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WASTE VALORISATION: EXPLORING WASTE PLASTIC BOTTLES MANAGEMENT IN AYAWASO WEST SUB-METROPOLITAN AREA, ACCRA

BY

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DECLARATION

I do hereby declare that this submission is my own work and that, to the best of my knowledge , it contains no material previously published by another person nor material which has been accepted for the award of any degree of at any University, except where due acknowledgement has been made in the text.

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DATE…… DATE……..

DEDICATION

I dedicate this thesis to my mother for her love and support through this entire academic journey.

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ABSTRACT

Management of waste in the Accra Metropolitan Area has been a very expensive venture for the Assembly over the years, yet coverage is still very low. Compounding the problem is the recent introduction of plastic products such as sachet water, whose waste are littered about the city daily. Bottled water, which has been on the market for years now, has always been a preserve of the rich. However, with the recent reports of falling sachet water quality, the bottled water industry appears to be expanding with more Ghanaian consumers patronizing the product. Managing the waste bottles therefore has the potential to become as challenging as the sachet water problem if sustainable solutions are not mapped out early. This study sought to look at the socio-demographic factors that are influencing the shift towards bottled water usage and also to assess the level of microbial contamination on waste bottles sold on the market to reusers. The study further sought to assess the possible management options available for the waste bottles. The results of the study showed that income level was the only socio-demographic variable that had a significant influence on bottled water patronage. This was attributed to the fact that bottled water is seen as safer and more hygienic than sachet water by most Ghanaians irrespective of their educational level, age or employment status. Media reports of unhygienic operations of illegal sachet water producers was given as the main reason for this perception. Income was the only limiting factor since bottled water is about eight times the price of an equal volume of sachet water. Thus as income levels in Ghana continue to rise, patronage of bottled water is expected to increase proportionally. Microbiological analysis of the used bottles from the markets revealed 60% of the bottles were contaminated with total coliforms and 40% of the bottles with faecal coliforms. The study proposed recycling as the best option for managing the bottles since reuse as it is currently practiced has serious public health implications and formalizing it would not be a financially viable option.

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LIST OF ACRONYMS

3R's	–	Reduce, Reuse, Recycle
AMA	–	Accra Metropolitan Assembly
CFSR	–	Centre for Fuel Studies Research
CHF	–	Cooperative Housing Foundation
CPCB	–	Central Pollution Control Board
DESSAP	–	District Environmental Sanitation Strategy Action Plan
EC	–	European Commission
EC DG ENV	-	European Commission Directorate General of Environment
EEA	–	European Environment Agency
EPA	–	Environmental Protection Agency
ETC/SCP	–	European Topic Centre on Sustainable Consumption and Production
EU	–	European Union
FDA	–	Food and Drugs Authority
GCLME	–	Guinea Current Large Marine Ecosystem
GLSS	–	Ghana Living Standards Survey
GSA	–	Ghana Standards Authority
GSS	–	Ghana Statistical Service
HACCP	–	Hazard Critical Control Points
HDPE	–	High Density Polyethylene
IRIN	–	Integrated Regional Information Networks
LDPE	–	Low Density Polyethylene
MSW	–	Municipal Solid Waste
NESSAP	–	National Environmental Sanitation Strategy Action Plan
PET	-	Polyethylene terephthalate (PET)

PP	-	Polypropylene
PS	-	Polystyrene
PVC	-	Polyvinyl chloride
SPSS	–	Statistical Package for Social Sciences
UNEP	–	United Nations Environment Programme
UNSD	–	United Nations Statistics Division
U.S.	–	United States
US EPA	–	United States Environmental Protection Agency
WHO	–	World Health Organization
Zoomlion AKTP	–	Zoomlion Africa Knowledge Transfer Partnerships

CHAPTER ONE

GENERAL INTRODUCTION

1.0 Introduction

Over the years, urbanization, industrialization and continuous economic growth have occurred worldwide. These processes have resulted in technological advancements, lifestyle changes and a general modernization of society as a whole. As a consequence, waste generation has increased both in type and volume (UNEP, 2009). Notably, the composition and volume of waste differs from low-income countries to high-income countries affecting the management choices in different parts of the globe. The main reasons why the waste characteristics vary are cooking and eating habits, social and economic factors, recycling and reuse, architecture and climate and geography. Notwithstanding, sustainable management of solid waste is a major problem for both national and local governments all over the world (Keynote, 2007).

1.1 Solid Waste Management in the Developed World

In the developed world such as the European Union (EU), over 3 billion tonnes of waste is generated annually comprising an increasingly complex mix of materials including plastics, metals and hazardous materials making waste management more and more complicated. The main waste management systems practiced in the EU are landfilling and incineration both having negative environmental impact (EEA, 2013). The impacts of landfilling include loss of land area resources, methane gas production which is a potent greenhouse gas, leachate production, which sometimes contain hazardous chemicals and heavy metals which runoff into nearby waterbodies, seep into groundwater and contaminate soils. Recognizing the serious impacts associated with this management method, the EU drafted legislations in 1995 covering all member states that govern

the use of landfills and these included reducing amount of waste landfilled and ensuring that methane generated at landfill sites are captured and used for energy production. This has made a significant difference, encouraging the closure of thousands of substandard landfills all over member states and reducing the amount of waste landfilled in the EU by about 25% since 1995 (EEA, 2013). The EU has also set standards for incineration which require that emission levels be restricted and recovery of heat generated as well as ensuring energy efficiency of the incineration plants. This has lead to a doubling of primary energy production from waste in the EU since 1995 (EEA, 2013). Prevention, Reuse and Recycling are the preferred management options in the EU thus member states through education and awareness campaigns, policies encouraging reuse and recycling targets for various materials have reduced the level of waste landfilled and incinerated. In spite of these interventions however, 67% of waste generated in the EU are still landfilled or incinerated.

In the United States, solid waste generation has increased by 65% since 1980 to about 250 million tonnes per year. The most common form of waste management is disposal in landfills with 54% of total solid waste generated in the United States being landfilled and these landfills in the U.S. were the third largest source of anthropogenic methane (CH_4) in 2010 (US EPA, 2011). Recycling and composting systems manage about 34.1% of solid waste generated in the United States. Curbside recycling programmes which have increased about three times since 1990, serve about 71% of people in the U.S. (US EPA, 2011).

The focus in the U.S. now is to reduce the amount of waste generated in the first place and also boost recycling rates thus many municipalities have implemented programs such as reuse centers,

food rescue and incentives such as Pay-As-You-Throw programs designed to reduce the volume of waste disposed off per household. Many states have deposit laws that encourage the return of empty containers for refunds (US EPA, 2010).

From the foregoing, it is discernable that, countries in the developed world have developed waste management systems which ensure efficient waste collection, storage, transportation and disposal while minimizing the impact of disposal on the environment. There is also emphasis on waste sorting, recycling and re-use including other practices which help to save waste management costs as well as further reducing the impact on the environment (Ukpong & Udofia, 2011). This is not the case in many developing countries.

1.2 The Solid Waste Situation in the Developing World

In the developing world, solid waste management is becoming a major public health and environmental concern. Solid waste management is one of the most difficult environmental problems in the urban centres of developing countries, where services are often grossly deficient, especially within low-income settlements. Often these low-income settlements comprise a sizable proportion of the city's area and population (UN-Habitat, 2010b). The public sector is unable to deliver services effectively and monitoring of the private sector is limited thus illegal dumping of both domestic and industrial waste is quite common. The difficulty in providing a level of service commensurate with demand is typically due to institutional, technical and financial constraints at national and local government levels, as well as in the private sector (UN-Habitat, 2010b).

In Nigeria, for instance, most state capitals and other large cities are littered with solid waste despite the presence of state and local government-owned waste management companies as well as private waste collectors (Ukpong and Udofia, 2011). In India, there is limited house-to-house collection and very old vehicles are used in waste collection. Although lots of significant efforts have been made in the last few decades in many developing countries supported technically and financially by developed countries and international organizations, substantial reforms in the management of solid waste have still not been attained (Khatib, 2011).

In developing countries, it is common for municipalities to spend 20-50 percent of their available recurrent budget on solid waste management. Yet, it is also common that 30-60 percent of all the urban solid waste remain uncollected and less than 50 percent of the population is served (World Bank, 2012). In some cases, as much as 80 percent of the collection and transport equipment is out of service, in need of repair or maintenance (World Bank, 2012). At best solid waste is collected and dumped at dumpsites, wetlands, water bodies or open space areas. Part of the solid waste is sometimes burnt openly to reduce the waste volume.

These practices have adverse impacts on the environment and causing long-term public health problems. Dumps are invaded by waste pickers and animals which scatter the wastes and the wastes serve as breeding grounds for disease vectors, primarily flies and rats. Leachate from decomposing garbage percolates into soil and nearby water sources, and the resultant contamination of food, water and soil can have serious environmental consequences. Uncollected refuse also finds its way into open drains; which become blocked causing flooding during rain,

and the dammed-up stagnant water encourages the breeding of mosquitoes resulting in turn in many cases of malaria.

1.3 The Solid Waste Situation in Ghana

In Ghana, the Environmental Health Sanitation Directorate of the Ministry of Local Government and Rural Development, NESSAP (2010) estimated that the average daily waste generation per capita was 0.75kg for municipal and metropolitan areas and 0.45kg for other small towns. The difference in waste generated per capita is linked to lifestyle differences. In small towns most of the waste generated is mostly organic and would be fed to livestock and food and drink containers reused for other household purposes (UN-Habitat, 2010b). In contrast, such waste generated in the towns and cities are mostly disposed of in the bins for collection. Therefore based on a population of about 4.01million (GSS, 2012), the Greater Accra Region alone generates approximately 1.09 million tonnes of waste annually.

Recent studies have shown that, high population growth and its associated increase in urbanization and economic activities in Accra have made the impact of the society's solid waste very noticeable. Currently, it is said that the Accra Metropolitan Assembly spends GH¢ 450,000 a month with an extra GH¢240,000.00 spent maintaining the landfill sites (Oteng-Ababio, 2010). This amount does not however cater for about 30% of solid waste in the metropolis that is littered or dumped on streets, in gutters and nearby water bodies (EPA, 2002). With these high levels of expenditure and low coverage rate, there is a need to re-evaluate the management systems in place such as to improve efficiency, sustainability and increase savings that can be used for other equally important competing developmental projects.

According to the UN-Habitat (2010a) the main objective of an efficient service should be minimization of solid waste collection costs, together with provision of an adequate and regular service to all target areas. In order to do this, one aspect of solid waste that should be critically evaluated is the waste characteristics. This would help determine which management systems would be most cost effective and what types of collection systems that must be put in place. It has been shown that with appropriate segregation and recycling systems, significant quantities of waste can be diverted from landfills and converted into resource (UNEP, 2009). In Accra, however, citywide waste composition data collection has been very limited. In most cases, projections have drawn on waste audit conducted by AMA in 1994. More recent waste characterization studies carried out have been limited in scale (Oteng-Ababio *et al*., 2012).

A waste audit carried out by Zoomlion at the major dumpsites in Accra in 2010 showed that Organics - 40.3%, Plastics – 19.7%, Paper – 7.0% had the highest composition in the waste generated in Accra (Zoomlion-AKTP, 2012). Of the three, waste plastics have increased rapidly over the past decade and have proved most problematic to manage over the years as they do not degrade easily and hence occupy space landfills, remain in the environment when littered about and choke up gutters and run-off into water bodies (Fobil and Hogarh, 2006).

In Ghana, studies by Fobil and Hogarh (2006) revealed that the use of plastic has been adopted as a more hygienic mode of packaging food, beverages and other products to replace the existing cultural packaging methods such as leaf wrappings, brown paper, cups etc. in cities and towns. Over the past two decades, Ghanaians have developed an insatiable taste for sachet water which is

seen as more portable and can easily be carried from one place to another. There is also a perception that sachet water is cleaner and more mineralized than tap water (Wienaah, 2007). At the same time, the waste from the used sachets form a major proportion of the plastic waste generated throughout the country and these sachets are littered on streets and gutters due to poor solid waste management practices in the country (Stoler *et al*., 2012).

Over the last few years, investigations conducted by the Food and Drugs Authority (FDA) and research institutions on sachet water from some companies have presented results that tend to question the safety of some of the water (Addo *et al*., 2009). The infiltration of water producers, who have not been certified by the FDA, has compromised some of the water found on the market. Accordingly, bottled water has over the years been promoted by experts as an alternative to help reduce the waste generated by the sachet water use (EPA, 2002). With the growing wariness of the quality of sachet water, more Ghanaians are turning to bottled water which is perceived to be of a higher quality than sachet water. A study conducted by Obiri-Danso *et al*. (2003) showed that bottled water on the Ghanaian market is of good microbiological quality while the quality of some factory bagged sachet and hand-filled/hand-tied polythene-bagged drinking water did not meet WHO standards for drinking water (WHO, 2011).

It is also important to state that in recent times, beverage companies in the country that used to offer their drinks only in refillable glass bottles now offer the option of the same drinks in disposable plastic bottles. Although this option is more expensive it is also apparently becoming increasingly popular with the Ghanaian public. New beverage companies are also springing up offering affordable drinks packaged in plastic bottles (Source: Market Survey).

It is important to state that though formal recycling of plastics has a recent history, the reuse of waste plastic has been informally experienced for a long time. Used plastic bottles in Ghana have always been sought after for reuse in homes and by traders. They are reused as containers for palm oil, locally prepared drinks, 'iced kenkey' etc. The bottles have thus been limited in the waste stream because they are picked and sold for reuse (Fobil and Hogarh, 2006). With the seemingly growing patronage of plastic bottled beverage, the rate of production of waste bottles may exceed the reuse needs which will invariably lead to an increase of plastic bottles in the waste stream making the need for alternative options quite imperative and imminent.

1.4 Statement of Problem

Over the years, the plastic waste from sachet water has become a serious problem in Ghana especially in the urban areas (Fobil and Hogarh, 2006). Government authorities are still grappling not only with the increasing volume generated, but also the product continues to change in form and type (Stoler *et al*., 2012). Recent years have seen increasing generation of plastic bottles. The upsurge in plastic usage has added to the problem of waste management due to the lack of appropriate institutional arrangements to tackle the problem. As at now, waste separation at the household level is not part of the vocabulary of any of the district assemblies. Those who indulge in waste separation do so voluntarily for the perceived financial gains. Thus, all waste generated are lumped together.

The current practice where wastes are lumped together have serious consequences environmentally and healthwise. For example, greater quantities of the plastics end up in the

dumpsites. Meanwhile, it is known that plastics are non-biodegradable and according to Finkelstein (2008) plastics can take up to 450 years to decompose. Additionally, when littered the plastics choke drains, degrade soil quality and are washed into nearby waterbodies where they degrade the quality of the water body. The choked drains also do not only result in incessant flooding, but they tend to become the breeding grounds for the anopheles mosquitoes responsible for the transmission of the malaria parasite.

More importantly, some of the waste plastic bottles generated are reused in homes, by traders and small scale beverage producers. Such informal reuse of plastic bottles, collected from among household waste, most likely contaminated, evince serious health concerns. It must be stated that though the idea of reuse of waste plastic bottles is commendable and is in tandem with tenets of proper waste management, the current system for the reuse of the plastic bottles is quite problematic.

To begin with there is currently paucity of data on the quantity of waste plastic bottles generated within the Accra Metropolis. Additionally, in the reuse process, it is not known the state in which the bottles are used as there are no standards for the sanitization of the bottles for reuse. Currently, no institution monitors and regulates the hygienic state before such bottles are used either to sell in the markets or within the neighbourhood. The microbial load on the reused bottles is unknown which can be a recipe for disaster and needs urgent policy intervention which cannot emanate from empirical vacuum.

This study attempts to fill this literature deficiency using the situation in Ayawaso West Sub-metropolitan Area in Accra as a case study.

1.5 Main Study Objective

The main objective of this study is to evaluate the waste plastic bottle situation in the Ayawaso West Sub-metro with the view to propose practical and sustainable management options.

1.5.1 Specific Objectives

The specific objectives of this study are to:

i. Assess the influence of socio-demographic factors on patronage of plastic bottles by residents in the Ayawaso West Sub-metro.

ii. Determine the microbiological quality of bottles reused for local beverages (first reuse).

iii. Assess the management options (based on 3R's – Reduce, Reuse, Recycle)

1.6 Research Hypotheses

The hypotheses which will guide the study are as follows:

i. Patronage of bottled beverages in Ayawaso West is independent of socio-economic and educational level.

ii. A significant proportion of waste bottles generated in the Ayawaso West Sub-metro are reused at home.

iii. Bottles reused for food are not microbiologically safe.

1.7 Study Rationale

Over the past decade, sachet water has become an important source of drinking water for most Ghanaians. However, the sachet water industry has come under attack in recent times over doubts of water quality as well as the waste the sector generates. Reports from studies carried out on the quality of sachet water have produced results indicating microbial contamination in some of the

samples. Bottled water has been seen as a more hygienic option in comparison to sachet water and its patronage has been on the increase in recent times. Although, this shift may be positive in providing a reliable source of drinking water as well as reducing waste sachet generation, currently there is no formal management system in place for waste plastic bottles. There is however an informal management system in place which involves the retrieval and reuse of the bottles by market women and small scale local beverage producers. The microbial load and hence health implications of reusing these bottles are unknown and thus poses a risk to consumers. The bottles not reused are littered about, choke up gutters, run off into water bodies or end up in landfills where they occupy space. This study is important to generate data towards developing a management plan as early as possible to forestall current or potential problems this type of waste might pose in future. Data from this study will serve as a baseline and a reference point for future studies.

1.8 Organization of the Study

This study is presented in six (6) chapters. Chapter one presents a general introduction to the study, outlining the problem, the study objectives, hypotheses and study rationale. Chapter two is essentially the review of the available literature on solid waste with emphasis on plastic waste. Chapter three presents some background information on the study area and outlines the various methods employed in carrying out the research. Chapters four and five are the analytical chapters in which various aspects of data collected from the field are examined and discussed in detail. Chapter six concludes with a summary of the major findings, conclusions and some recommendations for policy consideration.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter provides a literary review of the solid waste situation both at the international and national level, the contribution of plastic products to the solid waste problem and management options promoted over the years by experts. The chapter also examines the bottled water industry and how it has evolved in Ghana. The main purpose of this review is to provide a theoretical framework for this research, and show where the research fits in the existing body of knowledge as well as identify some of the gaps in existing knowledge.

2.1 Municipal Solid Waste: Character and Composition

According to Article 2.1 of the Basel Convention 1992**,** wastes are "…substances or objects which are disposed or are intended to be disposed or are required to be disposed of by the provisions of national laws…" (UNEP, 1992). The United Nations Statistics Division (UNSD) (2007) further defines wastes as "….materials that are not prime products (that is products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation or consumption, and of which he/she wants to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. Residuals recycled or reused at the place of generation are excluded…"

According to European Topic Centre on Sustainable Consumption and Production (ETC/SCP) (2009), waste types include, municipal solid waste (including commercial and household),

industrial (including manufacturing), hazardous waste, construction and demolition waste, mining waste, waste from electrical and electronic equipment (WEEE), biodegradable municipal waste, packaging waste, End-of-Life Vehicles (ELVs) and Tyres, and Agricultural waste.

Plastic bottles are generated on the household and commercial level and therefore fall within the Municipal Solid Waste (MSW) category of waste. Over the years a variety of descriptions reflecting different waste compositions have been used as definitions for Municipal Solid Waste (MSW) in different countries.

Schubeler (1996) defined municipal solid waste to include refuse from households, non-hazardous solid waste from industrial, commercial and institutional establishments (including hospitals), market waste, yard waste and street sweepings. Strange (2002) stated that the definition of MSW varies but typically includes waste arising from private households to that collected by or on behalf of local authorities from any source. Strange (2002) further states that depending on the country, the definition can include some or all of household wastes, household hazardous wastes**,** bulky wastes derived from households**,** street sweepings and litter**,** parks and garden wastes**.** The US EPA (2011) described MSW as everyday items that we throw away such as packaging, grass clippings, food scraps, bottles, furniture, clothing, appliances etc. that come from homes, offices, schools, hospitals and businesses. Eurostat (2012) also states that the definition for MSW varies in different countries, a reflection of diverse waste management practices. Eurostat (2012) therefore defined MSW as waste mainly produced by households though similar wastes can be generated from other sources such as offices, areas of commerce and public institution. In the United Kingdom MSW until 2011 was defined as waste materials

generated in homes, schools, shops and small businesses provided it was collected by a local authority or companies working for a local authority (Fewtrell, 2012).

Even though the definitions vary the key element that each has is that MSW results from activities of everyday life whether at home, work, school or in other locations. The Eurostat (2012) definition embodies this without being limited by specific examples and for the purpose of study will be the working definition for MSW.

It has been established that MSW is mainly generated from daily activities of humans. MSW generation rate is therefore one of the main aspects that influences its management. According to Keynote (2007) an estimated 2.02 billion tonnes of municipal solid waste was generated globally in 2006 representing an annual increase of 7% since 2003. The quantities of solid waste generated in highly developed countries range from 2.50kg - 1.99kg per capita per day with the least developed countries generating as low as 0.49kg per capita per day (Fewtrell, 2012).

In Ghana, the Environmental Health Sanitation Directorate of the Ministry of Local Government and Rural Development, NESSAP (2010) estimated that the average daily waste generation per capita is 0.75kg in metropolitan and municipal areas and 0.45kg for other small towns. The difference in waste generated per capita is linked to lifestyle differences. In small towns most of the waste generated is mostly organic and would be fed to livestock and food and drink containers reused for other household purposes (UN-Habitat, 2010b). In contrast, such waste generated in the towns and cities are mostly disposed of in the bins for collection. Therefore based on a

population of about 4.01 million (GSS, 2012), the Greater Accra Region alone generates approximately 1.09 million tonnes of waste annually (NESSAP, 2010).

Another major aspect of MSW that determines the type of management system required is the composition of this type of waste. In all countries, MSW generally comprises five major categories of waste namely putrifiable waste, paper, plastic, metal and glass. The proportions of these categories in MSW however vary within the different countries. Low income countries tend to have the highest level of putrifiable waste proportion which gradually decreases as affluence increases in favour of less putrifiable waste such as paper and plastics (World Bank, 2012).

In Accra, Ghana citywide waste composition data collection has been very limited. In most cases, projections have drawn on waste audit conducted by AMA in 1994. More recent waste characterization studies carried out have been limited in scale (Oteng-Ababio *et al.*, 2012). Fobil *et al*. (2005) for instance based on the characterization of MSW from 30 homes from three different income zones concluded that MSW in Accra is primarily made up 60% organic material, the remainder consisting of paper, plastic, glass, metals and textiles. A waste audit carried out by Zoomlion at major dumpsites in Accra in 2010, showed that Organics - 40.3%, Plastics – 19.7%, Paper – 7.0% had highest composition in the waste generated in Accra (Zoomlion-AKTP, 2012). Based on these studies it can be concluded that there has been an approximate decrease of about 25% in organics within a period of five years. This decrease could be attributed to increasing modernization and urbanization in Accra.

