



**AN ASSESSMENT OF THE QUANTITY AND MICROBIOLOGICAL QUALITY OF
DOMESTIC WATER SUPPLY IN PERI-URBAN AREAS OF LUSAKA DISTRICT,
ZAMBIA.**

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DECLARATION

I **Lillian Mambwe Mutesu** do declare that this dissertation herein presented for the Degree of Masters of Public Health (Environmental Health) has not been previously submitted either wholly or in part for other Degree at this or any other University nor is it being currently submitted for any other Degree.

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ABBREVIATIONS/ACRONYMS

AMCOW	African Ministers Council on Water
CSO.....	Central Statistical Office
CUs.....	Commercial Utilities
DTF.....	Devolution Trust Fund
EU.....	European Union
LWSC.....	Lusaka Water and Sewerage Company
MLGH.....	Ministry of Local Government and Housing
NWASCO.....	National Water and Sanitation Council
WHO.....	World Health Organization
ZEMA.....	Zambia Environmental Management Agency

ABSTRACT

Introduction: Access to safe and clean water is important as a health and development issue at regional, national and local levels (World Health Organization, 2006). Throughout human history, the major health problems that humans have faced are concerned with community life such as control of transmissible diseases, and the provision of safe and clean water in sufficient supply (Rosen, 1993). The Romans, for instance, in spite of the remarkable achievement in public health engineering still had to cope with the problem of endemic and epidemic water-borne diseases such as typhoid fever and dysentery (Rosen, 1993).

Objectives of study: The main objective of the study was to determine the quantity and microbiological quality of household domestic water supply in peri-urban areas of Lusaka.

Methods and Materials: This was a cross-sectional analytical study. The sampling strategies used in drawing the sample population was by first establishing clusters according to constituencies and then followed by simple random sampling for the households. Lusaka has seven constituencies from which one peri urban area was selected giving a total of seven peri-urban areas to be included in the study. The peri urban areas randomly selected were Kanyama from Kanyama Constituency, Kalikiliki from Munali Constituency, Garden from Mandevu Constituency, Bauleni from Lusaka Central Constituency, Chunga from Matero Constituency, Jack from Kabwata Constituency, and Misisi from Chawama Constituency. From the selected areas, a number of households were randomly picked for inclusion in the study.

Data in this study was collected using a structured questionnaire for the households and an interview guide for interviews with the Lusaka Water and Sewerage Company.

Fourteen water samples were collected from each of the peri-urban areas and submitted to University of Zambia, School of Engineering, for bacteriological analysis. The analysis included faecal coliform, and total coliform. The water samples were collected from every second household interviewed.

Results: The findings of the study indicate that most of the people (above 90%) in the study areas have access to piped water, mostly from boreholes and water kiosks. However, despite this accessibility, the quantity of water used per person per day is between 20 liters to 60 liters. This finding is also supported by data obtained from the LWSC, which indicated similar quantities of domestic water per person per day. It however, does not meet the recommended daily supply of 150 – 200 liters of water per capita, which is what is considered an adequate supply to meet the needs for all urban domestic purposes as indicated by Park, 2007.

Further analysis of the results revealed that the average quantity of water used by a typical household was 91.42 litres per day with a median value of 100 litres per day, and ranged from 40 to 220 litres per day. Also, the per capita daily consumption of water per household on average is about 17 litres/person/day and ranges from 2.5 to 100 litres/person/day.

A total of 99 water samples were collected from the seven peri-urban areas in the sample collectively. These water samples were examined for Total and Faecal coliform. In the end, the levels of the two parameters were determined so that the quality of the water in each area and collectively could be determined. The table below, therefore presents the prevalence rates for the total and faecal coliform levels as well as the water quality state for the entire sample. As indicated, the majority (60.61%) of the water samples examined contained total coliform while about 53% contained faecal coliform.

Among the areas sampled, Chunga had more (10.1%) safe water samples followed by Garden (9.1%), then Kanyama and Jack with 7.1% each. The least among the seven areas was Bauleni with the water quality of all the water samples turning out to be unsatisfactory. An analysis to see whether there is an association between the area and quality of water, revealed a significant relation of the two variables at 5% level of significance with a Pearson Chi-square Test value of 702.9, with 6 degrees of freedom Sqaure and a p-value of 0.000.

A test for the association between source and quality of water revealed that a relationship exists between the two. The chi-square test assumes that the expected value for each cell is five or higher. This assumption in this case did not hold, as a result the Fisher's exact test was used to conduct a chi-square test as some cells had an expected frequency of five or less. The Fisher's exact test has no such assumption and can be used regardless of how small the expected frequency is. The Fisher's exact test indicated a statistically significant relationship between the source of water and quality ($p=0.000$).

The logistic regression model was employed to establish the factors that affect the households' choice to use a piped water source. Therefore, a dummy variable for the water source (1= piped water and 0=other sources) was used as the dependent variables. From among the variables included in the analysis, only the monthly income of the household was found to have a statistically significant effect on the probability of a household having a piped water source at 5% level of significance.

Another multiple regression model used showed that variables like sex of the head of the household, the household size and monthly income have a significant effect on the daily per capita usage of water at 10%, 1% and 5% significance levels respectively. The remaining variables had no statistically significant contribution in explaining the daily per capita water usage. Explicitly, looking at the regression coefficients for the three variables reveals that, the sex of the household head has a value of -3.34 implying that male-headed households will have lower daily per capita water usage than female-headed households. The coefficient for the monthly income was less than a percentage point but still has a positive relationship with the per capita water usage while unexpectedly the household size has a negative one with a beta value of -2.82.

Conclusion and Recommendations: From this study, it can be concluded that most residents (above 90%) of Lusaka's peri urban areas receive water from the Lusaka Water and Sewerage Company either from the main network or from the water kiosks that are operated in their residential areas. The quantities of domestic water received by the residents are, however, not adequate (20 – 60 litres per person per day). Another conclusion that can be drawn from the findings of this research is that most of the domestic water supplied to, and used by residents of the peri urban areas of Lusaka is not safe with 60.61% samples containing total coliform and 53% containing faecal coliform.

The following recommendations are, therefore, made to the Lusaka Water and Sewerage Company:

- The LWSC should improve/increase the quantities of domestic water supplied to the peri urban areas in order to increase the quantity of water accessed per person per day to meet the minimum requirement of 150 – 200 litres.
- The utility company should urgently install meters for water tap-off points to the peri urban areas to be able to account for the water supplied to these areas.
- The company should also ensure that on-line dozers of chlorine are always in working condition to ensure safety of the water supplied to the peri urban areas.
- The water samples for quality analysis should be taken more often in these areas to monitor quality of the water supplied
- The company needs to urgently implement the Water and Sanitation programs planned for Lusaka's peri urban areas to address the problem of on-site sanitation that has contributed to the contamination of the domestic water in these areas.

Recommendations made to the Ministry of Local Government and Housing are as follows:

- The Ministry should consider separating and increasing the funding for water supply and sanitation given to the LWSC so that each area will receive the due and adequate attention.
- The Ministry, through NWASCO, should from time to time take their own water samples for analysis to monitor and ensure that the residents of Lusaka receive safe water.

1.0 INTRODUCTION

1.1 BACKGROUND

Access to safe and clean water is important as a health and development issue at local, national and regional levels (World Health Organization, 2006). Throughout human history, the major health problems that humans have faced are concerned with community life such as control of transmissible diseases, and the provision of safe and clean water in sufficient supply (Rosen, 1993). The Romans, for instance, in spite of the remarkable achievement in public health engineering still had to cope with the problem of endemic and epidemic water-borne diseases such as typhoid fever and dysentery (Rosen, 1993).

Furthermore, each year, an estimated 2.5 billion cases of diarrhea occur among children under five years of age, with more than half of these cases occurring among populations in low-income regions of South-East Asia and sub-Saharan Africa (UNICEF/WHO, 2009).

a) Population Distribution

Zambia's population was first comprehensively recorded at 5.7 million in 1980. Since then, it has increased to 7.8 million in 1990, 9.9 million in 2000, and 13.01 million people in 2010. This gives an annual growth of 2.8 percent between 2000 and 2010; with Lusaka Province having the highest average population growth rate of 4.7 percent yearly (Central Statistical Office, 2011).

Zambia is one of the most urbanized countries in southern Africa with an average of 35 and 40 percent of the population living in urban areas, and an annual urbanization rate estimated at 2.3 percent between 2005 and 2010. The urban population has continued to rise disproportionately to available resources. This has led to failure by some urban authorities to provide services such as portable water to urban dwellers resulting in ill health. Similarly, poverty levels have also increased resulting in unplanned settlements that have mushroomed all over the cities. This has resulted in 72.7% of urban people to live below the poverty line with malnutrition rate at 46% (World Bank, 1994). In addition, unemployment rates are alarmingly high while the production sector has continued to shrink.

According to the Ministry of Local Government and Housing, the water supply and sewerage infrastructure in most urban areas of Zambia were constructed in the 1960's and 1970's and have since received inadequately maintenance that has led to dilapidation. The peri-urban areas in all of the Zambian towns have grown considerably in recent years, and most have poor water supply and sanitation (Ministry of Local Government, 2011).

b) Economic situation

Lusaka District is the second largest economic centre in Zambia after Copperbelt, and is notable for its substantial diversification in the production of goods and services. With respect to Central and Southern Provinces, Lusaka is economically very significant since it provides the market for the absorption of agricultural products from these areas. Manufacturing, financial, transport, and retail businesses are the most important industries in Lusaka. It is estimated that only 9 percent of the city's population is engaged in formal employment. A major reason for this is that the local economy has been drifting towards the private sector and self-employment since the liberalization of the economy in the early 1990s. Due to its location and the fact that it is the capital and seat of government, Lusaka plays a significant role in the socio-economic life of adjoining rural and urban areas: it provides a ready market for agricultural and other goods. The overwhelming majority of the economic establishments in the city fall within the wholesale and retail trade categories, which together represent the largest formal employer in Lusaka after the government (UN-HABITAT, 2007).

c) Health status

Lusaka has 34 government health institutions and about 134 registered private clinics and health centers. There are 31 clinics (health centers) and two major hospitals (University Teaching Hospital and Levy Mwanawasa General Hospital) managed by the District Health Board. Lusaka District is divided into eight health zones. The government states that the overall vision of health reforms is “to provide Zambians with equity of access to cost-effective, quality health care as close to the households as possible”. The main approach to implementation involves the decentralization to the district level of responsibility for essential functions. The strategic intent is to make services responsive to local needs and accountable to users.

