, hence the idea of "efficiency gap" this in turn translates into wastage, losses, degradation and increased environmental costs.

Recently there has been a growing interest in sustainable use of water as a resource, indeed a third of all nations are suffering from water stress (between 1000 and 1500 cubic meters per capita). Since 1950, world population doubled but water use tripled. Water scarcity, in both its quantitative and qualitative manifestations, is emerging as a major development challenge for many countries. In countries racing toward their physical limits to fresh water expansion, the

amount of water available is a key concern. In other countries with expanding urban settlements, industrial sectors, and commercialized agriculture, water quality is a major concern. (ECA, 2006)

Africa is the world's second driest continent after Australia. At the continent level, Africa's 3931km^2 of renewable water resources represents 9% of the world's total freshwater resources. (FAO, 2009).Water is a crucial resource with great implications for African development however the freshwater situation in Africa is not encouraging. Africa's geography, climate, periodic drought, variable rainfall, growing populations, increased water demand, dwindling water supplies and increased cost of providing water contributes to water scarcity in the continent(UNEP,2010)

UNEP (2010) further asserts that water availability in the African continent is restricted by a trend towards urbanization, poor or no city planning, a lack of resources and competition for available freshwater between sectors such as industry, municipal water and agriculture.

Kenya has a total surface area of 586,367 km^2, of this surface water resources cover only 2% of the area (UNESCO, 2006) thus limiting fresh water resources. The five water towers of Kenya-Mount Kenya, the Aberdare Ranges, the Mau forest complex, Mount Elgon and the Cherangani hills are the sources of water for irrigation, agriculture, industrial processes and hydropower plants (UNEP,2010) among many other uses. According to FAO (2009) the total renewable water resources in Kenya stand at 21-100(10^9m^{3}yr) whereas the total water withdrawals by percentage were: 3.7% for Industrial, 79.2% for Agricultural and 17.1% for Municipal use.

According to the CIA world Fact Book (2013) freshwater withdrawal for industrial uses in Kenya currently stands at 6%,this represents a substantial increase as compared to the 2009 figures by FAO. This scenario is further aggravated by the fact that national water policies and conservation efforts often tend to focus on the supply-side for domestic and agricultural use, and less commonly on industrial needs. Under these circumstances the uncontrolled use of a limited resource by water intensive industries takes on a special significance. (ABIWSI, 2007)

1.2 Problem Statement

Athi River Town being one of the satellite towns of Nairobi city has witnessed tremendous growth over the years. According to Republic of Kenya (2000) the total population of Athi River Town was 48,260 persons whereas Republic of Kenya (2010b) puts the population at 139,502.The town's proximity to Nairobi and the strategic location on the Nairobi-Mombasa highway and on the railway has combined to make Athi River attractive as an industrial town. The rapid rate of population growth is however putting pressure on infrastructure and service delivery.

One of the services mostly affected by the growth of Athi River Town is water supply**.** According to MAVWASCO (2008) the demand for water in 2008 was 15,000m^3 per day and was expected to rise to over 25,000m^3 per day by 2013.MAVWASCO can only supply 3000m^3 per day of water which is 20% of the annual water demand. There is thus a huge deficit in the supply of water. Due to the increasing population and industrial expansion, water demand continues to increase whereas there is no corresponding development in the water sector thus exerting more pressure on this scarce resource. As asserted in Republic of Kenya (2002a) the already existing water supplies systems are overstretched and cannot supply enough water to the ever increasing and competing uses. Water is an integral part of sustainable industrial development hence its management will make it or break it for this industrial town. The insufficiency of water supply is thus an important drawback that may discourage and slow down further investment in the town as documented in Republic of Kenya (1997) if no effort is put to address the water problem.

Conversely no study has been done to document how industries and commercial enterprises are coping with the water supply deficit. In order to better respond to the water problem, it is important to investigate and elaborate pertinent issues surrounding it. This study therefore assessed water supply and demand in industries and commercial enterprises within the town by reviewing the policy, legal and institutional framework governing water supply and demand, documenting the current water situation and identifying the water demand management strategies in place at industries and finally coming up with recommendations to improve the water situation towards sustainable industrialization.

1.3 Research Questions

The study sought to answer the following questions:

1. What are the policies, legal and institutional framework governing water supply and demand in industries and commercial enterprises in Kenya?
2. What is the water supply and demand situation in industries and commercial enterprises in Athi River Town?
3. What are the water demand management strategies applied by industries and commercial enterprises in Athi River Town?

1.4. Objectives

The main objective of this study was to assess water supply and demand management among industries and commercial enterprises in Athi River Town and come up with measures that will lead to sustainable water utilization.

The specific objectives were:

1. To review policy, legal and institutional framework governing water use for industrial and commercial development in Kenya ;
2. To assess water supply and demand in industries and commercial enterprises in Athi River Town ;
3. To examine water demand management strategies applied by industries and commercial enterprises in Athi River Town ;
4. To suggest measures to improve water supply and demand management for industries and commercial enterprises in Athi River Town

1.5 Research Premises:

The research project was based on the assumptions that:

1. The policy, legal and institutional framework governing water use for industrial and commercial development in Kenya is ineffective and inefficient.
2. Water demand for industrial and commercial use in Athi River Town outstrips the water supply.
3. The water demand management strategies employed by industries and commercial enterprises in Athi River Town is inadequate.

1.6 Justification

Athi River Town being the headquarters of Mavoko Municipality has witnessed tremendous growth over the years primarily due to industrialization which has been boosted by its proximity to the capital city. Under Kenya's vision 2030, Athi River Town is projected to be an ICT hub hence this ICT hub status is expected to increase the pressure for provision of adequate water services. The town is part of Machakos County which is part of the Nairobi metropolitan area that the government has identified as one of the focus areas for development. The town is also a growing residential area due to its proximity to the capital.

Nairobi metropolitan region is projected to grow substantially in the next few years, Athi River Town therefore needs to have in place adequate water supply services to industries and commercial enterprises so as to contribute to job creation and contribute economically to the gross domestic product (GDP) and achieve sustainable development in line with Kenya's vision 2030.

1.7 Significance of the Study

Adequate and sustainable provision of water has been proven to be one of the prerequisites for economic growth and sustainable development of a region. Athi River Town being at the epicentre of the Nairobi metropolitan area stands to benefit tremendously if adequate water is provided for. In view of the foregoing, if appropriate measures are not taken to address water supply and demand issues then the town stands the risk of not realising its full potential in terms of economic and social development.

Addressing industrial and commercial development to ensure sustainable and efficient use of water would enhance the achievement of the millennium development goals(MDG) especially goal number 1(to eradicate extreme poverty and hunger) and goal number 7 (to ensure environmental sustainability) and consequently reduce stress on water resources.

The findings of this study will therefore be useful to government officials both at the National and county level especially in the ministry of environment & water and ministry of trade & industrialisation by informing policy decisions such as prioritising water management to meet the increasing demands of commercial and industrial users in Athi River Town. The study will also benefit the industrial and commercial users of water who stand to gain immensely if the issue of water scarcity is effectively addressed.

The research data gathered by this study will be of interest to scholars interested in water management. The research will add literature to the existing body of knowledge and also give insights on areas that require further research.

1.8 Scope of the Study

The study focused on water supply and demand management as pertains to industrial and commercial uses in Athi River Town.

Although water demand management is an important part of sustainable development and economic growth, the study could not exhaustively address all issues related to domestic, industrial, agricultural and commercial uses of water in Athi River Town.

The study paid particular attention to the strategies in place at the industries and commercial enterprises, the barriers to effective water demand management and the perception of the business community towards water management.

The study respondents were managers or staff at selected industries and commercial enterprises and relevant government officials drawn from ministries and government agencies such as water, environment and industrialization.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter presents literature related to water supply and demand. It looked into trends, concepts and approaches of water management. It also looked at the trends of industrial and commercial enterprise development as regards efficient water management. The chapter ends with a theoretical and conceptual framework for the study

2.1Trends and Concepts of Water Management

Today, water crisis is already a reality in many countries, threatening their economic growth and the livelihoods of their peoples. We all fear that the problems will only accelerate. Multiple thumbscrews are operating on these finite and vulnerable fresh water resources. The driving forces are strong: population growth and urbanization; tourism and industrialization; globalization; and climate variability and change – decreasing precipitation and increasing the frequency of droughts. (GWP, 2011)

Driven by these challenges and consistent with a worldwide movement towards more integrated water resources management, countries have embarked on reforming their water sector. A change in thinking and action in water management is slowly taking place. The experience suggests that meeting the challenge of water scarcity requires both a supply management strategy, involving highly selective development and exploitation of new water supplies (conventional and non-conventional) coupled with a vigorous demand management involving comprehensive reforms and actions to optimize the use of existing supplies.(UNEP,2012) The appropriate mix of supply and demand management may vary depending on the level of development, the governance structure and the degree of water scarcity in each country. However, as economies grow and the value of water increases, the benefits from and necessity for efficient demand management increase significantly. (GWP, 2011)

2.2 Approaches of Water Management

2.2.1 Water Supply Development

This is achieved by investing in water infrastructure, developing interregional and international transfers, increased 'mining' of non-renewable groundwater reserves, or using non-conventional water resources. But these supply-oriented policies are reaching their physical, social, economic, and environmental limits and as such they pose grave long-term risks. These include overexploitation of certain fossil and renewable water resources, the destruction of coastal aquifers by seawater intrusion, degradation of water quality and the eco-system services provided by the aquatic systems, loss of investment and jobs, and increased risks of social and political instability.(GWP,2011)

2.2.2 Water Demand Management

Water Demand Management (WDM) seeks to encourage better use of existing water supplies through economical and efficient management before further increasing the supply. WDM comprises a set of interventions and organisational systems intended to increase technical, social, economic, environmental, and institutional efficiencies in the various uses of water. (GWP, 2011). The traditional approach of hydrologists and water resources engineers has been to focus on the supply side and the assessment of available water resources. It is increasingly being recognised that supply and demand can only be balanced if water resources and water supply engineers address *both* sides of the balance. Water demand management is a key component of integrated water resources planning, which is in turn the pre-requisite for sustainable water management.

The 4th guiding principle of the 1992 Dublin states that ***"Water has an economic value in all its competing uses and should be recognised as an economic good."***The Dublin Statement goes on to say that the role of water as an economic and life sustaining good should be reflected in demand management policies, implemented through water conservation, efficient use, recycling and reuse, resource assessment and financial instruments.

There are several reasons for analyzing industrial water demand in developing countries. First, although current industrial withdrawal of water in developing countries is quite low in comparison to developed countries, this is expected to increase in comparison to other sectors of

the economy as well as in absolute terms since these countries is expected to have higher growth (Goldar and Pandey, 2001). There is also a greater appreciation for demand-side management, rather than increasing supply by building new infrastructure (UNEP, 2006)

Demand management aims to change the way industries and commercial enterprises use water in order to improve efficiency and reduce the need for expensive infrastructure development. It has been identified as an alternative or complement to the conventional approach of increasing supply by expanding infrastructure (UNEP, 2006). It thus reduces loss and misuse, optimizes water use, adds more value per unit of water mobilized, facilitates major financial and infrastructure savings and helps ease the pressure on water resources.

2.2.3 Integrated Water Resources Management

IWRM is an empirical concept which was built up from the on-the-ground experience of practitioners. Although many parts of the concept have been around for several decades - in fact since the first global water conference in Mar del Plata in 1977 - it was not until after Agenda 21 and the World Summit on Sustainable Development in 1992 in Rio that the concept was made the object of extensive discussions as to what it means in practice. The Global Water Partnership's definition of IWRM is widely accepted. It states: 'IWRM is a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems.'(GWP, 2011)

Integrated Water Resources Management is a cross-sectoral policy approach, designed to replace the traditional, fragmented sectoral approach to water resources and management that has led to poor services and unsustainable resource use. IWRM is based on the understanding that water resources are an integral component of the ecosystem, a natural resource, and a social and economic good.

2.3 Trends in Industrial and Commercial Enterprise Development

2.3.1 Relationship Between Water, Industry and Economic Development

Reliable and sufficient water supplies are critical for industrial and commercial development as well as reducing investment risk. Industrial facilities use water for a variety of purposes such as cooling and transportation, producing steam or electricity, sanitation and as a critical component of a firm's output (such as paper products). For example, it takes 230,000 litres of water to produce one tonne of steel in the US.

Over the years there has been an increased shift in adding impetus to the streamlining of business operations with a view of making them more sustainable in their utilization of key natural resources such as water. As a result many businesses in different regions are now increasingly aware of the need for improved water demand management and that reliable water access implies business opportunities. According to PricewaterhouseCoopers (2001) the Malaysian Industrial Development Authority (MIDA) which is the government's principal agency for promoting and coordinating industrial development successfully marketed reliable access to water as one key advantage of investing in the Malaysian economy.

2.4 Theoretical Framework

2.4.1 Industrial Ecology

People are used to considering the industrial system as isolated from the Biosphere, with factories and cities on one side and nature on the other. Industrial ecology explores the opposite assumption: the industrial system can be seen as a certain kind of ecosystem. After all, the industrial system, just as natural ecosystems, can be described as a particular distribution of materials, energy, and information flows. Furthermore, the entire industrial system relies on resources and services provided by the Biosphere, from which it cannot be dissociated. (Erkman, 2001)

Industrial ecology can also be seen as a practical approach to sustainability. It is an attempt to address the question: How can the concept of sustainable development be made operational in an economically feasible way? Industrial ecology represents precisely one of the paths that could provide concrete solutions. This theory understands how the industrial system works, how it is

regulated, and its interactions with the Biosphere; then, on the basis of what we know about ecosystems, to determine how it could be restructured to make it compatible with the way natural ecosystems function (Erkman, 2001)

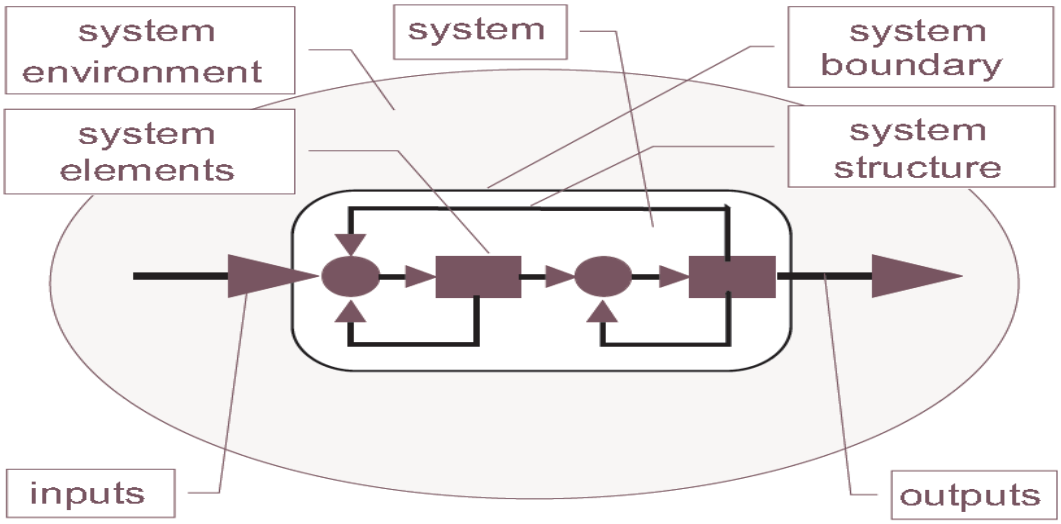
It considers technological dynamics, i.e. the long term evolution (technological trajectories) of clusters of key technologies as a crucial (but not exclusive) element for the transition from the actual unsustainable industrial system to a viable industrial ecosystem. (Braden & William, 1994)

In short, industrial ecology aims at looking at the industrial system as a whole. Industrial ecology does not address just issues of pollution and environment, but considers as equally important, technologies, process economics, inter-relationships of businesses, financing, overall Government policy and the entire spectrum of issues that are involved in the management of commercial enterprises. As such, industrial ecology can provide a conceptual framework and an important tool for the process of planning economic development (Burström, 2000)

Also, industrial ecology may offer options, which are not only effective for protecting the environment but also for optimizing the use of scarce resources. Thus, industrial ecology is especially relevant in the context of developing countries, where growing populations with increasing economic aspirations should make the best use of limited resources. (Erkman & Ramaswamy, 2001)

2.4.2 Systems Theory

A system is anything that is composed of system elements connected in a characteristic system structure This configuration of system elements allows it to perform specific system functions in its system environment. These functions can be interpreted as serving a distinct system purpose. The system boundary is permeable for inputs from and outputs to the environment. It defines the system's identity and autonomy. (Bossel, 1999)



Source: Bossel, 1999

Figure 1: A system interacts with its system environment through system inputs and outputs

In the case of water supply and demand management, industries and commercial enterprises can be seen as self organizing systems in that they can change their system structure to adapt to changes in their environment (water scarcity). They may also be seen as conscious systems because they have the ability to reflect about their actions and subsequent impacts.