According to Buenrostro *et al*. (2001), variables such as economic, cultural, climatic, geographical, demographic and social dimensions play a key role in the quantities and composition of MSW generated in different countries. According to Wienaah (2007), the quantity and composition of solid waste generated by a society is usually related to the cultural practices as well as the economic level of the population. Kreith (1994) further states that the factors that tend to increase the per capita and total amount of wastes as well as their constituents in waste stream include increased population, increased levels of affluence, changes in life style, changes in work patterns, new products, redesign of products, material substitution and changes in food processing and packaging methods. In the opinion of Strange (2002), apart from population density and economic prosperity, seasonality, housing standards and the presence of waste minimization initiatives are factors that also determine the composition of household waste.

With such varied definitions for MSW and so many variables influencing the quantities and composition of waste in different countries, it is important to note that a management system in one country may not necessarily work for another country. The UN-Habitat (2010a) is therefore of the view that countries especially low-income and middle-income countries should develop their own models for modern waste management that fit their own local conditions rather than developing imperfect copies of waste management systems from the developed world.

2.2 Current Municipal Solid Waste Management (SWM) Practices

According to Strange (2002) SWM in society has been a challenge for as long as people have gathered together in sufficient numbers to impose a stress on local resources. In the past, waste from homes and industries could be dealt with simply by hauling it to crude dumps where it could be buried, eaten by animals or burned. This practice still exists in some poor countries, however,

its effectiveness and sustainability remains questionable due to the changing nature of the character and volume of waste generated even in these poor countries.

In spite of relatively lower generation rates solid waste management in developing countries is still highly underdeveloped (Badgie *et al.*, 2012). Every year, governments of developing countries spend substantial resources on collection and disposal of waste but management system remains inadequate and expensive (World Bank, 2012). According to Guerrero *et al.* (2013) solid waste management is a challenge for the cities' authorities in developing countries mainly due to the increasing generation of waste, the burden imposed on the municipal budget as a result of the high costs associated to its management, the lack of understanding over a diversity of factors that affect the different stages of waste management and linkages necessary to enable the entire handling system functioning.

The main disposal options for municipal solid waste include disposal in a landfill and incineration. A modern properly engineered landfill is a large depression in the ground lined with synthetic liner and, in some state-of-the-art facilities, fitted leachate and/or methane collection equipment. Landfills are usually covered with soil and/or clay after they are filled (Ghosh and Hasan, 2010). Recycling and reuse are also other forms of municipal solid waste management which are more desirable environmentally. Recycling/reuse reduce the volume of solid waste that need to be disposed of and as a result helps to extend the lifespan of disposal facilities such as landfills (Ruzi, 2001).

Generally, solid waste in Ghana is managed through landfills, incineration, recycling or reuse. However, the choice of management depends on the type of waste. MSW is mainly managed

through landfills in Accra. These landfills are primarily open dumps without leachate or gas recovery systems. These landfills mostly consist of abandoned stone quarry sites, gouged natural depressions in the earth, or man-made holes in the ground. This type of landfilling is the preferred method of disposal by the Accra Metropolitan Assembly, because it is relatively affordable compared with setting up recycling/reuse system (Thompson, 2010). In spite of the seeming affordability of landfills, they have disadvantages that make it important to explore other more sustainable options. According to Kwawe (1995) and Botkin and Keller (2003) issues such as leachates in groundwater, unavailability of land and opposition of residents in areas proposed for landfills are among some of the disadvantages. Also Bogner *et al*. (2007) stated that methane emissions from landfills represent the largest source of greenhouse gas emissions from the waste sector, contributing, around 700 metric tonnes of carbon dioxide. According to Kwawe (1995) experiences from London showed that by 1995 waste disposal trucks had to travel over 64 km outside Central London to dispose of waste because all the landfills were full and there was no longer available land within closer reach. Botkin and Keller (2003) also noted that at the rate waste was being generated in the USA, the country might soon ran out of landfill space. In Ghana, contrary to Tsiboe and Marbell observation in 2004 that the "Not in my Backyard" syndrome had not taken root in the country, in May 2004, residents of Kwabenya in Accra held a series of demonstrations at the World Bank Offices against a proposed landfill which was to be sited within their community which eventually contributed to the stalling of the project (Oteng-Ababio, 2011). The AMA is currently over-dependent on the landfill system, this system is however unsustainable and there is a need to look to explore other options available.

The composition of the waste generated could inform the direction of the choice of the management system(s). As mentioned earlier, organics, paper and plastics form the major constituents of Accra's MSW. Critically, examining the options available for managing these components individually may be the key to unraveling the MSW management problem in Accra. This study will take a look at the options available for isolating and managing the plastic component of MSW in Accra taking into account the socio-demographic factors that are influencing the generation of these plastics and how these factors will further influence the success of managing these plastics.

2.3 Plastics: Types, Characteristics and their Wastes

Merriam-Webster Collegiate Dictionary, 11th edition, refers to plastics as "any of numerous organic synthetic or processed materials that are mostly…. polymers of high molecular weight and that can be molded, cast, extruded, drawn, or laminated into objects, films, or filaments." Baird & Cann (2008) describe plastics as polymers, a very large molecule made up of smaller units called monomers which are joined together in a chain by a process called polymerization. All the raw materials (except chlorine) from which the plastics are currently made are obtained from crude oil.

2.3.1 Types and Characteristics

Plastics are classified based on the polymers they are made from. The six major types of plastics that are commonly reprocessed are Polyethylene (PE) (High-density and Low-density), Polypropylene (PP), Polystyrene (PS), Polyethylene terephthalate (PET), Polyvinyl Chloride (PVC) (UNEP, 2009). These six polymers are thermoplastic**,** meaning that with heat they can be

melted and reshaped over and over again. Apart from Low Density Polyethylene (LDPE), all these types of plastics can be used in the bottling industry (Eubanks *et al*, 2009).

Plastic is a relatively cheap, durable and versatile material. Plastic products have brought benefits to society in terms of economic activity, jobs and quality of life. Plastics can even help reduce energy consumption and greenhouse gas emissions in many circumstances, even in some packaging applications when compared to the alternatives (EC DG ENV, 2011). Enviros RIS (2001) further stated that plastics are used by virtually every end-use segment of the economy and that the unique attributes of plastics such as processability, light weight and corrosion resistance have led to the creation of new products, and plastics have also displaced paper, glass and metal from traditional applications. According to Palminsano and Pettigrew (1992), plastics were specifically designed to resist degradation and to be durable thus they are inert. This durability had been considered to be a positive attribute for plastics, but now is commonly perceived by society as a negative.

2.3.2 Plastic Waste

Generally, plastic waste is the third major constituent of municipal waste in most cities after organics and paper (CFSR, 2011). In some cities, however, it is the second major constituent of municipal waste. The rapid increase in waste plastics worldwide has been attributed to growth in trade and industry and changing consumption patterns.

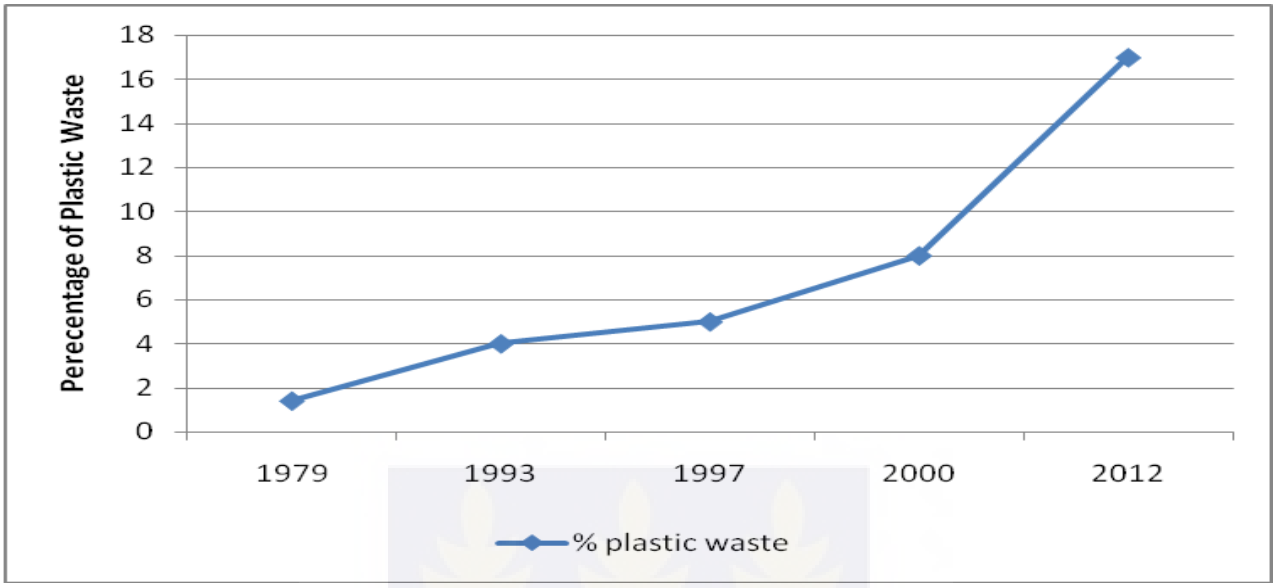
The world's annual consumption of plastic materials has increased from around 5 million tonnes in the 1950s to nearly 100 million tonnes (UNEP, 2009). The increase in consumption of plastic is not restricted to only the developed countries, cities in countries with low economic growth

have also started producing more plastic waste due to increased use of plastic packaging, plastic shopping bags, PET bottles and other goods/appliances using plastic as the major component (UNEP, 2009).

According to the Central Pollution Control Board (CPCB) of India (2007), there has been a tremendous rise in the usage of plastic disposables, such as packaging materials, house-hold consumer goods, automobiles, building containers, agriculture, electrical and electronics goods, health care products etc. and this coupled with the throwaway culture, lack of awareness and indifference among common people has lead to huge quantity of such waste on roads, pavements, gardens and parks, low-lying area, sewage drains, water bodies, along railway tracks and everywhere.

In Ghana, the major plastic wastes generated in the country include plastic bottles, polythene bags, sachets and wrappers. Schweizer & Annoh in 1996 analysed the historical trend of plastic waste composition in the waste stream in Ghana. Their results showed that in 1979 the percentage by component was 1.4% and by 1993 it had risen to 4%. In 1996/97, the proportion of plastic waste in the waste stream was 5% (Archer *et al*., 1997) and by 1999/2000 its proportion increased to 8% (Fobil, 2000). Currently, it is estimated that 1,980 tonnes (about 17% of total waste generated) of plastic waste is generated daily in the country, with 70% of the waste ending up in drains and at open spaces (Daily Graphic, 2012). This increasing trend is shown in Figure 2-1.

Figure 2-1: Percentage of plastic waste stream over a period of 30 years



(Source: Schweizer &Annor (1996), Archer et.al (1997); Fobil (2000), Daily Graphic (2012))

Statistics released by the AMA and other waste management bodies indicate some 270 tonnes of plastic waste is generated each day in Accra alone (IRIN, 2004). Plastic waste generation currently stands at 0.016–0.035 kg/person/day (Fobil and Hogarh, 2009). It is estimated that there are over 40 plastic producing industries in the country producing over 26,000 metric tonnes of finished plastic products per annum. Also about 10, 000 metric tonnes of finished products are imported annually into the country (Fobil, 2000).

2.3.3 Types of Plastic Waste

According to Metro Vancouver (2008) the plastic wastes present in municipal waste streams include:

a. Polyethylene terephthalate (PET) soft drink and custom bottles;

b. High Density Polyethylene (HDPE) bottles and jugs;

c. Polyvinyl chloride (PVC) bottles;

d. Wide mouth tubs and lids which includes LDPE, HDPE, and polypropylene (PP);

e. Polystyrene (PS);

f. Plastic films (including recyclable and non-recyclable);

g. Other residential plastics.

The Metro Vancouver residential waste audit in 2008 showed an annual per capita generation trend as follows: 7.55kg of plastic films, 4.96kg of plastic bottles, 3.18kg of other rigid containers, and 3.79kg of durables (toys, storage bins, pens, brushes etc). A waste stream analysis carried out by the Resource Recovery Forum (2001) in Eastleigh, UK showed the following trend 6.92% of plastic films, 3.51% of food and non-food packaging, 2.52% of plastic bottles and 2.08% of other dense plastic.

2.3.4 Management of Plastic Waste

ENVIS India (2008) has recommended the 3 R's principle i.e. Reduce, Reuse & Recycle as the basic components of any waste hierarchy that has to be understood and implemented to achieve a sustainable integrated waste management. Metro Vancouver (2008) states that the waste hierarchy has taken many forms over the past decade, but this basic concept has remained the cornerstone of most waste management strategies. The aim of the waste hierarchy is to extract the maximum practical benefits from materials and to generate the minimum amount of waste. The United Nations environmental program endorses The Waste Management Hierarchy, as do citizen groups, many industry leaders, and government officials in Europe, North America and Japan (Wagner, 1995).

The EU strategy for waste management, adopted in 1989 and reviewed in 1996, specifies that waste management should first of all aim at preventing waste generation. Material waste recycling and the incineration of waste with energy recovery should be pursued if prevention is not possible. The 'worst' options are identified as the use of landfill and incineration without energy recovery (EU, 2007). The Japanese Ministry of Environment (2005) has also outlined five major keywords that are necessary for the success of a sound material-cycle society. These are awareness creation, information sharing, partnership among various bodies, technological development and incentives.

The comprehensive waste management strategy adopted by Kenya for the city of Nairobi with the aid of UNEP in 2006 was also based on the 3R's principle. According to the Kenyan Cleaner Production Centre in 2006, factors that could however affect the effectiveness of this approach include awareness and acceptance among stakeholders i.e. MMDA's, businesses and residents, a policy framework to facilitate the implementation and capacity building and lack of technological support including human resources, finance and other inputs. In Ghana, NESSAP (2010) promotes reduction, re-use, recycling and recovery (4R's) of all types of waste streams as a way of reducing the volume and cost of waste delivered to final disposal sites.

In Ghana, segregation of domestic waste at source is not officially mandated and is therefore practiced on voluntary basis by few households largely motivated by cash returns that can be earned (CHF, 2010). Most waste reused or recycled are recovered from the waste stream. This collection and re-use/recycling of plastic waste is done mainly by the informal sector. This activity is however seen more as an income generating activity than a waste management strategy.

Formalizing the sector has the potential to lead to loss of income and this might raise opposition (Bjerkli, 2005). It is important to take into consideration these elements during the planning and implementation of a waste management plan.

In the waste plastic sector in Ghana, thin-film plastics which generally include empty water and ice cream sachets, black polythene carrier bags and thin-film wrappers used by vendors, are high-value recyclables used in the production of pellets which are the main raw materials for plastic manufacturing companies. Informal waste pickers are therefore actively involved in recovering this type of waste for sale to plastic manufacturing companies. This type of waste is therefore seen as having a high potential for value addition when recycled (CHF, 2010).

2.3.5 Environmental Impacts of Plastic Waste

Plastic waste has several impacts on ecosystems and humans. Some of these are more obvious and clearly proven, for example, the entanglement of marine wildlife. Others are less obvious and not well understood, such as the transport and possible concentration of contaminants by plastic waste. Again, there appears more knowledge of ecological and human health impacts in the marine environment than on land (UNEP, 2009). According to the European Commission DG ENV (2011) rising use of plastics and plastic waste generation as well as increasing levels of export form the most significant trends in environmental impacts of plastics. This is because the primary raw material for plastic will continue to be fossil fuels despite the expected rapid rise in the production of bioplastics, increasing plastic waste production will require an expanded waste management system and rising levels of export mean that plastics manufactured in developed countries will end up in developing countries without the management systems needed in place.

The CPCB India in 2007 stated that though plastics are not chemically active their major threat to the environment is essentially the fact that they are non-biodegradable and currently lack an efficient collection and disposal system. They float in water bodies close to the cities, settle on their beds, and cutting off oxygen to aquatic life and to anything they rest on. They also affect soil fertility and water percolation in the ground preventing the growth of plants. They also emit toxic gases when burnt (CPCB, 2007).

With the increasing usage of plastic registered by the Food and Drugs Authority, there is the need to study the potential for reuse/recycling of the waste plastic bottles in Ghana. Currently, no study has been carried out in Ghana regarding the fate of plastic bottles recovered from the waste stream.

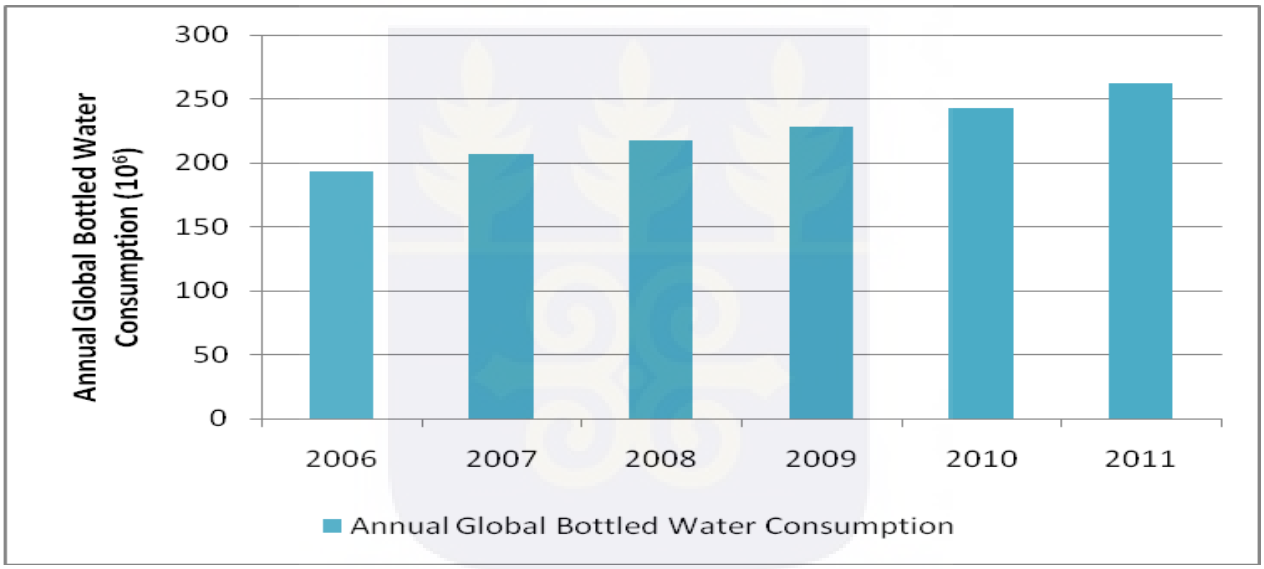
2.4 The Bottled Water Industry

The term 'bottled water' refers to water packaged in aluminium cans, laminated cartons, plastic bags, plastic or glass bottles. The most common form of packaging is however the plastic and glass bottles. Bottled water can come in various sizes from single serving packaging up to 80L carbuoys (WHO, 2000). Warburton (2000) also defines bottled water as any potable water that is manufactured, distributed or offered for sale, which is sealed in food-grade bottles or other containers and intended for human consumption.

According to the American Beverage Association (2013), the plastic bottles, most especially the PET bottles are the fastest growing preferred form of packaging for most beverage bottling companies because of its lightweight and durability. Plastic packaging is preferred over glass in

almost every country (Rodwan, 2012). Globally, bottled water consumption has increased dramatically. According to the Beverage Marketing Corporation, 154 billion litres of bottled water was consumed in 2004, an increase of 57% within a space of 5 years. The United States leads globally in consumption levels at 26 billion litres in 2004 (Franklin, 2006). An analysis of the global trend in bottled water consumption done by Zenith International in 2012 is shown in Figure 2-2.

Figure 2-2: Annual Global consumption of Bottled Water



(Source: Zenith International, 2012)

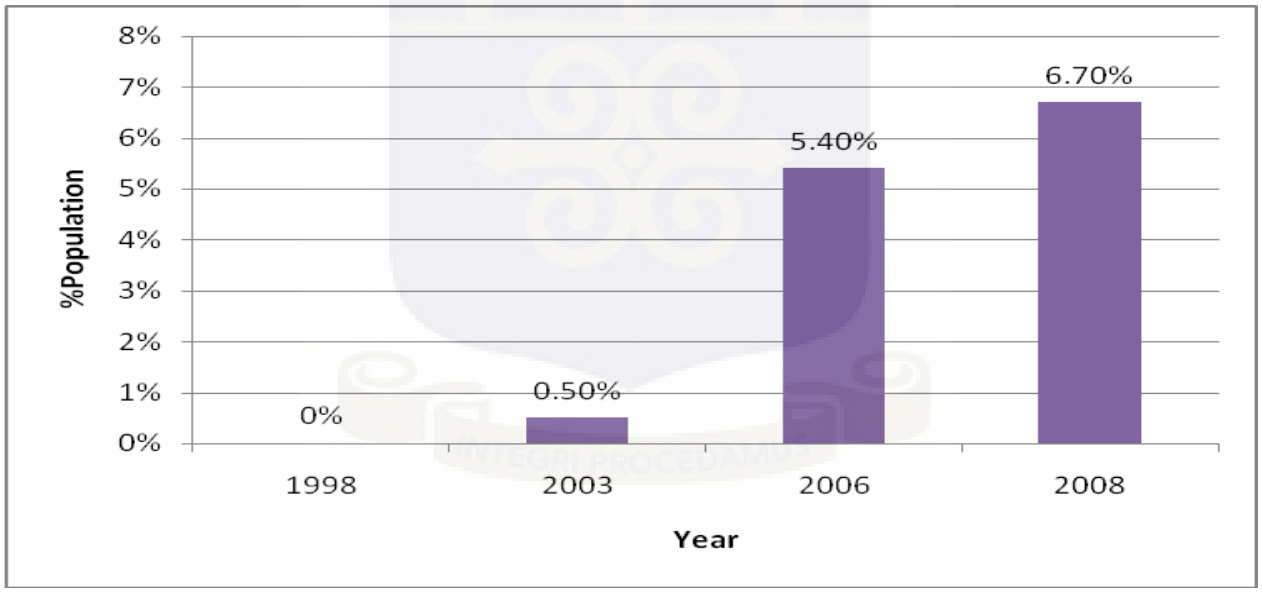
Figure 2-2 shows an increment of about 36% in bottled water consumption from 2006 to 2011 with an average yearly increase of about 6%. This increase in consumption will also result in a proportional increase in waste plastics generated requiring proper management to safeguard the environment.

Ferrier (2001) has attempted to assign reasons for the increase in bottle water consumption stating that consumption of bottled water reflects a certain way of life and that consumers think it tastes

better than tapwater. Also bottled water is perceived as safer and of better quality than tapwater. Bottled water is also seen as a healthier alternative (in terms of calories) to other beverages, thus some consumers drink bottled water to lose weight. The use of PET bottles rather than glass bottles also make the product lightweight and easier to carry around. Drinking bottled water is also sign of rising in the social scale (Ferrier, 2001).