For some time, the district priority areas have been malaria, reproductive and adolescent health, child health, tuberculosis and leprosy, sexually transmitted diseases, HIV/AIDS, environmental health, mental health, and supply of medicine. Current statistics indicate that the diseases in the above list are responsible for 90 percent of the health cases in the district. Quality health services are unaffordable for the majority of Lusaka residents (UN-HABITAT, 2007).

1.2 STATEMENT OF THE PROBLEM

Zambia’s urban population has continued to rise disproportionate to available resources. This has led to major challenges for the urban Local authorities to provide services such as portable water supply and appropriate sanitation to the residents, which has resulted in ill health. Similarly, poverty levels increased as unplanned settlements mushroomed all over the cities, with 72.7% of urban people living below the poverty line with the malnutrition rate standing at 46%. This is equally applicable to unemployment rates, which have reached an alarming level while the production sector has continued to shrink (World Bank, 1994).

Lusaka has over thirty-five (35) unplanned settlements, which are characterized by inadequate shelter, lack of essential services such as water supply and sanitation, and inadequate waste management, making the residents vulnerable to epidemics.

Water supply in Lusaka is highly fragmented with just about 30% of the population in peri-urban areas having access to piped water in their homes and yards. This is usually unreliable as many households go without portable water supply for several hours each day. The remaining 70% have to rely on a variety of water sources such as water kiosks, shallow wells

and deep wells to meet their daily needs, whose safety is not certain. In the majority of peri-urban settlements, the LWSC provides water via kiosks, which are mainly supplied from local boreholes. Water kiosks are run by community based organizations known as Resident Development Committees. However, water supplied via these kiosks is inadequate and erratic in most cases (Mulenga, 2011).

The link between the problem of attaining safe and clean water, and high incidence of water borne diseases is a serious problem that affects people world over, but those living in the third world are especially the most impacted (World Health Organization, 2006).

According to Zulu and Nyambe (2004), the 70% deficit of water in the peri-urban areas might be responsible for the diarrheal diseases experienced in these areas. The inadequate water supply to the majority of residents in Lusaka has led to self-supply initiatives by most households. The shallow wells in Lusaka are, however, often contaminated as a result of poor sanitation and seasonal flooding (Mulenga, 2011).

1.3 JUSTIFICATION

Much of ill health including diarrheal diseases, which affects humanity, especially in developing countries, can be traced to the lack of safe and wholesome water that is easily accessible, adequate in quantity, free from contamination, safe and readily available throughout the year.

In 1980, the United Nations General Assembly launched the International Drinking Water Supply and Sanitation Decade, 1981 – 1990. The aim was to provide all people with adequate supplies of safe water and sanitation by 1990. Safe water is that which is free from pathogenic agents and harmful chemical substances, pleasant to taste by being free from color and odor; and usable for domestic purposes. Park (2007) further states that a daily supply of 150 – 200 liters of water per capita is what is considered an adequate supply to meet the needs for all urban domestic purposes. This therefore means that, to meet the water needs of the residents of Lusaka District, the Lusaka Water and Sewerage Company (LWSC) has to supply at least 400 000m³ of water per day.

A number of studies have been conducted on Water and Sanitation in Lusaka's peri-urban areas. For example, a study done by Mulenga (2011) indicates that most people in the peri-

urban areas of Lusaka have resorted to ‘self-supply’ of water because of the inability of the LWSC to supply adequate domestic water to meet their daily needs. The study by Mulenga (2011) did not, however, look at the microbiological quality of the water used in the peri-urban areas. Another study conducted by Peletz and others (2011) which looked at water quality and diarrhea in Children of HIV positive mothers showed that at least 70% of the water samples from the peri urban areas of Lusaka had faecal coliforms. The study also showed that the water from areas without piped water had more contamination than that from areas with piped water. This study, however, did not go further to look at the quantities of water supplied to the peri-urban areas.

Therefore, undertaking this study on the quantity and microbiological quality of domestic water supply in peri-urban areas of Lusaka District is important for regulators and service providers, in order to improve on their service delivery.

1.4 RESEARCH QUESTION

What is the quantity and microbiological quality of household domestic water supply in peri-urban areas of Lusaka?

1.5 OBJECTIVES

1.5.1 General Objective

- To determine the quantity and microbiological quality of household domestic water supply in peri-urban areas of Lusaka.

1.5.2 Specific Objectives

- To establish the sources of water in the peri-urban areas of Lusaka;
- To determine the biological quality of domestic water supply in peri-urban areas of Lusaka;

- To determine the proportion of people with access to adequate domestic water;
- To investigate institutional capabilities to provide safe and adequate water in Lusaka.

1.5.3 Operational Definitions

Adequate water supply: means water supply between 150 – 200 liters per person per day that is reliable and accessible 24 hours per day.

Water borne diseases: any illness caused by drinking water contaminated by human or animal faeces, which contain pathogenic microorganisms.

Urbanization: this is the shift from a rural to an urban society, which leads to an increase in the number of people in urban areas.

Safe water: means water that is free from pathogenic agents and harmful chemical substances, pleasant to taste by being free from color and odor; and usable for domestic purposes.

Peri Urban Area: these are areas that surround metropolitan areas and cities – neither urban nor rural.

Protected water source: means conventional piped water system, protected stream, borehole and hand dug well constructed with concrete rings around its walls.

Water kiosk:

2.0 LITERATURE REVIEW

2.1 WATER SUPPLY

The issues of urbanization and population growth often result in significant excess demand and over usage of water from municipal water sources. It is estimated that about one-third (1/3) of the population in developing countries do not have safe drinking water (World Bank, 1990). In China, because of urbanization, urban water supply has declined both in quantity and in quality. In a recent survey, which was conducted in 600 Chinese cities, two thirds had inadequate water supply and one in six cities had severe water shortages (United Nations in China, 2009).

Similarly, water treatment plants for municipal water supply are sometimes inadequate to meet the increasing demand. In many cities such as Kumasi (Ghana) and Lagos (Nigeria), there is limited access to clean drinking water. The demand outstrips the capability of the municipal water supply to keep the water flowing, which usually results in intermittent disruption of water supply leading to increased bacterial count because of stagnation (Carneiro, 2002). This author explains that this is because most peri-urban areas are often concentrated with residents of high poverty levels who may not have access to running water. This situation creates a high risk of gastrointestinal pathogens, which is strongly associated with lack of a direct source of water in the home (Carneiro, 2002).

The increased population and industrial economic activities have also increased the demand for water supply in Lusaka. The city currently relies on both surface and ground water sources. LWSC distribute water from these sources via the central water distribution system

and this is usually inadequate and erratic. This has made local residents to resort to untreated boreholes and hand-dug wells, which are usually contaminated (UN-HABITAT, 2007).

2.2 WATER BORNE DISEASES

The use of unsafe drinking water is one of the major causes of diarrheal disease and death in young children in low-income countries. Diarrheal diseases are a leading killer of children under 5 years old, accounting for an estimated 21% of deaths of children in developing countries; children under 2 years are especially vulnerable, accounting for the highest portion of morbidity and mortality. It is estimated that almost 900 million people lack access to improved drinking water worldwide, and over 5 million of those people live in Zambia (Peletz et al., 2011).

The peri-urban areas of Lusaka are characterized with inadequate domestic water supply and sanitation that has led to outbreaks of most human infections, such as water borne and water related diseases (Zulu and Nyambe, 2004). Thus, access to safe and clean water is important as a health and development issue at regional, national and local levels (World Health Organization, 2006). It is evident that throughout human history, the major health problems that humans have faced have been concerned with community life such as the control of transmissible diseases, and the provision of safe and clean domestic water supply in sufficient quantities (Rosen, 1993). The Romans, for instance, in spite of the remarkable achievement in public health engineering still had to cope with the problem of endemic and epidemic water borne disease such as typhoid fever and dysentery (Rosen, 1993).

Furthermore, each year, an estimated 2.5 billion cases of diarrhea occur among children under five years of age, with more than half of these cases occurring among populations in low-income regions of South-East Asia and sub-Saharan Africa. Similarly, in developing countries, water-borne diseases cause four-fifths of all illnesses, with diarrhea being the leading cause of childhood death (UNICEF/WHO, 2009).

The global picture of water and health has a strong local dimension with some 1.1 billion people still lacking access to improved drinking water sources and some 2.4 billion to adequate sanitation. Many researchers indicate that eliminating disease and death due to

unclean domestic water supply and poor sanitation would reap billions of dollars in health and productivity gains. They estimate that for every dollar spent, there would be an economic return of between US\$3 and US\$34, depending upon the country. The United Nations has set a goal of cutting into half by the year 2015 the number of people without access to safe drinking water supply and basic sanitation (United Nations World Water Development Report, 1998 -2013).The problem of attaining safe and clean water supply places an enormous burden of waterborne diseases on the health of the citizens, particularly on the health of children. According to Chege and Agha (1999), the incidence of diarrhea among children in Zambia's low-income neighborhoods was about 42% higher than the national (urban) level. Therefore, access to safe and clean water supply is an important component to health (Museteka and Bäumle, 2009).

2.3 SERVICE FACTORS

2.3.1 MUNICIPAL INFRASTRUCTURE AND PLANNING

For the Water supply sector to function effectively there is need to have well defined institutional frameworks. According to the African Ministers Council on Water (AMCOW) Country Status Overview (2010), Ghana's water and sanitation sector has a well-established institutional set-up with clear lines of responsibility. All subsector policies have been consolidated into the National Water Policy and the National Environmental Sanitation Policy, both of which were approved by Parliament and are now in the public domain (AMCOW Country Status Report, 2010)

In Zambia, the Ministry of Local Government and Housing is responsible for providing water supply and sanitation, and the National Water Supply and Sanitation Council (NWASCO) is responsible for regulating water supply and sanitation sector. The Ministry of Environment and Natural Resources and the Zambia Environmental Management Agency (ZEMA) carry out the resource conservation function. NWASCO has formulated a number of guidelines on which the service providers can be measured. The guidelines help water utility companies to operate within the framework of the Water Supply and Sanitation Act of 1997. They are also responsible for facilitating the dissemination of information to the public on

service delivery expectations. Some of the guidelines developed are on minimum service levels, accounting standards, water quality, human resource development, extension of service to peri-urban, reporting, cooperative governance, investments and financial projections. Managers at the Commercial Utilities (CUs) are trained on how to use these guidelines to ensure understanding and effectiveness (Mbilima, 2010).