A system can only exist and prosper in its environment if its structure and functions are adapted to that environment (See Figure 1). If a system is to be successful in its environment, the particular features of that environment must be reflected in its structure and functions. Sustainable development is a property of viable systems: if a system is viable in its environment, it will be sustainable. (Bossel, 1999)

2.4.3 Integrated Water Resources Management

The IWRM approach promotes more coordinated development and management of land and water, surface water and groundwater, the river basin and its adjacent coastal and marine environment, and upstream and downstream interests. It is also about reforming human systems to enable people to obtain sustainable and equitable benefits from those resources. For policy-making and planning, taking an IRWM approach requires that:

- water development and management takes into account the various uses of water and the range of people's water needs;
- stakeholders are given a voice in water planning and management
- policies and priorities consider water resources implications, including the two-way relationship between macroeconomic policies and water development, management, and use

This study adopts the integrated water resources management framework that has underlying components that include; managing water at the basin or watershed, optimizing supply, managing demand, providing equitable access, establishing policy and inter-sectoral approach (GWP, 2011)

Managing water at the basin or watershed includes integrating land and water, upstream and downstream, groundwater, surface water, and coastal resources.

Optimizing supply involves conducting assessments of surface and groundwater supplies, analyzing water balances, adopting wastewater reuse, and evaluating the environmental impacts of distribution and use options.

Managing demand includes adopting cost recovery policies, utilizing water-efficient technologies, and establishing decentralized water management authorities.

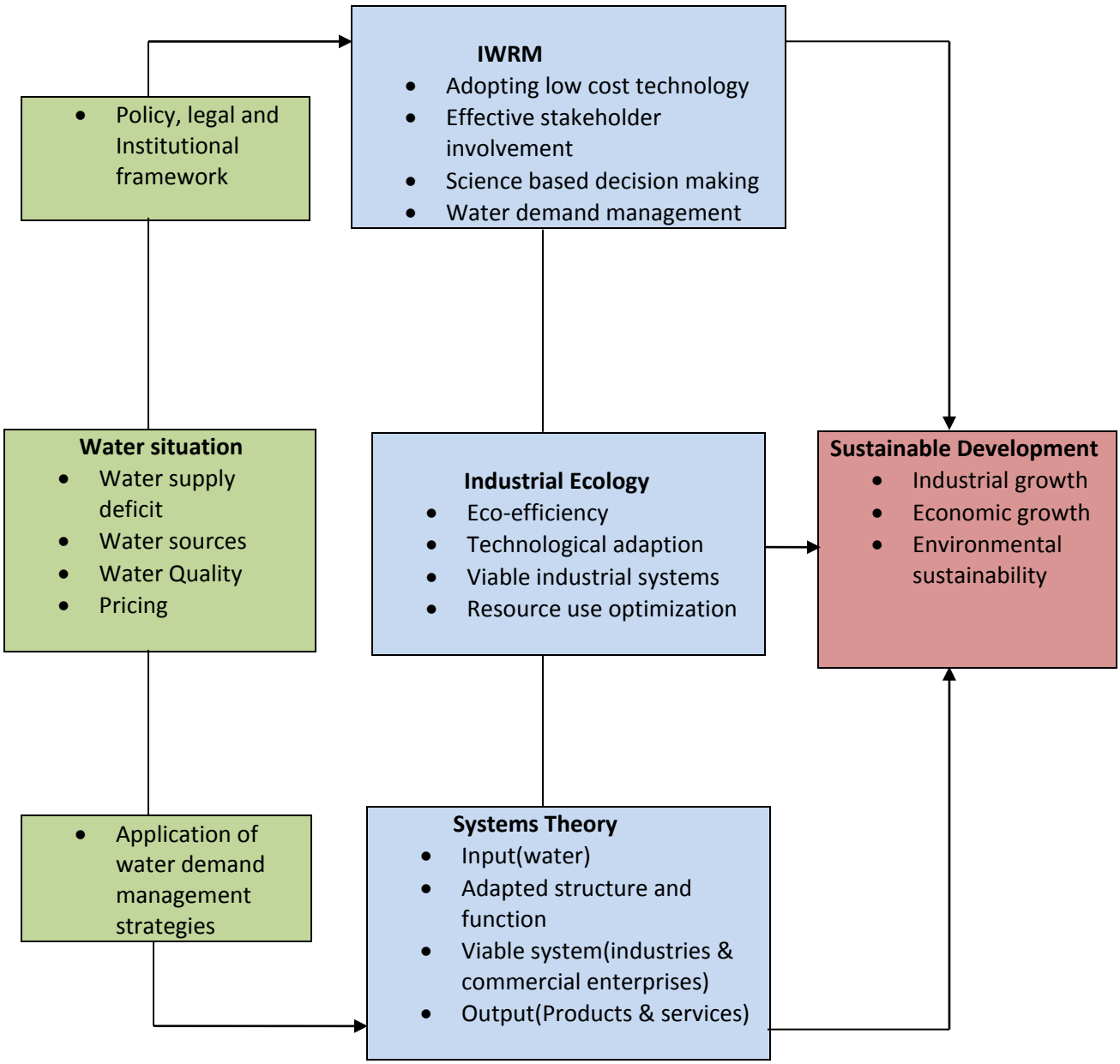
Providing equitable access may include support for effective water users' associations, involvement of marginalized groups, and consideration of gender issues.

Establishing policy includes examples such as implementation of the polluter-pays principle, water quality norms and standards, and market-based regulatory mechanisms.

Inter sectoral approach is based on Utilizing an inter sectoral approach to decision-making, where authority for managing water resources is employed responsibly and stakeholders have a share in the process.

2.5 Conceptual Framework

This study adopted the water demand management approach which is a key component of integrated water resources management. It also borrowed concepts from industrial ecology and systems theory. In this case industries and commercial enterprises were viewed as systems that operate and use scarce inputs (water) to produce outputs (products and services).The fact that water as a resource is retrieved from the natural environment gives industries and commercial enterprises an ecological aspect as underpinned in industrial ecology whereby efficiency has to be incorporated into the systems and processes so as to achieve sustainable development. (See Figure 2)



Source: Author, 2014

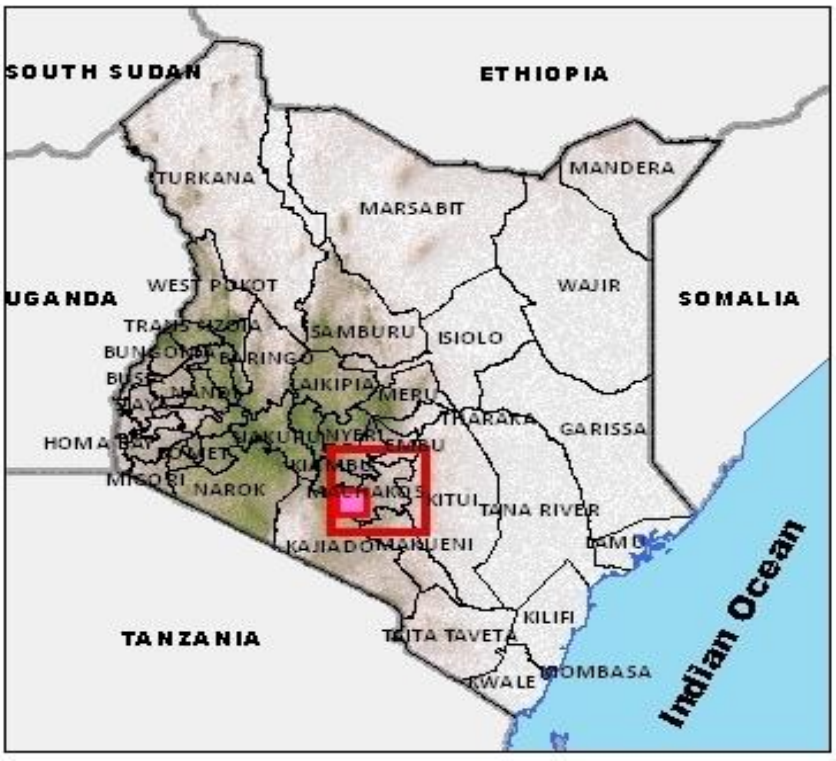
Figure 2: Conceptual Framework–Interaction of Industries and Commercial Enterprises with the Environment

CHAPTER THREE

STUDY AREA

3.1 Study Area Location and Extent

This study was conducted in Athi River Town in Mavoko municipality, Machakos County, Kenya. (See Figure 3 and 4) Mavoko municipality is located at latitude/longitude 01° 26'59"S, 36° 58' 43" E (Statoids, 2010).Athi River Town is located 30 km South East of Nairobi, The town is the main urban centre in Mavoko Municipality and hosts the Mavoko Municipal Council headquarters. Mavoko Municipality covers an area of 693 Km^2 extending from bordering Nairobi County to the West and North, Masaku County Council at the East and Kajiado County to the South. Athi River Town is at the junction of the Nairobi–Mombasa and Nairobi–Namanga Highways. The town also sits at confluence of the Mbagathi and Kitengela Rivers which join to form Athi River, the second largest drainage system in the country and from which it derives its name. (Njoroge, 2011)



Source: CETRAD, 2013

Figure 3: Map Showing Athi River Town in the National Context

Source: CETRAD, 2013

Figure 4: Map Showing Athi River Town within the County Context

3.2 Climate

3.2.1 Rainfall

The study area experiences average rainfall of between 500mm and 1000mm annually. The rainfall is bimodal and the rainfall figures in Athi River are one major and one minor monsoon seasons. The major monsoon season is experienced in the months of March, April and may and is called the long rains. The minor monsoon seasons occur between October and December, referred as short rains (Mbegera, 2010).The climate has been changing over the years and the mean monthly rainfall for the last 50 years is as in shown Table 1.This indicates that mean annual rainfall for the last 50 years is 695mm.According to Republic of Kenya (2002a) the rainfall is very unreliable and varies from year to year hence affecting water availability within the town.

Table 1: Mean Monthly Rainfall for the Last 50 Years

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
49 mm	49	115	195	137	42	15	21	24	52	114	77

Source: Mbegera, 2010

3.2.2 Temperatures

The mean monthly temperature ranges from 12^0C on the coldest months (July-August) to 25^0C on the hottest months (March and October). (Republic of Kenya, 2002a). Annual average temperatures are in the region of 30 degrees Celsius. (Muthama, 2012)

3.3 Geology and Soils

Geologically, the Athi River area lies on Cenozoic volcanic material overlying Basement System rocks at a depth (Wamwangi, 2010).The geology of the area is characterized by a succession of lava and pyroclastics overlying a foundation of pre-Cambrian schists and gneisses of Mozambique belt (Chimba, 2009).This region forms the eastern border zone of the rift valley which was associated with volcanicity. The study area is covered by black cotton soils, Athi tuffs and lake beds and Kapiti Phonolites that are underlain by gneisses and schists of Pre-Cambrian age(Chimba,2009).The black cotton soils overly thin layers of sandy sediments and tuffs of Athi tuffs and lake beds which resulted from consolidation of fragmented volcanic material deposits.

Wamwangi (2010) states that the Athi tuffs and lake beds were well developed from a very important Aquifer system (Athi Series) The volcanic rocks in this area are not particularly permeable to contribute to ground water, but fractures zones and weathered layers form zones for groundwater (Chimba, 2009).The groundwater may be saline or hard with concentration of chloride, sulphate and fluoride.

Athi River Town and its environs fall into Agro ecological zone VI. This is almost exclusively a ranching zone but with irrigation run-off catchment techniques, farming can be practiced (Republic of Kenya, 1997)

3.4 Hydrogeology

3.4.1 Groundwater Occurrence

Groundwater normally occurs in pores and interstices of various rock formations depending on the geological conditions and Physiography of the area, the permeability and porosity of the rock formations, the degree and depth of weathering, fracturing of the rock formation and the historical tectonic conditions of the area. The recharge conditions are also very important factors. (Wamwangi, 2010)

3.4.2 Regional Hydrogeology

In general groundwater in volcanic rocks is limited to fractures and erosion levels within the volcanic succession. Fresh lavas are usually not water bearing because of their massive and impervious nature. The most significant aquifer system in the study area is the Upper Athi Series aquifer system. The groundwater potential in the Basement System towards the east is generally lower than that of the volcanic areas to the west. (Wamwangi, 2010)

3.5 Topography

Athi River Town is located in a relatively flat escarpment area at the edge of rift valley, with a gentle slope and stands at 1.532m above sea level (Statoids, 2010). The terrain includes both plains and rolling hills, with occasional isolated hills, ridges and mountains projecting above the plains.

3.6 Vegetation

The vegetation type consists of woody plants (dwarf shrub grasslands) of less than 1.0m tall and a canopy cover of 3 –19%. (Republic of Kenya,2009).The main habitats within the Athi-Kapiti ecosystem are the Grass plain dominated by *Cynodon, Themeda*, *Cypress,* and *Digitaria* species; Dry forest, *Olea africana*, *Croton dichogamus*, *Brachylaena hutchinsii*, and *Calodendrum*; Riverine forest/valley forest, *Acacia xanthophloea*, *Euphorbia candelabrum*, *Apodytes dimidiata*, *Canthium schimperiana*, *Elaeodendron buchananii*, *Ficus eriocarpa*, *Aspilia mossambicensis*, *Rhus natalensis*, and *Newtonia* species.

3.7 Socio-Economic Profile

3.7.1 Demography and Population Growth

The population within the Athi River town area is varied due to the industrial nature of the town, but the rural population predominantly comprises of semi-nomadic pastoralists of the Maasai tribe and the sedentary Akamba of Eastern Province.(Charles & Baker,2011)

Republic of Kenya (2010b) indicated that Athi River township division had 139,502 persons with a population density of 1,260 whereas Machakos county had a population of 1,098,584.The growth rate of Athi River Town is 5.2% compared to that of the whole Mavoko municipality at

1.7%.This is attributed to immigration of people from other parts of the country to take advantage of employment opportunities and the proximity to the capital city, Nairobi (Mbegera,2010).Most of the immigrants to Athi River live in the town centre making the growth rate of the town more than that of the municipality. The high population and growth in the town indicates that there is more pressure on the provision of basic services such as water.

3.7.2 Economic Activities

There are approximately 150 light and heavy industries in the town (Tanathi,2011) this includes the four major cement manufacturers in Kenya; namely; East African Portland Cement (EAPC), Bamburi Cement, Athi River Mining and Mombasa Cement Companies. The town is host to the largest Export Processing Zone (EPZ) in the region which was established in 1995. The EPZ has many industries mostly textile firms exporting clothes to the US under the AGOA trade agreement. The national headquarters of the Export Processing Zone Authority (EPZA) is located within the EPZ in the Town. Other industries include Devki Steel Works Company and the Kenya Meat Commission (KMC) factory. In the vicinity of the town and within the larger Mavoko Municipality are the Kapa Oil Refinery, Nation Media Printer, Mabati Rolling Mills, and Sun-Rose and Primarosa flower companies among others. In total there are over sixty factories in the vicinity of the Town. (Njoroge, 2011). These industries are the main employers in the area and attract large numbers of semi-skilled and unskilled workers from around the country. (Mbegera, 2010)

Other economic activities include professional consultancy, banking, construction activities and open air markets. The main economic pursuit of the people of Athi River is employment and self-employment (Mbegera, 2010).

Land use within the Municipal Council of Mavoko is divided into nine categories namely residential, commercial, industrial, recreational, educational, public purpose and public utility.

3.7.3 Drainage, Water Resources and Provision

Athi River Town is largely in a semi-arid zone and the amount and frequency of precipitation is quite erratic. The general drainage pattern is from West to East. Athi River and its tributaries, most of which dry up during the dry spell (Chimba, 2009) drain the region to the west of the

Yatta Plateau. Machakos County and by extension Athi River Town depend upon river, streams, dams, boreholes, springs and roof catchment for sources of water (Republic of Kenya,2002a). Ground water potential in the county ranges from moderate to low. This is because of the massive nature of the parent basement rock. Because the rock bearing formation carries a high quantity of soluble minerals, most of the ground water is saline. However, the degree of salinity varies and in most cases the water is potable.

Major sources of water in Athi that may be tapped for industrial and commercial purposes are from EPZ through their Nairobi EPZ pipeline, Mavoko Water and Sewerage Company (MAVWASCO), from Kilimanjaro Water Pipeline, East African Portland Dam or by sinking individual boreholes. (Njoroge, 2011)

The water resources in the county have not been fully exploited to support domestic, livestock farming and industrial use. As asserted in Republic of Kenya (2002a) the already existing water supplies systems are overstretched and cannot supply enough water to the ever increasing and competing uses. In most cases, it is not possible to use gravity to get water from the perennial sources to the users. This usually calls for high investment. Such as investment has been made for the supply of water to Machakos and Athi River Towns from the Nol Turesh springs on the slopes of Mt. Kilimanjaro. Due to increase in population and economic activities, the water resource is continuously becoming scarce. (Republic of Kenya, 2009)

CHAPTER FOUR

METHODOLOGY

4.0 Introduction

This chapter describes the methodology that was used in the study. The chapter covers the following sections; research design, type and source of data, methods and instruments of data collection, target population, sample size, sampling technique and procedure and data analysis and presentation.

4.1 Research Design

According to Mugenda and Mugenda (2003), a research design guides the research in collecting, analyzing and interpreting observed facts. This study was based on case study design. This approach was appropriate for this study because the study sought to find out how industries and commercial enterprises are coping in light of the water scarcity that is looming in Athi River Town at present.