In Ghana, the use of bottled and sachet water as a primary source of drinking water has increased over the past ten years from 0% in 1998 to 6.7% in 2008 (WSMP, 2009). This is as shown in Figure 2-3.

Figure 2-3: Percentage of Population Patronizing Packaged Water from 1998 – 2008



(Source: Water and Sanitation Management Platform Publication, (WSMP, 2009))

Prior to the introduction of sachet and bottled water in Ghana, water was sold to the transient population in plastic or metal cups from buckets. Until the early nineties, this was the main source of water for people moving from one point to another (Stoler *et al.*, 2012). This system however had its hygiene and sanitary shortcomings such as one cup being used by several people without

any form of proper sanitization. In an attempt to remedy this problem, hand-tied plastic bagged water was introduced in the early nineties. Hygiene however remained a problem with the bagging process exposing the water to all degrees of contamination from the women and children involved in the process (Obiri-Danso *et al.*, 2003).

In the late nineties, a new machinery was introduced in Ghana and many other West African countries. This machine could heat-seal water into plastic sachets effectively creating the sachet water (Stoler *et al.*, 2012). Filtration, chemical treatment and other forms of disinfection systems were later incorporated resulting in our modern day sachet water. Over the past decade, the sachet water has become increasingly popular because of the perception of it being cleaner and more mineralized than tap water (Wienaah, 2007). There are currently over 800 sachet water producers in Ghana registered with the Food and Drugs Authority (www.fdaghana.gov.gh). With the increase, however, the quality of the sachet water has come under intense scrutiny in recent times.

The proliferation of illegal producers who oversimplify the production process of sachet water ignoring hygiene standards required by the regulatory authorities has become widespread. In 2011, over 100 companies were closed down by a team of FDA and GSA officials for operating illegally (Daily Graphic, 2013). This development coupled with results of studies done by several researchers showing unacceptable levels of bacteria in sachet water has made Ghanaians increasingly cautious about the source of their drinking water. A summary of results of studies addressing sachet water quality undertaken over the last decade is presented in Table 1.

Table 1: Summary of Results on Studies Addressing Sachet Water Quality

Reference	Study Area	Sample Size	Quality Measure	Results
Obiri-Danso *et al.*, 2003	Kumasi	88	Total Coliform, Faecal Colifom	4.5% elevated TC, 2.3% FC
Dodoo *et al.*, 2006	Cape Coast	180	Total Coliform, *Escherichia Coli*	45% TC, 14% *E. Coli*
Ampofo *et al.*, 2007	Southern Ghana	78	Total Coliform, Faecal Coliform, Salmonella, Clostridium and Bacillus spp.	40.2% elevated TC, 8.4% FC, 3.4% - 8.4% various bacterial species
Kwakye-Nuako *et al.*, 2007	Accra	27	Four parasitic organisms	77.8% contained one or more than protozoan pathogens
Okioga, 2007	Tamale	15	Total Coliform, Faecal Coliform	47% elevated TC, 6.7% FC
Addo *et al.*, 2009	Teshie – Nungua, Accra	30	Total Coliform, Faecal Coliform	100% high TC counts, 20% contained FC

(Source: Stoler et al., 2012)

According to Stoler *et al*. (2012), on the other hand, bottled water has always been available in Ghana through the shops and supermarkets; it however mainly catered for the rich due to higher price as compared to the sachet water. However, in an attempt to safeguard their health Ghanaians are gradually turning to bottled water. Bottled water tested in all the studies listed above met the quality standards set by the WHO. As a result patronage of bottled water which hither to has been the preserve of the elite has been on a gradual ascendency. Currently, there are over 20 bottling companies registered with the Food and Drugs Board. Table 2 gives a summary of the seven major water bottling companies and the price of their bottled water and sachet water of equal volume (See Appendix 1 for full list).

Table 2: Major Bottling Companies in Ghana

Company Name	Brand Name	Products	Prices (GH¢)
Voltic Ghana Limited	Voltic Natural Mineral Water	500 ml Sachet Water	0.10
	Cool pac Treated Water	500 ml Bottled Water	0.80
Magvlyn Industries Limited	Mobile Refreshing Natural Mineral Water	500ml Sachet Water	0.10
		500ml Bottled Water	0.80
Yes Natural Mineral Water	Yes Natural Mineral Water	500 ml Sachet Water	0.10
		500 ml Bottled Water	0.80
Ice Cool Purified Water Ltd., Tema	IceCool Purified Water	450 ml Sachet Water	0.10
		500 ml BottledWater	0.80
Everpure Ghana Ltd.	Everpure Drinking Water	500ml Sachet Water	0.10
		600ml Bottled Water	0.80
Baron House Limited	Ice Pak Mineral Water	500ml Sachet Water	0.10
		500ml Bottled Water	0.80
Special Ice Mineral Water	Special Ice Mineral Water	500ml Sachet Water	0.10
		500 ml Bottled Water	0.80

(Source: Food and Drugs Authority Website; Market Survey, 2013)

Most bottling companies produce both sachet water and bottled water. However, a few such as BonAqua Premium Drinking Water and Belaqua Mineral Water limit their products only to bottled water. Sachet water is commonly sold in 500ml volumes. Bottled water is however sold in several different volumes ranging from 500ml – 1.5L and 19L Dispensing Jars. For the purpose of comparison and avoidance of confusion, only the prices of the 500ml sachet water and the 500ml Bottled water have been presented in Table 2. As can be seen, bottled water costs about eight times the price of an equal volume of sachet water.

However it must be noted that, in spite of the apparent increase in bottled water production in the country in response to the increasing patronage, sachet water still remains extremely popular in

Ghana possibly because of economic reasons. Table 3 shows the regional distribution of sachet water and the bottled water producers in Ghana (See Appendix 1 for full list of companies).

Table 3: Number of Bottled and Sachet Water Producers in Ghana by Regions

Region		Packaged Water Producers in Ghana			
		Sachet Water		Bottled Water	
		No.	% of Total	No.	% of Total
1.	Ashanti Region	480	56.3	2	9.5
2.	Brong Ahafo Region	49	5.8	1	4.8
3.	Central Region	26	3.1	0	0.0
4.	Eastern Region	52	6.1	2	9.5
5.	Greater Accra Region	112	13.2	16	76.2
6.	Volta Region	42	4.9	0	0.0
7.	Northern Region	5	0.6	0	0.0
8.	Western Region	76	8.9	0	0.0
9.	Upper West Region	2	0.2	0	0.0
10.	Upper East Region	8	0.9	0	0.0
	Total	**852**	**100**	**21**	**100**

(Authors Compilation, Data Sourced from Food and Drugs Authority website)

The table depicts two interesting readings. First it is clear that the production of bottled water is skewed towards Greater Accra, recording about 76% concentration. This is in conformity with the general location pattern of most industries in Ghana. According to a UN-Habitat (2009) city profile report, Accra is the second most industrialised city in Ghana, contributing over 10% to the GDP. Over 30% of the manufacturing activities are located in the city offering 22.34% employment to labour force in Accra. Prior research (GLSS, 2008) describes Accra as the most economically endowed city, located in a region (Greater Accra) having the highest per capita income of GH¢544.00 in the country. This implies that all things being equal, most residents in

the region would be most likely to afford bottled water in spite of its high price. This may have accounted for more bottled water producers in this region.

Secondly, like the bottled water, majority of sachet water producers are concentrated in Ashanti and Greater Accra, regions, the most populous and economically endowed areas. The table reveals that Ashanti region accounted for 56.3%, of a total of 852 sachet water producers in Ghana. Greater Accra Region had a relatively lower percentage yet a significant number of sachet water producers at 13.2%. The Upper West and East regions had the lowest numbers of 0.2% and 0.9% of sachet water producers respectively with no bottled water producers registered in the two regions. This could be attributed to the fact that these two regions are also the poorest in the country with majority of residents engaged in unstable economic conditions, and live below the national poverty line of $210 per year (GLSS, 2008) therefore the production and patronage of both sachet and bottled water would not be affordable to residents within these regions.

There has however been little research into the transformation of drinking water delivery, exploring how privatized, packaged water is changing the drinking water landscape in developing urban centers such as Accra as well as West Africa in general (Stoler *et al*., 2012).

2.3.1 Waste Plastic Bottles

With the growing bottled water industry comes the associated waste i.e. the bottles. Plastic bottles even though the most readily recycled plastic products, have recycling rates as low as 10% in some countries. The rest end up in landfills, incinerators and in the oceans. In the U.S. the largest producer of this waste only about 20% of the bottles are recycled (US EPA, 2011).

In Ghana, there is very little published information on the fate of the plastic bottles generated in the country. According to Fobil and Hogarh (2006), these bottles are traditionally sought after for reuse in homes, by traders and local beverage manufacturers. Booyens (2012) states that one health concern that needs to be taken into account when reusing plastic bottles is that people can easily spread bacteria from their hands and mouth in sharing and reusing bottles that have not been properly washed and dried. Reynolds (2005) also stated that improper maintenance of plastic beverage bottles can lead to contamination with human faecal bacteria, or other harmful microbes, and with harmful chemical by-products that can leach into the water. A study carried out by Oliphant *et al*. (2012) found that 8.9% of 68 and 64.4% of 76 water samples collected from personal water bottles of elementary school children in the USA were contaminated with faecal coliform and Heterotrophic Plate counts, respectively, that exceeded federal standards.

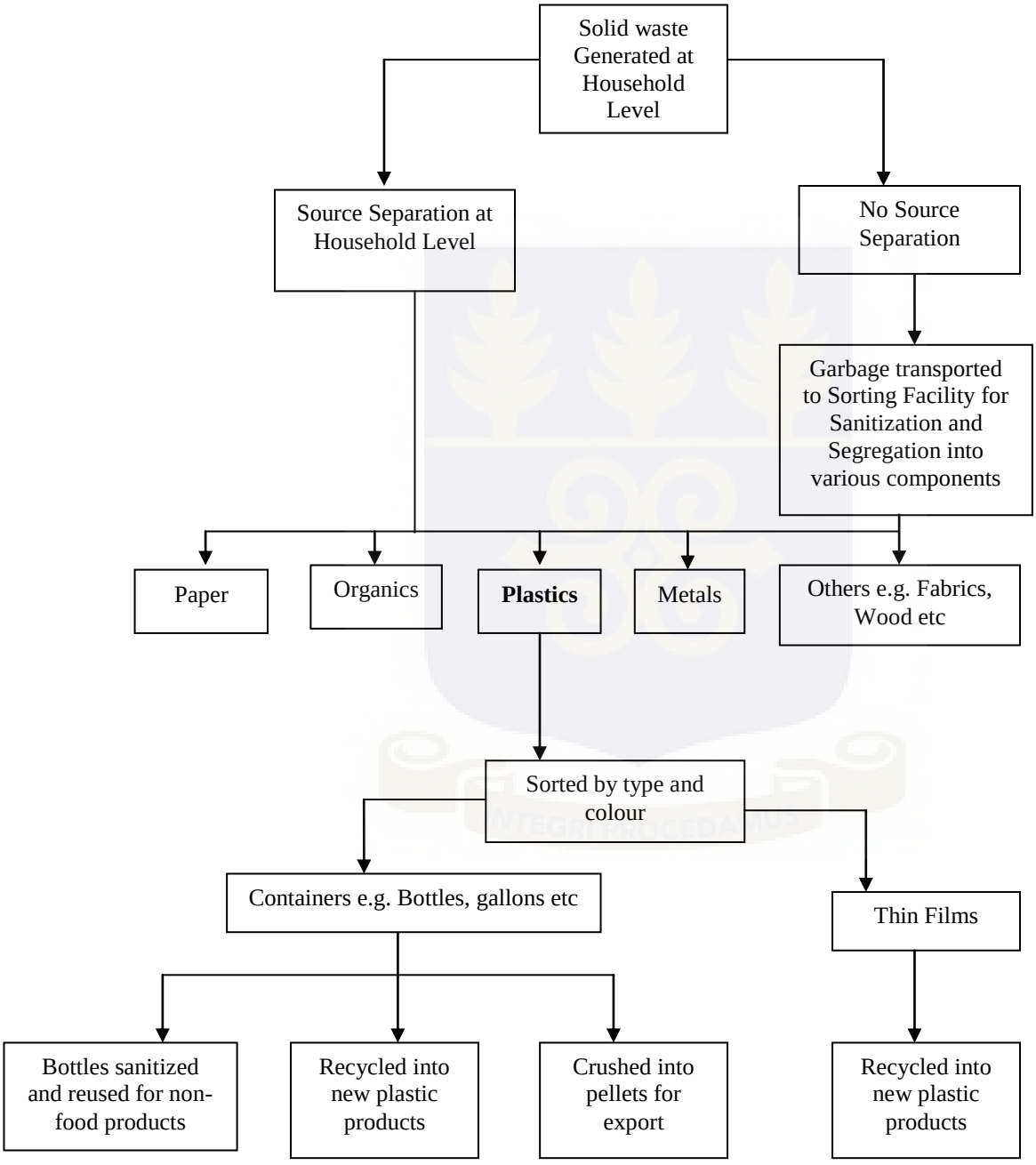
The Codex Alimentarius Commission's General Principles of Food Hygiene (2003) requires that packaging materials must be non-toxic and not pose a threat to the safety and suitability of food under the specified conditions of storage and use. Where appropriate, reusable packaging should be suitably durable, easy to clean and, where necessary, disinfect. The WHO Code of Hygienic Practice for Bottled/Packaged Drinking Waters (2001) also states that reused containers should be washed and disinfected in an appropriate system and positioned within the processing plant so as to minimize post-sanitizing contamination prior to filling and sealing.

2.5 Conceptual Framework for the Study

As stated earlier, the above literature review sought to provide a theoretical framework for this research, and show where the research fits in the existing body of knowledge as well as identify

some of the gaps in existing knowledge. Based on this review, the conceptual framework guiding the study has been crafted and is presented in Figure 2-4.

Figure 2-4: The Pathway to Efficient Management of Plastic Bottles



(Source: Author's Compilation)

Under the framework, it is envisaged that any efficient solid waste management begins with source or household separation, where different vehicles would pick up different categories of waste at separate times. However, in the absence of source segregation, mixed waste collected by one vehicle would be sent to sorting facilities to segregate and sanitize waste into the various categories, namely, organics, paper, plastics, metals etc. It must be stated, in the absence of source separation, the likelihood of the recyclables being contaminated remains very high.

Once the waste is segregated different systems of management most suitable for each category of waste will be applied. In the case of plastics, which happen to be the main focus of this study, further sorting, based on type and colour, will be required to further segregate them. The Society of the Plastic Industry Resin Identification Code for plastics will guide the sorting. Thin films would be recycled into new products. Containers such as bottles and gallons which are undamaged can be sanitized and reused for non-food products, the damaged ones can be recycled into new products or in the absence of the technology for recycling they can be crushed into pellets for export. Disposal of plastic waste would be non-existent.

It is important to state for source separation to be achieved it is important to put in place appropriate institutional arrangements that will ensure that separated wastes are collected on time and with very little stress for the household. Situations where households have to 'struggle' to dispose of separated waste will only serve as a disincentive for future source separation. This study will therefore seek to identify the lapses in the management of waste bottles in Ghana based on the above approach and attempt to assign reasons for these lapses towards evolving management options that will bear a closer resemblance to the ideal approach outlined above.

2.6 Chapter Summary

This chapter provided a review of the previous works and studies done in relation to solid waste both on the local and international front and therefore provide the theoretical framework for the study. The first section focused on Municipal Solid Waste, what it is, its characteristics and current management practices. The second section sought to examine plastics, their contribution to the Municipal Solid Waste and proposed management methods. The third section provided a background into the water bottling industry and the challenges in managing waste plastic bottles. The final section gave an outline of the conceptual framework guiding the study. The next chapter will provide a background to the study area and the methods adopted to achieve the study objectives.

CHAPTER THREE

MATERIALS AND METHODS

3.0 Introduction

This chapter provides a description of activities and analyses undertaken to achieve the objectives outlined for the study. These activities include design and administration of questionnaires to establish the practices, attitudes, perceptions and opinions of individuals within the study area on plastic bottles and assess how socio-demographic factors influence these practices. Also, microbiological analyses were carried out to test for contamination levels on reused plastic bottles. Details of these activities as well as challenges encountered have been discussed in subsequent paragraphs.

3.1 Study Area

The area chosen for the study was Accra Metropolitan Area. Accra is the capital city of Ghana and a major centre for manufacturing, marketing, finance, insurance, transportation and tourism and is located within the Greater Accra Region. The AMA covers a land area of 201sq. km and is the second most populated metropolis in Ghana. The population of AMA was 636,667 in 1970 and increased by 7.51% to a total of 969,195 by 1984. By 2000, the population of Accra Metropolitan area had again seen a 4.3% increase to a total of 1,658,937 which further increased by 9% to a total of 1,848,614 by 2010 (GSS, 2012). The Accra Metropolitan Area is made up of eleven sub-metros namely, Abossey-Okai, Ablekuma North, Ablekuma South, Ashiedu-Keteke, Ayawaso Central, Ayawaso East, Ayawaso West, La, Okai Koi South, Okai Koi North and Osu Klottey as shown in Figure 3-1. Accra is the most modernized and urbanized city in Ghana (Agyei-Mensah and De Graft Aikins, 2010).

Figure 3-1: Sub-Metros in Accra Metropolitan Area

(Source: City of Accra, Consultative Citizens' Report Card, a World Bank Report, 2010)

In spite of the high level of modernization, the Accra Metropolitan Area still faces a lot of challenges associated with high rates of urbanization. Water and sanitation are two of the most challenging and contentious issues in Accra. Solid waste generation is estimated to have tripled over the two last decades due to population growth, increased urbanization and lifestyle changes (Water Aid and EU, 2008).

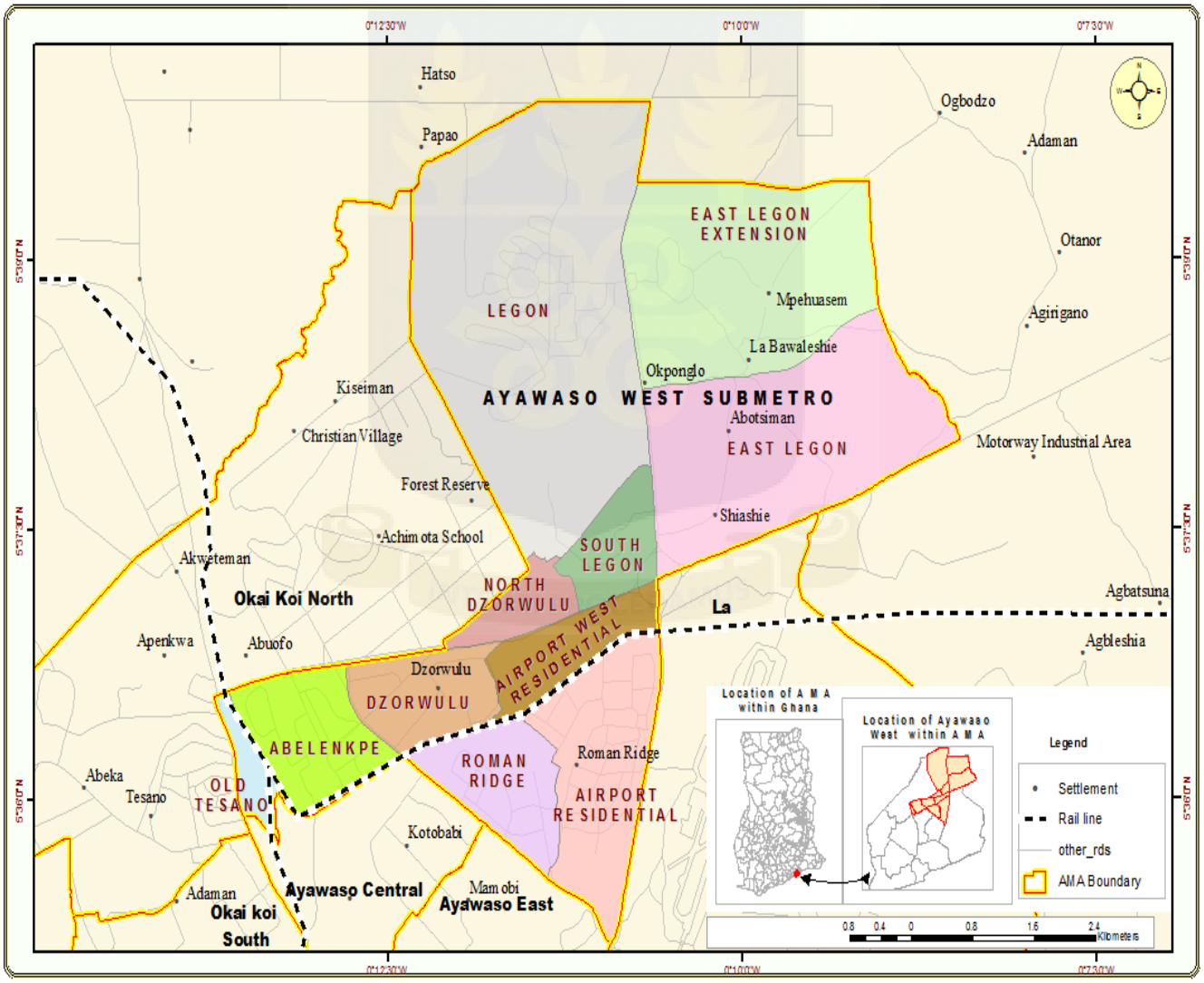
Private sector participation in waste management has been concentrated in waste collection. In low income areas central container system is operational. There are designated points where containers are placed for households to dislodge their domestic waste for on-ward carriage to final waste disposal and incineration sites. The other system, door-to-door collection, is prominent in affluent areas of Accra (AMA, 2006). About 1,500 – 1,800 tonnes of solid waste is generated in AMA daily and of this only about 60% is collected (UN-Habitat, 2009) with the remaining dumped indiscriminately, openly burned, left to clog drains and litter streets.

Accra is supplied by pipe-borne water from 2 operational sources - The Weija and Kpone Water Works (UN-Habitat, 2009). Access to water by people in Accra varies according to the three categories of urban dwellers in Accra. First, there are those who live in first class residential areas and are connected to the water supply network. This class of residence gets water 24 hours a day, and pay for water at the official rates (UN-Habitat, 2009). Second, there are those Accra residents (a large proportion) who live in areas which are connected to the network but do not get water through their taps on a regular basis. These people have to supplement their water supplies by buying water from vendors. Finally there are the majority of residents, mostly the poor and vulnerable groups living in slums and poor neighbourhood, which are not connected to the network, and have to buy their water from the vendors (UN-Habitat, 2009).

This study area was chosen because Accra is the most modernized and urbanized city in Ghana (Agyei-Mensah and De Graft Aikins, 2010) with residents having a relatively higher standard of living than other parts of Ghana. Usage of plastic bottle is a modern practice and has been associated with the elite in society; Accra is therefore an ideal location to carry out such a study.