However, the major problem faced by service providers is that most of the water supply and sewerage infrastructure in the urban areas of Zambia were constructed between the 1960's and 1970's without accompanying maintenance resulting in severe dilapidation. It is clear that over the years, peri urban areas in all of the Zambian towns have grown considerably, and most of them have poor water supply and sanitation services (Ministry of Local Government, 2011). According to the 2000 Census report, it indicates that at national level, only 49.1 percent of households in Zambia had access to safe water (Central Statistical Office, 2002).

2.3.2 MUNICIPAL FUNDING

Another important component of water supply and sanitation is funding. The water and sanitation sector in Ghana receives funding from a number of sources, which are captured in the government's Medium Term Expenditure framework. The sector has enjoyed considerable support from donors—principally as grants to the rural and small town subsector and mixed grant/loan financing for the urban water subsector in addition to government and user contributions. The sector has also been able to mainstream user payment for water services at both rural and urban levels (AMCOW 2010).

In contrast to Ghana, the Lusaka Water and Sewerage Company relies on Government funds for capital investments. However, as provided for in the Water Supply and Sanitation Act of 1997, the Regulator (NWASCO) has the powers to establish a fund to assist in extending water supply and sanitation services to the urban poor. The Devolution Trust Fund (DTF) was formed autonomous from NWASCO. The DTF is a basket fund that makes grants

available through applications by the country's commercial water utilities, and is in turn financed by foreign donors such as the World Bank, Danida and the EU. The DTF was created to contribute to capacity building among water providers who would probably otherwise not consider extending their services to poor areas (Mbilima, 2010).

2.4 URBANISATION

Nearly half of the world's 7 billion people now live in urban settlements. According to Argotti, 1993, cities play a vital role in the social fabric of countries and in national and regional economies worldwide. This is because cities have been formed to offer better employment, education, health care, and culture; and they contribute to national economies. However, rapid and often unplanned urban growth is often associated with poverty, environmental degradation due to population demands that outstrip service capacity. These conditions, according to Kwasi, 2005, place human health at risk.

Worldwide, urbanization is an ongoing process that has a profound positive impact on people's living conditions and health status. In 2003, almost 73% of Europeans were living in cities or city suburbs. By 2030, urbanization is projected to reach 80%, partly driven by rural-urban migration and influx of migrants from other countries (Eur J P H, October 2005).

Although urbanization is the driving force for modernization, economic growth and development, rapid and often unplanned urban growth is associated with settlement on marginal land, environmental degradation and population demands that outstrip environmental service capacity such as drinking water supply, sanitation, and waste disposal and treatment (United Nations Conference on Environment and Development, 1992).

Lusaka is the capital and largest city of Zambia. At independence (1964), the population of Lusaka was 195,700. The population of Lusaka is now estimated at 1.7 million with an annual average growth rate of 3.5 percent (Central Statistical Office, 2010). Hence, like other urban centers, the phenomenal growth in Lusaka's population has resulted into a housing crisis, which is evident in the growth of unauthorized settlements on the farms located on the edge of the town boundary. These settlements lack essential infrastructure and services, which makes the residents vulnerable to ill health, particularly because of lack of access to clean water supply and safe sanitation facilities. Due to lack of access to clean water supply and sewerage facilities, the residents of unauthorized urban settlements rely on shallow water

wells for their water supplies and pit latrines and even any available open bush for the disposal of human waste (Mulenga, 2011).

2.5 NATIONAL LEGAL FRAMEWORK

There are various legal framework that govern water resources and its quality as follows:

(i) The Local Government Act Cap 283 gives local authorities the prime responsibility for the provision of domestic water supply and sanitation services to all areas within their boundaries. The local authorities are empowered to make by-laws set standards and guidelines for provision of services.

(ii) The Water Supply and Sanitation Act No. 28 of 1997 specifies that local authorities may provide urban Water Supply and Sanitation services and establishes National Water And Sanitation Council (NWASCO) as the regulator for the Water Supply and Sanitation sector. Local authorities may provide by themselves or through commercial utilities licensed and regulated by NWASCO.

(iii) The Water Act from 1948 is concerned with the development and management of surface water resources but does not deal with ground water.

(iv) The Environmental Management Act no. 20 of 2011 which deals with protection of the environment and control of pollution.

(v) The Public Health Act of 1995 has provisions for the management of sanitation and prevention of pollution to water supplies by the local authorities.

2.6 CONCEPTUAL FRAMEWORK

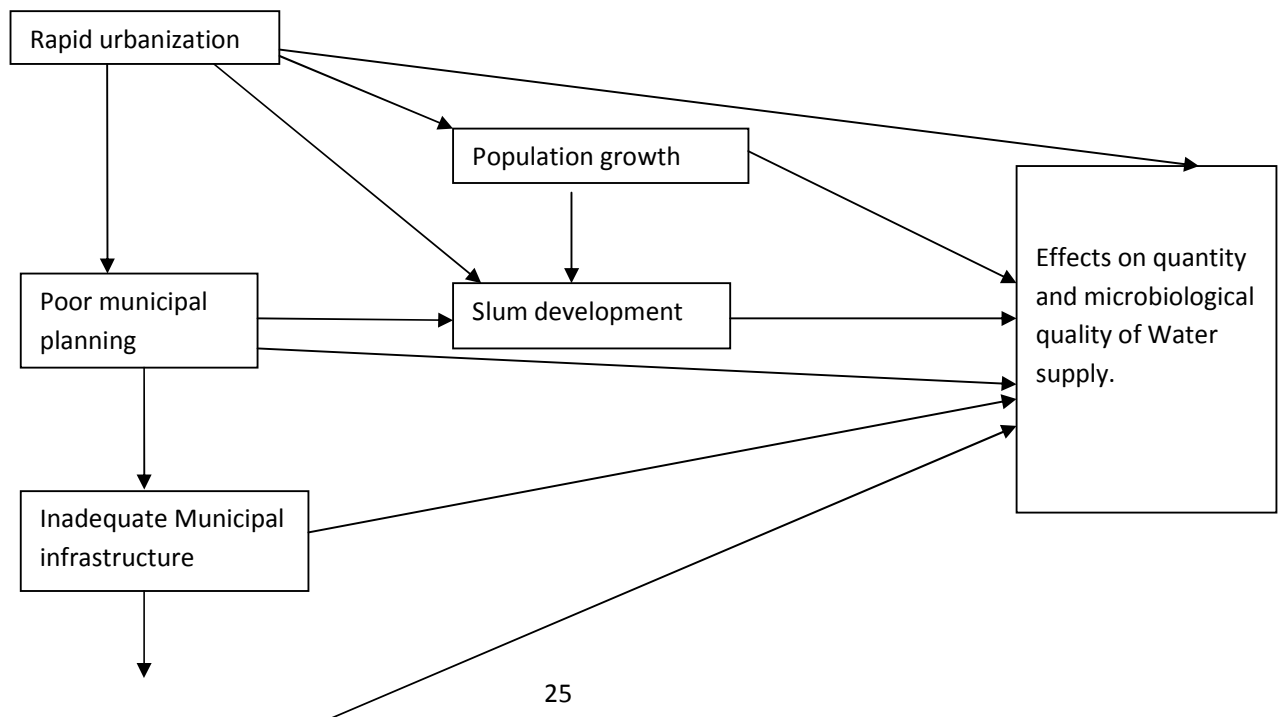
The provision of safe domestic water supply in cities such as Lusaka is influenced and affected by a number of factors. Some of the factors include rapid urbanization, population

growth, slum development, municipal planning, Municipal infrastructure and funding for service provision.

Rapid urbanization is where there is a quick or rapid shift/movement of people from rural areas to urban areas in search of better lives, leading to an increase in the population in the urban areas. This unplanned population growth leads to a situation where the available housing structures in the urban areas are not enough to cater for the population. The 'immigrants' end up trying to provide for their own accommodation and this leads to the development of illegal and unplanned settlements in the cities, popularly referred to as slums.

The increase in population and development of slums is usually not catered for in the planning by the municipalities. Thus lack of municipal planning for the rapid population growth, coupled with inadequate funding to the municipal service provision ends up outstripping the capacity of the available municipal infrastructure. Thus the ability of the municipalities to provide the necessary services such as safe domestic water supply becomes inadequate.

The linkages and relationships of these factors are illustrated in the diagram below:



Lack of Funding for
services

3.0 RESEARCH METHODOLOGY

INTRODUCTION

This chapter describes the research methodology and deals with variables, study setting, study design, study population, sampling and data management.

3.1 VARIABLES

The dependent variables for this study are quantity and microbiological quality of water supply while the independent variables are access to safe water supply, municipal funding, municipal planning and infrastructure. The table below outlines the definitions of indicators and their scale of measurement.

VARIABLES FOR MEASUREMENTS

TYPE OF VARIABLE	VARIABLE	INDICATOR	SCALE OF MEASUREMENT
Dependant	Quantity of water	Amount of water available per person per day	Adequate -200 lt/person/day Inadequate - Less than 200 lt/person /day

	Microbiological quality of water	Faecal coliform Total coliform	Present Absent
Independent	Access to safe water supply	Proportion of people with access to safe water	High= Above 80% Medium = 51% - 79% Low=Less than 50%
	Access to adequate water supply	Proportion of people with access to adequate water	High= Above 80% Medium = 51% - 79% Low=Less than 50%
	Municipal funding	Level of funding for service provision	Adequate Inadequate
	Municipal planning	Availability of plan for service improvement	Available Not available
	Infrastructure	Presence of infrastructure for water supply	Adequate Inadequate

3.2 STUDY DESIGN

This was a cross-sectional analytical study that was conducted in Lusaka District aimed at assessing the quantity and microbiological quality of domestic water supply in peri urban areas of Lusaka District.

3.3 STUDY SETTING

The study site for this research was in Lusaka District in Lusaka Province. Lusaka is the capital city of Zambia and has a population of over 2 million (CSO, 2010). Lusaka dominates the country's urban system and accounts for 32% of the total national urban population. The city's central location, in addition to its capital city status, gives it strategic importance, as it is easily accessible from all parts of the country.

Lusaka has over thirty-five unplanned settlements characterized by inadequate shelter, a lack of social services and inadequate waste management, making the residents vulnerable to epidemics.

3.4 STUDY POPULATION

The study population for this study was selected from residents in peri-urban areas of Lusaka. From these peri-urban areas, a number of households were selected for the study.