4.2 Type and Source of data

4.2.1 Primary Data

Primary data are those which are collected afresh and for the first time ,and thus happen to be original in character (Kothari, 2004).Primary sources of data were the industries and commercial enterprises operating in Athi River town, Mavoko Water and Sanitation Company, Resource persons from relevant institutions such as Machakos County Government, Mavoko Municipality, National Environment Management Authority(NEMA),Ministry of Water, Ministry of Environment, Ministry of Industry and Enterprise Development and Chamber of Commerce.

4.2.2 Secondary Data

Secondary data are those which have already been collected by someone else and which have already been passed through the statistical process (Kothari, 2004).All the information that was retrieved from already existing literature for the purposes of this study was treated as secondary data. This information was contained in Publications, Books, Annual/quarterly reports, Journals, Development plans, Environmental Action Plans, Periodicals and existing spatial information like maps of the study area.

4.3 Methods and Instruments of Data Collection

Various methods and instruments of data collection were used and these included the following;

4.3.1 Observation

Observation becomes a scientific tool and method of data collection for the researcher,when it serves a formulated research purpose,is systematically planned and recorded and is subjected to checks and controls on validity and reliability(Kothari, 2004).Physical aspects that were relevant to the study were capture using observation guides as an instrument. The information was then later used to verify respondent's verbal claims.

4.3.2 Personal/Oral Interviews

This method of collecting data involves presentation of oral-verbal stimuli and reply in terms of oral-verbal responses(Kothari, 2004).This method involved collecting data using interview schedules as the instrument through face to face interaction with key resource persons from relevant institutions such as Mavoko Water and Sanitation Company, Machakos County Government, Mavoko Municipality, National Environment Management Authority(NEMA), Ministry of Water, Ministry of Environment, Ministry of Industry and Enterprise Development and Chamber of Commerce.

4.3.3 Questionnaires

This method involved the collection of data through pre determined questions based on the study objectives. The questionnaire consisted of closed and open ended questions. Questionnaires were used because they are cheap and easy to administer to respondent and are convenient for collecting information within a short period of time (Onyango and Plews, 1999). It was administered to industries and commercial enterprises.

4.3.4 Literature Review

This method was used to capture secondary data. Documents such as reports, projects, books and publications were reviewed and information gathered used in the study analysis.

4.3.5 Checklists

These was used to gather data based on the study's premises, assumptions made on various aspects of the research variables were confirmed or disapproved by use of the above method.

4.4 Target Population

Cooper and Schindler (2008) define a population as the total of the elements (an element is the subject on which measurement is being taken) upon which inferences can be made. This in itself is a good description but it is slightly varied by Mugenda and Mugenda (2003) who defined target population as that population to which a researcher wishes to generalize the result of the study. The target population for this study comprised of managers and staff of selected industries and commercial enterprises that operate within Athi River town and key resource persons from relevant institutions such as Mavoko Water and Sanitation Company, Machakos County Government, Mavoko Municipality, National Environment Management Authority (NEMA), Ministry of Water, Ministry of Environment, Ministry of Industry and Enterprise Development and Chamber of Commerce.

4.5 Sample Size

The study population comprises of Industries and Commercial Enterprises operating in Athi River Town. The sample size in each stratum was determined using the formula recommended by Nassiuma (2000) as follows:

$$n = \frac{NC_V^2}{(C_V^2 + (N-1)\, e^2)}$$

Where n= Sample size
N=Population
Cv=Coefficient of variation (take 0.5)
e= Tolerance of desired level of confidence, take 0.05% at 95% confidence level

Based on the above formula and using N as 160, the sample size (n) was 61.77 rounded off to 62.The study therefore gathered field data from a total of 62 industries and commercial enterprises.

4.6 Sampling Technique and Procedure

The study employed both probability and non-probability sampling techniques as explained below

4.6.1 Stratified Sampling

The study applied stratified sampling design because the population from which the sample was to be drawn did not constitute a homogenous group; stratified sampling technique is generally applied in order to obtain a representative sample (Kothari, 2004).

A list of registered industries and commercial enterprises operating in Athi River Town was obtained from the County government of Machakos. The industries and commercial enterprises operating in Athi River town were then divided into categories (strata) which are more homogenous.

The strata were purposively formed on the basis of common characteristics which in this was the type of industry. The study therefore had 2 strata's as follows; Hospitality and Service and secondly manufacturing and Processing Industry. (See Table 2)

4.6.2 Simple Random Sampling

Within each stratum, simple random sampling was used to identify the industries and commercial enterprises to be sampled. The sample size in each stratum was determined using the formula recommended by Nassiuma (2000)

Table 2: The Sample Size Matrix

Categories(Industry type)	**Population(N)**	**Sample Size(n)**
Hospitality and Service	50	22
Manufacturing and Processing	110	40
TOTAL	160	62

Source: Field Survey, 2013

4.6.3 Purposive Sampling

Purposive sampling relies on the judgment of the researcher when it comes to selecting the units (e.g., people, cases/organizations, events, pieces of data) that are to be studied. The main goal of purposive sampling is to focus on particular characteristics of a population that are of interest, which will best enable you to answer your research questions. This method was employed in the identification of industries and commercial enterprises that utilize substantial amounts of water

in order to clarify key issues of concern to the study. It was also applied in identification of relevant institutions that deal with business and environment.

4.7.3 Snow Ball Sampling

Snowball sampling (or chain sampling, chain-referral sampling, referral sampling is a non-probability sampling technique where existing study subjects recruit future subjects from among their acquaintances. Thus the sample group appears to grow like a rolling snowball. As the sample builds up, enough data is gathered to be useful for research. This method was used in identifying and locating industries and commercial enterprises that are water dependent with the help of staff from already interviewed business entities and institutions.

4.7 Data Analysis and Presentation

Analysis of data involved sorting, coding, cleaning and organizing the data from the field. This information was then coded and entered into a spreadsheet and analyzed using SPSS (Statistical Package for Social Sciences).The data was analyzed using both qualitative and quantitative techniques. The open ended section of the questionnaire was analyzed using qualitative methods while the closed ended section of the questionnaire was analyzed through the use of quantitative techniques such as frequencies, percentages among others.

Qualitative data was cleaned and sorted then segregated according to research questions and objectives for similarities and differences. The data was then grouped in themes from which conclusions were drawn. The data was presented using pie chart, bar graphs, percentages, frequencies among others.

4.8 Ethical Considerations

A research permit was obtained from Kenyatta University prior to field work and data collection. An informed consent was also obtained from the participants and the findings of the study are purely for academic purposes.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.0 Introduction

This chapter gives the analysis and discussions of the research findings. It consists of the following three sections:

1. Evaluation of the policies, laws; how they had impacted on the industrial and commercial enterprises adoption of water demand strategies and overall use of water as a resource. Policies and laws are critical because they form part of governance statements that direct the activities of people within a society. The policies and laws that have been evaluated within this section included the following: The Constitution of Kenya, 2010, Water Act, 2002, EMCA, 1999, Urban Areas and Cities Act,2011,Physical Planning Act, Water Regulations, Water Policy and Industrialization Policy.

2. An assessment of the water supply and demand situation among industries and commercial enterprises in Athi River town. It looked into the factors that affect availability of water for production, the available sources for industrial production, the cost of water and other barriers that hinder adequate access to water for production. This was to give an in-depth understanding of the underlying water issues and build a case for the importance of embracing water demand management strategies at the industrial and commercial level.

3. The water demand management strategies applied at various industries and commercial enterprises were identified with the view of finding out how the industries are coping in light of the increasing water demand. Subsequently this objective dealt with looking into some of the challenges and opportunities that industries and commercial enterprises face in the adoption of water demand management strategies. It also looked into the perception of industries and commercial enterprises in Athi River town towards water management.

5.1 Legal, Policy and the Institutional Framework Governing Water Demand Management for Industries and Commercial Enterprises

5.1.1The Constitution of Kenya

The preamble of the Kenyan constitution mentions that the Kenyan people are " RESPECTFUL of the environment, which is our heritage, and determined to sustain it for the benefit of future generations:"in this respect the constitution acknowledges the importance of the environment. Industries and commercial enterprises are therefore obliged to be stewards of the environment by ensuring that they use water sustainably.

Article 42 of the bill of rights states that every person has the right to a clean and healthy environment, which includes the right a) to have the environment protected for the benefit of present and future generations through legislative and other measures, particularly those contemplated in Article 69, and b) to have obligations relating to the environment fulfilled under Article 70.

Article 69 of the constitution states that the State shall—

(a) Ensure sustainable exploitation, utilization, management and conservation of the environment and natural resources, and ensure the equitable sharing of the accruing benefits;

(d) Encourage public participation in the management, protection and conservation of the environment;

(f) Establish systems of environmental impact assessment, environmental audit and monitoring of the environment;

(g) Eliminate processes and activities that are likely to endanger the environment; and

(h) Utilize the environment and natural resources for the benefit of the people of Kenya.

(2) Every person has a duty to cooperate with State organs and other persons to protect and conserve the environment and ensure ecologically sustainable development and use of natural resources.

In the spirit of enforcing environmental rights, Article 70 of the constitution states that (1) If a person alleges that a right to a clean and healthy environment recognised and protected under Article 42 has been, is being or is likely to be, denied, violated, infringed or threatened, the

person may apply to a court for redress in addition to any other legal remedies that are available in respect to the same matter.

(2) On application under clause (1), the court may make any order, or give any directions, it considers appropriate—

(a) To prevent, stop or discontinue any act or omission that is harmful to the environment;

(b) To compel any public officer to take measures to prevent or discontinue any act or omission that is harmful to the environment; or

(c) To provide compensation for any victim of a violation of the right to a clean and healthy environment.

(3) For the purposes of this Article, an applicant does not have to demonstrate that any person has incurred loss or suffered injury.

5.1.2 Kenya Water Policy

Ogendi & Ongo'a (2009) asserts that Kenya's water policy at the time of its independence in 1963 placed a lot of emphasis on the participation of all stakeholders, including the Department of Water, the private sector, non-governmental organizations (NGOs), and the local people through self-help projects through the spirit of *Harambee (Harambee Motto:* the spirit of pooling resources together for the country's social and economic development).The policy gave control of the water resources, including water development projects, to the local communities with minimal input or control from the government during initiation, implementation and management of the projects.

The focus of water management in the country was solely on the provision of water for domestic, industrial and agricultural uses. Although the intention of the water policy was good, it achieved little, owing in part to limited financial resources, lack of skilled manpower on the part of the local communities, the country's weak and flawed environmental and land policies, poor governance and limited investment in new water projects.

In 1974, the National Water Master Plan was launched with the primary aim of ensuring that potable water will be available to all by to all by the year 2000.The Master Plan aimed to achieve this objective by providing for the development of water supply systems, sinking boreholes, constructing catchment dams and providing the conveyance infrastructure in the form of pipes

and furrows. To realize said objectives, it required the government to make financial and manpower investments in water development and supply to effectively meet the needs of its people (consumers). On top of this, the government needed to play a key role in policymaking and regulation in the use of water resources countrywide.

A revised water policy, the National Policy on Water Resources Management and Development, came into effect in 1999 after it was adopted by Parliament as Sessional Paper No. I of 1999. The policy not only addressed development and management of water resources but also water conservation across the country. The new policy, among other things, emphasized increased participation of local actors and the private sector in the development and management of water resources to benefit all Kenyans.

A new Master Plan (Strategic Plan 2005-2009) was also deemed necessary to effectively address issues of water resource development and management for the people of Kenya. Additional amendments and revisions targeting the 1974 Water Act resulted in the 2002 Water Act with far reaching goals and objectives.

5.1.3 Water Act (Act No: 8 of 2002)

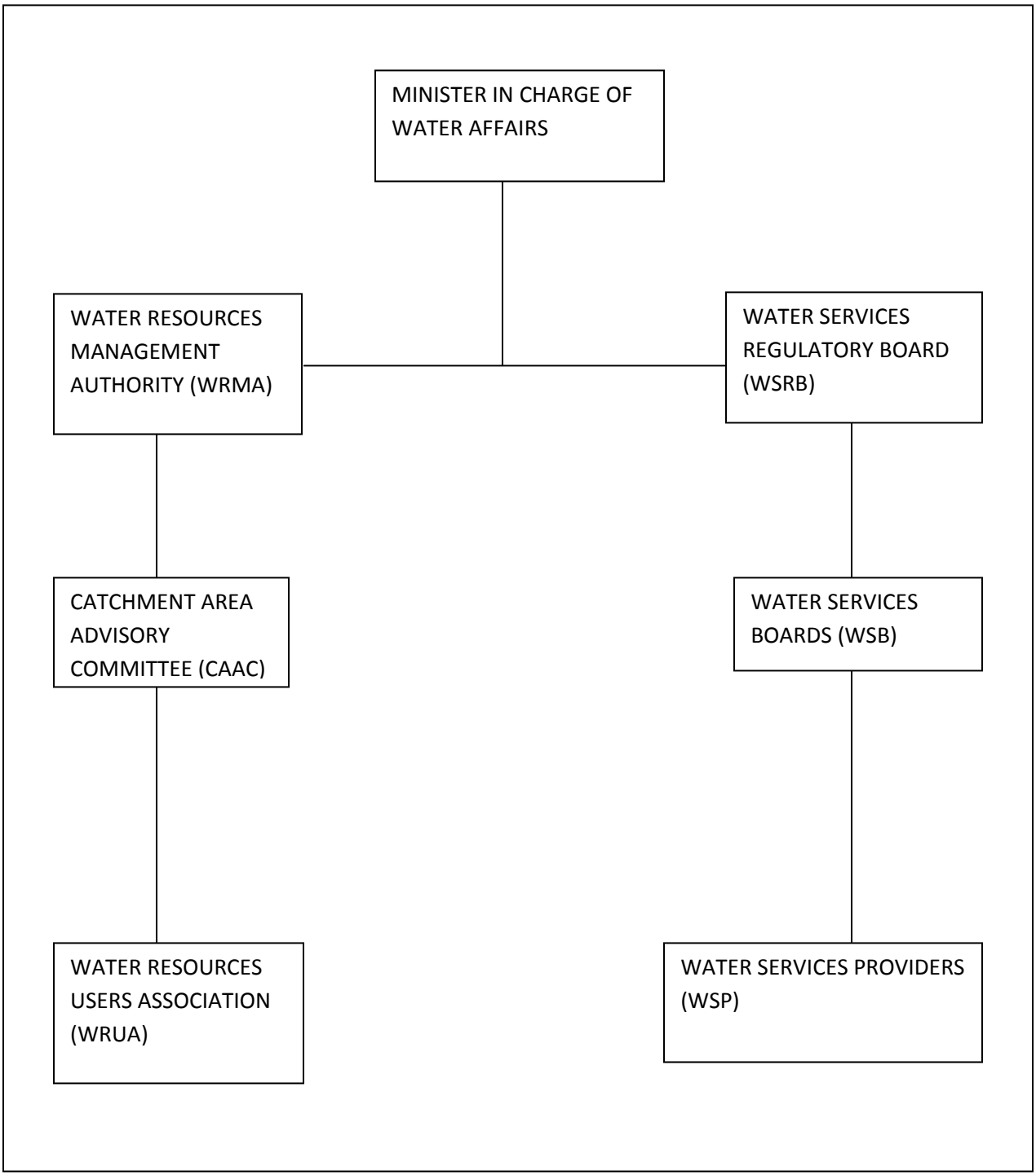
The Water Act of 2002 gave legal force to the National Water Policy objectives. It is the main statute governing water resources and vests the rights over all surface and ground water in the state, except for water that is wholly situated in a landowner's domain. It regulates matters such as the apportionment and utilization of water supplies, and the issuance of utilization permits.

The Water Act 2002 introduced comprehensive changes to the legal framework for the management of the water sector in Kenya. These reforms revolved around the following four themes: the separation of the management of water resources from the provision of water services; the separation of policy making from day to day administration and regulation; decentralization of functions to lower level state organs; and the involvement of non-government entities in the management of water resources and in the provision of water services. (Mumma, 2005)

The Water Act 2002 separates water resources management from the delivery of water services. Part III of the Act is devoted to water resources management while Part IV is devoted to the provision of water and sewerage services. It establishes two autonomous public agencies: the one to regulate the management of water resources and the other to regulate the provision of water and sewerage services. (See Figure 5)

Section 4 of the Act deals with control of water resources. It states that the Minister shall have, and may exercise, control over every water resource. In that respect, the Minister has the duty to promote the investigation, conservation and proper use of water resources throughout Kenya. It is also the Minister's duty to ensure the effective exercise and performance by authorities or persons under the control of the Minister of their powers and duties in relation to water.

5.1.4 Key Water Sector Institutions and Their Roles



Source: Field Survey, 2014

Figure 5: Institutional structure for the management of water affairs in Kenya

5.1.4.1 Ministry of Environment, Water and Natural Resources

The Ministry of Environment, Water and Natural Resources is the ministry in charge of the water sector and is therefore responsible for the overall management of water resources and general government policy on the water sector in the country. The Ministry has the goal of conserving, managing and protecting water resources for socio-economic development. Under the water sector reforms, the Ministry transferred management of and operation of water services to the Water Services Regulatory Board (WASREB) from mid 2005.