However, because of limited time and financial resources, Ayawaso West Sub-metro, one of the eleven sub metros, was chosen as the sampling area. As already noted, the Sub-metro is one of the eleven (11no.) sub metro district Councils of Accra Metropolitan Assembly (AMA). It is bounded to the North by Ledzokuku Krowor Municipal Assembly, to the West by Ga West Municipal Assembly, to the South by Okaikoi South Metro and to the East by Ayawaso Central Sub Metro (AMA, 2012).

Figure 3-2: Map of Ayawaso West Sub-Metro of Accra Metropolitan Area (AMA)



(Source: CERSGIS, University of Ghana)

Residential areas in Accra in 2002 were classified into four major classes by the income levels of residents, housing characteristics and environmental conditions (World Bank, 2010). Ayawaso West Sub-metro is the wealthiest sub-metro in Accra and is predominantly comprised of 1st Class residential areas such as Airport Residential Area, Dzorwulu and East Legon. However, a few 2nd Class and 3rd Class residential areas such as Tesano Zongo, Okponglo and South Shiashie can also be found within this sub-metro. Also the University of Ghana located at Legon can also be found within this Sub-metro and hence a large student population. The Ayawaso West Sub-metro was chosen because of its unique nature which embodies a majority of the classes of residents within Accra thus allowing for comparison of respondents of different economic groups.

With a population of 70,667, Ayawaso West Sub Metro forms 3.82% of the entire population of AMA an increase of about 47% since 2000 and a population density of 2,728.45 person/sq. km (GSS, 2012). The housing landscape of the Sub Metro is characterized by a mixture of very low-density development with under-utilized service infrastructure on one hand and low class, and high-density development with depressed conditions and overstretched infrastructure services on the other. Some of the major economic activities carried out in the Sub-metro include Hotels and restaurants, transport and wholesale and retail trade. Wholesale and retail trade is however the most popular activity with 33.92% of the population engaged in this (District Environmental Sanitation Strategy Plan, 2009).

The District Environmental Sanitation Strategy Plan (2009) for the Ayawaso West Sub-metro District Council Office of the AMA showed that out of the total number of public refuse dumps in the area 38.0% are approved with 61.1% unapproved. Characterization of solid waste disposed of

in the sub-metro showed that generally the organics formed the major component of solid waste at 65%. Plastics ranged from 3% - 5% depending on the income bracket within which the area fell. Waste samples from the communal containers showed 65% organics, 3% paper and 3.1% plastics (District Environmental Sanitation Strategy Plan, 2009).

3.2 Sampling Methods

The sampling methods chosen were geared at achieving the research objectives stated in Chapter One i.e. Assess the influence of socio-demographic factors on the patronage of bottled water, assessing the microbiological quality of reused bottles and assess management options (based on the 3R's concept).

a) To assess the influence of socio-demographic factors on the patronage of bottled water and bottle usage, questionnaires were administered to 200 residents within the sampling area.

b) To assess the microbiological quality of reused bottles, microbiological analysis for total bacteria, total coliforms and faecal coliforms was carried out in the laboratory.

c) The assessment of management options were based on responses results from the first two activities as well as an in-depth interview with a Director from Environmental Protection Agency who was also a member of the Waste Stock Exchange Committee which was part of the Guinea Current Large Marine Ecosystem Project (GCLME). The GCLME Project which commenced in 2004 is an ecosystem-based effort to assist countries within the Guinea Current Ecosystem to achieve environmental and resource sustainability.

3.2.1 The Pattern of Plastic Bottle Usage in Study Area

This section provides details of the materials and methods used in determining the pattern of plastic bottle usage in relation to socio-demographic variables of residents with the Ayawaso West Sub-metro and also their opinions on how the used bottles should be managed.

3.2.1.1 Sampling tool

To be able to evolve the patterns in plastic bottle usage in Ayawaso West the sampling tool used was semi-structured questionnaires. Questionnaires were used to enable collection of data from many respondents simultaneously, thus saving time and reducing cost. The questionnaires were semi-structured to ensure that even though the views of the respondents will be restricted by closed ended questions, at various points within the questionnaire the respondent had the opportunity to freely express their opinions. This ensured that the views gathered were fully representative of the opinions of the respondents and thus reduced bias due to limited response ranges. The information required from respondents included their socio-economic status, educational Status, their preference for bottled beverages, how empty (waste) bottles are disposed of, their level of patronage of products in reused bottles and their opinions on how disposal or management methods can be improved.

3.2.1.2 Sample size

A sample size of 200 residents within the Ayawaso West Sub-metro was chosen. It is expected that this size will provide statistically reasonable data considering that as stated earlier the community predominantly comprises of 1st Class residents with a few 2nd and 3rd Class residents and is thus largely homogeneous and opinions are not expected to vary significantly.

3.2.1.3 Sampling Technique

The sampling technique chosen was the systematic random sampling method. A house was chosen at random and thereafter every other two houses were visited with the questionnaires. This was used for convenience and to eliminate any bias that any other sampling method may introduce. It was also expected that this method will provide data that is representative of the population.

3.2.1.4 Questionnaire Analysis

To analyse the filled out questionnaires the Statistical Package for Social Sciences (SPSS) was used. The statistical analyses used included descriptive statistics (frequency and percentages) to present tables and charts on demographic data, level of patronage of bottled beverages and products in reused bottles. A chi-square analysis (test of independence) was used to test whether the patronage of plastic bottled beverages is dependent on socio-economic and educational status.

3.2.1.5 Challenges to Questionnaire Administration

The challenges faced during the questionnaire administration process are outlined below:

a) Unwillingness to participate by individuals as well as absence or non-availability of house owners within the high-class residential areas made it difficult ensuring an even spread of respondents from all residential areas

b) Some questionnaires were not filled out completely by respondents

3.2.2 To determine the microbiological quality of reused bottles

The determination of the microbiological quality of the reused bottles was carried out to assess the level of contamination of these bottles. A comparison of the results from the analysis with established standards will allow an inference to be drawn on the risk consumers are exposed to and also explore possible means of improvement. The main standards the results from these analyses were compared to were the WHO Standards, the Ghana Standard Authority Standards and the US EPA standards for drinking water quality. There is currently no clear standards for microbiological quality of food packaging therefore the standards set for drinking water quality will be used as a yardstick for measuring the compliance level of the used bottles with these standards.

The World Health Organisation (WHO) is the directing and coordinating authority for health within the United Nations system. It is responsible for among others providing leadership on global health matters, and setting norms and standards. The WHO has outlined microbiological standards for drinking water and a comparison of the results obtained with the WHO Standard will provide picture of the acceptability of the contamination levels on the bottles on the global scale.

The US EPA is the Environmental Protection Agency in the United States set up to protect Americans from significant risks to human health and the environment where they live, learn and work. The US EPA also set standards for the States in the U.S. to implement. Even though this Agency's authority does not go beyond the U.S., it also provides a basis for comparison of how the results from the microbiological analyses will perform in relation to Standards from other Nations.

The Ghana Standard Authority (GSA) is the national Standards body and was established by the Standards Decree, 1967 (NLCD 199) which has been superseded by the Standards Decree, 1973 (NRCD 173). Among others the GSA has been mandated to undertake national standards development and dissemination. The Ghana Standard Authority also has its own standards for drinking water quality and a comparison of the results with this standard will provide a picture of the acceptability of the contamination levels on the bottles on the National level. The GSB (1998) also specifies that the appropriate number of samples to be obtained for each lot of packaged water considered for water quality analysis should range from 15 to 24. This requirement therefore informed the choice of the number of bottles (sample sizes) chosen for each category of bottles tested.

3.2.2.1 Sample Size

Samples, 25 each, of used washed and unwashed PET Bottles were purchased from three market places, namely, Madina Market, Makola Market and Kaneshie Market. A total of 25 used PET bottles were also obtained from five different homes with the Ayawaso West Sub-metro. A total of 25 new bottles were also purchased from the plastic bottle producers as control. In total 200 bottles were analysed.

3.2.2.2 Sampling Locations

The used bottles were sampled from three major markets. These were Madina Market, Makola Market and Kaneshie Market. These market places were chosen because there are currently no major markets within the Ayawaso West Sub-metro and these markets are three major market

places in Accra that waste pickers within the sub-metro and beyond sell the bottles and where bottles may be purchased for reuse.

3.2.2.3 Laboratory Analysis

To assess the level of contamination of the bottles bacteriological analysis was carried out on the bottles for Total Bacteria, Total Coliforms and Faecal Coliforms.

(a) **Total Bacteria** represents the total bacterial load in a given sample. It is a test to detect all viable microorganisms that could grow aerobically on plate count agar at appropriate incubation condition. The Total Bacterial test could reflect the general hygiene condition of a sample.

(b) **Coliforms** are facultative anaerobes, gram negative, non-spore forming, rod-shaped bacteria capable of growing in the presence of relatively high concentrations of bile salts with the fermentation of lactose and production of acid or aldehyde within 24 h at 35–37 °C. The total coliform group includes both Faecal and environmental species. Most coliform bacteria do not cause disease but their presence is a cause for concern because of the potential for other disease causing strains of bacteria to also be present.

(c) **Faecal coliforms** are a subcomponent of this larger group of coliform bacteria. Faecal coliform are indicator organisms for faecal contamination and potential presence of enteric pathogens (Baron, 1996).

A. Materials used for Laboratory Analysis:

a) Agar Powder i.e.:

i. Nutrient Agar for culturing Total Bacteria

ii. Violet-Red-Blue Agar for culturing Total Coliforms

iii. MacConkey Agar for culturing Faecal Coliforms

b) Distilled Water

c) 0.85% Physiological Saline

d) 70% Ethanol

e) Sterile Petri dishes

f) Flasks and Beakers

g) Bunsen Burner

The agar powders, ethanol and physiological saline were sourced from the University of Ghana Soil Science Department Laboratory. All other materials were sourced from the University of Ghana Ecological Laboratory where the laboratory analyses were conducted.

B. Method

a) Agar preparation

23g of Agar powder was weighed and dissolved in 1000ml of distilled water. The mixture was boiled for 1 minute over a flame. The melted agar was removed and allowed to cool.

b) Culturing Process

The Pour Plate Technique was employed (Nollet, 2007).

a. Total Bacteria

The inner portion of each bottle was washed with 9ml of 0.85% physiological saline. A 1ml sample of the saline in the bottle was measured with a sterile 1ml disposable pipette and aseptically dispensed into a well-labelled Petri dish (label indicating source of bottle and whether washed or unwashed). 10ml of double strength melted Nutrient Agar was added to the 1 ml sample in the Petri dish. The Petri dish was securely covered and the agar allowed to solidify. The

petri dishes were turned upside down and incubated for 18 – 24 hours in the Laminar Flow Hood at a temperature of 35°C. This was repeated for all 200 bottles tested. The total number of colonies were counted and recorded in CFU/ml. All processes were carried out within the Laminar Flow Hood to prevent external contamination.

b. Total and Faecal Coliforms

The method for culturing the Total and Faecal Coliforms were similar to the process carried out for determining the Total Bacteria. The agar used for the total and faecal coliforms were Violet-Red-Blue Agar and MacConkey Agar respectively. Results recorded were collated and analysed and presented in frequency charts and tables.

3.2.2.4 Quality Assurance

In order to ensure that the results of analysis obtained were accurate, quality assurance measures were observed as follows:

a) Samples were analysed based on WHO's Analytical Methods for Microbiological Water Quality Testing
b) All the glassware were thoroughly cleansed with appropriate detergent and rinsed with distilled water and autoclaved. The pair of scissors, Petri dishes, beakers, automatic pipette and agar were all autoclaved.
c) Disinfection of the work area (the Laminar Flow Hood) and hands with 70% ethanol.

3.3 Chapter Summary

This chapter provided a background to the study area and the research methods adopted. The first section provided details and maps of the study area, the second section outlined the methods

adopted to analyse the socio-demographic characteristics of the respondents and its influence on bottle water patronage. The third and final section presented the microbiological analysis undertaken to determine the levels of bacterial contamination on the bottles.

CHAPTER FOUR

PATTERNS IN BOTTLED WATER USAGE AND MICROBIOLOGICAL ANALYSIS OF USED PLASTIC BOTTLES

4.0 Introduction

In this chapter, results of questionnaire and microbiological analyses are presented, described and discussed in full detail. As mentioned in the previous chapter, the questionnaire was administered to establish patterns in plastic bottle usage as well as to sample views and opinions of residents within Ayawaso West on how management of these bottles can be improved. Reuse of plastic bottles in Ghana is a whole industry and one of the current informal systems of management of plastic bottles. The microbiological analyses of the bottles were therefore carried out to establish the contamination levels on these bottles and hence ascertain its level of safety for use for food products.

4.1 Socio-Demographic Characteristics and Water Packaging Preferences of Respondents

A total of 200 questionnaires were administered to respondents of different age groups, educational backgrounds, economic status and living in different areas within the Ayawaso West Sub-metro. Out of the 200 questionnaires administered, all 200 were returned.

The main purpose of collecting the demographic data was to get an idea of the socio-demographic profile of the study area and also to enable comparisons to be made between the socio-demographic status of the people and the patronage or preferences for beverages packaged in plastic bottles or otherwise. To assess the level of patronage of products in plastic bottles

respondents were required to indicate their preference between: Tap water, Sachet water, Bottled Water. This was done to establish the current status or output of plastic bottles within the area.

A comparison of the responses was made with the demographic characteristics of respondents i.e. educational level, income status to determine if patronage of these bottles depends on these socio-economic characteristics. Table 4 below provides a summary of demographic data provided by the respondents. Subsequent paragraphs provide a description of the demographic information as well as a comparison of these with responses given on the preference for bottled water.

Table 4: Socio-Demographic Characteristics of Respondents

Characteristic	Classification	Frequency	Percentage
Gender	Male	97	48.5
	Female	103	51.5
Total		**200**	**100.0**
Age Range	20 – 25	47	23.5
	26 – 30	44	22.0
	31 – 35	45	22.5
	36 – 40	33	16.5
	41 – 45	8	4.0
	≥ 46	23	11.5
Total		**200**	**100.0**
Educational Status	No Formal Education	2	1.0
	Primary/JSS	20	10.0
	Secondary	53	26.5
	Tertiary	125	62.5
Total		**200**	**100.0**
Employment status	Unemployed	20	10.0
	Student	75	37.5
	Employed	105	52.5
Total		**200**	**100.0**
Income Range	<100	7	6.6
	100-499	31	29.5
	500-1000	36	34.4
	>1000	28	26.7

Characteristic	Classification	Frequency	Percentage
	Undisclosed	3	2.8
Total		**105**	**100**
Residential Areas	Abelenkpe	36	18.0
	Airport	18	9.0
	Bawaleshie	2	1.0
	Dzorwulu	20	10.0
	Legon	55	27.5
	Mempeasem	7	3.5
	Okponglo	18	9.0
	Roman Ridge	2	1.0
	Shiashie	14	7.0
	Tesano	28	14.0
Total		**200**	**100**
Types of Residences	Student Hostel	42	21.0
	Single/Chamber & Hall (Shared	34	17.0
	Single/Chamber & Hall (self-contained)	38	19.0
	Self-contained House (≥ two bedrooms)	86	43.0
Total		**200**	**100.0**

(Source: Field Data, 2013)

As shown in Table 4, 88.5% of the respondents were below the age of 40 reflecting a youthful sample population. Young people are usually abreast of modern trends so it is expected that a majority of the population would be aware of all the public health as well as environmental problems associated with sachet water. Also, 62.5% of the respondents had attained tertiary education, therefore all things being equal, should be conscious about environmental health and be gainfully employed to be able to afford bottled water. About 34% of the respondents earned between GH¢500.00 - GH¢1000.00 representing the modal income range. Another 27% of the sample population earned above GH¢1000.00. The income range observed further buttresses the point that the respondents would most likely be able to afford to patronize bottled water. Also, about 28% of the respondents live in the Legon area and this was the most represented residential

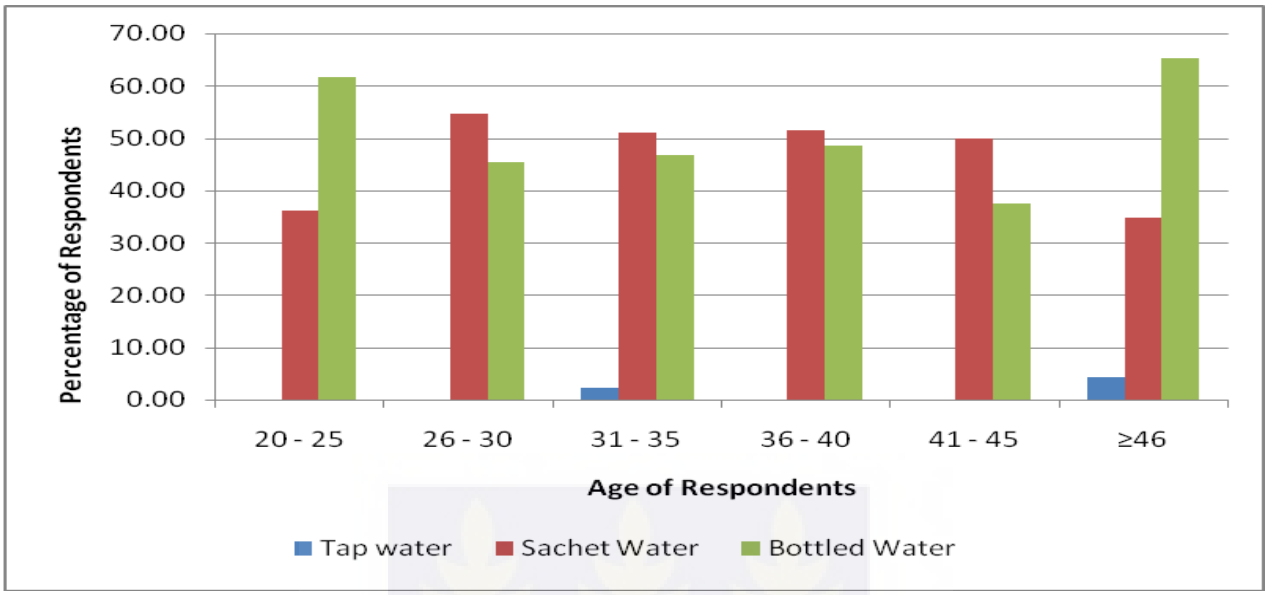
area. Legon being the home of the University of Ghana is predominantly inhabited by academics and are expected to be knowledgeable about the environmental and health implications of the water packaging choices.

To verify or confirm these assumptions made, a cross-tabulation of the socio-demographic characteristics outlined above has been done and the patterns observed are described in the paragraphs that follow.

4.1.1 Gender and Age Distribution of Respondents

Out of the total of 200 respondents, both male and female were quite adequately represented with 51.5% being male and 48.5% being female. The ages of the respondents ranged from 20 to 46 and above. The age range ≥46 comprised of the respondents of ages 46 – 70. The modal age range was 20 – 25 represented by 23% of the respondents. The age range least represented was 41-45 represented by only 4% of respondents. The pattern observed in the ages of the respondents reflects a youthful community. The plastic bottle phenomenon is a relatively recent one and it is expected to be patronized more by the youth, there will therefore be a greater likelihood of high patronage of the bottled products within this area. To verify this, a comparison of the age of respondents with their drinking water packaging preference is shown in Figure 4-1.

Figure 4-1: A Comparison of the Ages of the Respondents with their Packaging Preferences



(Source: Field Data, 2013)

About 61% of the respondents in their early twenties (20 – 25 years) indicated they preferred bottled water to sachet and tap water. On the other hand, about 65% of respondents 46years and above also indicated they preferred bottled water to the other options. Respondents of all other ages between 26 and 45 had an average of about 52% opting for sachet water. Overall, only 1.5% of the total number of respondents opted for tapwater. The trend observed implies that the respondents of the two extreme age categories largely prefer bottled water.

The fact that respondents of the youngest age category had a majority opting for bottled water may be attributed to the fact that young people are generally believed to be more susceptible to marketing and advertising, which are key elements in the success of the bottled water industry (Ferrier, 2001; Gleick, 2011). Also, the use of bottled water has arguably assumed some status symbolization. Thus, the use of bottled water is equated to ones economic status in the society.

Also, generally, 55% of respondents within this age group who preferred bottled water gave the major reason to be "for safety and hygiene". As far back as 2003, studies by Obiri-Danso *et al*.and Dodoo *et al*. (2006) began to query the quality of sachet water and since then several subsequent studies have shown microbial contamination of various degrees. Respondents aged between 20 – 25 years would have been between 10 – 15 years when quality issues began to surface. They would therefore have grown up with a general mistrust for the product. Bottled water has so far been seen as the safest drinking water option and persons within this age group may have turned to this as the healthier option. This trend is interesting for future projections because respondents of this age category will most likely continue to have the preference for bottled water well into their adult lives and further influence their children towards this product.

The fact that the category of the oldest respondents (46 and above) also had a majority opting for bottled water may also be associated with the fact again that bottled water has been seen as the safest drinking water option. Older people tend to be more health conscious as they are more susceptible to illnesses and diseases which take a greater toll on them than younger people (Yamada, 2005) and may tend to veer towards the healthiest option available. This is also buttressed by the fact that even within our health institutions, patients are advised strongly to 'clean water', preferably bottled water when administering their medication. The older respondents were largely homeowners within the community who could afford to buy bottled water regularly. This may account for the majority of that group having a preference for this option. A chi-square test to determine whether the packaging preference of the respondents depended on the age of the respondents, however, failed to show any significant relationship between the two variables, X^2 (5) = 4.579, p = 0.469 (an alpha level of 0.05 was adopted for this

and all subsequent statistical tests). This means that though the distribution may appear to have tendencies that may cause an assumption to be made that the choice of the respondents would depend on their ages, the chi-square test in fact reveals that preference for bottled water, sachet water or tapwater is independent of the age of the sample population. This means that the choice of respondents may have been influenced by other factors such as their educational level, income earned or the locality they live in.