3.5 SAMPLE SELECTION

The sampling strategies used in drawing the sample population was by first establishing clusters according to constituencies and then followed by simple random sampling for the households. This was in order to eliminate bias and obtain a representative sample. Lusaka has seven constituencies from which one peri urban area was selected giving a total of seven peri-urban areas to be included in the study. The constituencies in Lusaka are Munali, Chawama, Kabwata, Mandevu, Matero, Lusaka Central and Kanyama constituencies. The selection of peri urban areas was done by listing all the peri urban areas in each constituency and through a raffle one area was picked. However, Kabwata and Lusaka Central constituency each has only peri urban area and these were picked for study to represent the particular constituency. The peri urban areas randomly selected were Kanyama from Kanyama Constituency, Kalikiliki from Munali Constituency, Garden from Mandevu Constituency, Bauleni from Lusaka Central Constituency, Chunga from Matero Constituency, Jack from Kabwata Constituency, and Misisi from Chawama Constituency. The selected peri-urban areas are indicated on the map below:

LUSAKA CITY PERI- URBAN



From the selected areas, a number of households were randomly picked for inclusion in the study. This was done by assigning numbers to the households and by way of a raffle, 28 households were picked.

Fourteen water samples were collected from each peri-urban area for microbiological analysis to determine levels of faecal coliform and total coliform contamination. These water samples were collected from the water source of every second household interviewed. The water sampling was done using aseptic methods where the taps/containers were first sterilized and the already sterilized sampling bottles that were obtained from the Food and Drugs Control Laboratory, were rinsed with the sample water before being filled.

The water samples collected were stored in cool boxes and delivered to the laboratory for analysis within the same day of collection.

3.6 INCLUSION CRITERIA

- a) The inclusion criteria for this study were all residents in peri urban areas selected for the study.
- b) All wells that are more than 30m from of a pit latrine or soak away in the selected households of study sites.

3.7 EXCLUSION CRITERIA

- a) Non – residents in peri-urban area selected for the study and households that did not give consent.
- b) Wells that are within a radius of 30m from a pit latrine or soak away in the selected households and those outside the study site.

3.8 DETERMINATION OF SAMPLE SIZE

Sample size for this study was calculated using the formula below:

$$n = \frac{Z^2 P(1-P)}{d^2}$$

- n = the sample size
- d = Confidence error
- Z = confidence interval
- P = Precision

$$\begin{aligned} n &= \frac{1.96^2 * 0.5(1-0.5)}{0.07^2} \\ &= \underline{\underline{196}} \end{aligned}$$

$$196/7 \text{ residential areas} = \underline{\underline{28}}$$

This, therefore, means that about 28 households were randomly selected from each of the seven residential areas included in the study.

3.9 DATA COLLECTION

Data in this study was collected using a structured questionnaire for the households and an interview guide for interviews with the service providers.

Fourteen water samples were collected from each of the peri-urban areas. One batch of samples from Bauleni was submitted to the Food and Drugs Control Laboratory while the rest of the samples were submitted to University of Zambia, School of Engineering, for bacteriological analysis. This was because the Food and Drugs Laboratory was unable to continue the analysis of all the samples. The said analysis of the water samples included faecal coliform, and total coliform. The water samples were collected from every second household interviewed.

3.10 DATA PROCESSING AND ANALYSIS

After data collection, qualitative data from Lusaka Water and Sewerage Company was grouped into themes and discussed. The quantitative data was analyzed using Stata version

11 and SPSS. Chi-square test was used to test association between the variables. Data was later summarized and presented using tables and charts in order to facilitate understanding.

3.11 ETHICAL CONSIDERATIONS

It was not anticipated that this study is going to cause any physical harm to the participants. However, ethical clearance was sought from the ERES CONVERGE IRB committee because individual face-to-face interviews were going to be conducted with the participants in order to collect data for the research. This might infringe on some rights of the participants either intentionally or unintentionally.

A formal letter was written to Lusaka Water and Sewerage Company to seek authority and inform them about the purpose of the study. Both written and verbal consent was obtained from the respondents. The researcher adhered to anonymity and confidentiality of the respondents throughout the research process.

3.12 UTILISATION AND DISSEMINATION OF RESULTS

The findings of this study will be disseminated by presenting summary copies of the final report to all stakeholders, and these include:

- Lusaka Water and Sewerage Company
- Ministry of Local Government and Housing and
- University of Zambia Libraries, for academic referencing.

4.0 STUDY RESULTS

4.1 Household Descriptive Characteristics and Statistics (N=196)

Table 1 presents the descriptive characteristics of the interviewees by gender. As indicated, the majority (70%) of the interviewees were females with about 29% of them being tenants of the households enumerated. In addition, about 13% of the males interviewed are tenants of the households enumerated. In terms of age, the majority (about 14%) of the male interviewees were in the 41 to 50 years age group while about 23% of the females were in the 31 to 40 years age group. The least, less than 3% were 50 years and above for both sexes. Among the male interviewees, the majority, about 12% indicated having attained secondary school education in comparison with their female counterparts where the majority, about 41% attained primary level education. In addition, more (6%) males attained Tertiary education compared to females (3%).

Table 1. Descriptive characteristics of the interviewees by Gender (N=196)

	Gender		Total
	Male	Female	
	N (%)	N (%)	
Respondents	58 (30)	138 (70)	196
Status of Interviewee			
Land lord	25 (12.75)	56 (28.57)	81 (41.33)
Tenant	33 (16.84)	82 (41.83)	115 (58.7)
Total	58 (29.6)	138 (70.4)	196 (100)
Age Category			
Less than 20	4 (2.04)	8 (4.08)	12 (6.12)
21 to 30	9 (4.59)	39 (19.9)	48 (24.49)
31 to 40	17 (8.67)	46 (23.47)	63 (32.14)
41 to 50	27 (13.78)	42 (21.43)	69 (35.20)
Greater than 50	1 (0.51)	3 (1.53)	4 (2.04)
Total	58 (29.6)	138 (70.4)	196 (100)
Education Level			
Primary	22 (11.22)	81 (41.33)	103(52.55)
Secondary	24 (12.24)	51 (26.02)	75 (38.27)
Tertiary	12 (6.12)	6 (3.06)	18 (9.18)
Total	58 (29.6)	138 (70.4)	196 (100)

The average number of people living in the household is 6.2 and ranges from 1 to 16 members (Table 2). Also, the average monthly income per household is 1009 ZMK with a median value of 500 ZMW, with the source of income for the majority of the respondents is business as indicated in Table 3.

Table 2. Summary Statistics of the household size and estimated monthly income (ZMK) (N=196)

Variable	Min	Mean	Std Dev.	p25	p50	p75	Max
Household size	1	6.2	2.23	5	6	7	16
Monthly Income (ZMK)	0	1009.9	1801.25	300	500	1000	20000

Table 3. Household sources of Income (N=196)

Source of Income	Count	Percent
Business	114	58.16
Work	78	39.8
Farming	4	2.04
Total	196	100

4.2 Domestic Water Sources

Table 4 presents the frequency and percentage distribution of different main water sources and their respective categories. The source of domestic water supply for most of these peri-urban areas is piped water (90.31%). More specifically, the source of this water is communal taps as indicated by about 72% of the respondents. The second source of water is/are covered well(s) or borehole(s) representing only about 9%. For this main water source, about 67% of the respondents indicated a protected public well as the source of water. On the other hand, less than 1% of sample indicated getting water from an open well open to the entire public.

Table 4. Frequency and Percentage Distribution of Different Water Sources (N=196)

Source of water	N	%
Piped Water		
Piped water into dwelling (house)	49	27.34
Communal tap	128	72.32
Total	177	90.31
Water from open well		
Unprotected well	1	100
Total	1	0.51
Covered well or borehole		
Protected well in yard or plot	6	33.33
Protected public well	12	66.67
Total	18	9.18
Overall Total	196	100

Further analysis of the results revealed that the average quantity of water used by a typical household was 91.42 litres per day with a median value of 100 litres per day, and ranged from 40 to 220 litres per day. Also, the per capita daily consumption of water per household on average is about 17 litres/person/day and ranges from 2.5 to 100 litres/person/day (Table 5).

Table 5. Residential water consumption (litres/day) and per capita consumption (litres/person/day)

Variable	Mean	Std Dev.	Median	Min	Max
Quantity of residential Water consumed (Litres/day)	91.43	46.67	100	40	220
Per capita daily water consumption (Litres/person/day)	16.95	11.86	16.67	2.5	100

4.3 Storage and Safety of Drinking Water

The source, storage and treatment of water are some of the cardinal things to be considered to ensure the safety of the commodity to the consumer. When asked the main water storage methods, 65% of the respondents in the sample indicated the use of closed containers and/or buckets compared to 35% who store water in open containers and/or buckets. However, when asked whether the household boil and/or treated the drinking water with chlorine, the majority, (89%) said no to boiling water with the least, 11% saying yes to boiling water before drinking most of the time. Similarly, most, (72%) of the respondents reported not treating the drinking water with chlorine. However, the majority, 66% of the respondents did state that they are concerned about the source of water despite their exhibited inability and/or unwillingness to treat the water before consumption (Table 6).

Table 6. Storage and safety of the drinking water (N=196)

	Count	Percent
Storage of drinking water		
Closed container/ Budiza	128	65%
Open container/bucket	68	35%
Total	196	100
Boil drinking water		
Boil	22	11%
Does not boil	174	89%
Total	196	100
Treat water with chlorine		
Treat with chlorine	54	28%
Does not treat water	142	72%
Total	196	100
Concerned about source of drinking water		
Concerned	129	66%
Not concerned	67	34%
Total	196	100