The Ministry remains in charge of developing legislation, policies and national strategies on water and sanitation. It is also responsible for ensuring that all the water sector institutions work in coordination with each other and monitoring performance of the water sector. In addition the Ministry is also responsible for ensuring that funds are mobilized and properly allocated country wide.

5.1.4.2 Water Resources Management Authority (WRMA)

Section 7 of the Water Act 2002 gives life to a water resources management Authority which will be charged with handling matters relating to water resources. The overall mandate of WRMA is to protect and conserve water resources. Water resources for purposes of the Water Act include lakes, ponds, swamps, streams, marshes, watercourses or any body of flowing or standing water both below and above the ground. The functions of the WRMA include planning, management, protection and conservation of water resources. The WRMA is also authorized to receive and determine applications for water permits and monitor their compliance. In the case of Athi River Town the regional office is Athi catchment area in Machakos.

The WRMA responsibilities extend to the management of water catchments. The Water Act establishes the Catchment Area Advisory Committees whose principal functions are to advise the WRMA on water resources conservation, use and apportionment at the catchment levels. WRMA is also expected to implement policies and strategies relating to the management of water resources; these include the National Water Resources Management Strategy and Integrated Water Resources Management and develop management strategies for water catchment areas.

5.1.4.3 Water Services Regulatory Board (WASREB)

The Water Services Regulatory Board is established under the Water Act and was operationalised in March 2003. The functions of the WASREB include the issuance of licenses to Water Service Boards and to approve service provision agreements concluded between Water Service Boards and Water Service Providers. The Water Service Providers are the agencies that directly provide water and sanitation services to consumers. WASREB is responsible for ensuring that water services and supply are efficient and meet expectations of consumers through regulation and monitoring of Water Service Boards and Water Service Providers. To standardize service provision, the Board has the responsibility of developing among others, tariff guidelines. In setting up guidelines WASREB tries to balance commercial, social and ecological interests by ensuring access to all while allowing after Water Service Boards and Water Service Providers to recover justified costs. Therefore the tariff guidelines take into consideration financial sustainability, the human right to water, efficiency, water conservation and simplicity.

5.1.4.4 Water services Trust Fund (WSTF)

The Government of Kenya, through the Ministry of Water and Irrigation established the Water Services Trust Fund (WSTF) under the Water Act 2002 to channel funding for its long-term objectives of developing water and sanitation services in areas of Kenya without adequate water. The main objective of the WSTF is to assist in financing capital costs of providing services to communities without adequate water and sanitation services

5.1.4.5 Water Appeals Board (WAB)

The Water Appeals Board is established under the Water Act to adjudicate disputes within the water sector. The Appeals Board is made up of three persons, one appointed by the President on advice of the Chief Justice and two others appointed by the Minister for Water and Irrigation. The Water Appeals Board can hear and determine appeals arising from the decision of the Minster of Water and Irrigation, the WASREB and the Water Resources Management Authority (WRMA) with respect to the issuance of permits or licensees under the Water Act.

5.1.4.6 Water Services Boards (WSB)

Water Service Boards (WSBs) are constituted under the Water Act 2002. The WSBs are responsible for the provision of water and sewerage services within their areas of coverage and are licensed by the WASREB. The WSBs are also responsible for contracting Water Services Providers (WSPs) for the provision of water services. WSB and WSP enter into service provision

agreements that include but not limited to the supply area, development, rehabilitation and maintenance of water and sewerage facilities of the WSBs. The WSBs are responsible for the review of the water services tariffs proposals from WSP before submission to WASREB for consideration.

5.1.4.7 Tanathi Water Services Board

The Tanathi Water Services Board is a Parastatal under the Ministry of Water and Irrigation, created through Gazette or Legal Notice No.69 of 4th June 2008. The core mandate of the Board is drawn from the Water Act 2002 and entails the following:-

1. Efficient and economic provision of Water Services as authorized by the Licensee.
2. Development and management of assets.
3. Plan development of services and facilities to increase access to water and sanitation
4. Contract Water Services Providers (WSP) and ensure efficient and economical provision of services

TANATHI covers an area of 65,888 sq km comprising of 4 Counties namely: Kajiado, Makueni, Kitui and Machakos.

5.1.4.8 Water Service Providers (WSPs)

The functions of Water Service Providers (WSPs) include the direct provision of water and sanitation services and the development, rehabilitation and maintenance of water and sewerage facilities of the WSB. The Water Service Providers act as agents of the Water Service Boards. Under the Water Act, Water Service Providers are defined to include companies, NGOs, other persons or bodies.

Currently TANATHI has 2 Urban Water Service Providers supplying water to Athi River Town, namely: Mavoko Water & Sewerage Company (MAVWASCO) and Nol-turesh/Loitokitok Bulk Water and Sewerage Company.

5.1.5 Environmental management and coordination act (EMCA, 1999)

Section 3 of EMCA, 1999 provides that every person in Kenya is entitled to a clean and healthy environment and has the duty to safeguard and enhance the environment. To this end, the Act contains some relevant provisions that, as a consequence of their enforcement, amount to mitigation against environmental harm. These include provisions for the establishment of water quality standards, including emission requirements (Part VIII), environmental impact assessment requirements (Part VI), environmental restoration orders and environmental conservation orders (Part IX)

58.(1) Notwithstanding any approval, permit or license granted under this Act or any other law in force in Kenya, any person, being a proponent of a project, shall, before financing, commencing, proceeding with, carried out, executing or conducting or causing to be financed, commenced, proceeded with, carried out, executed or conducted by another person any undertaking specified in the Second Schedule to this Act, submit a project report to the Authority, in the prescribed form, giving the prescribed information and which shall be accompanied by the prescribed fee.(Republic of Kenya, 1999)

68. (1) The Authority shall be responsible for carrying out environmental audit of all activities that are likely to have significant effect on the environment. An environmental inspector appointed under this Act may enter any land or premises for the purposes of determining how far the activities carried out on that land or premises conform to the statements made in the environmental impact assessment study report issued in respect of that land or those premises under section 58(2). (Republic of Kenya, 1999)

5.1.6 Environmental Management and Coordination (Water Quality) Regulations, 2006

Water Quality Regulations apply to water used for domestic, industrial, agricultural, and recreational purposes; water used for fisheries and wildlife purposes, and water used for any other purposes. Different standards apply to different modes of usage. These regulations provide for the protection of lakes, rivers, streams, springs, wells and other water sources.

The objective of the regulations is to protect human health and the environment. The effective enforcement of the water quality regulations will lead to a marked reduction of water-borne diseases and hence a reduction in the health budget.

Regulation 6 states that 'No person shall: cultivate or undertake any development activity within full width of a river or stream to a minimum of six (6*)* meters and a maximum of thirty (30) meters on either side based on the highest ever recorded flood level'.

Regulation 12. (1) states that 'every local authority or person operating a sewage system or owner or operator of any trade or industrial undertaking issued with an effluent discharge license as stipulated under the Act shall comply with the standards set out in Third Schedule to these Regulations'.

Regulation 14(1) obliges every person who generates and discharges effluent into the environment under a license issued under the Act to carry out daily effluent discharge quality and quantity monitoring and to submit quarterly records of such monitoring to the Authority or its designated representative.

All firms or persons discharging effluent into the aquatic environment are required to submit quarterly discharge monitoring records to NEMA based on prescribed procedures of sampling and analysis.

5.1.7 National Industrialization Policy

This Policy was developed as a framework to synchronize and coordinate the various policies, strategies and activities within Kenya's industrialization process.One of the guiding principles of this policy is environmental sustainabilty. the policy therefore acknowledges the need to promote sustainable industrial development while at the same time upholding environmental protection, management and efficient resource utilization.

5.1.7.1 Cleaner Production

Cleaner production practices in industries and environment conservation are intricately intertwined and need to be integrated for sustainable development. The implementation of cleaner production programs is an integral part of the policies that aim at increasing competitiveness and efficiency of firms as they assist in energy saving, water conservation, pollution control and ensures safety of machines, equipment and workers; and enhances the image of the firm in national and international arenas. The policy therefore seeks to:

1. Promote investment in local manufacturing of cleaner production equipment along with other emerging technologies.
2. Develop a National Cleaner Production Policy.
3. Mainstream the operation of the Kenya National Cleaner Production Centre (KNCPC) into the ministry responsible for industrialization.

5.1.7.2 Water and Sewerage Systems for Industrialization

Clean water is one of the most important ingredients in the industrial production processes. Current available water is inadequate for industrial and other domestic uses. Competition for water use has often denied the industry adequate clean water in the required quantities. Due to this competition the current tariff structure is disadvantageous to industrial users therefore making the cost of water to these users very high. As a result of poor sewerage system the cost of waste water management is also very high for industries.

The policy states that the Ministry of industrialization together with other relevant stakeholders will pursue the implementation of existing water-related policies that also have a bearing on the growth of the Industrial sector. These include:

1. Fast tracking the provision of clean and reliable water to areas of existing and high potential for industrial development prioritized in this policy document;
2. Providing preferential water tariffs for industrial consumers in key industries prioritized in this Policy document;
3. Promoting Public-Private-Partnerships in the provision of water and waste management systems, including water harvesting, storage and recycling.

5.1.7.3 Institutional Framework for Implementing the National Industrialization Policy

The previous framework for the development of the industrial sector in Kenya cut across various institutional arrangements and was not efficient in resource allocation. Furthermore it duplicated roles and responsibilities. This was a major shortcoming that affected the industrial sector negatively and thus in response to this, the ministry of industrialization considered the need for a more robust and well-coordinated institutional framework that is capable of spearheading the process of national industrialization in a new, contemporary and highly competitive global culture. In this regard, the institutional arrangements were made with three objectives in mind, including:

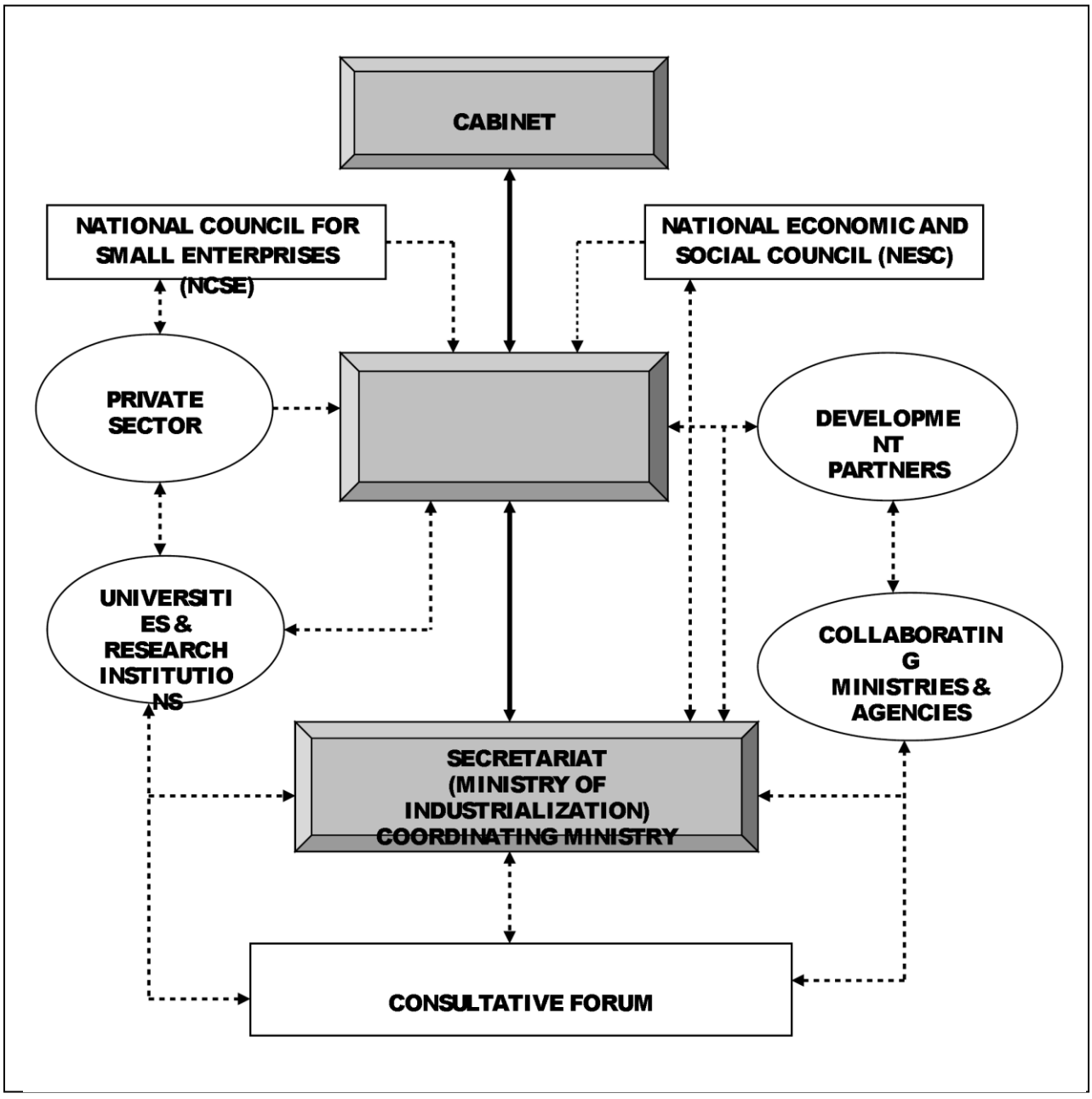
1. The need to ensure decentralization while also facilitating the delivery of efficient and cost effective services;
2. The need to facilitate Public Private Partnerships (PPPs) in policy formulation and implementation and ensure the involvement of all stakeholders, and;
3. The need to facilitate adequate access to infrastructure for industrial development

It is also to be noted that the institutional framework was designed to take into consideration the factors that have hindered a more robust industrial growth and development in Kenya. The success of implementation is therefore largely depend on strong political will and commitment by the top policy making organs of the government who are in turn expected to take firm and resolute decisions on the sector's development issues and priorities.

In view of these factors, it was considered that necessary to create a vertical, apex institution to be known as the National Industrial Development Commission, (NIDC) that will provide leadership and vision; allocate resources, set targets as well as oversee and synchronize the activities of all the different stakeholders as further elaborated in this chapter.

This institutional framework provides for both top-down and bottom-up approach to issues that would arise during the implementation of the policy, and for an all inclusive participation by the public and private sector as well as universities and other research institutions as well as the civil society and other stakeholders.

The clear roles, responsibilities, and lines of authority are established as indicated in figure 6. It is further envisaged that this institutional arrangement will facilitate various stakeholders to participate effectively in the manner that contributes effectively to the vision of the Industrial sector in Kenya.



Source:Republic of Kenya,2011a

Figure 6: National Industrialization: The new institutional framework

5.1.8 Physical Planning Act (Act No: 6 of 1996)

Section 36 of the physical planning act states that, if in connection with a development application a local authority is of the opinion that proposals for industrial location, dumping sites, sewerage treatment, quarries or any other development activity will have injurious impact on the environment, the applicant shall be required to submit together with the application an environmental impact assessment report.

The above measure safeguards the rights of individuals to a clean and healthy environment because it encourages the identification of environmental impacts well in advance and demands that mitigation measures be put in place.

5.1.9 Urban areas and cities Act NO.13 of 2011

The above act was enacted to provide for the, classification, governance and management of urban areas and cities; to provide for the criteria of establishing urban areas and to provide for the principle of governance and participation of residents and for connected purposes. Industries and commercial enterprises are key stakeholders within the urban area of Athi River town and their use of water in large volumes necessitates their involvement in planning of the town.

Section 38 of the act states that a city or urban area shall prepare an integrated city or urban area municipal development plan with the following objectives:

(a) Give effect to the development of urban areas and cities as required by this Act and any other written law;

(b) Strive to achieve the objects of devolved government as set out in Article 174 of the Constitution;

(c) Contribute to the protection and promotion of the fundamental rights and freedoms contained in Chapter Four of the Constitution and the progressive realization of the socio-economic rights;

(d) Be the basis for—

(i) The preparation of environmental management plans;

(ii) The preparation of valuation rolls for property taxation;

(iii) Provision of physical and social infrastructure and transportation;

(iv) Preparation of annual strategic plans for a city or municipality;

(v) Disaster preparedness and response;

(vi) Overall delivery of service including provision of water, electricity, health, telecommunications and solid waste management; and

(vii) The preparation of a geographic information system for a city or municipality;

(e) Nurture and promote development of informal commercial activities in an orderly and sustainable manner;

(f) Be the basis for development control.

5.1.10 County Governments Act,2012

This act grants county governments powers, functions, and responsibilities to deliver services and to provide for the implementation of Chapter Eleven of the Constitution pursuant to Article 200 of the Constitution.

A county government may enter into partnerships with any public or private organization in accordance with the provisions of any law relating to public or private partnerships for any work, service or function for which it is responsible within its area of jurisdiction.

Two principles of county planning are directly linked to the sustainable use and management of water as a resource. Section 102 (d) of the county governments act,2012 states that the county government shall protect and develop natural resources in a manner that aligns national and county governments policies whereas section 102 (f) states that the county government shall engender effective resource mobilization for sustainable development.