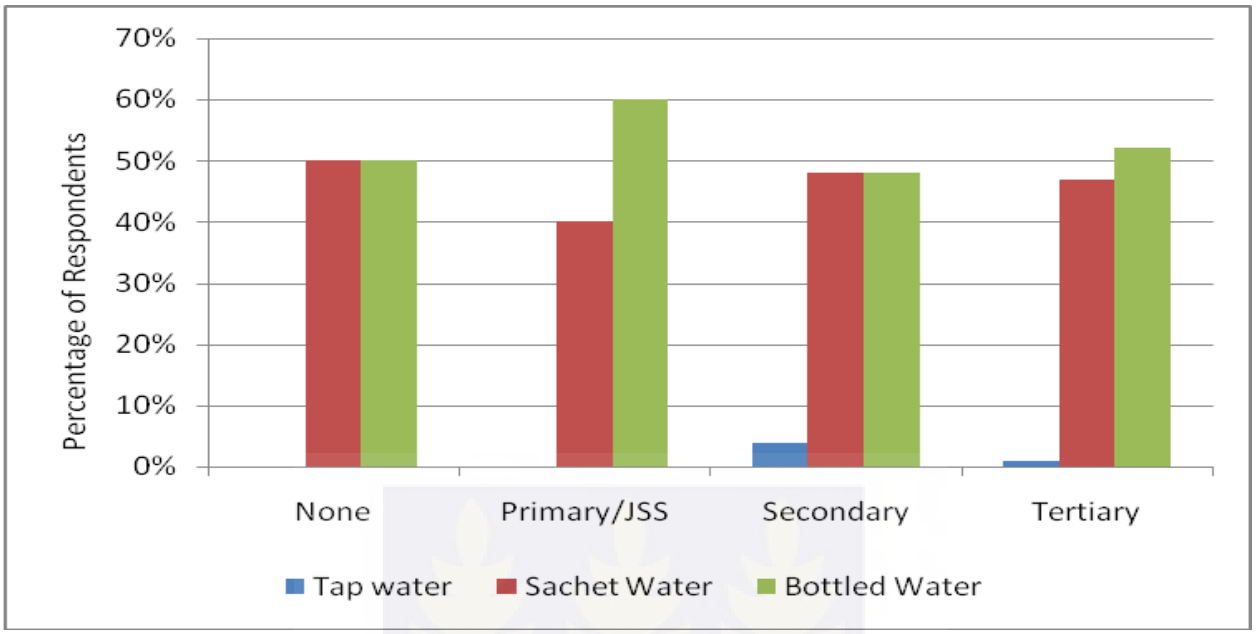
To determine this, an analysis was also carried out on the relationship between the educational level of respondents and the choice made as shown in the subsequent paragraphs.

4.1.2 Educational Level of Respondents

Of the 200 respondents 62.5% had acquired tertiary level education and only 1% had no education at all. This trend implies that the area is primarily a literate one with the majority attaining higher level education.

Bottled water, according to research carried out by different researchers has been proven to be of good microbiological quality as compared to sachet water and tapwater (Obiri-Danso *et al.*, 2003; Dodoo *et al*, 2006). The highly educated are expected to be more conscious of the hygiene and issues associated with the different types of water packaging available in Ghana and it is therefore expected that the education will have some level of influence on the choice of packaging. Figure 4-2 shows the relationship between respondents' education level and their preferred drinking water sources.

Figure 4-2: Comparison of Educational Level of Respondents with Packaging Preferences



(Source: Field Data, 2013)

Out of a total of 125 respondents that had attained Tertiary level education, 47.2% preferred Sachet water and 52% preferred bottled water. Only 0.8% of the tertiary level respondents preferred tap water. Out of a total of 53 secondary level education respondents only 3.77% preferred tap water, 47.17% preferred sachet water and 49% preferred bottled water. Respondents with Primary/JSS level education were a total of 20 out of which 40% preferred sachet water and 60% preferred bottled water. No member of this group of respondents preferred tap water. There were a total of 2 respondents with no formal education. Out of these two, 1 preferred bottled water and the other preferred sachet water. Overall, the most preferred water packaging type among respondents of all the educational groupings was bottled water. Tapwater was the least preferred within all the educational groupings.

It would have been expected that a higher proportion of the educated respondents would prefer bottled water while a higher proportion of the less educated respondents would prefer sachet water or even tapwater. The educated respondents by virtue of their exposure and knowledge base are expected to have more awareness of hygiene and health issues associated with drinking water than the less educated respondents. However, this was not the case.

Respondents of all educational categories preferred bottled water. The educational level of respondents which, in this study, was measured by formal academic qualifications did not appear to influence the packaging preferences.

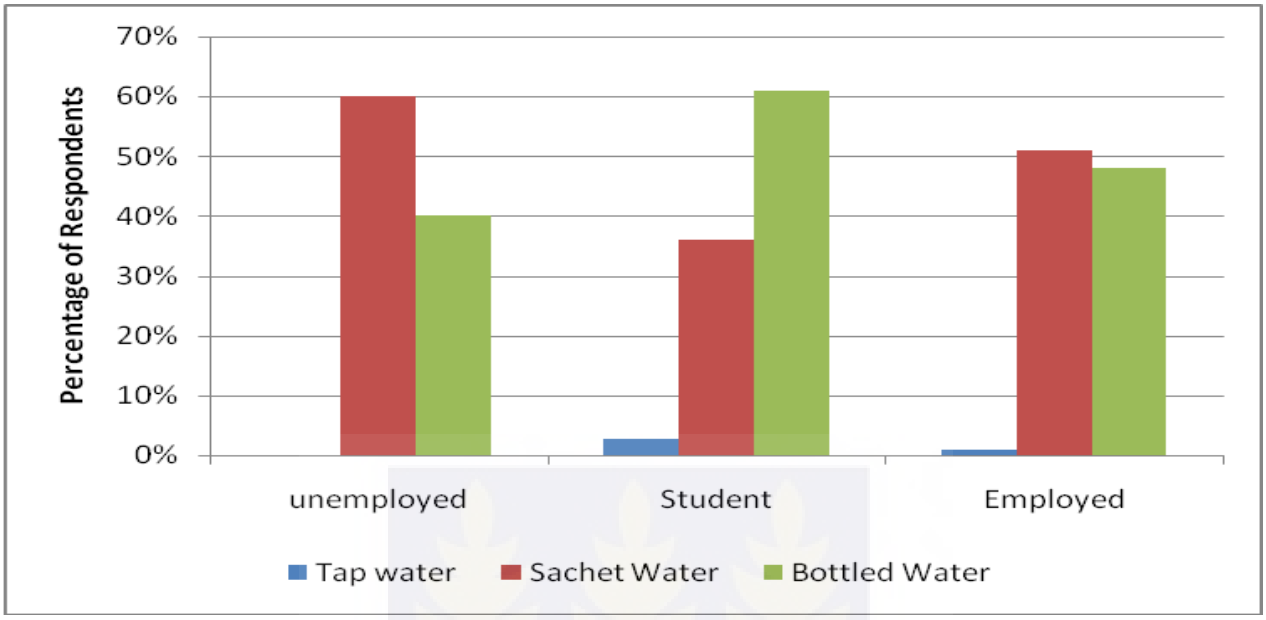
This pattern observed may be attributed to mass media publications over the past years on the risks of sachet water consumption which has raised awareness of the risks of choosing questionable drinking water sources. The power of the news media to focus public attention on key issues is an immense and well-documented influence (McCombs and Shaw, 1972). The dramatic revolution in the broadcasting environment in Ghana started in 1992, particularly with radio broadcasting. Radio broadcasting is relatively cheaper to consumers, timely in its message delivery and flexible in its use of local languages (Ibis, 2003). There are currently, as at the third quarter of 2012, 225 radio stations operational in Ghana (Adogla, 2013). With the proliferation of all these radio stations, news is disseminated faster and over a wider area than before. The issue of unregistered sachet water producers and the contamination levels in the product continues to be a recurring news item that surfaces periodically, thus the awareness has been created. The general preference for bottled water across all the educational categories could therefore be attributed to increased awareness of safety and hygiene issues among the population. A chi-square analysis

was carried out to further ascertain whether packaging preference was influenced by educational level. The test failed to indicate a significant dependence, X^2 (3) = 0.992, p = 0.803. On the basis of the chi-square result, it is safe to conclude that the preference for bottled water, sachet water or tapwater is independent of educational level of respondents.

4.1.3 Employment Status and Income of Respondents

Out of a total of the 200 respondents, the employed respondents represented 52.5% of the total number of respondents, the students 37.5% and the unemployed 10%. Of the 105 employed respondents, about 97% were willing to disclose their income range. Of this number, about 35% fell within the GH¢500.00 - GH¢1000.00 income range and this was the modal income range. Only 6.67% of the respondents fell below the GH¢100.00 and this represented the lowest income range. This data is consistent with the Ghana Living Standards Survey 5 carried out in 2008 which recorded the average per capita income in the Greater Accra Metropolitan Area to be GH¢564.00. Bottled water has been associated with affluence and high living standards. The income range registered suggests that a majority of the employed respondents would prefer bottled water. To verify this Figure 4-3 presents a comparison of the employment status of respondents and their packaging preference.

Figure 4-3: Comparison of Employment Status of Respondents with Packaging Preferences



(Source: Field Data, 2013)

As shown in Figure 4-3, 51.43% of the employed respondents preferred sachet water, 47.6% preferred Bottled water and 0.95% preferred tap water. Out of the 75 of the respondents that were students, 61.33% preferred bottled water, 36% preferred sachet water and 2.67% preferred tap water. Out of the 20 unemployed respondents, none preferred tap water, 60% preferred sachet water and 40% preferred bottled water.

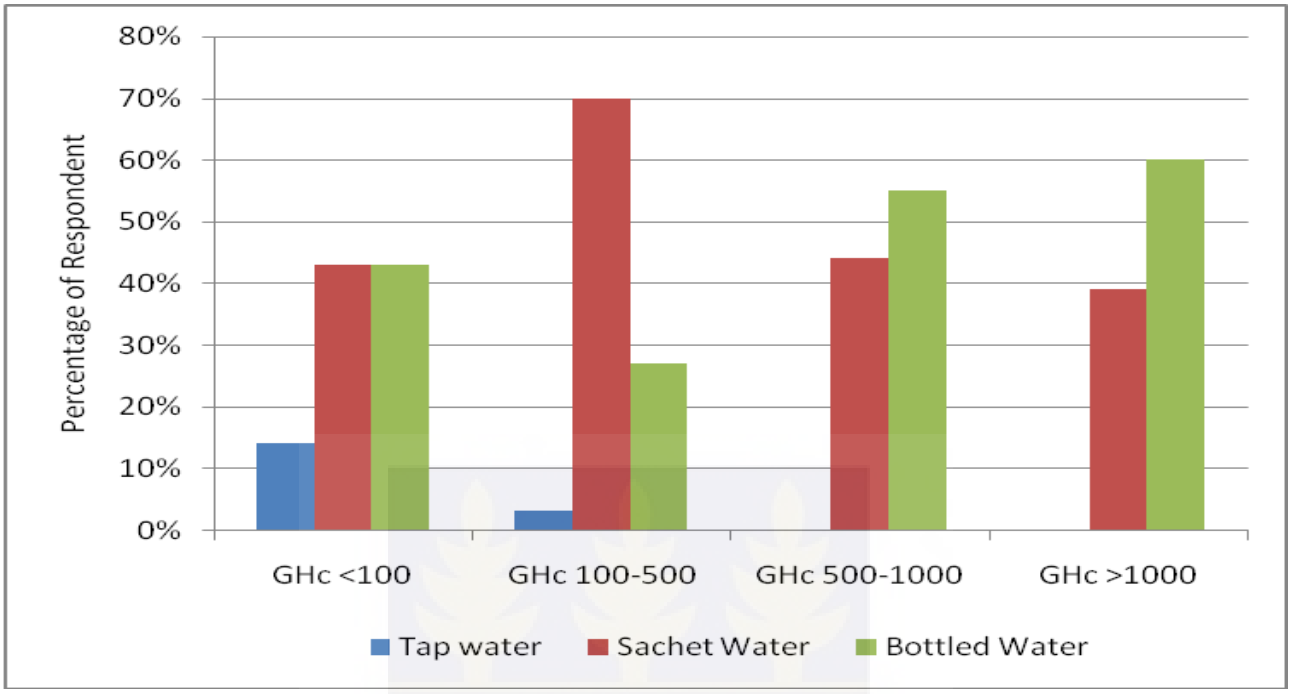
Generally, a majority of the unemployed and the employed group appeared to prefer sachet water with only the student population having more of their respondents preferring bottled water. This observed pattern may be due to the fact that the student population comprises a relatively younger population and as discussed earlier may have grown to believe that bottled water is the most hygienic and safest option due to the reports in the media and published articles.

About 36% of the student population gave 'safety and hygiene' as their main reason for opting for bottled water, while another 21% gave 'convenience and portability' as their main reason for choosing bottled water. A student's lifestyle demands a lot of movement from lectures, study groups, field trips and other student activities, bottled water being convenient to carry around without affecting mobility or movement presents an option that fits perfectly into the lifestyle of a student. Also, bottled water has been a symbol of affluence and status and students generally are more vulnerable to the need to impress their peer and would most likely prefer or create the impression of preference for bottled water.

The majority of the unemployed preferring sachet water is not surprising because being unemployed means the person does not earn an income and is most likely dependent on another person. They would therefore want to choose what they can afford and the more practical option rather than to impress their peers. About 42% of the unemployed respondents gave their main reason for opting for sachet water to be 'hygienic and cheap'. A chi-square test failed to show any dependence between employment status and preference, X^2 (2) = 4.257, p= 0.119. The choice of the respondents is therefore independent of employment status.

To further understand the choices within the employed group, a comparison of the income levels among the employed with their preference is presented in Figure 4-4.

Figure 4-4: Comparison of Income Levels of Respondents with Packaging Preferences



(Source: Field Data, 2013)

Out of the 200 respondents, 105 were employed. Out of the 105 only 102 were willing to disclose their income range. Out of the 102 respondents, 7 earned below GH¢100.00 and of this number 14% preferred tapwater, and 42.9% preferred sachet water and another 42.9% preferred bottled water. A total of 31 of the respondents fell within the income range of GH¢100.00 – GH¢499.00 and out of this number, 3.22% preferred tap water, 70.97% preferred sachet water and 25.8% preferred bottled water. A total of 36 of the respondents fell within the GH¢500.00 – GH¢1000.00 range of which 44% preferred sachet water and 55.56% preferred bottled water. No respondents within this income bracket preferred tap water. Out of a total 28 respondents that earned above GH¢1000.00, 39.30% preferred sachet water and 60.7% preferred bottled water. No respondent from this category preferred tapwater.

Generally, respondents of the income range <GH¢100.00 and GH¢ 100.00 – GH¢ 499.00 had more of their respondents preferring the sachet water. Respondents of the income range of GH¢ 500 – GH¢1000 and > GH¢1000 had more respondents preferring bottled water. Again, tap water was the least preferred in all the income ranges.

From the trend observed, the income levels appeared to influence the preferences of the respondents. As shown in Table 2, the price of bottled water is about 8 times the price of an equal volume of sachet water. It would therefore appear to be more economical and sustainable to rely on sachet water if your income levels are low. A chi-square test of income levels of the employed respondents showed a dependence of preference on the income earned by respondents, X^2 (3) = 8.809, p = 0.032. In Ghana, income levels have consistently been on the increase with the population living under the poverty line of $1.25 a day decreasing by 3.1% from 31.4% in 1992 to 28.5% in 2007 (World Bank, 2013). It is therefore expected that since bottled water patronage depends on income levels and income levels in Ghana are on a constant rise, then bottled water patronage will also increase with a subsequent increase in waste bottle generation. There is therefore a need to map out strategies now to ensure that the waste bottles do not become a nuisance in society.

4.1.4 Residential Areas Represented within the Sub-Metro

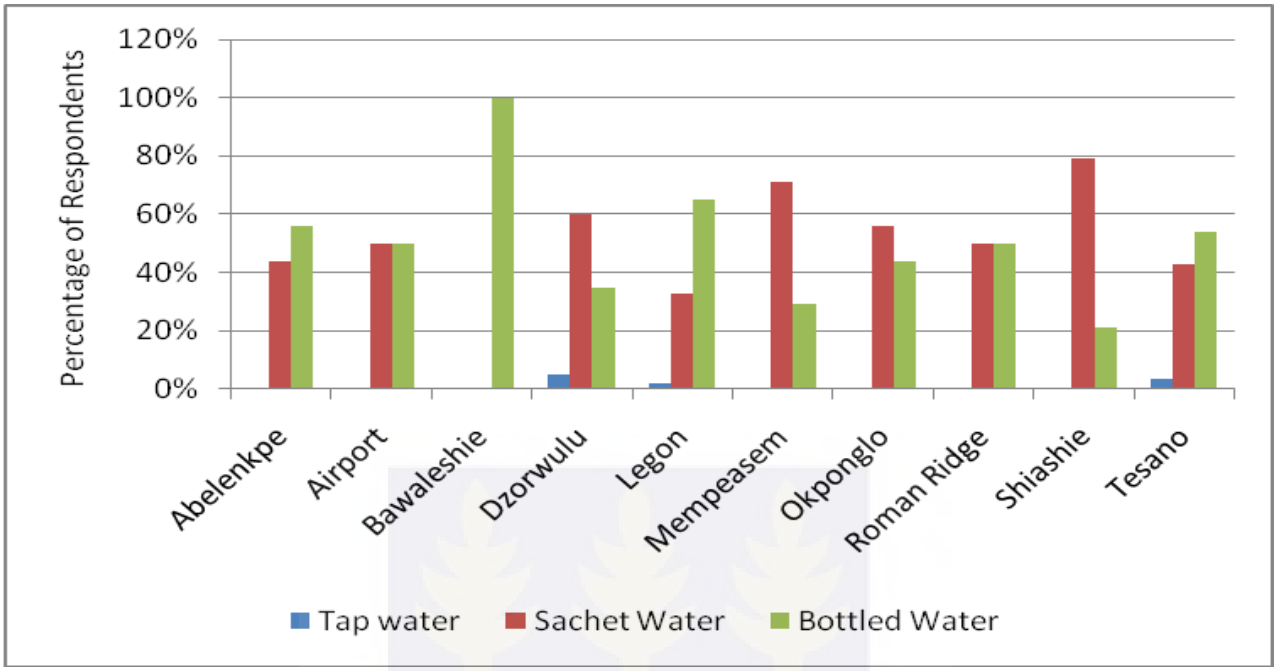
Ten residential areas were represented among respondents. The area most represented was Legon with 55 of respondents representing 27.5% of the total from that area. The least represented were Bawaleshie and Roman Ridge with only 2 of respondents from that area. Legon is the home of the University of Ghana with a student population of about 39,376 as of the 2012/2013 academic

year. Most of the respondents from Legon are therefore expected to be students or in the field of academia. It is important to note however that because of accommodation shortages and preferences some students within the University of Ghana live outside the campus in nearby communities such as East Legon, Shiashie, Okponglo etc.

The residential areas in Accra Metropolitan Area have been classified by the AMA according to income levels of residents into first, second, third and fourth class. Of the areas represented in this study, Airport Residential Area, Roman Ridge, Bawaleshie (a part of East Legon) and Dzorwulu fall within the first class residential areas. Some parts of Abelenkpe and Tesano fall within the first class and others the second class residential areas. Okponglo and Mempeasem (parts of East Legon) fall within the second class residential areas and South Shiashie in the third class residential area (AMA, 2006). Legon was not accounted for in the classification since it is not primarily a residential area.

With this classification it can be assumed that the area in which a respondent lives could affect his/her water packaging preference. It is expected that the respondents from the first class residential area would have a preference for bottled water and the respondents from the second class residential areas as well as the third class residential areas may have a greater majority having a preference for sachet water. Figure 4-5 shows a comparison of residential area of respondents and their preference.

Figure 4-5: Residential area versus Packaging Preference



(Source: Field Data, 2013)

The pattern from the comparison in Figure 4-5 shows that Tesano, Abelenkpe, Bawaleshie and Legon had majority of their respondents preferring bottled water to tapwater and sachet water. In Legon over 65% of respondents indicated a preference for bottled water. In Tesano and Abelenkpe, 53.5% and 55.5% preferred bottled water respectively. Both respondents from Bawaleshie indicated a preference for bottled water. At the Airport Residential Area and Roman Ridge, 50% of the respondents opted for bottled water and the other 50% opted for sachet water. In all the other areas i.e., Shiashie, Mempeasem, Dzorwulu and Okponglo sachet water was the most preferred by 78.6%, 71.4%, 60%, 55.5% respectively.

The obvious preference by a majority of respondents from Legon for bottled water implies that the student population has a preference for bottled water. This may be due to the fact that they are

a younger group and as discussed earlier may have been raised within this era where bottled water is becoming increasing popular and its patronage being encouraged as a more hygienic option and also a more environmentally sound option comparing to sachet water by environmentalists. When asked the reason for their preference about 30% of respondents from Legon indicated they believed it was more safe and hygienic. Another 25% of respondents from Legon gave the reason for their preference of bottled water to be because of its 'convenience and portability'. A student's lifestyle demands a lot of movement from lectures, study groups and other student activities, bottled water being convenient to carry around without affecting mobility or movement presents an option that fits perfectly into the lifestyle of a student.

Generally, in the other areas, i.e. Tesano, Dzorwulu, Roman Ridge, Airport Residential Area, Abelenkpe about half of the respondents preferred bottled water and the other half sachet with a negligible percentage opting for tap water. This may imply that even though these areas are seen as high income areas the use of bottled water is not necessarily guaranteed.

One reason for this observation could be the fact that some trusted bottled water companies produce sachet water and people from high income areas may still patronize these brands of sachet water, bought in bulk, purchased from reliable distributors and this may be more economical for them in the long term. According to Hu *et al*. (2011), location tends to influence the choice when the quality of drinking water available at the different locations varies. The residential areas covered within the sub-metro all fall within an area of about 25.9sq. km and have access to the same brands and quality of sachet water and bottled water and this may have accounted for the small differences.

When asked why they had the preferences they made about 14% of the respondents from these high income areas indicated that they opted for sachet water because they found it to be both 'hygienic and cheap'. This means that these respondents believe that sachet water can provide the quality of water they require at a cheaper cost. A chi-square test failed to show any dependence of residential area in which the respondents lived on water packaging preference, X^2 (6) = 10.808, p = 0.94. Overall, based on the chi-square apart from income level of employed respondents, preference for bottled water, sachet water or tap water was independent of all other socio-demographic parameter. The hypotheses that the patronage of bottled water is independent of age, educational and area of residence is true, however patronage does depend on income levels.

This implies that all things being equal the only certain variable that would influence a person within the study area toward patronizing bottled water or not is their ability to afford it. Information about the quality of different drinking water sources has been all over the media and this has influenced to a large extent the choice of individuals on what to drink. Bottled water is assumed to be safer and thus most people opt for it for this reason.

Also, the convenience and portability of the bottled water, makes it attractive to people in transition or always on the move. However the cost of bottled water relative to sachet water appears to be the limiting factor. Bottled water costs about eight times an equal volume of sachet water and barring all other factors makes more economic sense to patronize sachet water than bottled water. Based on this observation, it is expected that as income levels rise patronage of

bottled water will also rise. This rise will also lead to generation of more waste bottles. The need for proper management will come to play.