Figure 1: Treatment of water by boiling

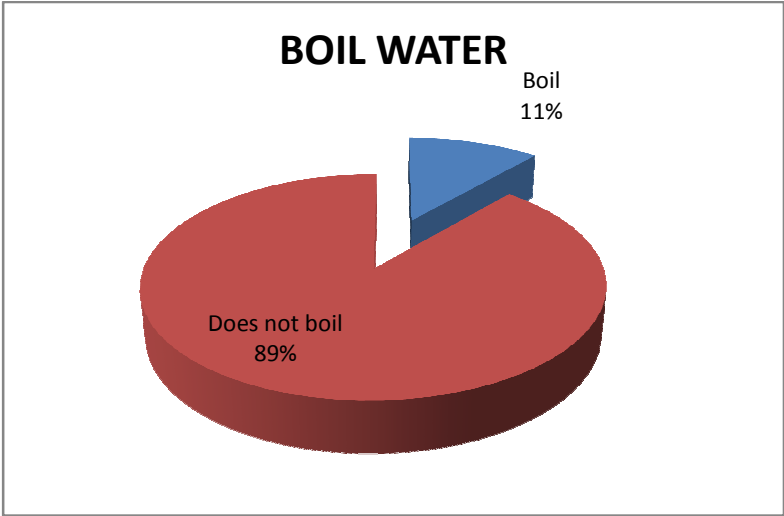
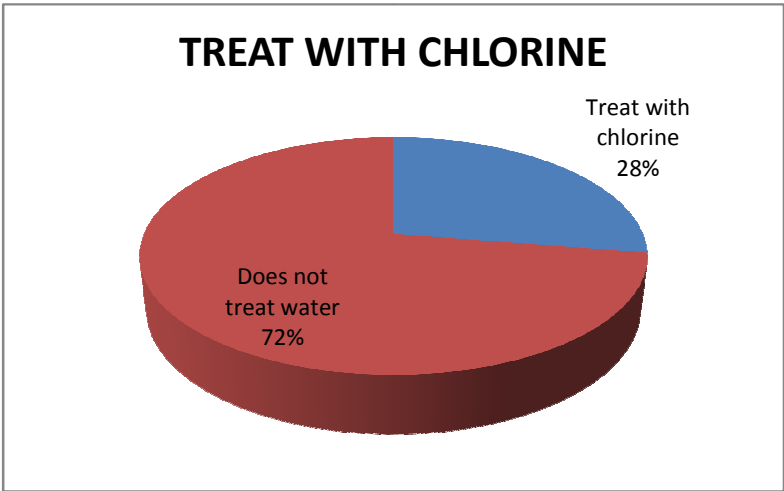


Figure 2: Treatment of water with chlorine



4.4 Water Quality

4.4.1 Presence of Total and Faecal Coliform for the entire sample

A total of 99 water samples were collected from the seven peri-urban areas in the sample collectively. These water samples were examined for Total and Faecal coliform. In the end, the levels of the two parameters were determined so that the quality of the water in each area and collectively could be determined. Table 6, therefore presents the prevalence rates for the total and faecal coliform levels as well as the water quality state for the entire sample. As indicated, the majority (60.61%) of the water samples examined contained total coliform while about 53% contained faecal coliform.

Table 7. Total and Faecal Coliform Levels the overall water quality for the Entire Sample (N=99)

	Count	Percent (%)
Total Coliform		
Free from contamination	39	39.39
Contaminated	60	60.61
Faecal Coliform		
Free from contamination	47	47.47
Contaminated	52	52.53
Water Quality		
Satisfactory	39	39.39
Unsatisfactory	60	60.61
Total sample	99	

4.4.2 Area and the presence of Total and Faecal Coliform

Comparison of Total and Faecal Coliform levels by area shows that all (100%) the water samples from Bauleni contained total coliform (Table 8). Kalikiliki and Misisi had about 86% and 71% of their water samples containing total coliform respectively. On the other hand, Kanyama and Jack Compound each had 50% of their water samples containing total coliform. Last, Garden and Chunga, each had less than 40% of their water containing total coliform. For the presence of faecal coliform, Bauleni once more had more (80%) water samples with this problem followed by Kalikiliki with about 79%, Misisi, 71% with the least,

Garden Compound having only about 14% of the water samples having this problem. The rest of the areas, Chunga, Jack and Kanyama, had 25% to 50% of their water samples with the faecal coliform presence.

Table 8. Area and the respective Total and Faecal Coliform levels (N=14)

Area	Total coliform				Faecal coliform			
	Absent		Present		Absent		Present	
	N	%	N	%	N	%	N	%
Kalikiliki	2	14	12	86	3	21	11	79
Garden	9	64	5	36	12	86	2	14
Kanyama	7	50	7	50	8	57	6	43
Jack	7	50	7	50	7	50	7	50
Bauleni	0	0	15	100	3	20	12	80
Misisi	4	29	10	71	4	29	10	71
Chunga	10	71	4	29	10	71	4	29
Total	39		60		47		52	

4.4.3 Area and Quality of Water

Among the areas sampled, Chunga had more (10.1%) safe water samples followed by Garden (9.1%), then Kanyama and Jack with 7.1% each. The least among the seven areas was Bauleni with the water quality of all the water samples turning out to be unsatisfactory. A Test to see whether there is an association between the area and quality of water, revealed a significant relation of the two variables at 5% level of significance with a Pearson Chi-Square Test value of 702.9, with 6 degrees of freedom and a p-value of 0.000 (Table 9).

Table 9. Area and Quality of Water

AREA	No. of water samples collected	Quality of water			
		Satisfactory		Unsatisfactory	
		N	%	N	%
Kalikiliki	14	2	2.0	12	12.1
Garden	14	9	9.1	5	5.1
Kanyama	14	7	7.1	7	7.1
Jack	14	7	7.1	7	7.1
Bauleni	15	0	0	15	15.2
Misisi	14	4	4.0	10	10.1
Chunga	14	10	10.1	4	4.0
Total	99	39		60	

Notes: Pearson $\chi^2(6)=702.9$; $Pr=0.000$

4.5 Econometric Analysis of Water Source Choice and quantity used

4.5.1 Analysis of Choosing Piped Water among Households

The logistic regression model was employed to establish the factors that affect the households' choice to use a piped water source. Therefore, a dummy variable for the water source (1= piped water and 0=other sources) was used as the dependent variables. The independent variables contained in the model included: the status of the interviewee, age of the household head, gender, level of education, monthly income, household size and cost per month.

From among the variables included in the analysis, only the monthly income of the household was found to have a statistically significant effect on the probability of a household choosing a piped water source at 5% level of significance (Table 10). The odds ratio value of 1.01 for monthly income implies that a one-unit increase in the independent variable monthly income of the household 1 time more likely that the households will report piped water as the primary source of water holding all other factors in the model constant. This is probably due to the fact that households with larger monthly incomes are better off and can be able to cover expenses that come with having piped water connected.

Table 10. Logistic Regression Results for Reporting Piped Source of Water (N=160)

	Odds Ratio	Robust Std. Err.	z	P>z	[95% Confidence Interval)	
Status of Interviewee	0.63	0.56	-0.52	0.60	0.11	3.60
Age	0.54	0.32	-1.03	0.30	0.17	1.75
Sex	0.84	0.84	-0.17	0.86	0.12	5.94
Level of education	1.75	1.68	0.59	0.56	0.27	11.41
Household size	0.70	0.17	-1.49	0.14	0.44	1.12
Monthly income	1.01	0.00	2.32	0.02	1.00	1.01
Cost per month	1.01	0.01	0.61	0.54	0.99	1.03
Constant	462.77	1432.45	1.98	0.05	1.07	199604.60

4.5.2 Analysis of Factors Affecting Household Water Usage

A multiple regression model was used to find out the effect of independent variables (the status of the interviewee, age of the household head, gender, level of education, monthly income, household size and cost per month and water source) on the dependent variable, in this case the daily per-capita water usage, obtained by dividing the quantity of water used by the household per day by the household size.

Table 11 shows the results of the regression analysis. The results indicate that variables like sex of the head of the household, the household size and monthly income have a significant effect on the daily per capita usage of water at 10%, 1% and 5% significance levels respectively. The remaining variables had no statistically significant contribution in explaining the daily per capita water usage. Explicitly, looking at the regression coefficients for the three variables reveals that, the sex of the household head has a value of -3.34 implying that male-headed households will have lower daily per capita water usage than female-headed households. The coefficient for the monthly income was less than a percentage point but still has a positive relationship with the per capita water usage while unexpectedly the household size has a negative one with a beta value of -2.82.

Table 11. Multiple regression analysis of the factors affecting household water usage (N=160)

	Coef.	Robust Std. Err.	t	P>t	[95% Confidence Interval)	
Status of Interviewee	-0.34	2.03	-0.17	0.87	-4.35	3.67
Age	0.62	1.65	0.37	0.71	-2.63	3.87
Sex (1=male, 0=female)	-3.34	1.80	-1.85	0.07	-6.90	0.22
Level of education	0.42	1.78	0.23	0.82	-3.10	3.93
Household size	-2.82	0.74	-3.82	0.00	-4.28	-1.36
Monthly income	0.00	0.00	2.50	0.01	0.00	0.00
Cost per month	0.01	0.01	1.58	0.12	0.00	0.02
Water source	0.05	1.26	0.04	0.97	-2.43	2.53
Constant	24.80	6.92	3.58	0.00	11.13	38.47

4.6 Source and Quality of Water

A look at the source of water and the quality, a test for the association revealed that a relationship exists between the two. The chi-square test assumes that the expected value for each cell is five or higher. This assumption in this case did not hold, as a result the Fisher's exact test was used to conduct a chi-square test as some cells had an expected frequency of five or less. The Fisher's exact test has no such assumption and can be used regardless of how small the expected frequency is. The Fisher's exact test indicated a statistically significant relationship between the source of water and quality ($p < 0.001$).

Table 12. Source and quality of water

Source of Domestic Water Supply	No. out of sample	Quality of water			
		Satisfactory		Unsatisfactory	
		%	N	%	N
Piped Water	177	41	72	59	105
Open Well	1	0	0	100	1
Covered Well or Borehole	18	29	5	71	13
Total	196		77		119

Notes: Pearson $\chi^2(2) = 14.5487$; $Pr = 0.001$;

Fisher's exact = 14.847; $Pr = 0.000$

4.7 Data from Lusaka Water and Sewerage Company

The data from Lusaka Water and Sewerage Company was qualitative and was obtained through an interview with one of the Engineers in charge of one of the zones in Lusaka District.

The Lusaka Water and Sewerage Company has a department called Peri Urban Water responsible for water supply in the peri urban areas of Lusaka. This department has divided the city into zones namely Southern, Eastern and Western zones and an engineer manages each of these zones. The Utility Company has several other departments that work in conjunction with the Peri Urban Water Department and these include departments of Technical Services and Maintenance.

According to the Utility Company, the average water consumption per person day in the peri urban areas of Lusaka is between 20 to 60 liters. This therefore, means that for an average household with six members, the average water consumption is between 120 to 360 liters per household per day. The LWSC could not, however, give the exact quantities of water supplied to the peri urban areas of Lusaka because at the time of the data collection, the tap-off points for the peri urban areas were still unmetered.

Some peri urban areas of the city of Lusaka are connected to the LWSC main water supply network. However, the ones that are not connected receive water from boreholes either through water kiosks established by LWSC or through Water Trusts which are run as businesses by members of the community. A few members of these peri urban communities draw their water for domestic use from shallow wells.