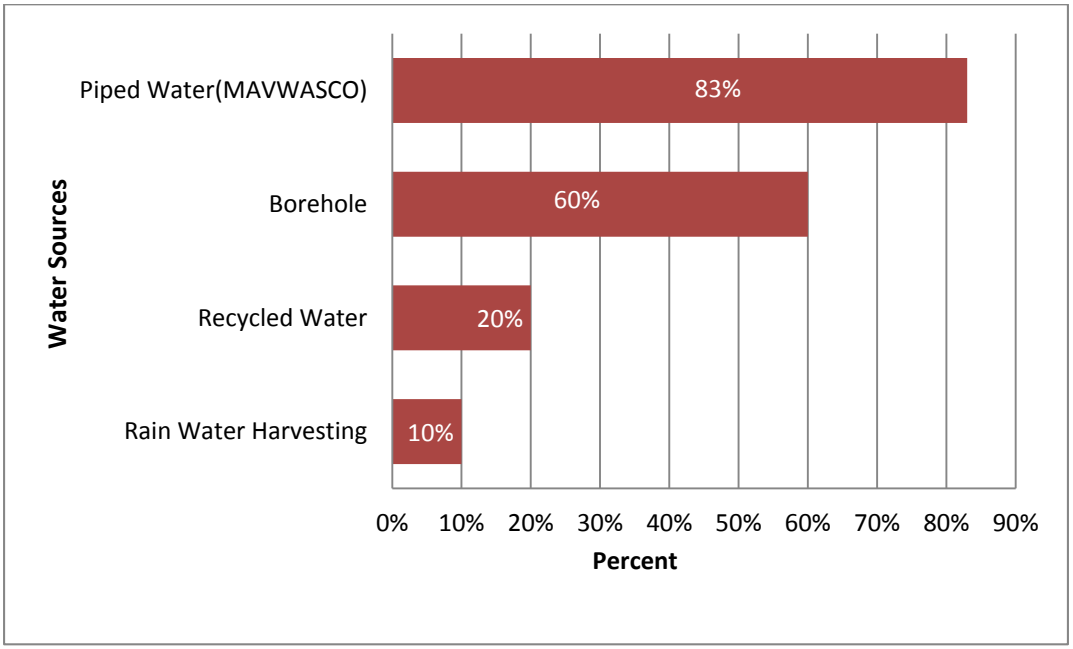
In relation to sustainability, the objectives of county planning shall be to:

1. Facilitate the development of a well-balanced system of settlements and ensure productive use of scarce land, water and other resources for economic, social, ecological and other functions across a county
2. Work towards the achievement and maintenance of a tree cover of at least ten per cent of the land area of Kenya as provided in Article 69 of the Constitution
3. Ensure harmony between national, county and sub-county spatial planning requirements.

There shall be a five year county integrated development plan which should have clear objectives, an implementation plan, provisions for monitoring and evaluation and clear reporting mechanisms. Currently Machakos County has not yet released its 5 year county integrated development plan but the process is at an advanced stage and most of the pillars including environmental sustainability will be aligned to vision 2030.

5.2 Water Supply and Demand Situation in Industries and Commercial Enterprises in Athi River Town

5.2.1 Available Sources of Water for Industrial and Commercial Use



Source: Field Survey, 2014

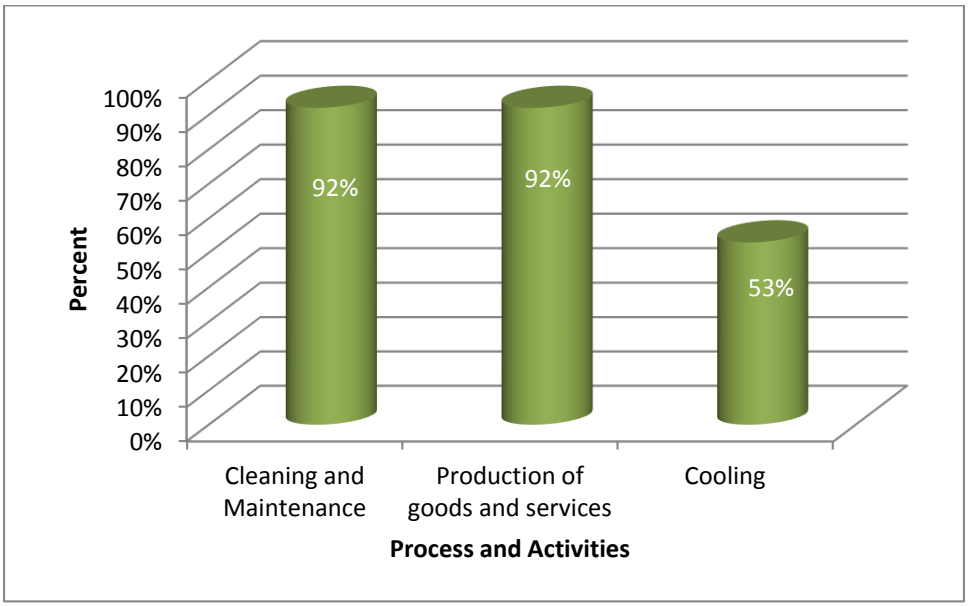
Figure 7: Water Sources for Industrial and Commercial Use

The available and currently tapped sources of water in Athi River Town for industrial and commercial use were as listed in Figure 7.Piped water being supplied by Mavoko Water and Sanitation Company(MAVWASCO) was identified as the most common source of water at 83% folllowed secondly by borehole water at 60%.This clearly indicates the importance and dependability of piped water by the industrial and commercial users within the town.It is worth noting that most of the welll established industries and commercial enterprises have invested in supplementarty sources of water such as borehole drilling.This was also confirmed during an interview with the environmental officer,Mavoko Municipality who stressed upon the need for industries to diversify their sources of water and use it more sustainably so as to effectively maximise on the price per unit.This further indicates the extent to which the shortage in water supply has driven the industries to explore alternative sources of water.This initiative is commendable however the findings of the study also showed that only a paltry 20% of the

industries and commercial enterprises recycle water for use whereas only 10% of them harvest rain water.

Direct water from River Athi was not identified as a major source of water for industrial and commercial use.This can be attributed to the high level of pollution of the River hence making its extraction not feasible.

5.2.2 Process and Activities



Source: Field Survey, 2014

Figure 8: Process and Activities that utilize water in Industrial and Commercial Enterprises

Athi River being an industrial town hosts a number of industries and commercial enterprises ranging from large to small scale.The nature of the industries are largerly manufacturing constituting of both dry and wet industries.Service industries are also present including hotels,restaurants and supermarkets.According to the findings of the study, cleaning and maintenance was reported as a major use of water at 92%,followed by production of goods and service also at 92% and thirdly as a coolant in industrial processes at 53% (See Figure 8).The figures above clearly indicate the importance of water as a resource in the operations of indusries and commercial enterpises.The presence or lack of water clearly has an effect on how goods and services are produced within the town and the resultant price per unit.Furthermore the ease at which water is available for industrial and commercial use affects the towns marketability in

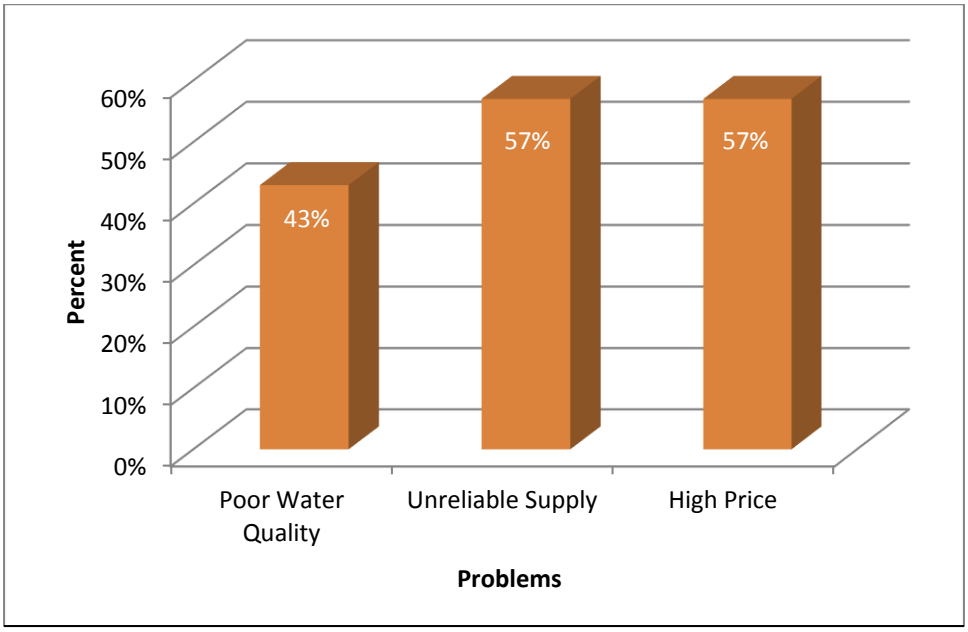
terms of attracting investors keen on setting up industries within the town.According to the technical manager-MAVWASCO,the industrial water demand has been on the increase due to expansion of industries and the natural increase of staff.Currently MAVWASCO serves 60% of the towns water demand.

5.2.3 Water Consumption in Industries and Commercial Enterprises

Water consumption in the industries and commmercial enterprises varied from a minimum of 1000 litres per month to a maximum of 300,000 litres per month.The amount of water consumed largely depends on the nature and type of industry.Wet industries use more water in their production process as compared to dry industries.Conversely factories utilise more water as compared to service industries such as hotels and restaurants.

The waters of Athi river are heavily polluted from domestic and industrial sources which discharge effluents into it.The higher the volume of water being used in systems and processes then the higher the volume of waste water generated,which unfortunately finds it way into Athi River.

5.2.4 Problems Encountered in Accessing Water for Industrial and Commercial Use



Source: Field Survey, 2014

Figure 9: Problems Encountered in Accessing Water

Just as experienced other industrial towns in the world, Athi River Town grapples with various challenges when it comes to accessing water for industrial and commercial use. The study findings revealed that high prices and unreliable water supply come top of the list of problems encountered as indicated in Figure 9.

56.67% of the industries and commercial enterprises interviewed reported that they do not receive enough water for running their business operations. The water supply by MAVWASCO is often insufficient due to the current apportioning to cater for the increased demand. It therefore has to be supplemented by other sources such as borehole water. Investing in alternative sources of water impacts the business community negatively by increasing cost of production (44.44%) and limiting production (55.56%)

Asked whether the price of water is sustainable and economical to the running of business in Athi River Town, 56.67% of the respondents said it was not economical whereas 43.33% of the respondents were comfortable with the current price that they pay. The above results vary widely primarily because water is a factor of production and hence its affordability will be determined by the scale of business and the profit margins achieved by each individual business entity. Large scale companies are bound to be comfortable with paying a higher price for water as opposed to small and medium enterprises.

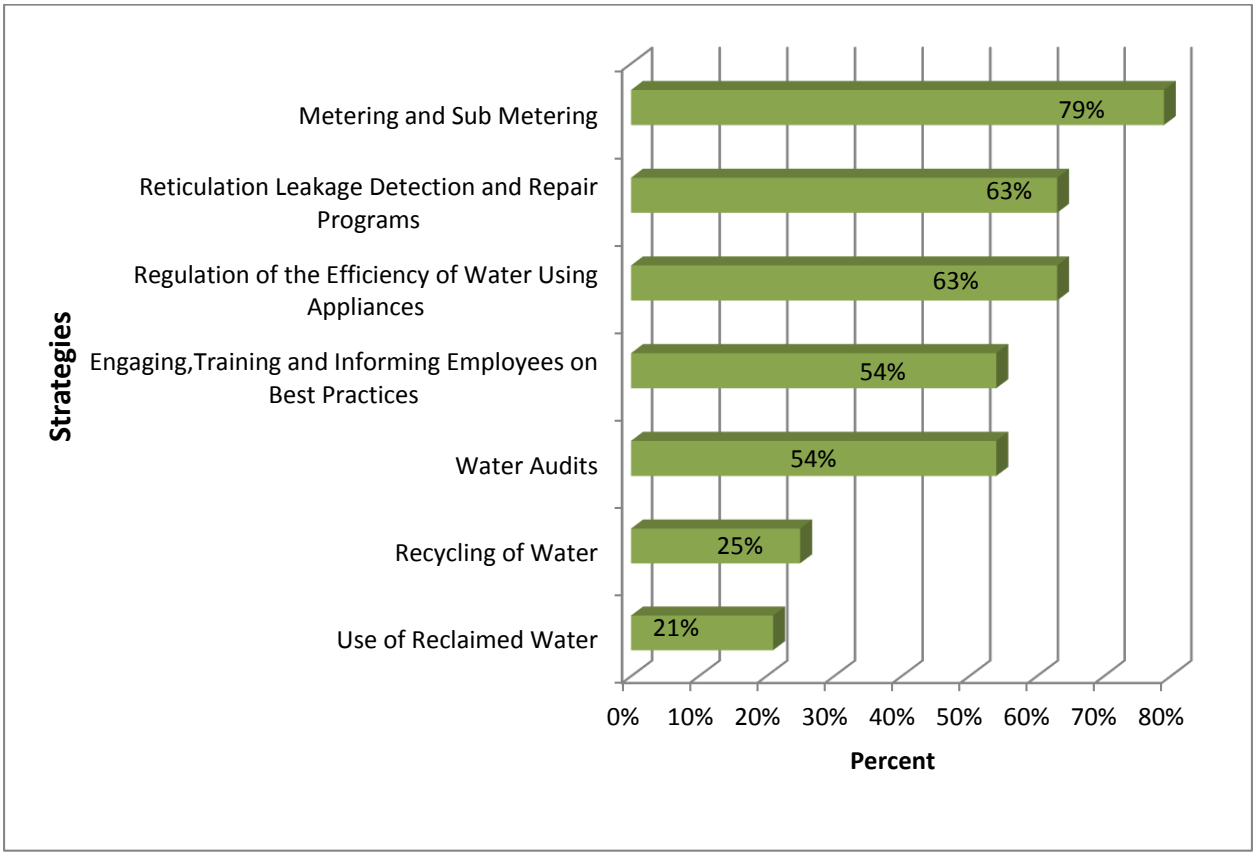
The study found out that the price of water negatively affects the business community by limiting the production capacity (41.18%) and also by increasing the overall cost of production (58.82%).This in turn has a negative effect on the consumer who will ultimately have to pay higher prices for goods and services.

Poor water quality was also identified as a challenge especially for borehole water users. (See Figure 9).Past studies have shown that the underground water in Athi River Town is relatively salty due to the underlying bed rock. The water therefore has to be treated prior to consumption. A discussion with the environment officer at Mavoko Municipality also confirmed the water quality challenge not only to industries and commercial enterprises but also to the larger Athi River Town community.

5.3 Water Demand Management Strategies Employed By Industries and Commercial Enterprises in Athi River Town

Water demand management has been proven to be an effective strategy in managing water as a scarce resource. The study findings revealed that 80% of the industries and commercial enterprises within Athi River Town do apply some form of water demand management whereas 20% of them do not carry out any form of water demand management. These finding indicates the importance that industries and commercial enterprises give to water as a scarce resource and a key input in their daily operations.

5.3.1 Water Demand Strategies in Place



Source: Field Survey, 2014

Figure 10: Water Demand Management Strategies

As stated earlier,80% of the industries and commercial enterprises are engaged in some form of water demand management.Figure 10 shows the various water demand strategies identified during the study and their percentage in terms of implementation.

5.3.1.1 Metering and Sub Metering

Metering and sub metering emerged as the top most strategy implemented by industries and commercial enterprises at 79%(See Figure 10).Sub metering involves the installation of water meters into individual units within a multi development.Metering and sub metering is instrumental in measuring the amount of water used in processes and systems as well as forecasting future water demands hence aiding in the planning process.MAVWASCO indicated that currently they are at 100% in terms of metering and that this initiative has increased the effectiveness of water supply to the industrial and comercial users as well as the larger Athi River Town community.

5.3.1.2 Reticulation Leakage Detection and Repair Programs

This strategy was identified as the second most practiced by industries and commercial enterprises at 63% (See Figure 10).Leakage detection and repair programs are instrumental in ensuring that systems and processes are running efficiently so as to avoid water wastage.Herein also lies the issue of technology and use of modern systems that are computerised and hence able to accurately identify leaks within a system for quick repair.

5.3.1.3 Regulation of the Efficency of Water Using Appliances

63% of the industries and commercial enterprises interviewed identified regulating the efficiency of their appliances as a strategy(See Figure 10).Non efficient water using appliances are known to waste high volumes of water which could have otherwise been used in other systems or processes.The more efficent the water using appliance then the cheaper the process and subsequently less waste water is generated.For example some of the establishments have installed press taps and sensor taps instead of screw taps.

5.3.1.4 Engaging,Training and Informing Employees on Best Practices

54% of the respondents reported that they engage,train and inform their employees on best practices. (See Figure 10).Well informed employees are in a better position to implement water management strategies and promote water sustainability within the establishment.MAVWASCO indicated that one of the major challenges faced in adoption of water demand management technologies is the attitude and mentality of middle level management and staff.