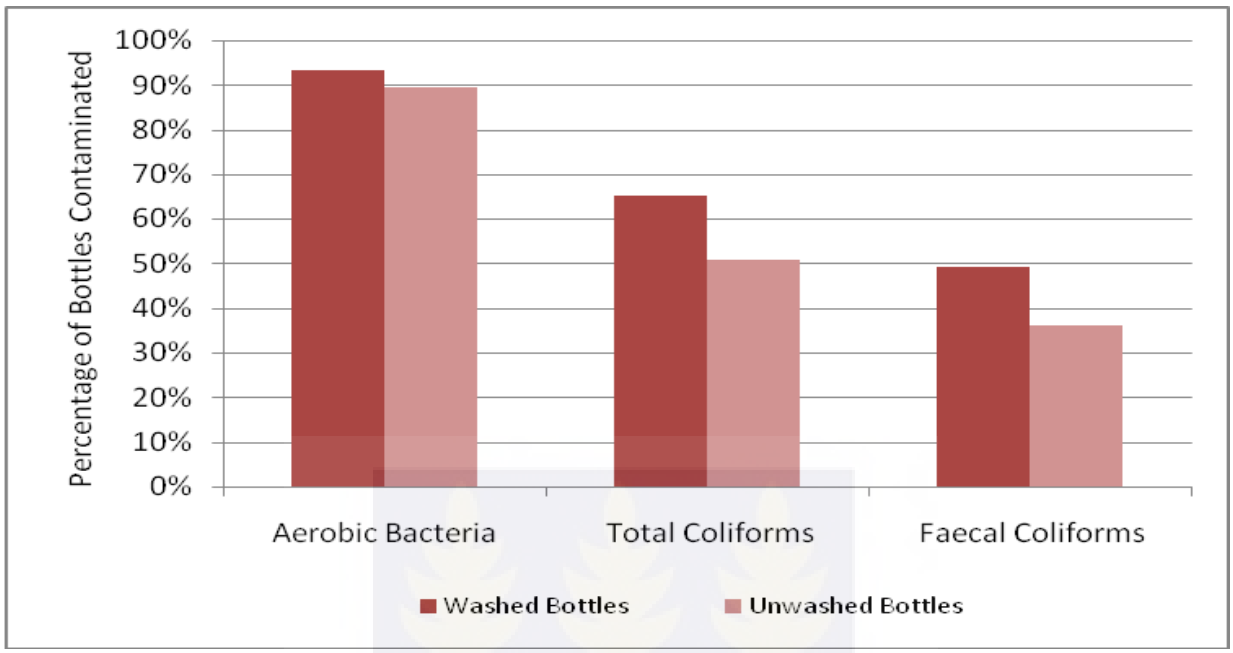
Reusing plastic bottles for food products has become increasingly popular in Ghana. These bottles are used as packaging for local drinks such as 'sobolo' and 'iced kenkey". It is also used by market women for sale of palm oil, coconut oil or other locally made oils. The sale of used bottle is therefore a major industry that the market women and local beverage producers depend on. As mentioned earlier, it serves as a major informal management method for this type of waste, at an income generating activity.

The microbial load or levels of contamination on these bottles are however unknown and could pose health risk to consumers. A microbiological analysis was carried to assess the extent of contamination of the bottles sold for reuse in the markets. This information will help in determining if this practice should be encouraged, re-evaluated or completely discontinued. The results of this are presented in the paragraphs that follow.

4.2 Microbial Load on Reused Plastic Bottles Sold in the Markets

To achieve this objective, 50 used bottles were taken each from three different geographical locations within Accra, namely, Makola market, Madina market and Kaneshie market. These markets were chosen based on referrals from vendors of local drinks within the study area who indicated these markets as their main source of these bottles. Each sample contained 25 samples each of washed and unwashed bottles. In addition a total of 25 bottles were collected directly from 5 different homes. As a control test 25 new unused bottles were also sampled. The results are presented in Figure 4-6.

Figure 4-6: Percentage of Bottles Positive for the Presence of Microbiological Organisms



(Source: Field Data, 2013)

As shown in Figure 4-6, out of the total washed and total unwashed bottles tested from the three major markets in Accra, the washed bottles generally recorded higher presence of microbiological organisms than the unwashed bottles. Also, among the three organisms tested for the Total Bacteria recorded the highest presence both in the washed and unwashed and the Faecal Coliforms recorded the lowest presence.

Of the total number of bottles tested 93.34% of the washed bottles tested positive for the presence of Total Bacteria whereas 89.34% of unwashed bottles tested positive for the presence of Total Bacteria. Of the total number of bottles, 65.33% of the washed bottles tested positive for the presence of Total Coliforms, the unwashed bottles however had a relatively lower number testing positive at 50.67%.

Results for Faecal Coliforms also followed the same trend with the washed bottles having 49.33% positive and the unwashed recording 36% positives. This means that the washed bottles pose a higher health risk to consumers than the unwashed bottles. This pattern may be attributed to the quality of water used in washing, the contamination level of the washing equipment or the washing procedure.

In the Accra Metropolis, the Ghana Water Company (GWCL) produces most of the water used but only about 51% of the population has access to this supply. The rest depend on private and community service provider who either also get their supply from the GWCL, through tanker services or wells and boreholes. These private providers charge different rates for the water which are considerably higher than the costs per unit paid by households with direct connections from the GWCL (Adank *et al*, 2011). Thus with a situation like this it is difficult to determine where the market people access the water used for the washing from. Most of the sellers claimed they buy the water from nearby vendors. Therefore the source of the water may be the first source of contamination.

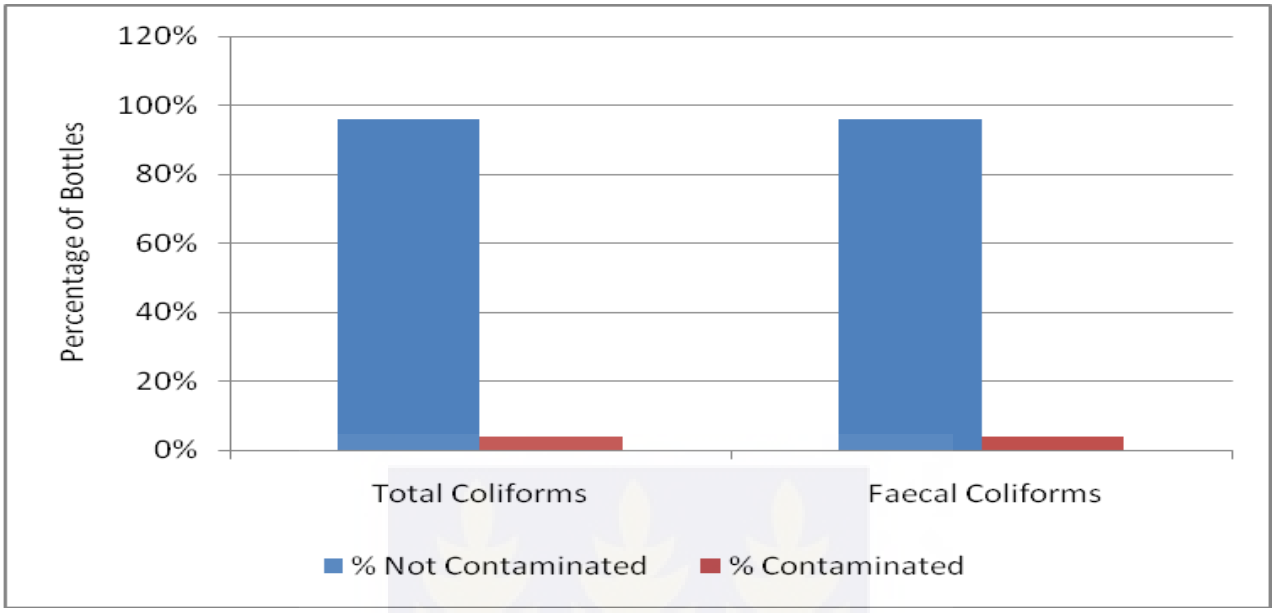
The washing equipment may already be contaminated with coliforms and may spread the contamination to the bottles. The washing tools do not undergo any form of prior disinfection before usage. Hazard Critical Control Points (HACCP) Standard Operating Procedures adopted by the U.S. National Food Safety Management Institute as well as other national institutions require that to ensure food hygiene and safety, cleaning equipment should be sanitized and allowed to air dry between uses or after four hours if in constant use.

Also the washing procedure depending on how frequently the washing water is changed and how many rinses the bottle is taken through may also cause increased contamination. Because water is scarce, water used for both washing and rinsing the bottles are probably reused several times before changing, if at all. This could lead to cross contamination. Hazard Critical Control Points (HACCP) standards also require that water used for washing should be clean, free of grease and food particles, also that washing be done in three separate compartments i.e. washing compartment, rinsing compartment and sanitizing compartment, each with defined temperatures. These standards to a market woman or vendor of these used bottles would be a luxury they cannot afford.

Finally, bottles are washed in bulk and stored in sacks without drying awaiting purchase. The moisture provides an ideal environment for bacterial re-growth and multiplication. Bacteria need water to dissolve the food they use for energy and growth. Water allows the food to get into the cells, is used for the many chemical reactions necessary for life and growth, and allows waste products to escape. In ideal conditions (i.e. in moist foods at 37°C) bacteria will grow and multiply by dividing into two every 20 minutes. After 6 hours, in ideal conditions, one bacterial cell could become 131,072 bacteria (Wilmcow, 2012).

This trend also implies that bottles direct from consumers may not necessarily have high bacterial contamination levels, however it is the quality of treatment it undergoes after leaving the consumer that could degrade the quality or otherwise. To verify this, 25 bottles were collected from 5 different homes within the sub-metro and tested for the same parameters. The result is as shown in Figure 4-7.

Figure 4-7: Contamination Levels on Bottles Directly from Home



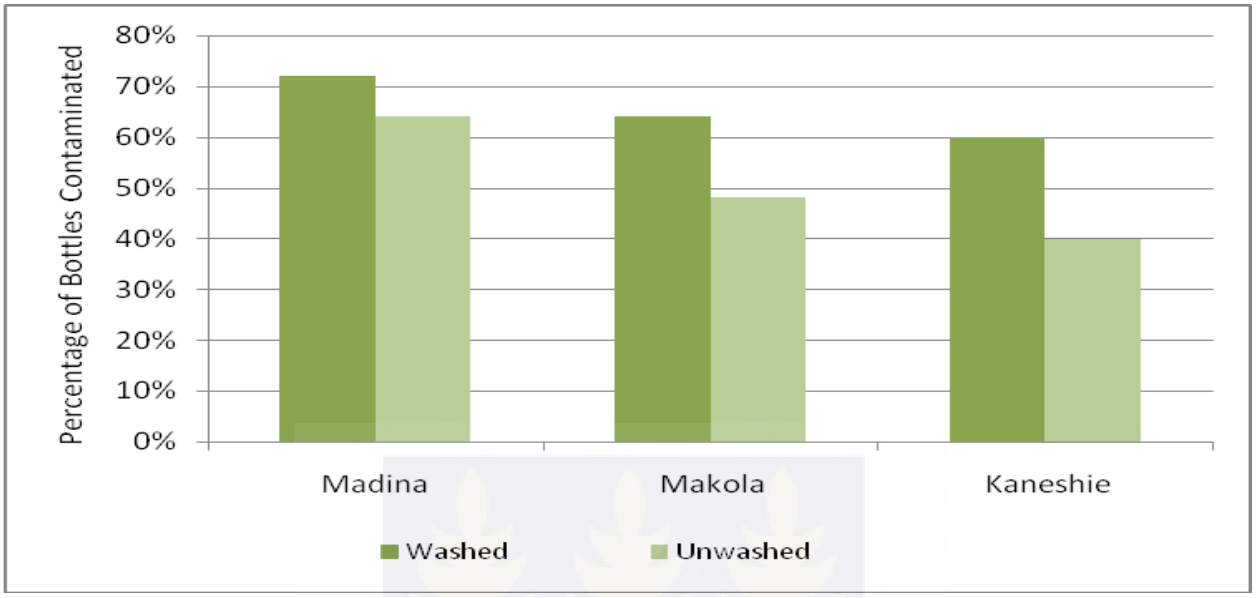
(Source: Field Data, 2013)

The results shown in Figure 4-7 indicate that out of the 25 bottles tested for total coliforms and faecal coliforms only 1 representing 4% tested positive for both parameters. This confirms the earlier statement that bottles disposed of by users at home are more likely to have low levels of contamination however the processes or the treatment they undergo after they are disposed of may compromise their quality.

4.2.1 Comparison of Results from Different Locations

The study further explored the spatial differentiation of the level of contamination of the sampled bottles. This was to see if the location from which the bottles were taken would affect the quality of the bottles tested.

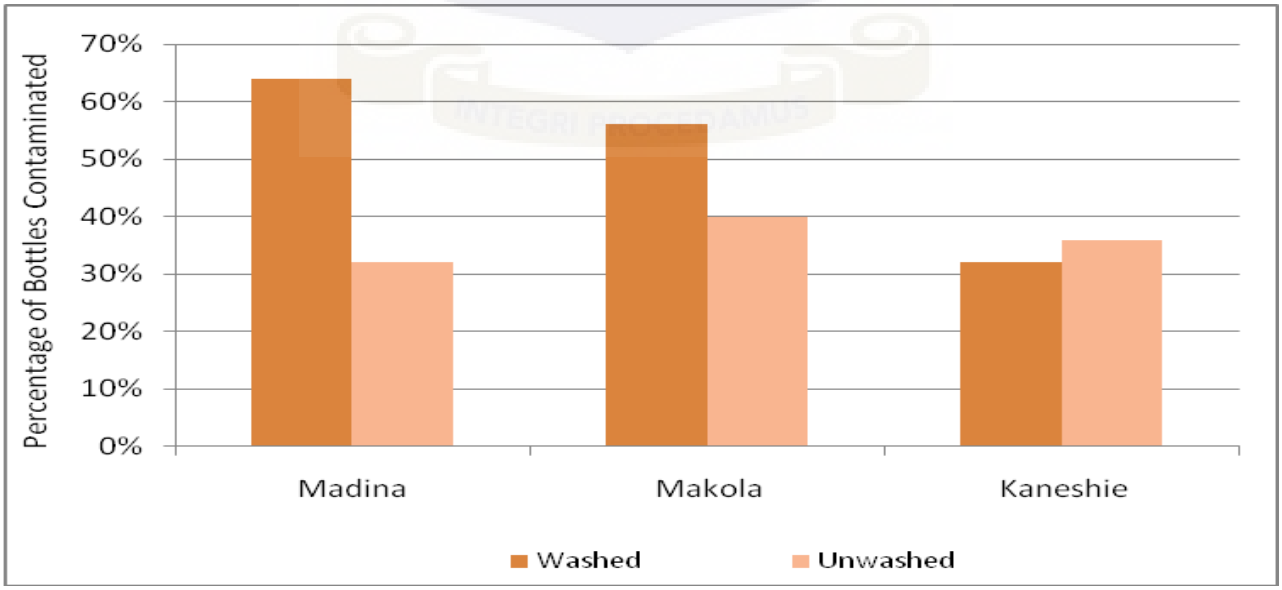
Figure 4-8: A Comparison of Percentage of Bottles positive for Total Coliforms from Three Markets



(Source: Field Data, 2013)

As shown in Figure 4-8, washed bottles from Madina recorded the highest level of contamination of Total Coliforms (72%) with Makola and Kaneshie recording (64%) and (60%) respectively.

Figure 4-9: Percentage of Bottles Contaminated with Faecal Coliforms from Three Markets



(Source: Field Data, 2013)

In terms of Faecal Coliforms, the results in Figure 4-9 show bottles from Madina again recording the highest level of contamination of 64% while 56% and 32% were recorded in Makola and Kaneshie respectively.

Madina market has one major (male) vendor from which all the market women buy their bottles. According to the vendor, the bottles are sourced from the University of Ghana Campus where some degree of sorting is done at the central disposal containers located near some Halls of residence. High levels of contamination of washed bottles at Madina may be attributed to both source of the bottles i.e. the exposure to contaminants in the garbage and the quality of water used by the vendor to sanitize the bottles before selling.

Madina is a town in the Ga East Municipallity of the Greater Accra Region. Madina and its environs face a serious challenge of availability of water with limited or no availability of pipe borne water. Residents are therefore highly dependent on water tanker services and other sources of water such as hand-dug wells and boreholes. The quality of all the main sources of water in Madina cannot be assured. Also, the scarcity of water makes the price of water in this area very high and most residents are very frugal in water usage. From observation, the vendor uses the water for both washing and rinsing several times without changing in order to minimize his water consumption. The major issues there were therefore the source of the bottles, initial quality and source of the water, cross-contamination from bottles and from washing equipment.

Makola Market has several vendors. The bottles tested were therefore sourced from three different vendors. The vendors in Makola indicated that they receive their unwashed bottles from the waste pickers but were not sure where exactly the bottles were sourced from. The vendors in

Makola were mainly women and they wash their bottles off-site. This may be an indication that the bottles are washed in a location where resources need for the washing of the bottles such as water can be sourced more conveniently than in the market. This would encourage a more rigourous or intensive washing. This may have accounted for the relatively lower numbers of contamination recorded on the bottles from Makola as compared to Madina.

Kaneshie had the lowest level of contamination in relation to the others. There were two main female vendors in Kaneshie. One indicated that she only sources her bottles from homes of family and friends. She does not buy her bottles from the waste pickers around. The other vendor however indicated that she receives her bottles from the waste pickers but also washes it off-site. The fact that one of the vendors only sources her bottles from the homes may have been significant in relatively lower levels recorded in Kaneshie. As shown earlier, bottles taken directly from home when analysed had only 1 representing 4% of the bottles contaminated with coliforms.

The different vendors, sources and treatments of the bottles therefore may have played a key role in the different patterns observed from the various markets.

4.2.2 Comparison of Results with Regulatory Standards

A comparison of the results from the analysis with established standards will allow an inference to be drawn on the risk consumers are exposed to and also explore possible means of improvement. The main standards the results from these analyses were compared to were the

WHO Standards, the Ghana Standard Authority Standards and the US EPA standards for drinking water quality.

There is currently no clear standards for microbiological quality of food packaging therefore the standards set for drinking water quality will be used as a yardstick for measuring the compliance level of the used bottles with these standards.

The WHO has outlined microbiological standards for drinking water and a comparison of the results obtained with the WHO Standard will provide picture of the acceptability of the contamination levels on the bottles on the global scale. The WHO Standard for drinking water requires that no total coliform or faecal coliform be detected in samples tested (WHO, 2011).

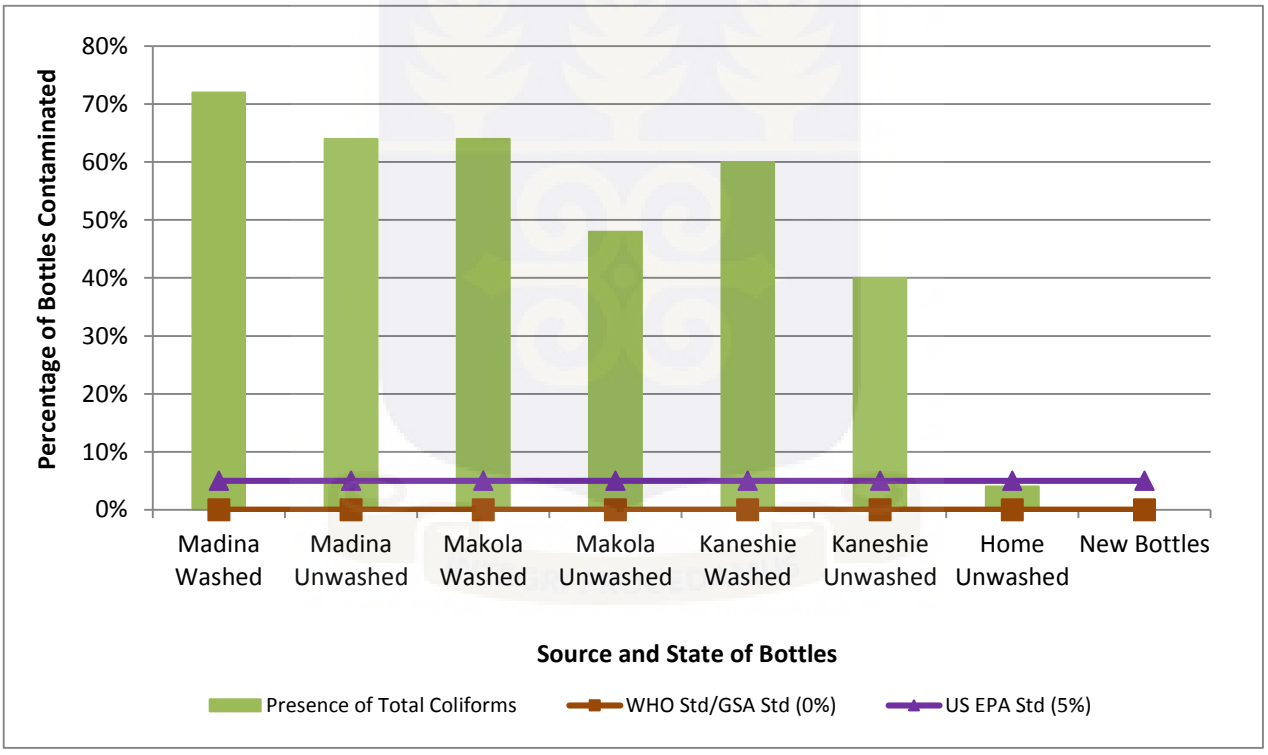
The Ghana Standard Authority (GSA) also has its own standards for drinking water quality and a comparison of the results with this standard will provide a picture of the acceptability of the contamination levels on the bottles on the National level. The Ghana Standard Authority, as the WHO Standard, also requires that no total coliform or faecal coliform be detected in samples tested (GSB, 1998).

The US EPA also set standards for the States in the U.S. to implement. Even though this Agency's authority does not go beyond the U.S., it also provides a basis for comparison of how the results from the microbiological analyses will perform in relation to Standards from other national standards. The US EPA standard on the other hand requires that no more than 5.0% of samples tested in a month should be total coliform positive, however samples positive for total

coliform should be further tested for faecal coliform; no faecal coliforms are allowed (US EPA, 2011).