For the individual households that are connected to the main water supply network, the charges are either fixed or metered. The fixed charge in these areas is **K78.40** whereas for the metered clients, the charges are based on usage per household. Residents using water kiosks are charged K0.10 per 20-liter container of water drawn, while those getting water from the Water Trusts pay K0.20 per 20 liters of water.

The LWSC has in its budget a specific component for peri urban water supply and sanitation, and it is from this budget line that they undertake projects for improvement and expansion of

peri urban water supply. However, the company does not work in isolation. They have support from partners and donors such as the European Commission and the World Vision.

The main sources of domestic water supply in Lusaka's peri urban areas are boreholes. However, a few of these areas such as Misisi, part of Garden compound and parts of Jack compound, are connected to the main water supply network and others receive their water from water kiosks.

Among these sources of water, the source that is the most polluted is the boreholes. The LWSC explains that this is because of the on-site sanitation that is the most commonly used in the peri urban areas, which leads to cross contamination between the water sources and the latrines.

The measures that the Company has put in place to help prevent/control this water pollution include network improvements in sewage disposal, protection of their boreholes, installation of online dozers, and maintaining the recommended distances between their boreholes and the households. In a bid to further prevent water pollution, the Company endeavors to include sanitation as a component in all projects of water supply improvement.

As a strategy for water quality control, the Company has also incorporated the use of other technologies such as the faecal sludge technology, which they are piloting in Kanyama to address the problem of water pollution. Another innovation to address this problem has been the School Sanitation program, which aims at providing sanitation network in all schools in the peri urban areas. The Company has also developed a Sanitation Marketing Strategy that is used to educate residents of Lusaka on the need for each household to have a toilet.

The department of Water Quality has a schedule for random sampling that is used to monitor the microbiological quality of all water supplied by the Company in the peri urban areas of Lusaka. The department also follows guidelines set out by NWASCO on the numbers and time that water sampling should be conducted by all Water Utility Companies for microbiological quality monitoring.

5.0 DISCUSSION

5.1 *QUANTITY OF WATER SUPPLY*

The findings of the study indicate that most of the people (above 90%) in the study areas have access to piped water, mostly from boreholes and water kiosks. This finding indicates a difference with the findings of the review by Mulenga, 2011, which showed that most residents of Lusaka's peri urban areas had resorted to self-supply of domestic water. However, despite this accessibility, the quantity of water used per person per day is between 20 liters to 60 liters. This finding is also supported by data obtained from the LWSC, which indicated similar quantities of domestic water per person per day. It however, does not meet the recommended daily supply of 150 – 200 liters of water per capita, which is what is considered an adequate supply to meet the needs for all urban domestic purposes as indicated by Park, 2007. These findings are in line with the assertions by Zulu and Nyambe (2004), that there is a 70% deficit of water supply in the peri-urban areas of Lusaka, which might be responsible for the diarrheal diseases experienced in these areas.

As indicated in the African Ministers Council on Water (AMCOW) Country Status Report, 2010, for any Water Supply Sector to be effective, there is need for well-defined institutional frameworks and adequate municipal funding. The LWSC indicated that they have a budget and organizational capacity for improvement of domestic water supply and sanitation in Lusaka, and is working with donor agencies such as the European Union (EU), the World Bank and The Millennium Challenge Account, to set up water supply and sanitation projects. Despite this indication, some infrastructure is lacking such as meters for the tap-off points for water supply to the peri urban areas, which are essential for the company to know how much water is supplied to these areas.

5.2 WATER QUALITY

Implementation of the above mentioned projects by the utility company is very cardinal because not only do the results of this study indicate a deficit in the quantity of domestic water supply, the findings also show that all the water samples collected either had faecal or total coliform, or both. This may be explained by the findings that indicate that most of the water used from boreholes (71.3%) was of poor quality, which as explained by the LWSC representative is the most commonly polluted source of water. The pollution of this source of water is because of the on-site sanitation most commonly used in the peri-urban areas of Lusaka, which may lead to cross-contamination of the water sources. The findings also indicate that even the piped water from the LWSC main network is contaminated with about 61% being of unsatisfactory/poor quality, which is in conflict with the standards set by the WHO (2008) that domestic water should contain zero faecal and total coliform. This could be as a result of ineffective chlorination from the source, ineffective dozers along the distribution line or leaking pipes along the line of distribution.

The problem of the use of unwholesome water in the peri urban areas of Lusaka is further compounded by the fact that most of the residents (72%) do not treat their water either with chlorine or by boiling before use in the home. This lack of treatment of the contaminated water may be responsible for the high prevalence of diarrheal diseases in low-income urban neighborhoods of Zambia as indicated by Chege and Agha (1999).

6.0 STUDY LIMITATIONS

The limitations of this study included:

- The cost of doing analysis of the water limited the number of water samples collected for analysis.
- The LWSC was not able to avail the researcher with the quantities of water supplied to the peri urban areas of Lusaka and this in turn meant that the researcher could not compare whether the quantities of water being supplied is the same as that being used in the households.

7.0 CONCLUSION

From the findings and discussion above, it can be concluded that most residents (above 90%) of Lusaka's peri urban areas receive water from the Lusaka Water and Sewerage Company either from the main network or from the water kiosks that are operated in their residential areas. The quantities of domestic water received by the residents are, however, not adequate (20 – 60 litres per person per day). This is in reference to the quantities recommended by Park, (2007) of 150 – 200 litres of water per capita per day. Another conclusion that can be drawn from the findings of this research is that most of the domestic water supplied to, and used by residents of the peri urban areas of Lusaka is not safe with 60.61% samples containing total coliform and 53% containing faecal coliform. This is in reference to the definition of safe water, which states that safe water is that which is free from pathogenic agents and harmful chemical substances, pleasant to taste by being free from color and odor; and usable for domestic purposes. In addition, the World Health Organization (2008), states that levels of faecal and total coliform should be zero for domestic water.

8.0 RECOMMENDATIONS

The following recommendations are made to the Lusaka Water and Sewerage Company based on the findings of the research:

- The LWSC should improve/increase the quantities of domestic water supplied to the peri urban areas in order to increase the quantity of water accessed per person per day to meet the minimum requirement of 150 – 200 litres.
- The utility company should urgently install meters for water tap-off points to the peri urban areas to be able to account for the water supplied to these areas.
- The company should also ensure that on-line dozers of chlorine are always in working condition to ensure safety of the water supplied to the peri urban areas.
- The water samples for quality analysis should be taken more often in these areas to monitor quality of the water supplied
- The company needs to urgently implement the Water and Sanitation programs planned for Lusaka's peri urban areas to address the problem of on-site sanitation that has contributed to the contamination of the domestic water in these areas.

Recommendations made to the Ministry of Local Government and Housing are as follows:

- The Ministry should consider separating and increasing the funding for water supply and sanitation given to the LWSC so that each area will receive the due and adequate attention.
- The Ministry, through NWASCO, should from time to time take their own water samples for analysis to monitor and ensure that the residents of Lusaka receive safe water.

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10.0 APPENDICES

10.1 QUESTIONNAIRE FOR HOUSEHOLDS

INSTRUCTIONS

- a. You are asked to answer all questions freely in the way you know how to
 - b. Do not write your name on the questionnaire
 - c. Tick against the correct answer or write as asked
-

PERSONAL INFORMATION

1. Name of area:
2. House No.:
3. Date of interview:
4. Status of interviewee
 - a) Owner ☐
 - b) Occupier ☐
 - c) Dependent ☐
 - d) Other (Specify)
5. Age:
 - a) >20 ☐
 - b) 21 – 30 ☐
 - c) 31 – 40 ☐
 - d) 41 – 50 ☐
 - e) <51 ☐
6. Sex:
 - a) Male ☐
 - b) Female ☐
7. Level of education
 - a) Never been to school ☐
 - b) Primary ☐
 - c) Secondary ☐
 - d) Tertiary ☐

8. Number of people living with you

9. Source of income

a) Business ☐

b) work ☐

c) farming ☐

10. Monthly income K.....

QUESTIONS ON WATER SUPPLY

11. What is your source of domestic water supply?

- **Piped water**

Piped water into dwelling (house) ☐

Piped water into yard or plot ☐

Communal tap ☐

- **Water from open well**

Open well in yard or plot ☐

Open public well ☐

- **Covered well or borehole**

Protected well in yard or plot ☐

Protected public well (City council or NGO provided well) ☐

- **Surface Water**

River/stream ☐

Pond/lake/dam ☐

Rainwater ☐

- **Tanker truck** ☐

- **Bottled water** ☐

- Other, specify.....

12. How much water do you use per day in your home?

- a) >1 * 20lt container ☐
- b) 1 - 2 * 20l container ☐
- c) 3 – 4 * 20l containers ☐
- d) 5 – 6 * 20l containers ☐
- e) Other (specify)

13. Do you pay for water?

- a) Yes ☐
- b) No ☐

14. If yes, how much do you pay for water per month?

15. How do you store your drinking water?

- Closed container/ Budiza ☐
- Open container/bucket ☐
- Other_____

16. How do you ensure that your drinking water is safe for consumption?

- a) Boil it ☐
- b) Add liquid chlorine ☐
- c) Nothing because it is already treated ☐
- d) Nothing ☐

17. Do you care about the source of your household drinking water?

- a) Yes ☐
- b) No ☐

18. If the City Council piped water was supplied to your household, would you be willing to pay for the service?

- a) Yes ☐
- b) No ☐

19. If yes in number 18, how much would you be willing to pay per month for your water bill?

- a) K15 – K25 ☐
- b) K26 – K36 ☐
- c) K37 – K47 ☐
- d) K48 or more ☐

20. If the City Council water is currently supplied to your household, how frequently do you receive the supply?

- 2-6 hours daily ☐
- 24 hours daily ☐
- None ☐
- Other _____

21. General

remarks

.....
.....
.....
.....

Thank you for your co-operation.

TRANSLATED QUESTIONNAIRE FOR HOUSEHOLDS

ZIMENE MUYENELA KUSATILA.