5.3.1.5 Water Audits

Conducting water audits was identified as a water demand strategy at 54% (See Figure 10).Water audits reveal how much water has been used within a specific period of time and whether it was used economically and sustainably.Water audits are effective in informing the company management on the direction to take as regards efficiency of water use in their systems and process.The water audits can be undertaken internally or externally depending on the capacity of the company.

5.3.1.6 Recycling of Water

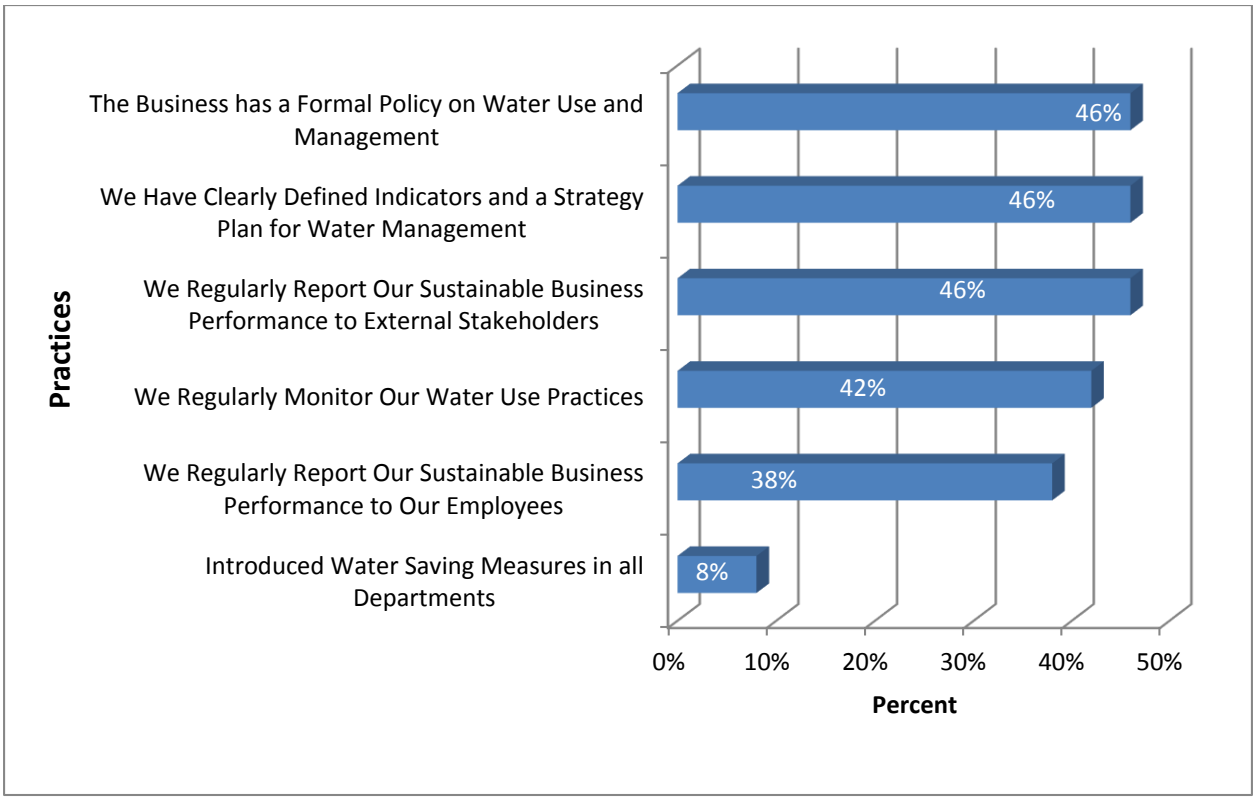
Recycling of water was at 25% (See Figure 10) this is a low percentage compared to the other strategies in place.This can probably be attributed to the level of technology needed to recycle water.Most compnaies shy away from recycling owing to the high cost related to it.this observation posses a challenge to future water management in Athi River Town,more so considering the fact that huge volumes of waste water are generated daily from operations of industries and commercial enterprises.Recycling of water is an effective water demand strategy owing to the fact that it converts waste water into a resource. By so doing it reduces the demand for fresh water and subsequently reduces the cost of water.

5.3.1.7 Use of Reclaimed Water

Use of reclaimed water was the least practiced water demand strategy at 21 % (See Figure 10).This can be attributed to the high cost and technology needed to succesfully reclaim water from processes and systems.It is a process that mostly suits large scale businesses that use large volumes of water on a daily basis.Athi River Town has quite a number of such industries and thus the low percentage of use of reclaimed water could be an indicator that more efforts need to be directed towards reclaiming water for future sustainability. Reclaiming water is an effective

water demand strategy owing to the fact that it converts waste water into a resource. By so doing it reduces the demand for fresh water and subsequently reduces the cost of water.

5.3.2 Complementary Sustainable Business Practices



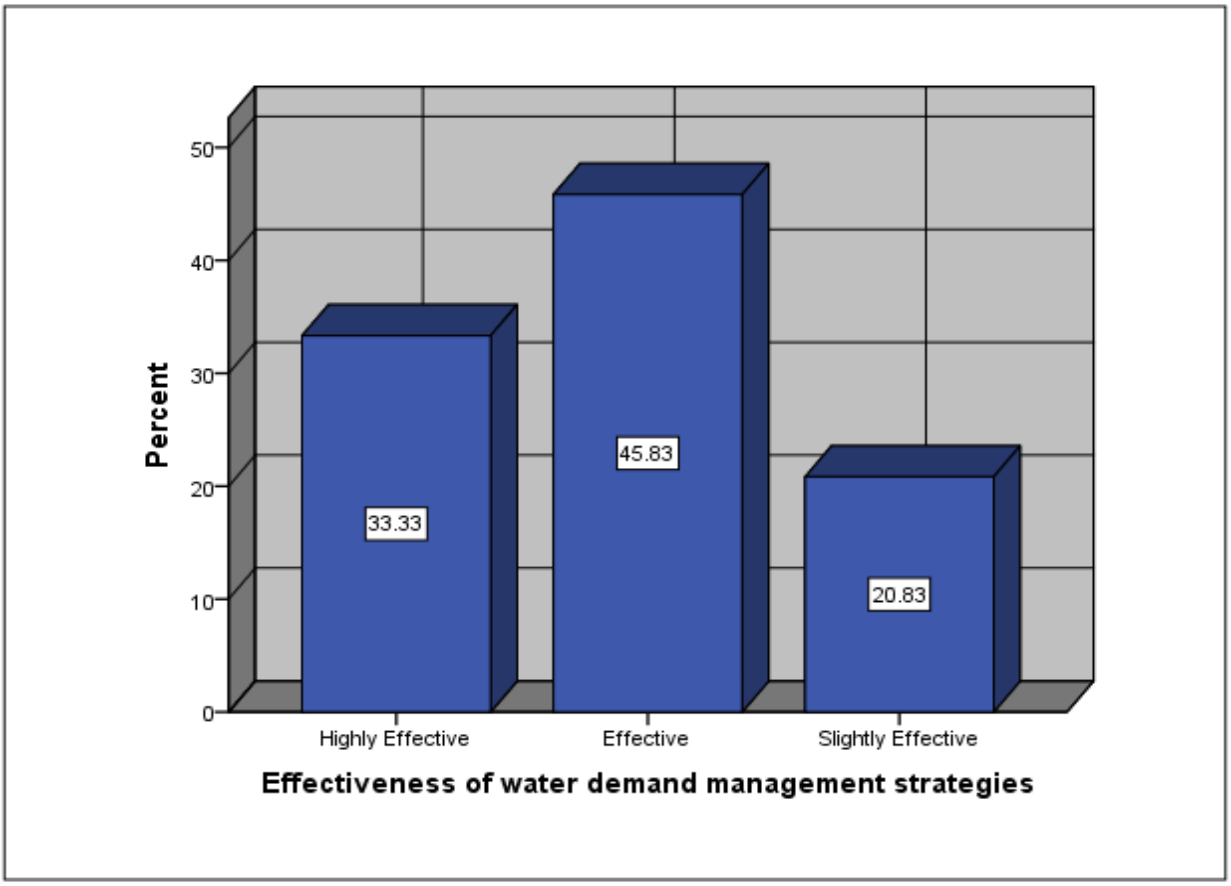
Source: Field Survey, 2014

Figure 11: Sustainable Business Practices

The study revealed a number of sustainable business practices in place that complement water demand management strategies implementation.The respondents were posed with questions relating to sustainable business practices and the responses ranked as illustrated in Figure 11 above.46 % of the respondents had a formal policy on water use and management which was guiding water strategies within the business function.complementary to this,46% of the respondents also indicated that they have a strategy plan for water management. 42% of the respondents regularly monitor their water use practice in order to make effective management changes as and when needed to.

The study also found out that 46% of the respondents regularly report their sustainable business performance to external stakeholders whereas only 38% report the same to their employees. The reporting is critical in ensuring that there is continual improvement and some measure of accountability within the company towards sustainable water use.Only 8% of the respondents had introduced water saving measures in all departments within their company.Overall the above figures indicate that there is still room for more to be done as regards sustainable business practices.

5.3.3 Effectiveness of Water Demand Management Strategies



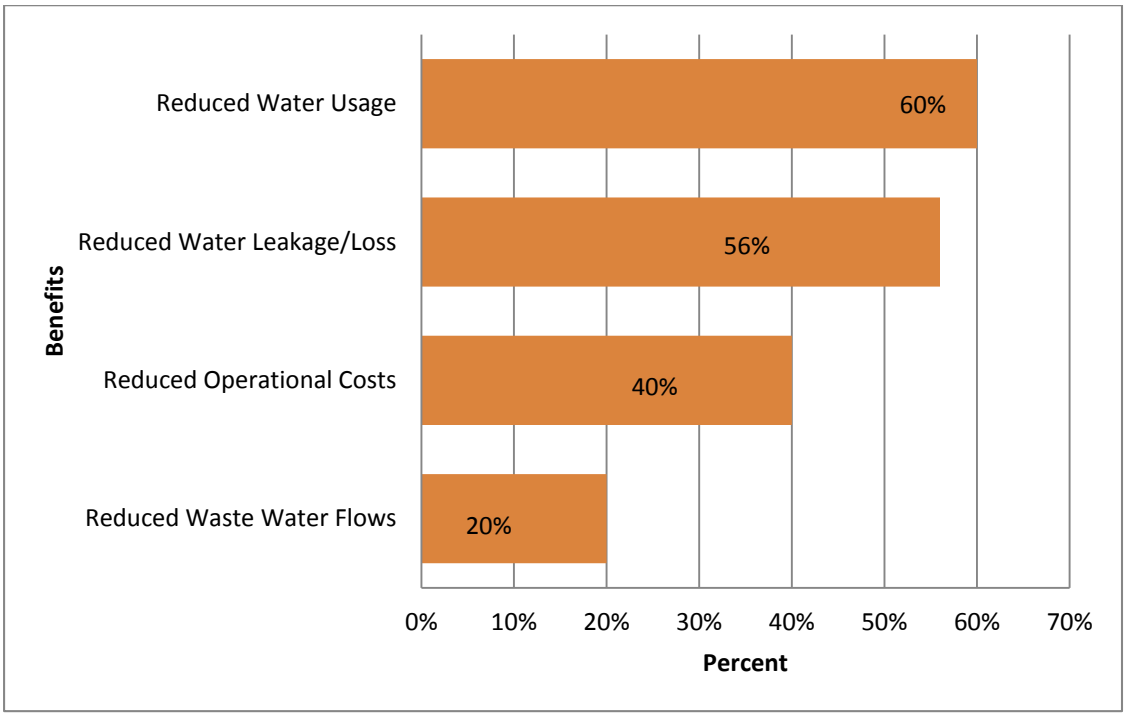
Source: Field Survey, 2014

Figure 12: Effectiveness of Water Demand Management Strategies

Of the 80% of industries and commercial enterprises that utilise water demand management strategies,they termed the effectivensss of those measures as illustrated in Figure 12.From the above figures it is thus clear that water demand management is effective in business operations

and therefore beneficial to the business community ,natural environment and the society at large in terms of sustainability.

5.3.4 Benefits of Applying Water Demand Management Strategies

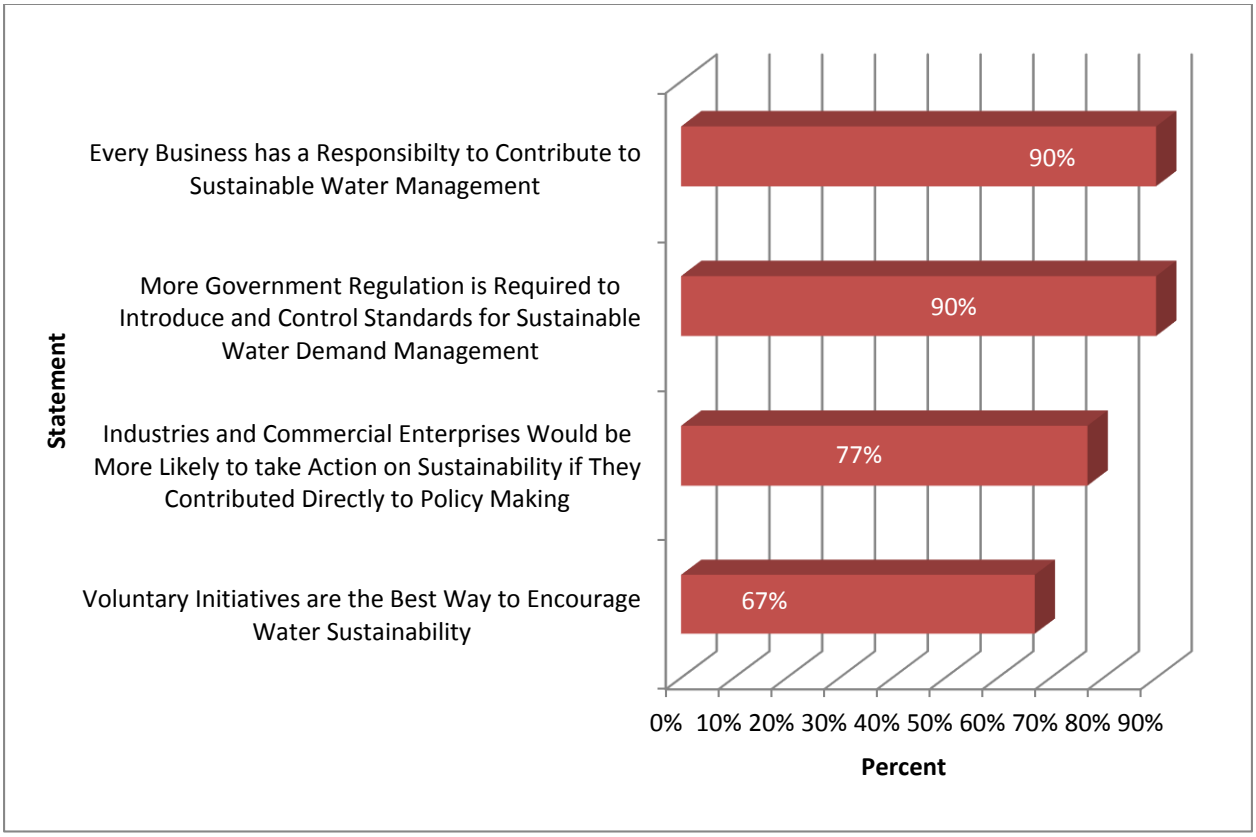


Source: Field Survey, 2014

Figure 13: Benefits of Applying Water Demand Management Strategies

The benefits that accrue from applying water demand management strategies on the daily operations of industries and commercial enterprises are as shown in Figure 13 above.Reduced water usage was the top most benefit at 60% whereas the lowest was reduced waste water flows at 20%.Few companies are currently benefiting by having their waste flow reduced,this is because recycling and reclaiming of water are the least practiced water demand management strategies in Athi River Town.The maximum potential of water demand management is thus yet to be achieved in Athi River Town.There is thus potential to explore more water demand management strategies that will propel the town towards continued industrial growth while at the same time ensuring environmental sustainability.