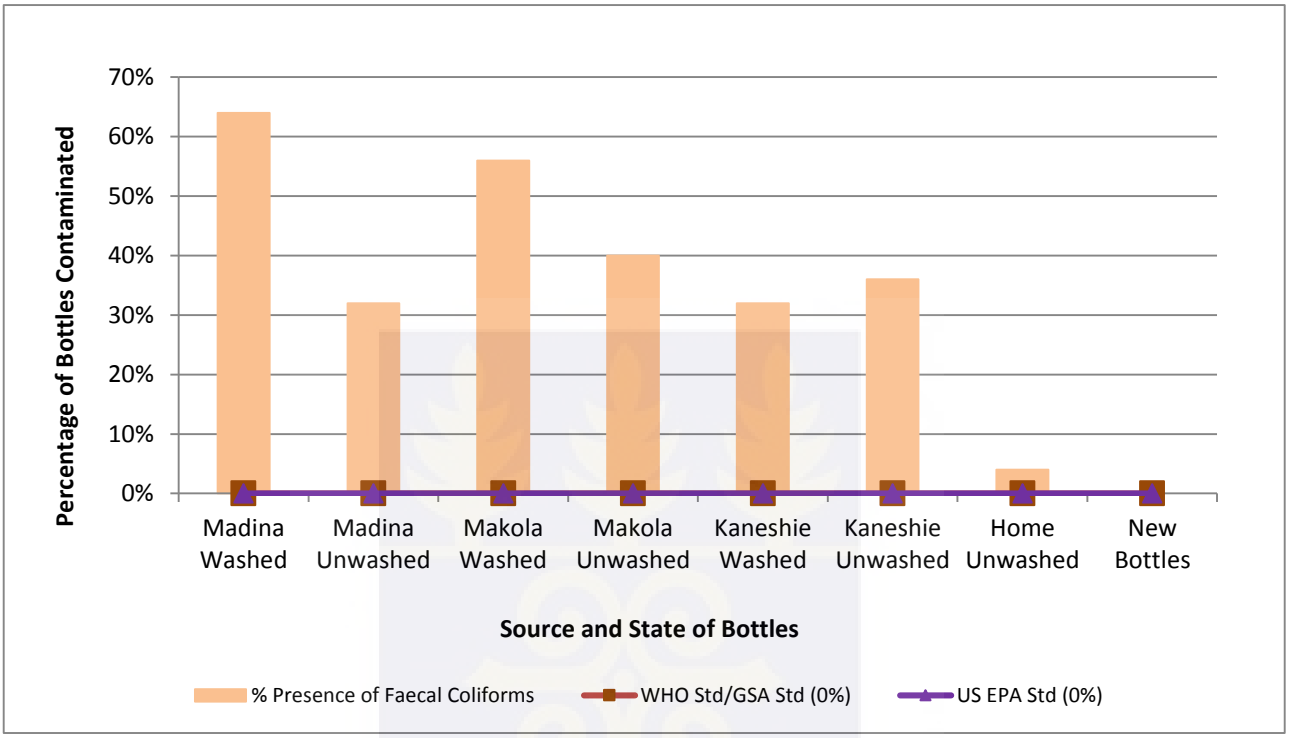
A comparison of the results for total coliforms and faecal coliforms of all the bottles tested at the various locations with the Ghana Standard Authority Standards/WHO Standards and the US EPA standards is shown in Figure 4-10 and 4-11 respectively.

Figure 4-10: A Comparison of Total Coliform results with US EPA Standards and Ghana Standard Authority Standards



(Source: Field Data, 2013)

Figure 4-11: A Comparison of Faecal Coliform results with US EPA Standards and Ghana Standard Authority Standards



(Source: Field Data, 2013)

Of all the bottles tested only the new unused bottles (control) met the GSA and WHO Standard of 0%. The unwashed bottles directly from home as well as the new bottles met the US EPA standard of 5%. Further testing of the home used bottle that registered positive for total coliform recorded a positive for faecal coliform as well thus only the new bottles met US EPA standard, the GSA and the WHO Standard for faecal coliforms. The reused bottles do not meet the any of the standards.

The washed bottles are mainly of concern because they are released to reusers and consumers. Total coliforms were detected on more than 50% of samples from each locations. The presence of total coliform may not necessarily pose a health risk but may be an indication that other more serious health threatening bacteria may be present. For this reason, the WHO and GSA standards require that no coliform bacteria should be detected. The US EPA standard offers a bit of laxity of a minimum detection of 5%. However, it requires further testing to ascertain that faecal coliforms are not present at all.

Faecal Coliforms were detected on over 30% of washed bottles from each location. Presence of faecal coliforms is an indication of a health hazard. It is an indication that the bottles have been contaminated by faecal material which could have been from the garbage from which the bottles were picked or the water used to wash the bottles. Faecal coliforms may include disease-causing organisms such as viruses, parasites and pathogenic bacteria. Consumption of food containing faecal colifoms could cause dysentery, typhoid fever, hepatitis A, viral and bacterial gastroenteritis.

These used bottles, as indicated earlier, are mostly used for food products especially drinks that are consumed directly without any further processing. This presents a health risk to the consumers.

Respondents in the survey were asked to indicate if they patronize products in these bottles. Of the total of 200 respondents, 27% indicated that they do patronize beverages sold in these bottles and 45.5% indicated they patronize cooking oil sold in these bottles. Even though a majority of

the respondents do not patronize giving the mistrust of the source and hygiene of the bottles as the main reason, the percentages of respondents who patronize is still significant and are constantly exposed to the health risks associated with consumption of food from these bottles. There is the need to protect this section of the public from these products.

The observations and results call for a holistic management system that will reduce waste bottles in the waste stream at the same time making it a valuable resource that will provide income generating opportunities for Ghanaians without compromising the health of the general public.

4.3 Chapter Summary

This chapter presented the details of the results obtained from the work done on the field. The first section presented the socio-demographic characteristics of the respondents. The section attempted to establish a relationship between the socio-demographic variables of the respondents and their water packaging preference. The section also provided an evaluation of how respondents dispose of their used bottles. The second section presented the results of the microbiological analysis of the used bottles. The variation of the results from different locations was assessed. Also, a comparison of the results with established local standards i.e. Ghana Standard Authority standards and international standards, i.e. WHO standards and US EPA standards was also presented and discussed. The subsequent chapter will present an assessment of management options based on the respondent's opinions and expert opinion.

CHAPTER FIVE

ASSESSMENT OF MANAGEMENT OPTIONS FOR WASTE PLASTIC BOTTLES

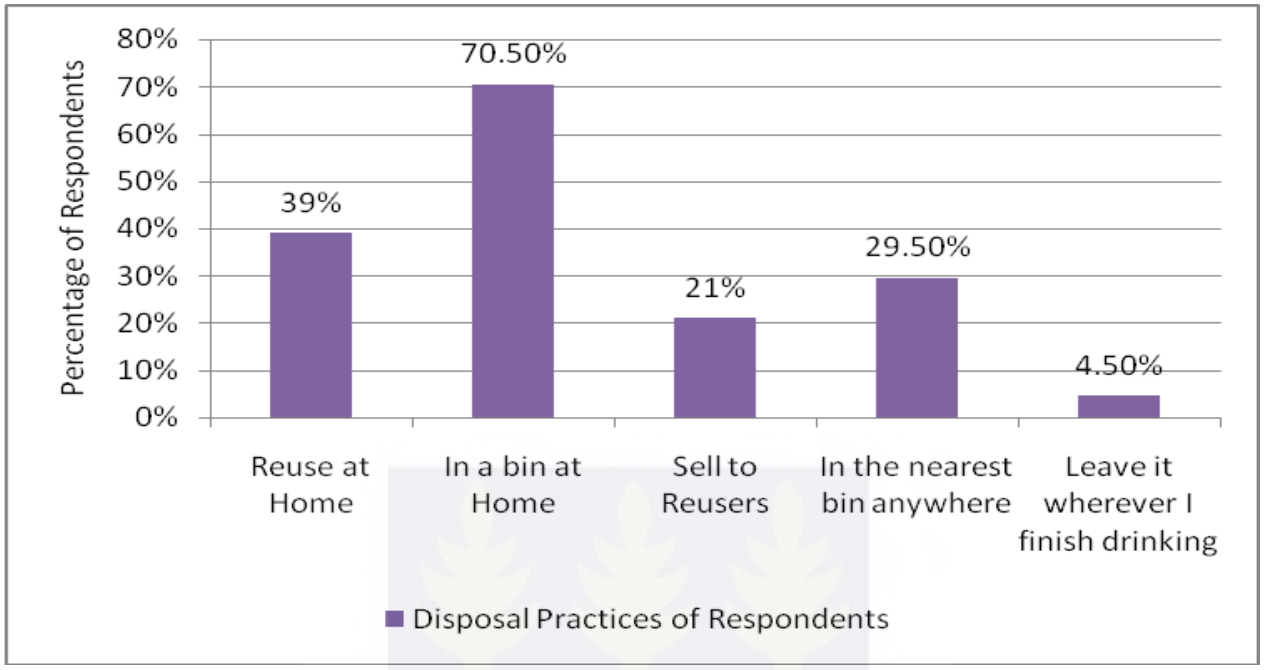
5.0 Introduction

This chapter seeks to assess the options available for improving the management of plastic bottles in the Accra Metropolis. The assessment is based on the perspective of respondents as expressed in the questionnaire administered in the study and in-depth interviews conducted with experts from the Environmental Protection Agency and other key informants. The assessment will seek to identify the best options available taking into consideration the socio-demographic patterns identified in the previous chapter.

5.1 Disposal Practices of Respondents

To enable the assessment of management options, it was important to identify and evaluate what the existing practice for handling waste bottles by residents is. The respondents were therefore asked to indicate how they dispose of the bottles when they finish drinking from it in order to gain an insight into what the current disposal practices of the respondents were based on which the management options can be evolved. The trend is shown in Figure 5-1.

Figure 5-1: Disposal Practices of Respondents



(Source: Field Data, 2013)

When respondents were asked how they disposed of their used bottles 70.50% said they dispose of their bottles in a bin at home, 39% also said they reuse at home, 29.50% said they dispose of the bottles in the nearest bin, 21% said they sell to reusers and 4.50% leave it wherever they finish using the bottles. This implies that the most popular disposal method was in a bin at home. The second most popular option was reusing the bottles at home. This method however would likely end up in a bin at home after it has exhausted its usefulness in the home.

Disposal in a bin at home may be the most popular because it is the most convenient option. Also, with the increase in patronage of bottled water or beverages, more waste bottles are generated in the households which most likely exceed the reuse needs of the home. Waste bottles in the past were valued because of their scarcity, however, now with its abundance it appears to be less valuable to households. Also one major reuse area in the past was refilling used bottles

with tapwater for drinking at home, however with the current switch to the bottle and sachets the used bottles appear to have limited use in homes.

Selling to reusers was not too popular with 21% of the respondents indicating this as their practice. This method may not be too popular because very few neighbourhoods have reusers or waste pickers who come directly to purchase these bottles from their homes. Bottles are kept pile up and are in the end disposed of along with the garbage at home. This pattern also points to the fact that most of the bottles sold for reuse within Accra are bottles intercepted after they have been discarded by first time users mainly at the central waste containers or at the final disposal sites.

The retrieval of the bottles, although informally done, performs an important role in the waste management process by reducing the waste volumes managed at the landfill sites at the same time serving as an income generating activity for those involved. However, the risks involved require that it is evaluated and better options explored. Because the bottles are exposed to other forms of garbage and contaminants therein, it compromises the quality of the bottles and poses a health risk to consumers who patronize food products sold in these recovered bottles. Although these bottles are washed by the pickers or the reusers who purchase the bottles from the pickers, the efficacy of the process cannot be assured and may even expose the bottles to more contaminants.

As shown in chapter 4, over 60% of 75 washed bottles tested from three markets in Accra tested positive for total coliforms and about 50% of the bottles tested positive for faecal coliforms. These levels are unacceptable by all standards both national and international and there is the

need to find a solution to this problem as soon as possible to safeguard the health of the Ghanaian public.

5.2 Status of Current Waste Management System from the perspective of Respondents

Solid waste management in Accra is a major problem for the Accra Metropolitan Assembly. The problems include low spatial coverage in collection and non-availability of land for disposal of collected waste (Oteng-Ababio, 2010). This has led to open dumping, burning and littering of waste. The main aim of this study is to identify ways in which plastic bottles as a component of the solid waste generated in Accra can be managed with the view to reduce the waste volumes at the same time making the bottles a valuable resource.

Before an assessment of management options for the bottles can be done it is important to analyse the respondent's perspective on the current waste management system operating within their locality. This will help to identify the aspects of the current system resident's are dissatisfied with such that in developing a new system these problems are catered for. It will also help to ensure that options considered fit into the existing culture of the people. The respondents were therefore asked to indicate the type of waste collection system operating in their locality and their opinion on its efficiency. The results are shown in Table 5 and Table 6.

Table 5: Waste Collection System Indicated by Respondents

Type of Waste Collection	Frequency	Percent
Door to Door Trucks	153	76.5
Door to Door Tricycles	11	5.5
Central waste containers	28	14.0
Open dump	8	4.0
Total	**200**	**100.0**

(*Source: Field Data, 2013*)

Out of a total of 200 respondents, 76.5% of the respondents indicated that their waste was collected by Door to Door trucks. Only 4% of the respondents indicated their waste was disposed of in open dumps. The observed pattern is not surprising as the sampling area, Ayawaso West Sub-metro, has mainly high income residential areas which predominantly enjoy the Door to Door waste collection system in the AMA (UN-Habitat, 2009). In spite of this, there are a few low income residential areas within the sub-metro such as parts of Okponglo, Shiashie and Tesano and this accounted for the other waste collection systems indicated.

The Door to Door truck system is the most convenient form of waste collection which requires the least effort from the household. Households are only required to collect their waste in a dustbin and make it available for emptying on specific days as indicated by their contract with the waste management company. This system also ensures the most efficient collection with minimal littering (Hann *et al.*, 1998). It can therefore be assumed that respondents who enjoy this type of collection system are used to the convenience and efficiency in their waste collection system. This therefore implies that for the success of any new management system proposed in this area,

it should be characterized by two main features, efficiency and convenience. Table 6 shows the opinion of respondents on the efficiency of their management system.

Table 6: Respondents' Opinion about the Efficiency of their Waste Collection System

Respondents' Rating of Collection System	Waste Collection System			
	Door to Door Trucks	Door to Door Tricycles	Central waste containers	Open dump
Very good	24.14 (%)	36.36(%)	14.81(%)	0.00(%)
Good	47.59(%)	45.45(%)	37.04(%)	14.29(%)
Fair	24.14(%)	9.09(%)	33.33(%)	0.00(%)
Poor	3.45(%)	9.09(%)	14.81(%)	42.90(%)
Very poor	0.69(%)	0.00(%)	0.00(%)	42.90(%)
Total	**100.00(%)**	**100.00(%)**	**100.00(%)**	**100.00(%)**

Out of a total of the 153 respondents that indicated being served by door-to-door trucks, about 72% felt their system ranged between very good and good. The main reason given by 82% of the respondents that were satisfied with the efficiency of their collection system was that they felt the trucks were regular.

Of the 28% that ranked the system from fair to very poor, their main reason was for the irregularity of the trucks to their areas. Since the respondents were from different residential areas within the sub-metro, it is possible that some areas have more regular service than others. This disparity could be due to different waste management contractors servicing the respondents. Also, generally, 1st Class residential areas tend to enjoy priority when it comes to waste collection, so even though a residential area classified as 2nd Class may also be serviced by the Door-to-Door trucks, the regularity with which residents in such areas are attended to may vary

from residents in areas classified as 1st Class. As of June 2010, the AMA introduced a fee-based performance collection system, where each service contractor is "zoned" a specific area within a sub-metro through a tender process. Under this arrangement, each house owner and/or landlord, office building, business, and street-vending kiosk is required to register with the contractor and pay a fee, which is tiered according to income status (Oteng-Ababio *et al.*, 2012). In Accra, the growth in waste collection demand far outstrips the ability of the municipality and the waste management contractors to expand their fleet. Most disposal trucks in Accra are therefore old and too few in number this puts pressure on the trucks eventually causing them to also breakdown. Since these private contractors sole motivation is to make profits and in view of shortages in trucks, there is the tendency for contractors to give priority to residential areas that pay higher fees and are more consistent with their payments to the disadvantage of lower income areas.

The respondents that dispose their waste in central waste containers were 28 and of this number about 52% were satisfied with the system. The main reason given by 82.4% of these respondents was that the containers are emptied regularly and the skip is always neat. Of the 48% that were not completely satisfied with the system operated in their area, the main reason given by 37% of them was that the skip was not emptied regularly. Another 30% felt that because they had to carry the refuse to the skip themselves, their neighbours litter around.

The responses showed a majority of residents within the Ayawaso West area appeared to be satisfied with how their solid waste is managed. It is therefore important that whatever new system is introduced will also continue to keep the residents satisfied, if not improve satisfaction.

From the responses, it can be seen that most of the respondents graded the efficiency of their system based on the how regularly waste is picked up. Domestic solid waste is generated daily and therefore accumulates quickly. Waste stored over a period of time begins to putrefy and generate odour depending on the amount of organics present in them. Households are therefore very particular and concerned about how often their waste is evacuated and how reliable and regular the system is. Where the waste is taken to or how it is handled after it is collected from their homes is of little concern to most people as long as it is not near them.

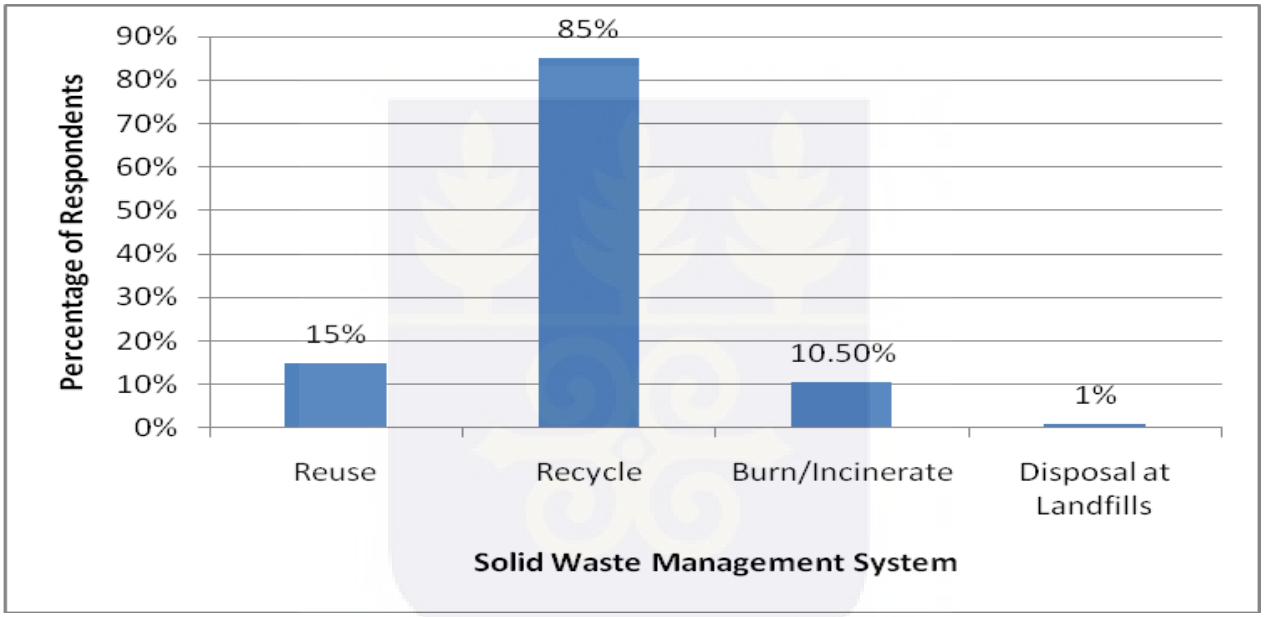
Waste segregation is one way of ensuring that biodegradable waste is kept separate from non-biodegradable for pickup. This also reduces the volume of waste the contractors needs to urgently evacuate to the landfill. Once waste is segregated management of the various components becomes easier. This will also increase the number of households each truck can service before reaching its capacity. The management of the other components of the segregated waste becomes easier. In this case, bottles separated from the garbage to be disposed of can be a resource used for other purposes.

In most developed countries, collection and recycling is the main method for managing waste bottles. It would however be presumptuous to conclude that once these systems operate in the developed world, it would necessarily work in the developing world and in this case Ghana. There is therefore the need to assess the management options within the local context. The role of residents in the success or failure of any solid waste management system cannot be underestimated; because of this the residents were asked their opinion on the best way to manage waste plastic bottles. The subsequent paragraph provides details on their responses.

5.3 Respondent's Opinion on Management Options of Plastic Bottles

Any management system implemented is heavily dependent on the cooperation of the households and individuals who will be affected by the system instituted, therefore it is important to seek their views. Respondents were therefore asked to indicate what the best management method for plastic bottles should be. The results are presented in Figure 5-2.

Figure 5-2: Respondents Opinion on the Best Way to Manage Plastic Bottles



(Source: Field Data, 2013)

Out of the total of 200 respondents, 85% indicated that recycling would be the best management option for the plastic bottles and only 1% indicated that disposal at landfills would be best. This could be associated with the fact that awareness has been created over the years regarding the problems associated with solid waste management in Accra as well as innovative things that can be done with waste plastics. Also it was established in the previous chapter that majority of the respondents had tertiary education and are therefore expected to have some level of enlightenment regarding environmental issues. This may have accounted for the high percentage of respondents that indicated recycling as the best option.

Interestingly, only 15% indicated reuse would be the best management option. This is an indication that reusing plastic bottles is not viewed favourably by a majority of the respondents. This may be due to the fact that the area is a high income area with a high percentage of highly educated residents. They are most likely aware of the health implications of the reuse of waste bottles and not view this as the best solution.

When respondents were further asked if they were willing to segregate waste at home for collection, 90% of the respondents were willing and only 10% were not willing indicating reasons such as not having the time and not accepting reuse and recycling as the best option for management. From these responses it would be easy to conclude that residents would readily accept to segregate their waste. However experiences indicate otherwise, a study carried out by Dagadu and Nunoo (2011) showed low levels of separation especially in high income homes where managing waste is left to house helps. This was attributed to the fact that even though there was the willingness to carry out separation by homeowners, the helps in the home do not understand the importance of the exercise and generally tend to forget to separate their waste. Their recommendation by Dagadu and Nunoo (2011) for the implementation of source segregation was public education supported by the right infrastructure. The next paragraph will assess the practicality of the options proposed by the respondents.

5.4 The Practicality of Management Options Proposed by Respondents in Ghana

The respondents proposed four management options i.e. recycle, reuse, burning/incineration and disposal into landfills. About 85% of the respondents viewed recycling as the best, whereas 15% also viewed reuse as the best. Burning was also proposed by 10.50% of the respondents.

However, burning of plastics release dangerous gases into the environment which causes cancers and respiratory diseases (EU, 2007). Disposal into landfills is the current management system which this study seeks to improve on. One of the main reasons for this study is to assess ways the plastic bottles can be made useful with minimal effect on the environment. Burning and disposal into landfills are therefore viewed here as the last options and will not be considered here. Therefore the main management systems proposed by the respondents which will be assessed here will be the recycling and the reuse options.

5.4.1 Assessment of Plastic Bottle Recycling as a Management System in Ghana

Recycling was the most popular management option proposed by respondents. Recycling involves converting waste into a usable material. Plastic bottles (and other plastic materials) can be recycled into a varied number of products including fibre for carpets and textiles. This option may have been popular with the respondents because of the current media hype on environmental issues and recycling stories from other nations. However the practicality of this option within our local context is important to the implementation of this system so that it can be tailored to suit our environment and does not become an imperfect copy of systems being run in developed countries.

To aid in this analysis, an in-depth interview was held with a Director of the EPA who was also a part of the committee that conducted a research into tradable waste or the waste stock exchange in Ghana under the Guinea Current Large Ecosystem Marine Project. The committee evaluated the various solid waste streams with the view to converting them to resource rather than just waste. The Director indicated that recycling plastic bottles was the best option; however the major

challenge was that the bottles were not being generated at a rate to make an investment into this sector in Ghana attractive.