- a. Mufunsidwa kuyankha mafunso yonse momasuka kulingana ndi m`mene mudziwila.
 - b. Musalembepo dzina lanu pa pepala iyi yamafunso.
 - c. Chongani pa yankho imene muganiza kuti ndi yazowona kapena kulemba kulingana ndi m`mene mwauziwila.
-

PERSONAL INFORMATION

1. Dzina la malo anu:
2. Nambala ya nyumba:
3. Tsiku limene mwafunsidwa mafunso:
4. Zokhudza munthu wofunsidwa mafunso
 - e) Ndinu mwini nyumba ☐
 - f) Mungokhalamo cabe ☐
 - g) Musungidwa ☐
 - h) Ngati pali zina zace (fotokozani)
.....
5. Zaka zakubadwa:
 - f) >20 ☐
 - g) 21 – 30 ☐
 - h) 31 – 40 ☐
 - i) 41 – 50 ☐
 - j) <51 ☐
6. Mwamuna kapena mkazi:
 - c) Mwamuna ☐
 - d) Mkazi ☐
7. Maphunzilo munafika poti
 - e) Sindinapite kusukulu ☐
 - f) Pulaimale ☐
 - g) Sekondale ☐
 - h) Ndinafika ku koleji ☐

8. Mukhalapo angati panyumba
9. Mumapeza bwanji ndalama zakudya
- d) Nigulisa zinthu ☐
- e) Nisewenza ☐
- f) Nimalima ☐
10. Ndalama zimene mumapeza pamwezi ndi K.....

QUESTIONS ON WATER SUPPLY

11. Kodi madzi yamene mumagwilisa nchito yachokela kuti?
- **Madzi ya kupompi**

Mapompi yoikidwa mumalo athu (Munyumba) ☐

Mapompi yoika payadi pathu kapena pa poloti ☐

Pompi imodzi ya anthu ambili ☐
 - **Madzi yocokela pa cisime cosavalapo**

Cisime cosavalapo cili muyadi kapena pa poloti ☐

Cisime cosavalapo ca anthu ambili. ☐
 - **Cisime covalapo kapena borehole**

Cisime covalapo ndiponso cotetezedwa muyadi ☐

Cisime ca anthu ambili cotetezedwa (coikidwa ndi acounci ☐pena mabungwe ena)
 - **Madzi amumsinje**

Mumsinje/ ☐

Mumichela/Nyanja/Damu ☐

Madzi amvula ☐
 - **MumaTanka** ☐
 - **Madzi amubotolo** ☐
 - **Ngati pali zina, fotokozani.....**
12. Kodi mumagwilisa nchito madzi ambili motani patsiku imodzi?
- f) >1 * 20lt container ☐
- g) 1 - 2 * 20l container ☐
- h) 3 – 4 * 20l containers ☐
- i) 5 – 6 * 20l containers ☐

- j) Ngati pali zina (fotokozani)
13. Kodi mumalipila madzi? ☐
- c) Inde ☐
- d) Iyai
14. Ngati yankho ndi inde, kodi mumalipila zingati pa mwezi ?
15. Kodi madzi akumwa mumayasunga bwanji?
- Timaika mubudiza nakuvalapo ☐
- Timaika mubudiza yosavalapo/mun...omo ☐
- Pali njila zina_____
16. Kodi mumacita bwanji pofuna kuti madzi anu akumwa akhale abwino kumwa?
- e) Mumagadusa. ☐
- f) Timaikamo mankhwala a chlorine ☐
- g) Palibe cimene timaikamo, anaikamo kale ☐
- h) Palibe ☐
17. Kodi mumalabadila kumene mumatapa madzi akumwa?
- c) Inde ☐
- d) Iyai ☐
18. Ngati acouncil akuyikilani mapompi mumanyumba, kodi mungavomele kuyamba kulipila?
- c) Inde ☐
- d) Iyai ☐
19. Ngati yankho ndi ine pa namba 18, kodi mungavomele kulipila zingati pa mwezi kumadzi?
- d. K15 – K25 ☐
- e. K26 – K36 ☐
- f. K37 – K47 ☐
- g. K48 kapena kuposapo ☐
20. Ngati madzi acouncil muli nayo panyumba panu, kodi mumakhala nayo nthawi yaitali motani?
- Maola 2-6 masiku yonse ☐
- Maola 24 masiku yonse ☐

Kulibe



Pali zina _____

21. Pali zina zace zimene mungafune kulankhulapo

Zikomo potilola kukambilana nanu.

10.2 INTERVIEW GUIDE FOR LUSAKA WATER AND SEWERAGE COMPANY

QUESTIONS ON QUANTITY

1. Do you have someone responsible for water supply to the peri urban areas of Lusaka?
2. How much water does the company supply to Lusaka District as a whole?
3. How much of that water is supplied to the peri urban areas?
4. What is the average water consumption per person per day?
5. What is the average water consumption per household per day?
6. Do you supply water to all the peri-urban areas of Lusaka?
7. How much do you charge for water supply to the peri-urban areas per month?
8. Is there a specific component in your budget for peri-urban water supply?

QUESTIONS ON MICROBIOLOGICAL QUALITY

1. What are the main sources for domestic water for Lusaka's peri-urban areas?
2. Among these sources, which one is the most polluted?
3. What measures are there to control this water pollution?
4. Do you have a strategy for water quality control?
5. Do you monitor the microbiological quality of water in peri-urban areas?
6. How often do you draw water samples for microbiological water quality?

10.3 INFORMATION SHEET

University of Zambia
School of Medicine
Department of Public Health
Box 50110
LUSAKA

THE INTERVIEWEE INFORMATION SHEET.

INFORMATION:

My name is Lillian Mambwe Mutesu, a student at the University of Zambia. I am currently pursuing a Master of Public Health and this research is in partial fulfillment of the requirements for my Masters program.

I invite you to participate in my research, which I believe will contribute greatly to knowing about the quantity and microbiological quality of water supply in the peri urban areas of Lusaka. I would therefore, like to ask a few questions about the availability of water and the source of water in your area that I have prepared. This interview will take approximately **10 - 15 minutes**.

There are no direct benefits, compensation or incentives to you for participating in this study. However, the information that you will provide will contribute to the improvement of the domestic water supply in your community particular and the city in general. This will ultimately contribute clean water and healthy residents.

I have requested you to be part of my study because as a Lusaka resident, I believe that your contribution will be helpful to the development of policies on service provision. The answers to the questions will be treated as confidential and your name will not appear anywhere. In order to ensure confidentiality, no names or house numbers will be recorded. In this regard study participants will be assigned numbers. As mentioned earlier, the information obtained from this study will be only used for the purposes of this study and will not be availed to any

other person not connected to the study.

You have the right to withdraw or refuse to participate in the study before questions are asked or when questions are asked that you are uncomfortable with answering as they relate to the program.

Any information about you will be treated in the strictest confidence and will not be able to be linked to you. However, should you have any further queries, please do not hesitate to contact the following persons:

Lillian Mambwe Mutesu
University of Zambia, School of Medicine
Department of Community Medicine,
P. O Box 50110, Lusaka,
0977 853 625, and

The Chairperson
ERES Converge IRB
33 Joseph Mwila Road
Rhodespark, Lusaka
0955 155 633

Thank you for your willingness to contribute to the success of this research.

L. M. Mutesu
MPH Environmental Health Student
Signature.....

TRANSLATED INFORMATION SHEET

University of Zambia
School of Medicine
Department of Public Health
Box 50110
LUSAKA

PEPALA YA UTHENGA WA MUNTHU WOFUNSIDWA MAFUNSO

Ine zina langa ndine Lillian Mambwe Mutesu, ndine ophunzila pa sukulu la University of Zambia. Palipano nikucita maphunzilo okhudza zaumoyo wa anthu mumalo okhalamo ndipo nchito iyi imene nikuchita yofufuza ndi mbali imodzi imene izathandiza pazofunikila zakuti nikwanisa kumaliza maphunzilo anga amasters.

Nikupemphani kuti mutengeko mbali panchito yanga iyi yofufuza, imene nikhulupilila kuti izathandiza kwambili kuti tikhale odziwa zaukhondo wamadzi ndi zofunikila zina pa madzi yomwe timagwilitsa nchito mumalo yokhalamo mumzinda uno wa Lusaka. Conde, nizafuna kufunsa mafunso ang'ono cabe yofuna kudziwa ngati madzi yamapezeka kumene mukhala ndi kumene mumacotsa madzi mudela lanu. Ndipo kukambilana kwathu kuzatenga phindi pakati **10-15**.

Palibe phindu yeni-yeni imene izabwela, kulipilidwa kapena kupasidwa cinthu cina ciliconse kamba kakuti mwatengako mbali mu nchito iyi yofufuza. Koma uthenga umene inu muzapeleka uzathandiza kukomesa nchito zamadzi akumwa mumalo anu okhalamo ndi mumzinda wonse. Ici cizathandiza kuti mukhale ndi madzi abwino aukhondo ngakhale umoyo wa anthu uzakhala wathanzi.

Nakupemphani inu kuti mutengeko mbali mu nchito yanga iyi yofufuza kamba kakuti inu pokhala nzika ya mzinda uno wa Lusaka muzathandiza kukomesa nchito zamadzi muno mu Lusaka. Mayankho yomwe inu muzapeleka yazakhala yacisinsi ndipo dzina lanu sizalembedwa paliponse. Pofuna kuona kuti pakhala cisinsi, kulibe dzina kapena nambala ya nyumba imene tizalemba paliponse. Koma aja otengako mbali azapasidwa manambala. Monga m'mene nakambila paciyanbi, zonse zimene tizakambilana zizakhala zacisinsi ndipo kulibe munthu aliyense amene tizawonesa amene Sali modzi mwa anthu otengako mbali

panchito iyi yofufuza. Inu ndinu omasuka kukana kutengako mbali mafunso yakalibe kuyamba kufunsidwa kapena mafunso yayamba kufunsidwa ndipo sindinu okondwa ndi mafunso yomwe yakupelekedwa.

Uthenga uliwonse umene muzapeleka uzakhala wa cisinsi ndipo kulibe munthu aliyense amene azadziwa kuti uthenga uyu wochokela kwa inu. Koma, ngati pali mafunso yomwe mungafune kufunsa, Musataye nthawi kufunsa anthu awa:

Lillian Mambwe Mutesu
University of Zambia, School of Medicine
Department of Community Medicine,
P. O Box 50110, Lusaka,
0977 853 625, and

The Chairperson
ERES Converge IRB
33 Joseph Mwila Road
Rhodespark, Lusaka
0955 155 633

Zikomo kwambili pakuvomela kwanu kutengako mbali pa nchito iyi yofufuza.

L. M. Mutesu
MPH Environmental Health Student
Signature.....

10.4 CONSENT

The above information has been explained to me clearly and I fully understand and consent myself to participate in the research.

Full Name.....

Signature/thumb print.....

Date.....

Witness Name.....

TRANSLATED CONSENT

Uthenga wonse umene uli pamwamba wafotokozedwa kwa ine bwino-bwino ndipo ndine okonzekela kutengako mbali panchito yakufufuza.

Dzina lanu

Siginecha/fwatikani.....