5.3.5 Attitudes towards Responsibility for Water Management



Source: Field Survey, 2014

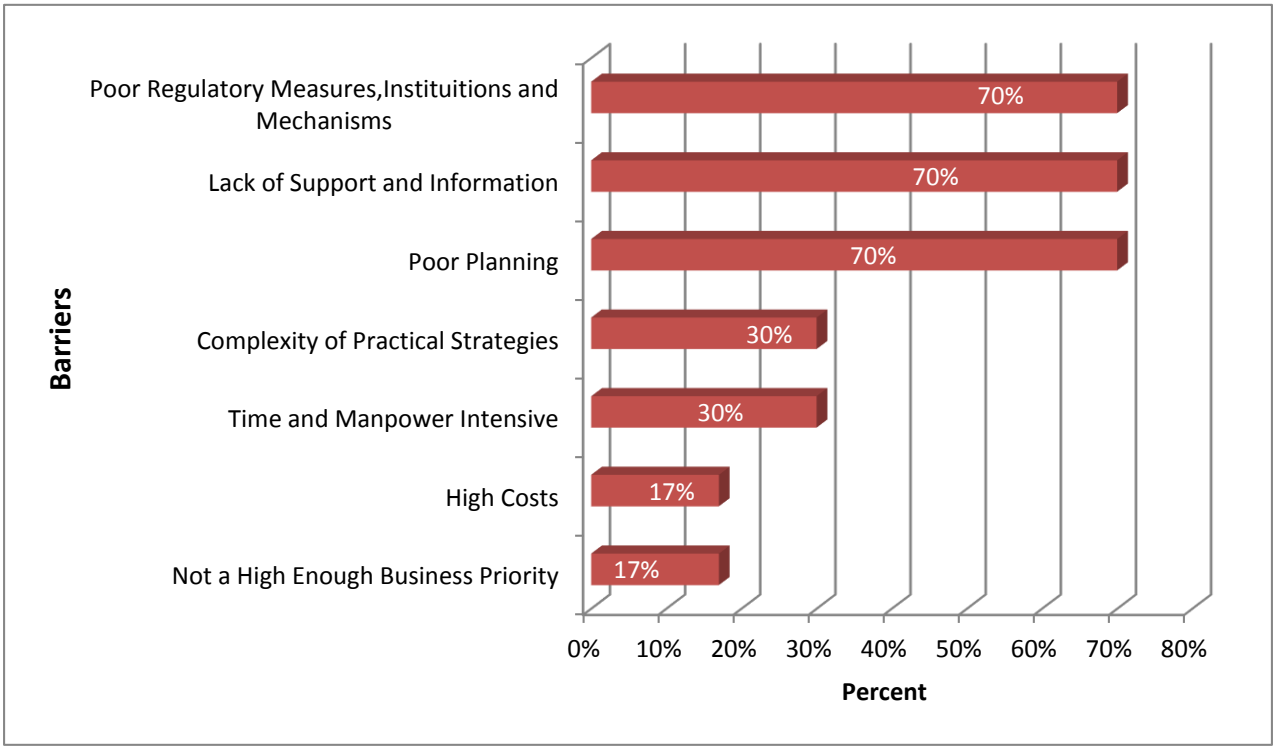
Figure 14: Attitudes towards Water Management

The adoption of water demand management strategies is largely dependent on the top and middle level management of the company.This study therefore found out that 90% of the respondents agree that every business has a responsibility to contribute to sustainable water management(See Figure 14).This is encouraging since it reflects the willingness of the stakeholders to preserve and conserve the enviornment while at the same time providing much needed goods and services.Asked whether more government regulation is required to introduce and control standards for sustainable water demand management,90% of the respondents agreed with the statement.(See Figure 14)

77% of the respondents were of the view that industries and commercial enterprises would be more likely to take action on sustainability if they cintributed directly to policy making. (See Figure 14).This indicates that there needs to be more concerted efforts by the government to

bring all relevant stakeholders on board.67% of the repsondents agreed that voluntary initiatives are the best way to encourage water sustainability. (See Figure 14).This was also confirmed by MAVWASCO who indicated that adoption of water demand technologies is largely dependent on the management of the industries since there is no exclusive control of the indsutrial processes by external stakeholders.

5.3.6 Barriers to Effective Implementation of Water Demand Management Strategies



Source: Field Survey, 2014

Figure 15: Barriers to Effective Implementation of Water Demand Management

Effective water demand management faces many challenges in its implementation. As indicated in Figure 15, the respondents identified poor regulatory measures, institutions and mechanisms as the top most barriers followed by lack of support and information and poor planning. At the bottom of the list were high costs and not a high enough business priority. From the above it is clear that the business community is willing to adopt and apply water demand management measures however they feel they lack the necessary environment in terms of effective policy, legislation and support and information from stakeholders such as the government and development partners.

CHAPTER SIX

SUMMARY OF THE FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Summary of the Findings

The study was assessing water supply and demand in industries and commercial enterprises in Athi River Town. The objectives that informed the study included review of legislature, policies and institutional framework governing water demand management, assessing the water supply and demand situation, examining the current water demand management strategies applied at industries and commercial enterprises and suggesting measures to improve the water supply deficit in relation to industries and commercial enterprises operating in Athi River Town. In carrying out the study, questionnaires and interview schedules were used to collect the data which was then analysed descriptively using SPSS software and the results presented using measures of central tendency. The findings of the study are summarized below;

6.1.1 Legal, Policy and Institutional Framework

There are several sectoral legislations concerned with water management, the main one being the water act. The water act, 2002 separated water resource management and water service provision and thereby established various institutions to run the affairs of water. This however is yet to yield results especially in relation to the application of water demand management. The current water policy and legislature is effective in issuing water permits and licenses to interested developers but it is weak in controlling how the water is used once it is connected to a business premise. Furthermore the water act to a large extent focuses on the water catchment areas but not at the user point which in this case is the industries and commercial enterprises. There are no fines provided in these legislations to deter water wastage and encourage sustainability.

EMCA 1999 provides for environmental audits to be conducted annually to ensure industries are not harming the environment. It is effective in ensuring waste water from industries is not discharged into the environment in a harmful manner; however it is weak in ensuring that industries and commercial enterprises adopt water demand management. The industries therefore solely control the amount of water they use and are not in any way obliged by the law to do so.

The Kenyan constitution recognizes the importance of ensuring sustainable exploitation, utilization, management and conservation of the environment and natural resources. It further decentralizes resources and powers to county level hence providing proper grounds for water management through the county integrated development plans. The county government therefore now has the opportunity to initialize proper urban planning as envisaged in the Urban Areas and Cities Act, 2011

6.1.2 Water Supply and Demand Situation in Industries and Commercial Enterprises in Athi River Town

Currently there is a huge water deficit in Athi River Town and MAVWASCO is currently only able to supply 60% of the water demand. Most of the industries and commercial enterprises sampled use alternative sources of water such as from boreholes. Close to half of the industries interviewed admitted to not receiving enough water.

The effect of the unreliable water supply has a negative impact on the business community by limiting their production capacity and increasing the cost of providing goods and services. Athi River being an industrial town must put water at the epicenter of management issues because water is a key factor of production and will determine the future of this town in terms of industrial growth and environmental sustainability.

The impact of the water deficit in the town hits mostly at the small and medium scale enterprises that are limited in their financial capability to explore alternative sources of water. The drilling of boreholes is the most common alternative however the expense of the drilling process may be beyond such industries. It is however worth noting that small and medium enterprises are also capable of coping better if they use the water sustainably and therefore avoid adverse impacts on their business performance. Large scale water dependent industries on the other hand have no option but to invest in the alternative sources. It is however disappointing that very few companies in the area recycle or reclaim water as an alternative supplement to the main water sources.

6.1.3 Water Demand Management Strategies Applied By Industries and Commercial Enterprises in Athi River Town

The water demand management strategies applied at the sampled industries and commercial enterprises are effective however much effort is still needed to increase the practice within the business community. The strategies range from as simple as metering and sub metering to the most complex such as recycling and reclaiming water. The adoption of such strategies is heavily dependent on the management team of the business entity. It is thus encouraging to note that most of the sampled respondents agreed that each business has a sole responsibility of ensuring water sustainability and that voluntary initiatives are the best way to achieving this.

Industries which have applied the water demand management strategies have benefited by reducing the volume of water used, reducing leakages and volume of waste water discharged. In the long run they have witnessed a reduction in the operational costs of the business. It is however worth noting that most of the industries are yet to achieve the maximum benefits of water demand management. This is because the level of implementation of the strategies is not yet at an advanced level especially in the case of large scale manufacturing companies there is a lot that can be borrowed and embraced from developed nations in terms of technology and best practice.

The adoption of the use of water specific policy plans, strategic plans and sustainable business reporting to employees and external stakeholders was below average. Such practices can encourage sustainable utilization of water and complement water demand management strategies. The lack of effective adoption of the above mentioned sustainable business practices is bound to be a major drawback towards sustainability and thus concerted efforts are needed by all relevant stakeholders to share best practices.

6.2 Conclusion

Industries and commercial enterprises in Athi River Town are currently being faced by a water deficit. This situation necessitates upon them to explore alternative and sustainable business practices such as water demand management so as to cope with the situation.

The town being industrial in nature has witnessed the adoption of some strategies of water demand management although much still needs to be done by all relevant stakeholders to promote efficient use of the scarce water resources.

The town is bound to benefit tremendously if water security is achieved through effective use of current water sources and by exploring alternative sources especially those that reduce waste water volumes such as recycling and reclaiming.

6.3 Recommendations

6.3.1 Short Term Recommendations

- Implementing water reuse practices by promoting the application of alternative sources of water through recycling and reclaiming of water and providing users with guidance for optimization. This will reduce the reliance on main water sources.
- Encouraging industries to replace water intensive technologies by introducing water saving technologies and practices. This will have a huge impact in terms of reducing waste water and by extension reducing the water demand.
- Issuing of water permits to industries for borehole digging should be well regulated and should be reviewed depending on the efficiency of water use within a specific company. This will reduce water wastage and encourage sustainable use of water within systems and process.
- Education and awareness creation on WDM, water sustainability and industrial growth targeting key industries having the biggest impacts. This will be instrumental in sharing best practices and streamlining the industries towards maximum water efficiency.
- Improved water management practices; control of water consumption, technologies and sustainable business reporting. This will promote accountability of the industries to stakeholders and investors in the water sector.

- Promotion of industrial ecology principles as the norm rather than the exception. In this sense the business community should act as stewards of the environment as opposed to masters. Effective public private partnerships are thus required to make this possible.
- Provision of financial and technological support to the industries and commercial enterprise as an incentive to promote the adoption of water demand management strategies.
- Continuous capacity building for the various water institutions to be carried out on a phased basis. This will assist in effectively implementing water strategies and regulating the water sector.
- Information management is one of the most important technical issues for water demand management and especially for integrated water resources planning. Adoption of a good information system that will be instrumental in highlighting water wastage and inefficiency is therefore proposed. Typical information management tools include databases, bespoke computer models, and general strategies for managing data and information.

6.3.2 Long Term Recommendations

- Policy Review; need for review of the Water Act to address the identified weaknesses. The main areas include; regulation and control of water use practices towards sustainability, empowering water institutions and giving them power to enforce the adoption of water demand management.
- Encouraging/increasing adoption of alternative sources of water; Rain water harvesting, recycling and reclaiming.
- Enhanced integrated management of water as a resource to address the issue of water resource depletion. Integrating demand management options into water resources plans and long-term operational and investment plans.
- An integrated water demand management plan for Athi River Town to be prepared specifying clear roles of the various stakeholders and how these roles are to be effectively coordinated.
- The use of computer controlled management systems by MAVWASCO for leak detection and combating fraudulent meter by passing.

6.4 Areas for Further Studies

- Modeling Industrial water demand and Supply in Athi River Town.
- Business vs. Environment: Exploring the potential of Industrial Park Concept in the industrial Town of Athi River.
- The Economics of industrial water demand management in Athi River Town.

PLANNING MATRIX FOR INDUSTRIAL AND COMMERCIAL WATER DEMAND MANAGEMENT IN ATHI RIVER TOWN

Objectives	Planning Issue	Strategies	Activities	Time Frame			Actors
				Short	Medium	Long	
To review policy, legislation and institutional framework governing water use for industrial and commercial development in Kenya	• Ineffective policy, legal and institutional framework in the water and industrial sector	• To promote a well coordinated industrial sector	• Developing a National Industrialization Act • Establishing a National Industrial Development Commission	✓ ✓			MOIED MOIED
		• To promote a well coordinated water sector	• Review of water act 2002 to focus on demand side options		✓		MOEWNR Private sector County government National government
		• To encourage environmental sustainability	• Developing a National Cleaner Production Policy		✓		MOIED MOEWNR NEMA Private sector

	• Inadequate private and public dialogue	• To establish an inclusive private public dialogue	• Form a coordinating structure that is transparent	✓		✓	National government County government MOEWNR MOIED Private sector
			• Promote the Public-Private-Partnerships in generation and distribution of water including water harvesting, storage and recycling	✓			MOEWNR NEMA Private Sector County government
To assess water supply and demand in industries and commercial enterprises in Athi River Town	• Inadequate and unreliable water supply	• To ensure adequate and affordable water to industrial and commercial sector	• Fast track the expansion and diversification of water generation sources in a cost effective manner		✓		MOEWNR KIRDI Universities Private Sector MAVWASCO

		• To reduce frequency of water rationing	• Separate water feed for industrial consumers from water feed for residential use to increase reliability especially during times of rationing		✓		MOEWNR KIRDI Universities Private Sector MAVWASCO County government
	• High water tariffs	• To make the price of water more economical	• Providing preferential water tariffs for industrial consumers in key industries		✓		MOEWNR NEMA Private Sector
	• Poor water quality	• To provide alternative water sources	• Conducting research and sharing of best practices	✓	✓		MOEWNR Universities KIRDI
	• Increasing water demand and over reliance on traditional sources of water	• To encourage sustainable use of water and diversification of sources	• Conducting research and sharing of best practices	✓	✓		MOEWNR Universities KIRDI Private sector

To examine water demand management strategies applied by industries and commercial enterprises in Athi River Town	• Lack of adoption of appropriate technologies	• To encourage environmental sustainability	• Promoting investment in local manufacturing of cleaner production equipment along with other emerging technologies	✓			MOIED NEMA Private Sector County government
		• To increase volume of waste water being managed	• Providing incentives for recycling and reclaiming of water	✓		✓	MOEWNR NEMA Private Sector
		• To increase certification capacity	• Strengthening capacity for technology certification and adoption		✓	✓	KIRDI NCST MOIED Universities Private Sector
	• Poor partnerships and lack of collaboration between institutions	• To increase collaboration and partnerships	• Formulating mechanism to facilitate collaboration with the private sector in research, technology and development	✓	✓		KIRDI NCST MOIED Universities Private Sector

	• Lack of support and information	• To increase industrial production and promote water use sustainability	• Establishing an industrial information database	✓	✓	✓	KIRDI NCST MOIED Universities Private Sector

REFERENCES

ABIWSI (2007). *Water Utilization in African Beverage Industries: Current Practices and Prospects.* ARSCP & UNEP

Bhatia, R., Rogers, P., Briscoe, J., Sinha,B. and Cestti,R. (1994),*'Water conservation and pollution control in Indian industries: how to use water tariff, pollution charges and fiscal incentives'*, Currents, UNDP-World Bank, Water and Sanitation Programme.

Bossel,H.(1999). *Indicators for Sustainable Development: Theory, Method, Applications. A Report to the Balaton Group*. International Institute for Sustainable Development (IISD).Canada

Braden, R. and William, E. (1994*). Understanding Industrial Ecology from a Biological Systems Perspective.* Total Quality Environmental Management, Vol. 3, No. 3, pp. 343-354.

Burström, F. (2000).*Environment and Municipalities. Towards a Theory on Municipal Environmental Management.* Stockholm, Royal Institute of Technology, Division of Industrial Ecology

Charles & Baker. (2011). *ESIA Study report for the Proposed Edible Oil Refinery And Fraction Packing Shortening And Soap Plant* On L.R No. 12648 /8 In Athi River, Mavoko Municipality. Golden Africa Kenya Ltd

Chimba, S.W. (2009).*Hydrological survey and borehole sitting*: aqua well services

CIA World Fact book (2013).*Kenya Freshwater withdrawal (domestic/industrial/agricultural).* Retrieved December 7, 2013, from: https://www.cia.gov/library/publications/the-world-factbook/geos/ke.html

Commission for sustainable development (CSD) (2005). *Making Water a Part of Economic Development: The Economic Benefits of Improved Water Management and Services*. A report commissioned by the Governments of Norway and Sweden. Retrieved December 7,2013fromhttp://www.unwater.org/downloads/CSD_Making_water_part_of_economic_development_2005.pdf

Commonwealth (1991).Sustainable development: *An imperative for environmental protection.* Report by a group of experts on environmental concerns and the commonwealth. Economic Affairs Division. Commonwealth secretariat. Paul Mall. London

Cooper, R., & Schindler, P. (2008).*Business Research Methods* (7th ed.).New York, USA: McGraw-Hill Companies

ECA (2006).*Water in Africa: Management options to ensure survival and growth*. NEPAD and Regional Integration Division (NRID), ECA.

Erkman, S. (2001).*Industrial Ecology: A New Perspective on the Future of the Industrial System*. Institute for Communication and Analysis of Science and Technology (ICAST), Geneva, Switzerland

Erkman, S and Ramaswamy, R. (2001.) *Applied Industrial Ecology: Leveraging the Wealth of Societies.* Case Studies on Resource Optimization in India. Geneva & Bangalore, ICAST

FAO (2009).*AQUASTAT* Database. Food and Agricultural Organization of the United Nations. Retrieved November 17, 2013, from http://www.fao.org/nr/aquastat

Goldar, B. and Pandey, R. (2001), *'Water pricing and abatement of industrial water pollution: study of distilleries in India',* Environmental Economics and Policy Studies, 4: 95-113

Global Water Partnership (2011).*Technical focus paper 1, water demand management*: The Mediterraneanexperiencehttp://www.gwp.org/Global/The20Challenge/Resource20material/gwp_tech_focus.pdf

Kothari, C.R. (2004).*Research Methodology: Methods and Techniques*. New Age International (P) Ltd Publishers. New Delhi

Kumar, S. (2008). *Analyzing Industrial Water Demand in India*: An Input Distance Function Approach

MAVWASCO. (2008).*Strategic Plan for 2008-2013*.Mavoko Water and Sewerage Company

Mbegera,O.M.(2010).*EIA report for the proposed low income residential area*, Athi River. Nairobi: Sunset Boulevard Ltd

Merrett, S. (1997). *Introduction to the Economics of Water Resources,* London: Routledge.

Mugenda, O and Mugenda, A. (2003) *Research methods: Quantitative and qualitative Approaches*. Acts Press Pg 41-95.Nairobi, Kenya

Mumma, A. (2005). *African Centre for Technology Studies, Kenya's New Water Law: An Analysis of the Implications for the Rural Poor*. Retrieved January 4, 2014 from http://www.nri.org/projects/waterlaw/AWLworkshop/MUMMA-A.pdf

Muthama, G.K. (2012).*EIA Report for the Proposed Petrol Filling Station* On Plot No L.R 337/2311 & 2312 Athi River.

Nassiuma, D.K. (2000) *Survey sampling: Theory and methods.* Nairobi: University of Nairobi Press

Njoroge, N.K.B. (2011). *ESIA Study report for the proposed Athi River 81MW power*, Athi River. Triumph Power Generating Company Ltd

Ogendi, G., Ongo'a, I. (2009).*Water Policy, Accessibility and Water Ethics in Kenya*. Santa Clara Journal of International Law. Vol 7.Retrieved January 5, 2014 from http://digitalcommons.law.scu.edu/scujil/vol7/iss1/3

PricewaterhouseCoopers. (2001). *Water: A World Financial Issue – a Major Challenge for Sustainable Development in the 21st Century*. Sustainable Development Series. Paris

Renzetti, S. (2002) *The Economics of Water Demands*, Boston: Kluwer Academic Publishers.

Republic of Kenya (2012). *County Governments Act,2012,* Government Printers, Nairobi, Kenya

Republic of Kenya (2011a). *National Industrialization Policy Framework, Final Draft*, Government Printers, Nairobi, Kenya

Republic of Kenya (2011b). *Urban Areas and Cities Act, No.13 of 2011*, Government Printers, Nairobi, Kenya

Republic of Kenya (2010a). *The Constitution of the Republic of Kenya,* Government Printers, Nairobi, Kenya

Republic of Kenya (2010b).*The 2009 Population and Housing Census*, Kenya National Bureau of Statistics, Nairobi

Republic of Kenya (2009): *District Environmental Action Plan 2009-2013-Machakos District*. Government Printers, Nairobi, Kenya

Republic of Kenya (2006). *Environmental Management and Coordination (Water Quality) Regulations, 2006,* Government Printers, Nairobi, Kenya

Republic of Kenya (2002a): District Development Plan 2002-2008-*Machakos District.* Government Printers, Nairobi, Kenya

Republic of Kenya (2002b). *Water Act, No. 8 of 2002*, Government Printers, Nairobi, Kenya

Republic of Kenya (2000).*The 1999 Population and Housing Census*, Kenya National Bureau of Statistics, Nairobi

Republic of Kenya. (1999).*Environmental Management and Co-ordination Act (EMCA), Act No.8 of 1999,* Government Printers, Nairobi, Kenya

Republic of Kenya (1997): *District Development Plan 1997-2001-Machakos District.* Government Printers, Nairobi, Kenya

Republic of Kenya (1996). *Physical Planning Act, No. 6 of 1996,* Government Printers, Nairobi, Kenya

Spulber, N. and Sabbaghi, A. (1994) *Economics of Water Resources: From Regulation to Privatisation*, Boston: Kluwer Academic Publishers.

Statoids (2010, June 11).statoids.com-*Districts of Kenya*. Retrieved October 17, 2013, from Wikimedia foundation,Inc:http://www.wikimidiafoundation.statoids.districtsofkenya.com

TANATHI. (2011). *Mavoko Water and Sewerage Project under Public Private Partnership (PPP).*Ministry of Water and Irrigation

Thuku, W.P. (2011).*EIA report for the proposed Housing Estate on* Plot L.R No. 12715/448, Mlolongo Area in Mavoko Municipality, Athi River. Nairobi: Green Eco Consultants Limited

UNEP 2012. *The UN-Water Status Report on the Application of Integrated Approaches to Water Resources Management*. Division of Communications and Public Information, Nairobi, Kenya

UNEP. (2010) *"Africa water Atlas".* Division of Early Warning and Assessment (DEWA).United Nations Environment Programme (UNEP).Nairobi. Kenya

UNEP (2006) .*Fresh water shortage.* Retrieved December 7, 2013 from http://www.unep.org/publications/finalreport/freshwater_shortage.pdf

UNESCO (2006).The 2nd UN World Water Development Report: "*Water a Shared Responsibility" Section 5-sharing responsibilities, case study Kenya.* United Nations Education, scientific and cultural organization. Retrieved November 17, 2013, from http://www.unesco.org/water/wwap/wwdr2/table_contents.shtml

Wamwangi, E. (2010).*Geology and hydrogeology report*. Nutek solutions

Waswa, F., Otor, S., Olukoye, G and Mugendi, D. (eds) 2007.*Environment for Sustainable Development. A Guide for Higher Education in Kenya,* Volume 2.School of Environmental Studies and Human Science, Kenyatta University

WBCSD. (2005).*Facts and trends:* Water. World Business Council for Sustainable Development (WBCSD) secretariat

Worthington, C.A. (2010). *Commercial And Industrial Water Demand Estimation*: Theoretical and Methodological Guidelines for Applied Economics Research. Griffith University

APPENDICES

Appendix 1

QUESTIONNAIRES

KENYATTA UNIVERSITY

SCHOOL OF ENVIRONMENTAL STUDIES

DEPARTMENT OF ENVIRONMENTAL PLANNING AND MANAGEMENT

QUESTIONNAIRE FOR INDUSTRIES AND COMMERCIAL ENTERPRISES

This questionnaire is meant to collect data for a Master of Environmental Planning and Management Project by Brian Jaoko. Information given will be treated with confidentiality and used for academic purpose only.

Section 1: Background Information

1. Indicate your designation

(i) Owner/Manager [ ] (ii) Technical and operations [ ] (iii) Support staff [ ]

2. Name of Business……

3. Nature of Business……

4. What is your business size classification? (i) Small [ ] (ii) Medium [ ] (iii) Large [ ]

5. How long has the business been operating?.....(Please indicate year of business opening)

6. How many employees does the Business have?

GENDER	NUMBER
MALE	
FEMALE	
TOTAL	

7. Age of employees

AGE BRACKET (YEARS)	NUMBER
18 – 35	
36 – 55	
56 and above	

Section 2: Water Supply and Demand in Industries/Commercial Enterprises

8. What is/are the source/s of water for your business? **(OBJ 2)**

.....

9. For which processes or activities do you use water in your business? **(OBJ 2)**

……

10. What is your average daily water consumption? **(OBJ 2)**

……

11. a) Do you receive enough water for your daily business activities? (i) Yes [ ] (ii) No [ ]

b) If No, how has this affected your business operations? **(OBJ 2)**

……..

12. a) Is the price you pay for water sustainable and economical for your business? (i) Yes [ ] (ii) No [ ] **(OBJ 2)**

b) If No, how has this affected your business operations? **(OBJ 2)**

……

13. What are the problems you encounter in accessing water? **(OBJ 2)**

……

Section 3: Water Demand Management Strategies at Industries/Commercial Enterprises

14. Do you apply any water demand management strategies in your business? **(OBJ 3)**

(i) Yes [ ] (ii) No [ ]

14. b) If yes, please fill in the table below **(OBJ 3)**

No.	**Water demand management strategies**	Yes	No	Partly
(i)	Reticulation leakage detection and repair programs			
(ii)	Regulation of the efficiency of water using appliances			
(iii)	Use of reclaimed water (e.g. waste water/grey water) to reduce the need for fresh water supplies			
(iv)	Recycling of water			
(v)	Water audits			
(vi)	Engaging, training and informing employees on best practices			
(vii)	Metering and sub metering			

15. Please respond to the following statements. (Tick one box only for each statement). **(OBJ 3)**

No.	Business Practices	Yes	No	Partly
(i)	The business has a formal policy on water use and management			
(ii)	We have clearly defined indicators and a strategy plan for water management			
(iii)	We regularly monitor our water use practices			
(iv)	We regularly report our sustainable business performance to our employees			
(v)	We regularly report our sustainable business performance to external stakeholders, such as guests, investors, community			
(vi)	Introduced water-saving measures in all departments			

16. How would you term the effectiveness of water demand management strategies in your business? **(OBJ 3)**

(i) Highly Effective [ ] (ii) Effective [ ] (iii) Slightly Effective [ ] (iv) Not Effective [ ] (v) Not Sure [ ]

17. What are some of the benefits of applying water demand management that you have experienced in your business? **(OBJ 3)**

(i) Reduced water usage [ ] (ii) Reduced water leakage/loss [ ] (iii) Reduced waste water flows [ ] (iv) Reduced operational costs [ ] (v) Any other (Please specify)

……

Section 4: Attitudes towards Responsibility for Water Management

18. Indicate the extent to which you agree with each of the following statements. Use the key below to give your answers. Put a tick on the appropriate column. **(OBJ 3)**

SA: Strongly Agree A: Agree U: Undecided D: Disagree SD: Strongly Disagree

No.	Statement	SA	A	U	D	SD
(i)	Every business has a responsibility to contribute to sustainable water management					
(ii)	More government regulation is required to introduce and control standards for sustainable water demand management					
(iii)	Voluntary initiatives are the best way to encourage water sustainability in industries and commercial enterprises					
(iv)	Industries and commercial enterprises would be more likely to take action on sustainability if they contributed directly to policy making					

Section 5: Barriers to Effective Water Demand Management Strategies

19. Indicate the extent to which you agree with each of the following statements. Use the key below to give your answers. Put a tick on the appropriate column **(OBJ 3)**

SA: Strongly Agree A: Agree U: Undecided D: Disagree SD: Strongly Disagree

No.	Main obstacles for implementing water demand management strategies are:	SA	A	U	D	SD
(i)	The high costs which make the implementation commercially not worthwhile					
(ii)	Their complexity which cannot be translated into practical strategies					
(iii)	Lack of support and information					
(iv)	Poor planning					
(v)	Too much time and manpower intensive in every day operations					
(vi)	Not a high enough business priority					
(vii)	Poor regulatory measures, institutions and mechanisms					

20. In view of the above barriers what are some of the recommendations you would give as a stakeholder in Industrial development in Athi River town? **(OBJ 4)**

……
……

END

THANK YOU

Appendix 2

KENYATTA UNIVERSITY

SCHOOL OF ENVIRONMENTAL STUDIES

DEPARTMENT OF ENVIRONMENTAL PLANNING AND MANAGEMENT

INTERVIEW SCHEDULE FOR MAVOKO WATER AND SANITATION COMPANY

This schedule is meant to collect data for a Master of Environmental Planning and Management Project by Brian Jaoko. Information given will be treated with confidentiality and used for academic purpose only.

Q1.What is MAVWASCO's role and mandate in relation to water supply and demand management in Athi River Town? **(OBJ 1) (OBJ 2)**

Q2.Please comment on the current water supply and demand balance in Athi River Town **(OBJ 2)**

Q3.Please describe the current pattern of water consumption in industries and commercial enterprises **(OBJ 2)**

Q4. In what ways and to which extent do you work with industries and commercial enterprises in Athi River Town to ensure water sustainability? **(OBJ 1)**

Q5.Please comment on the adoption of water demand management strategies by industries and commercial enterprises in Athi River Town **(OBJ 3)**

Q6.What are some of the challenges that industries and commercial enterprises in Athi River Town face in relation to the implementation of water demand management strategies? **(OBJ 3)**

Q7**.**What are some of the initiatives and projects that have been put in place to address water supply and demand in Athi River Town? **(OBJ 2)**

Q8.How effective is the above mentioned initiatives? **(OBJ 2)**

Q9.Please comment on the way forward in terms of ensuring environmental sustainability and industrial growth in respect to water management amongst industries and commercial enterprises in Athi River Town **(OBJ 4)**

THANK YOU

Appendix 3

KENYATTA UNIVERSITY

SCHOOL OF ENVIRONMENTAL STUDIES

DEPARTMENT OF ENVIRONMENTAL PLANNING AND MANAGEMENT

INTERVIEW SCHEDULE FOR ENVIRONMENT OFFICER, MAVOKO MUNICIPALITY

This schedule is meant to collect data for a Master of Environmental Planning and Management Project by Brian Jaoko. Information given will be treated with confidentiality and used for academic purpose only.

Q1.What is Mavoko Municipality's role and mandate in relation to water supply and demand management in Athi River Town? **(OBJ 1) (OBJ 2)**

Q2.Please comment on the current water supply and demand balance in Athi River Town **(OBJ 2)**

Q3.Please describe the current pattern of water consumption in industries and commercial enterprises **(OBJ 2)**

Q4. In what ways and to which extent do you work with industries and commercial enterprises in Athi River Town to ensure water sustainability? **(OBJ 1)**

Q5.Please comment on the adoption of water demand management strategies by industries and commercial enterprises in Athi River Town **(OBJ 3)**

Q6.What are some of the challenges that industries and commercial enterprises in Athi River Town face in relation to the implementation of water demand management strategies? **(OBJ 3)**

Q7**.**What are some of the initiatives and projects that have been put in place to address water supply and demand in Athi River Town? **(OBJ 2)**

Q8.How effective is the above mentioned initiatives? **(OBJ 2)**

Q9.Please comment on the way forward in terms of ensuring environmental sustainability and industrial growth in respect to water management amongst industries and commercial enterprises in Athi River Town **(OBJ 4)**

THANK YOU

Appendix 4

KENYATTA UNIVERSITY

SCHOOL OF ENVIRONMENTAL STUDIES

DEPARTMENT OF ENVIRONMENTAL PLANNING AND MANAGEMENT

INTERVIEW SCHEDULE FOR GOVERNOR'S OFFICE, COUNTY GOVERNMENT OF MACHAKOS

This schedule is meant to collect data for a Master of Environmental Planning and Management Project by Brian Jaoko. Information given will be treated with confidentiality and used for academic purpose only.

Q1.What is Machakos County Government's role and mandate in relation to water supply and demand management in Athi River Town? **(OBJ 1) (OBJ 2)**

Q2. In what ways and to which extent do you work with industries and commercial enterprises in Athi River Town to ensure water sustainability? **(OBJ 1)**

Q3.Please comment on the adoption of water demand management strategies by industries and commercial enterprises in Athi River Town **(OBJ 3)**

Q4. Please comment on the legal, policy and institutional framework for water management in Machakos County **(OBJ 1)**

Q5. Do you have a County specific plan/policy for the management of water within Machakos County? **(OBJ 1)**

Q6. To what extent do political considerations affect the management of water as a resource within Machakos County? **(OBJ 1)**

Q7.Please comment on the way forward in terms of ensuring environmental sustainability and industrial growth in respect to water management amongst industries and commercial enterprises in Athi River Town **(OBJ 4)**

THANK YOU

Appendix 5

KENYATTA UNIVERSITY

SCHOOL OF ENVIRONMENTAL STUDIES

DEPARTMENT OF ENVIRONMENTAL PLANNING AND MANAGEMENT

INTERVIEW SCHEDULE FOR NATIONAL CHAMBER OF COMMERCE AND INDUSTRY

This schedule is meant to collect data for a Master of Environmental Planning and Management Project by Brian Jaoko. Information given will be treated with confidentiality and used for academic purpose only.

Q1. What are National chamber of commerce and industry's role and mandate in relation to water supply and demand management in industries and commercial enterprises in Athi River Town? **(OBJ 1)**

Q2. What are the economic contributions of industries and commercial enterprises to the development of Athi River Town? **(OBJ 1) (OBJ 2)**

Q3. In what ways and to which extent do you work with industries and commercial enterprises in Athi River Town to ensure sustainable industrial growth? **(OBJ 1)**

Q4. Please comment on the legal, policy and institutional framework for industrial management in Kenya **(OBJ 1)**

Q5.What are the issues constraining or enhancing the development of industries and commercial enterprises in Athi River Town? **(OBJ 2)**

Q6.What are the alternative opportunities for investment that can promote sustainable water management in industries and commercial enterprises in Athi River Town? **(OBJ 3)**

Q7.Please comment on the way forward in terms of ensuring environmental sustainability and industrial growth in respect to water management amongst industries and commercial enterprises in Athi River Town **(OBJ 4)**

Appendix 6

WORK PLAN

TIME / ACTIVITY	2013 SEP	OCT	NOV	DEC	2014 JAN	FEB	MAR	APR	MAY	JUN	JUL
Writing the concept	■	■									
Class presentation of concepts		■									
Identification of supervisors		■									
Consultation with supervisors and development Of proposals			■								
Presentation of proposals (departmental seminar)			■								
Correction of proposals and Refining of instruments			■								
Field data collection				■							
Writing of the research Project report					■	■					
Presentation of research project report(departmental seminar)							■				
Improvement of the project							■				
Submission of the signed project report for examination								■			
Examination of the research project									■		
Correction of the examined research project and final binding										■	
Final submission of hard bound project to the chairman,EPM for records											■