Tsiku

Dzina la mboni

10.5 LABORATORY RESULTS



SCHOOL OF ENGINEERING
CIVIL ENGINEERING DEPARTMENT
ENVIRONMENTAL ENGINEERING LABORATORY

P.O Box 32379, Lusaka
Direct Telefax: 260-1-290962

Telegram: UNZA LUSAKA

Telex: ZA44370

BACTERIOLOGICAL EXAMINATION OF WATER

Attn : Lillian M.
Lusaka City Council
P. O. Box 30789
Lusaka
Sampled by : Client
Sampling date : 13.02.2014
Report date : 24.02.2014

Laboratory Results

Sample ID	Total coliforms (#/100ml)	Feacal coliforms (#/100ml)
M1	0	0
M2	TNTC	TNTC
M3	TNTC	TNTC
M4	85	58
M5	0	0
M6	0	0
M7	TNTC	TNTC
M8	TNTC	TNTC
M9	TNTC	TNTC
M10	TNTC	TNTC

M12	TNTC	TNTC
M13	70	48
M14	0	0

Tests carried out in conformity with “ Standard Methods for the Examination of water and Wastewater APHA, 1998”.

TNTC: Too Numerous To Count

Laboratory Results

Sample ID	Total coliforms (#/100ml)	Feacal coliforms (#/100ml)
J1	0	0
J2	71	40
J3	0	0
J4	TNTC	TNTC
J5	80	64
J6	TNTC	TNTC
J7	TNTC	TNTC
J8	0	0
J9	60	32
J10	0	0
J11	0	0
J12	0	0
J13	0	0
J14	TNTC	TNTC

Tests carried out in conformity with “ Standard Methods for the Examination of water and Wastewater APHA, 1998”.

TNTC: Too Numerous To Count

Laboratory Results

Sample ID	Total coliforms (#/100ml)	Feacal coliforms (#/100ml)
K1	0	0
K2	0	0
K3	7	0
K4	33	2
K5	36	8
K6	7	4
K7	0	0
K8	TNTC	TNTC
K9	0	0
K10	14	3
K11	TNTC	TNTC
K12	0	0
K13	0	0
K14	0	0

Tests carried out in conformity with “ Standard Methods for the Examination of water and Wastewater APHA, 1998”.

TNTC: Too Numerous To Count

Laboratory Results

Sample ID	Total coliforms (#/100ml)	Feacal coliforms (#/100ml)
C1	22	8
C2	14	2
C3	28	10
C4	0	0
C5	0	0

C6	14	6
C7	0	0
C8	0	0
C9	0	0
C10	0	0
C11	0	0
C12	0	0
C13	0	0
C14	0	0

Tests carried out in conformity with “ Standard Methods for the Examination of water and Wastewater APHA, 1998”.

Laboratory Results

Sample ID	Total coliforms (#/100ml)	Feacal coliforms (#/100ml)
G1	0	0
G2	66	5
G3	54	0
G4	36	0
G5	10	1
G6	0	0
G7	36	0
G8	0	0
G9	0	0
G10	0	0
G11	0	0
G12	0	0

G13	0	0
G14	0	0
G15		

Tests carried out in conformity with “ Standard Methods for the Examination of water and Wastewater APHA, 1998”.

Laboratory Results

Sample ID	Total coliforms (#/100ml)	Feacal coliforms (#/100ml)
KA1	0	0
KA2	0	0
KA3	13	3
KA4	18	5
KA5	88	42
KA6	42	10
KA7	TNTC	TNTC
KA8	TNTC	TNTC
KA9	18	2
KA10	24	3
KA11	44	0
KA12	52	9
KA13	103	12
KA14	96	10

Tests carried out in conformity with “ Standard Methods for the Examination of water and Wastewater APHA, 1998”.

TNTC: Too Numerous To Count

J. Kabika

Co-ordinator- Environmental Engineering Laboratory

Results

Serial #	Sample Ref. #	Type of sample	Aerobic Plate Count CFU/ml	Faecal Coliform CFU/100 ml
1.	W1252	Treated tap water	$<3.0 \times 10^2$	1
2.	W1253	Treated tap water	$<3.0 \times 10^2$	0
3.	W1254	Treated tap water	$<3.0 \times 10^2$	2
4.	W1255	Treated tap water	$<3.0 \times 10^2$	14
5.	W1256	Treated tap water	$<3.0 \times 10^2$	2
6.	W1257	Treated tap water	$<3.0 \times 10^2$	26
7.	W1258	Treated tap water	$<3.0 \times 10^2$	0
8.	W1259	Treated tap water	$<3.0 \times 10^2$	3
9.	W1260	Borehole water	$<3.0 \times 10^2$	1
10.	W1261	Borehole water	$<3.0 \times 10^2$	17
11.	W1262	Borehole water	$<3.0 \times 10^2$	55
12.	W1263	Borehole water	$<3.0 \times 10^2$	1
13.	W1264	Borehole water	$<3.0 \times 10^2$	1
14.	W1265	Borehole water	$<3.0 \times 10^2$	0
15.	W1266	Borehole water	$<3.0 \times 10^2$	11

The results were as tabulated above.


Hilary Chibiya
PUBLIC ANALYST

10.6 ETHICAL CLEARANCE



33 Joseph Mwilwa Road
Rhodes Park, Lusaka
Tel: +260 955 155 633
+260 955 155 634
Cell: +260 966 765 503
Email: eresconverge@yahoo.co.uk

I.R.B. No. 00005948
E.W.A. No. 00011697

31st October, 2013

Ref. No. 2013-Sept-004

The Principal Investigator
Ms. Lillian Mambwe Mutesu
Lusaka City Council
P.O. Box 30789,
LUSAKA.

Dear Ms. Mutesu,

RE: An Assessment of the Quantity and Microbiological Quality of Domestic Water supply in peri urban areas of Lusaka District, Zambia.

Reference is made to your corrections dated 28th October, 2013. Noting that all concerns have been addressed the IRB resolved to approve this study and your participation as Principal Investigator for a period of one year.

Review Type	Ordinary	Approval No. 2013-Sept-004
Approval and Expiry Date	Approval Date: 31 st October, 2013	Expiry Date: 30 th October, 2014
Protocol Version and Date	Version-Nil	30 th October, 2014
Information Sheet, Consent Forms and Dates	• English, Nyanja.	30 th October, 2014
Consent form ID and Date	Version-Nil	30 th October, 2014
Recruitment Materials	Nil	30 th October, 2014
Other Study Documents	Questionnaire for Households, Interview guide.	30 th October, 2014
Number of participants approved for study	-	30 th October, 2014

Where Research Ethics and Science Converge

Specific conditions will apply to this approval. As Principal Investigator it is your responsibility to ensure that the contents of this letter are adhered to. If these are not adhered to, the approval may be suspended. Should the study be suspended, study sponsors and other regulatory authorities will be informed.

Conditions of Approval

- No participant may be involved in any study procedure prior to the study approval or after the expiration date.
- All unanticipated or Serious Adverse Events (SAEs) must be reported to the IRB within 5 days.
- All protocol modifications must be IRB approved prior to implementation unless they are intended to reduce risk (but must still be reported for approval). Modifications will include any change of investigator/s or site address.
- All protocol deviations must be reported to the IRB within 5 working days.
- All recruitment materials must be approved by the IRB prior to being used.
- Principal investigators are responsible for initiating Continuing Review proceedings. Documents must be received by the IRB at least 30 days before the expiry date. This is for the purpose of facilitating the review process. Any documents received less than 30 days before expiry will be labelled "late submissions" and will incur a penalty.
- Every 6 (six) months a progress report form supplied by ERES IRB must be filled in and submitted to us.
- ERES Converge IRB does not "stamp" approval letters, consent forms or study documents unless requested for in writing. This is because the approval letter clearly indicates the documents approved by the IRB as well as other elements and conditions of approval.

Should you have any questions regarding anything indicated in this letter, please do not hesitate to get in touch with us at the above indicated address.

On behalf of ERES Converge IRB, we would like to wish you all the success as you carry out your study.

Yours faithfully,
ERES CONVERGE IRB


Mrs. M.M Mbewe
RNM, DNE, BSc., M.Ed.
ACTING CHAIRPERSON

10.7 LUSAKA WATER AND SEWERAGE COMPANY AUTHORITY



Lusaka Water and Sewerage Company Ltd.

Telephone : +260 211 257579/257580/257581
+260 211 257582/257583/250666
Telefax : +260 211 252578/251549
E-mail : lwsc@lwsc.com.zm

All Correspondence to be addressed
to the Managing Director

Stand # 871/2
Katemo Road, Rhodes Park
P.O. Box 50198
Lusaka, Zambia

22nd August, 2013
HRS/430/8073/HRM/PP/AHRO-qt

Ms Lillian M Mutesu
C/o Department of Public Health
School of Medicine
University of Zambia
LUSAKA

Dear Madam

RE: AUTHORISATION TO CARRY OUT RESEARCH-AN ASSESSMENT OF THE
MICROBIOLOGICAL QUALITY OF DOMESTIC WATER SUPPLY IN PERI-
URBAN AREAS OF LUSAKA.

We refer to your letter dated 9th July, 2013 in which you were requesting to carry out
research on the above stated subject.

We wish to inform you that Management has granted you authority to conduct research
in Peri-Urban operational areas of Lusaka Water and Sewerage Company Limited. This
authorization is on condition that results are used for academic purposes only.

Should you need further assistance, do not hesitate to contact the Manager - Human
Resources.

Yours faithfully

G Ndongwe
MANAGING DIRECTOR

10.8 GRADUATE FORUM CLEARANCE



THE UNIVERSITY OF ZAMBIA
SCHOOL OF MEDICINE

Telephone: 252641
Telegram: UNZA, Lusaka
Telex: UNZALU ZA 44370
Email: selestinenzala@yahoo.com

P.O. Box 50110
Lusaka, Zambia

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12th August, 2013

Ms Lillian Mambwe Mutesu
Department of Public Health
School of Medicine
LUSAKA

Dear Ms Mutesu,

RE: GRADUATES PROPOSAL PRESENTATION FORUM (GPPF)

Having assessed your dissertation entitled **"An Assessment of the Quantity and Microbiological Quality of Domestic water supply in Peri – Urban Areas of Lusaka District, Zambia"**. We are satisfied that all the corrections to your research proposal have been done. The proposal meets the standard as laid down by the Board of Graduate Studies.

You can proceed and present to the Research Ethics.

Yours faithfully,

Dr. S.H. Nzala
ASSISTANT DEAN, POSTGRADUATE

CC: HOD – Public Health