> *"...Recycling is the best option for the management of plastic bottles. There are a few recycling plants in Ghana such as Cyclus Elmina Plastic Recycling which is the main recycling company for plastic bottles located in Elmina where they crush the bottles into pellets for sale to domestic plastic manufacturers as well as export. However, one of the challenges the sector faces is that the bottles available are not enough to make recycling here in Ghana financially viable considering the high taxes companies have to pay for importation of machinery. Also, since waste is not segregated in the homes, they source the waste from the pickers who also sell the bottles to reusers. Reusing bottles in Ghana is so popular that the recycling companies are in direct competition for the bottles from the reusers. This does not auger well for business because the quantities received cannot be assured. Cyclus has had to add on thin-film plastic recycling to make up for the non-availability of the bottles..."*

With the issues presented above, recycling of the bottles does not appear to be a blossoming industry in Ghana at the moment. The thin-film plastic sector on the other hand appears to be thriving. This may be due to be the fact that on the whole sachet water is still extremely popular with the Ghanaian public. Also, sachets once used cannot be reused, the sachet recycling sector therefore has an abundance of resource with no competition from other sectors. On the other hand, waste bottle collection and sale for reuse in Accra is a whole industry that depends on constant retrieval of the waste bottles from dumpsites.

5.4.2 Assessment of Plastic Bottle Reuse as a Management System in Ghana

The recycling industry comes into direct competition with the reusers for the resource. When asked his view on the reuse sector, The Director explained that the reuse of the bottles is currently a public health hazard and should not be encouraged.

> *"... The reuse of the bottles poses health hazards to the section of public that consume the products in these bottles. It should never be encouraged. Formalizing the collection and sanitization of the bottles in an attempt to improve the microbiological quality is a costly venture which will not yield any returns. There is the need to provide vehicles for collection, a processing site for washing and disinfecting the bottles and employ staff to do the work. The price at which a reused bottle is sold is not enough to ensure that the venture will break even. Who takes financial responsibility for this? Finding a sustainable management system for waste bottles in Ghana has been difficult and is still pending..."*

Based on this presentation, it is obvious that both recycling and reuse in Ghana have their challenges. The main challenge the recycling industry faces is the non-availability of bottles to sustain the industry. This non-availability is as a result of the reuse industry whose sole raw material is the used bottles.

The reuse industry as it is now is an informal sector which relies heavily on retrieving bottles from waste dumps and cleaning them with unknown sources and qualities of water all of which have unacceptable health implications. Formalising the sector, to eliminate the health risks, however, requires high financial investments with minimal expected returns. Currently, reused bottles are retailed at GH¢0.20 for every four (4) bottles and a new fresh bottle is sold at GH¢0.20

per bottle (source: Market survey, 2013). This price difference shows clearly the attraction the used bottle holds for those who patronize them. The processes required to ensure that the bottles meet the quality standards will most likely cause an increase in the price of the used bottles and may eventually cost more or equal to the price of the used bottle, making the venture pointless.

Also the PET bottle, which is most popularly reused here in Ghana, was made for single use only. Repeated reuse could compromise the quality and strength of the bottle. This therefore puts a limit on the number of times the bottles can even be reused. Again, the foods and beverages which are packaged in these bottles such as the palm oil, ice kenkey, 'soboloo' etc. stain the bottles. Therefore if the bottles cleaned for reuse are sold to the producers of these products, taking the bottles back after use will require a more intensive cleaning regime than before, some of these products may even render the bottles unusable. Effectively, this means that the capacity for reusing the bottles is limited and if this system is adopted will require the support of another system for a complete management system, most probably a recycling system.

5.5 Findings of the Comparative Assessment of Recycling and Reuse in Accra

Based on the presentation above, recycling would be a more ideal management system to adopt than reuse in terms of financial viability and sustainability. Recycling also offers the advantage of not being overly dependent on source segregation. Even though source segregation would be the ideal way of making the waste bottles accessible, experience has shown that cooperation can be quite low (Dagadu and Nunoo, 2011). Also, as indicated earlier, the residents in the study area are generally used to a convenient waste collection system. Introducing any strategy that would involve more effort on their part may not be successful. With recycling, intermediary sorting

facilities can be set up where garbage is taken for sorting. Other waste streams can also be sourced for management at this point. This however will increase the need for more rigorous washing regime for the bottles before starting the recycling process at the recycling facility.

The success of recycling bottles in Accra, however, is hinged on the elimination of the reuse sector. The reuse sector, although informal, provides income to a wide range of people, the waste pickers, the market women who sell the bottles and the local beverage producers who use these bottles. These people stand to lose their income if this sector is eliminated. However, the public health implications of allowing this sector to continue to operate as they do are also numerous and varied and cannot continue to be overlooked. This is particularly important since there are currently no official institutional arrangements for recycling or reuse. The lack of an official avenue has provided the impetus for the private sector to create an economic niche for itself in the informal waste reuse.

A holistic management system should therefore aim at incorporating these issues. Complete elimination of the reuse of plastic bottles on the commercial level should be the ultimate goal. However, the approach should take into consideration the section of the public that will lose their source of livelihood.

5.6 Chapter Summary

The aim of this chapter was to assess the management options available for waste plastic bottles. The first section sought to evaluate the respondents' views on the current waste management system operating within their locality. The type of collection system as well as the respondents'

views on its efficiency was discussed. The second section was a discussion on the respondents' opinion on the best management system for plastic bottles. The third section evaluated the management systems proposed by the respondents based on expert opinion.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

This final chapter will provide a summary of the entire study, the conclusions and the summary of the findings of the study based on the objectives as well as provide recommendations for policy consideration.

6.1 Summary of the Study

Broadly, the study sought to contribute to the surging literature which seek to explore efficient and sustainable ways of managing municipal solid waste which in recent years have been increasing in volume and character. It specifically sought to investigate better options for managing waste plastic bottles, based on a case study in the Ayawaso Sub-metropolitan Area of Accra Metropolitan Area. The selection of the sub-metro was based on the fact that it presents a microcosm of AMA, habouring parts of all the socio-economic characteristics – High, Middle and Low income communities of Accra.

The study adopted multiple research methods including questionnaire surveys, laboratory analysis, key informant/stakeholders' interviews and critical participant observation. The fieldwork lasted for five months beginning from December 2012 to April 2013.

From the results of the study, even though the younger respondents, the students as well as the tertiary level educated respondents generally had a higher percentage of their respondents having a preference for bottled water, the was no significant difference between them and respondents

from the other categories to conclusively say that the patronage of bottled water depends on age, educational level, employment status and area of residence. The only factor that appeared to significantly affect the choice of bottled water was income levels.

The main reason attributed to this pattern observed was media reports in recent times on the bacterial contaminations in sachet water, infiltration of unregistered sachet water producers operating under unhygienic conditions. These media reports especially the radio stations have a nationwide coverage and are available in local languages so are able to reach every sector of population. The reports have thus created awareness about the activities of the unregistered sachet water producers and in effect have created a general mistrust of the sachet water. Since bottled water is significantly more expensive than sachet water, the choice of whether or not to drink bottled water was therefore only limited by the ability to afford the product.

Based on this, it is expected that as income levels increase the patronage of bottled water will also increase. In Ghana, income levels have consistently been on the increase with the population living under the poverty line of $1.25 a day decreasing by 3.1% from 31.4% in 1992 to 28.5% in 2007 (World Bank, 2013). Since income level is directly linked to patronage of plastic bottles, the generation of waste plastic bottles is expected to increase directly proportionally to rise in income levels. In this light there is the need to develop a management plan as early as possible to ensure that the management of the bottles do not become as problematic as the sachet problem.

The study further analysed the microbiological contamination levels on the plastic bottles reused for local beverages, cooking oils etc. The reuse of plastic bottles is primarily an income

generating activity for those engaged in it. It, however, performs a secondary function as an informal means of managing the bottles disposed of by users. These bottles are mostly sorted from garbage disposed of at landfills, central waste containers and open dumps. They are washed and sold to reusers who use them as packaging for their products, mostly food products. The essence of the analysis of the bacterial levels on the bottles was to determine the health implications of the usage of these bottles for food products.

Generally, the washed bottles had higher presence micro-organisms than the unwashed bottles which could be attributed to the quality of water used in the washing process. About 66% of the washed bottles recorded presence of total coliform and about 50% of these same bottles recorded presence of faecal coliforms. On the whole the samples did not meet of the standards they were measured against. The WHO Standard and the Ghana Standard Authority Guidelines states that for no coliforms (total or faecal) should be detected on samples of drinking water tested. The study therefore showed that the reuse of the bottles poses health risk to consumers and should be re-evaluated.

The study further assessed the management options available taking into consideration the opinions of respondents and an expert opinion. The management systems proposed by the respondents included reuse, recycling, burning/incineration and disposal at landfills. The most popular management system proposed by the respondents was recycling and the least popular was disposal at landfills. Burning/incineration and disposal at landfills because of the level of their environmental impacts were viewed as unsustainable options and were not considered in the assessment. Reuse and recycling were therefore critically examined.

The assessment revealed that recycling of used bottles even though the option popularly promoted by the governments and international organizations all over the world, has not been too successful in Ghana. This has primarily been due non-availability of the bottles. The recycling sector is in direct competition with the reuse sector for the bottles. The reuse sector as mentioned earlier, though informal, is a whole industry made up of waste pickers, market women and the actual re-users whose livelihoods depend on it. This industry however is stifling the recycling sector which needs constant supply of the used bottles to make the sector profitable. Thus most plastic recycling companies focus on the recycling of the thin-film plastics which are abundant in the Ghanaian environment.

The assessment further looked as the reuse sector as a primary means of management of the used bottles. The study showed that in order to improve the re-use system and eliminate the health risks currently associated with it there will be the need to formalize the sector in a way that will ensure that collection, cleaning and distribution of the bottles are done in a controlled, sanitary manner. Establishing a system for proper processing of the used bottles will have financial implications that may affect the pricing of the final bottles if profit is to be made. However, the main attraction currently to the used bottles is its pricing. The new bottles cost about four times the price of an equal volume of a used bottle. An increase in the price of used bottles may make it less attractive and reduce its marketability.

Also, PET bottles, which are the most common type of plastic bottles used in Ghana, were made for single use only. Reusing them repeatedly could compromise the strength and quality of the

bottles. There would therefore be the need to limit the number of times a bottle can be used. Also, products such as ice kenkey, 'soboloo' and palm oil stain the bottles they are contained in or even render them unusable. These are however the most common reuse areas for the bottles. This would mean that bottles used for these purposes would need to be disposed of in a different way. Effectively, for the reuse sector to work holistically, it will need to work in conjunction with another management system, most probably, recycling.

6.2 Conclusion

Bottled water has become the main source of water that Ghanaians turn to for safety and reliability in terms of quality. The reports of the unhygienic operations of unregistered sachet water operators and even poor results of quality tests on sachet water from some of the registered operators has made Ghanaians skeptical about drinking sachet water. The findings of this study showed that patronage of bottled water in the Ayawaso West Sub-metro was independent of age, educational level or residential area of residents. It however pointed to the fact that patronage of bottled water had a dependency on income levels. The price of bottled water is about seven times the price of an equal volume of sachet water and a consumer would be limited by his/her economic status in the choice between sachet and bottled water.

The study therefore concluded that since the only socio-demographic factor that was limiting the patronage of bottled water was income levels, then as income levels in Ghana rise, patronage will also rise proportionally assuming the price stays the same. Bottled water patroange is dependent on income levels with patronage rising with rising income levels. This therefore points to the fact that bottled water patronage in Ghana and hence waste bottle generation is expected to continue to

increase in Ghana as income levels continue to also rise. There is therefore the need to evolve a sustainable management plan for this type of waste to reduce their impacts on the environment.

The current informal management system of reusing the bottles has serious public health implications and should not be allowed to continue to operate as it is. Tests conducted on the bottles showed high levels of bacterial contamination on over 60% of the bottles.

Two main options for management of the bottles were assessed in the study, recycling and formalizing the reuse the bottles. Overall, recycling was seen as a more sustainable option that would provide a holistic solution to the problem. However, bottle retrieval from garbage and reuse has become a popular commercial activity in Ghana causing shortages in availability of bottles for the recycling companies. The option of formalizing the reuse sector has its shortcomings of requiring high financial investment with low returns and also being an incomplete solution, in that there is a limit on the number of times the bottles can be used and also may be damaged during the reuse. It will require the support of another management system to completely solve the problem.

Recycling is the best solution for managing waste bottles in Ghana. It not only manages the waste bottles by transforming them into items that have long life spans such as carpets and textiles, but an opportunity also to generate income. There is a need however to find ways of discontinuing the current practice of retrieving used bottles and reusing them. This will free up the bottles for recycling and make the sector more attractive for industry players.

6.3 Recommendations

The study concluded that there is the need for a management system for the waste bottles. Recycling has been proposed as the most ideal system for managing the bottles however the practice of retrieving bottles for reuse has a negative impact on the current bottle recycling industry. The study therefore proposes the elimination of the reuse sector, predominantly an informal sector, in light of the health implications and also to free up the bottles for recycling. However, a large number of people depend on this sector as a source of livelihood and eliminating it would cause a loss of income to these people. The process of eliminating the reuse of bottles therefore should be a gradual process which should involve intensive education on the health implications of reusing the bottles. The study showed the tremendous impact the mass media has had on the shift from sachet water to bottled water. This same media should be employed in educating the public. The market generally responds to consumer demands, therefore if the public is educated to stop buying the products in used bottles, the market will also shift accordingly.

This informal sector therefore should be allowed to play a role in the recycling process. Waste pickers could be encouraged as they are with the thin-film plastics to deposit their bottles with recycling companies at a price rate higher than they stand to earn when they sell to the market women.

Also how the various components of the recycling system will work in terms of allocation of responsibilities needs to be clearly mapped out. Municipalities own the solid waste that is put on their public streets, have full control over who they allow as their agents to handle that waste, and

are expected to provide waste management services from the source to the final disposal (Cointreau, 2005). This means that Accra Metropolitan Assembly is overall responsible for what happens to waste generated within the metropolis. However, other sectors have a stake in making this management system successful. There will therefore be the need for the AMA to collaborate with other sectors such as the Ghana Standard Authority, the Food and Drugs Authority, the Environmental Protection Agency, the Recycling companies and media houses in mapping out and implementation of the management system.

6.4 Opportunities for Further Research

This study paves the way for further research into more aspects of managing used bottles. These areas should include:

i. Research on the financial and environmental implications of implementing the recycling system.

ii. Also, further research on the impacts of implementing the management options presented will be on the livelihood of people in the reuse industry i.e. the waste pickers, the retailers and the actual re-users.

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Appendix 1: List of Bottled and Sachet Water Producers Registered with the Food and Drugs Authority (Ghana) *(FDA Website, 2013)*

	FDA Registration No.	Product Name	Company Name & Location
ASHANTI REGION			
	Bottled Water Producers		
1.	FDB/Wt 09A-0084	Grafton Natural Mineral Water(Satchet, Cup, Bottle)	Intrapex Ghana Ltd., Tema
2.	FDB/Wt 09A-0056	Previan Natural Mineral Water(1.5L & 500ml)	Paramount Distilleries Ltd., Kumasi
	Sachet Water Producers		
3.	FDB/Wt 02A-0010	Otaqua (Water)	Otayamako Agencies, Kumasi
4.	FDB/Wt 02A-0016	Dero Drinking Water	Dero Enterprise, Kumasi
5.	FDB/Wt 02A-0017	Adehye Nsuo Royal Water	Popular Merchants, Kumasi
6.	FDB/Wt 02A-0018	Bethel Filtered Water	Bethel Oasis Enterprise, Kumasi
7.	FDB/Wt 02A-0019	Shalom Drinking Water	Vassilussa Ventures, Yennyawaso- Kumasi
8.	FDB/Wt 02A-0020	Sister Comfort Filtered Water	Sister Comfort Filtered Water Ent., Kumasi
9.	FDB/Wt 02A-0021	Osada Filtered Water	Great Osada Co. Ltd., New Tafo-Kumasi
10.	FDB/Wt 02A-0022	Addomet Drinking Water	Adomso Business complex, Sunyani.
11.	FDB/Wt 02A-0023	Mizu Filtered Water	Minboat Enterprise, Kumasi
12.	FDB/Wt 02A-0024	Alice Filtered Water	Pet-Kee Enterprise, Buokrom Estate, Kumasi
13.	FDB/Wt 02A-0025	The Truth Drinking Water	Fosbot Enterprise, Agric Nzema, Kumasi
14.	FDB/Wt 02A-0026	Boadwo Drinking Water	Abraham Osei Enterprise, Kwadaso Estate, Kumasi
15.	FDB/Wt 02A-0027	Fresh Natural Filtered Water	Ahmesa Co. Ltd., Kumasi
16.	FDB/Wt 02A-0028	Stand Still Filtered Water	StandStill Farms & Trading Ent., Ayigya, Kumasi
17.	FDB/Wt 02A-0029	Fantacy Filtered Water	Kaf Industries Ltd., Atasomanso-Kumasi
18.	FDB/Wt 02A-0030	Unity Treated Water	Asuo Gyebi Ent., Agric Nzema, Kumasi
19.	FDB/Wt 02A-0031	Majesty Drinking Water	Majesty Enterprise, Bomso- Kumasi
20.	FDB/Wt 02A-0032	Afosek Drinking Water	Afosek Trading Ent., Kokoso-Kumasi
21.	FDB/Wt 02A-0033	Aninwaa Treated Water	Aninwaa Treated Water Ent., New Tafo, Kumasi

	FDA Registration No.	Product Name	Company Name & Location
22.	FDB/Wt 02A-0034	Kate's Filtered Water	Abraham Osei Enterprise, Kwadaso Estate, Kumasi
23.	FDB/Wt 02A-0035	Original Asukokyea (Water)	Frimkids Ventures, Kumasi
24.	FDB/Wt 02A-0036	Fabulous Filtered Water	Fosbot Enterprise, Agric Nzema, Kumasi
25.	FDB/Wt 02A-0037	Emmanuels Drinking Water	Emmanuels Hygenic Ent., Pankrono-Atafoa, Kumasi
26.	FDB/Wt 02A-0038	Dwoakoma Drinking Water	Low Cost, Konongo, Ashanti Region
27.	FDB/Wt 02A-0039	Vic'mike Drinking Water	Vic'mike Co. Ltd., Ashanti Region
28.	FDB/Wt 02A-0040	Maa Rose Filtered Drinking Water	Maa Rose Ventures Ltd., Mampong, Ashanti Region
29.	FDB/Wt 02A-0041	Medo Me Man Filtered Water	Old Tafo, Kumasi
30.	FDB/Wt 02A-0042	Nsuo Eye De	Embik Ltd., Old Tafo, Kumasi
31.	FDB/Wt 02A-0043	O'one Drinking Water	Conjay Ventures, Kumasi
32.	FDB/Wt 02A-0044	Mo Maria Filtered Water	Mo Maria Enterprise, Abrepo-Kumasi
33.	FDB/Wt 02A-0045	Anocumps Drinking Water	Old Tafo, Kumasi
34.	FDB/Wt 02A-0046	Abrempong Nsuo (Water)	Jok Art Consult, Ofori Krom, Kumasi
35.	FDB/Wt 02A-0047	Trampio Drinking Water	Trampio Motors, Tanoso, Kumasi
36.	FDB/Wt 02A-0048	Kube Nsuo Drinking Water	Kube Nsuo Enterprise, Adiebeba, Kumasi
37.	FDB/Wt 02A-0049	Wabos Drinking Water	Wabos Enterprise, Kumasi
38.	FDB/Wt 02A-0050	Crystal Drinking Water	A. A. Mini Mall Ltd., Asuoyeboa, Kumasi
39.	FDB/Wt 03A-0001	Samreg Millenium Filtered Water	Samreg Enterprise, Kumasi
40.	FDB/Wt 03A-0002	Willis Drinking Water	William Appiah Enterprise, Suame-Kumasi
41.	FDB/Wt 03A-0003	Abotare Drinking Water	Olivia Owusu Enterprise, Old Tafo, Kumasi
42.	FDB/Wt 03A-0021	Francophone Filtered Water	Deekay Adom Company Ltd., Kumasi
43.	FDB/Wt 03A-0022	Ohene Gyan Filtered Water	Ohene Gyan Estate Developers, Kumasi
44.	FDB/Wt 03A-0023	Make Peace Filtered Water	Kelly Gold Collection Ltd., Kumasi
45.	FDB/Wt 03A-0024	Leit Treated Water	Kasanaleit Enterprise, Dichemso, Kumasi
46.	FDB/Wt 03A-0025	UG Drinking Water	Sunrise Electricals, Kumasi
47.	FDB/Wt 03A-0026	Happy Home Filtered Water	K. Osei Tutu Co. Ltd., Kumasi
48.	FDB/Wt 03A-0027	Feel Good Drinking Water	P. K. Boamah Ent., Abuakwa, Ashanti Region

	FDA Registration No.	Product Name	Company Name & Location
49.	FDB/Wt 03A-0028	Jarac Filtered Water	Jirajero Enterprise, Ayigya, Kumasi
50.	FDB/Wt 03A-0029	Bismark Filtered Water	Keep The Faith Ent., Asuyrboa, Kumasi
51.	FDB/Wt 03A-0030	Fasta Filtered Water	Fasta Co. Ltd., Kumasi
52.	FDB/Wt 03A-0031	Home Spring Filtered Water	Ash & Shah Enterprise Patasi, Kumasi
53.	FDB/Wt 03A-0032	Paamuka Filtered Water	Paamuka Water Company Ltd., Kumasi
54.	FDB/Wt 03A-0033	Akwag Drinking Water	Akwag Enterprise, Suame, Kumasi
55.	FDB/Wt 03A-0034	New Iseaz Filtered Water	Paktoria Praises, Ent., Kumasi
56.	FDB/Wt 03A-0035	Bobia Filtered Water	Bobie-Ansah Enterprise, Kumasi
57.	FDB/Wt 03A-0036	Tomgra Filtered Water	Tomgra Enterprise, Sesuame, Kumasi
58.	FDB/Wt 03A-0037	Sere Aqua (Water)	Jojem Pharmaceutical Ltd., Suame, Kumasi
59.	FDB/Wt 03A-0038	Asomfo Drinking Water	Asomfo Investment Ltd., Ejisu, Ashanti Region
60.	FDB/Wt 03A-0039	Mama Thess Filtered Water	Couples Enterprise, Kwadaso, Kumasi
61.	FDB/Wt 03A-0040	Sebon Filtered Water	Sewaa Bonna Ventures, Tafo, Kumasi
62.	FDB/Wt 03A-0041	Asido Filtered Water	Asido Enterprise, Kumasi
63.	FDB/Wt 03A-0042	Maa Feli Filtered Water	Agyepok Enterprise, Kumasi
64.	FDB/Wt 03A-0043	Moon 'N' Star Water	Syb Vission Ltd., Ejisu
65.	FDB/Wt 03A-0044	Littbarski Drinking Water	Kwakye & Sons, Kumasi
66.	FDB/Wt 03A-0045	Mars Filtered Water	Eleazora Enterprise, Kumasi
67.	FDB/Wt 03A-0046	Aquabella Filtered Water	Frerdom Enterprise, Kumasi
68.	FDB/Wt 03A-0047	Kaeya Filtered Water	Kaeya Enterprise, Berkwai, Ashanti Region
69.	FDB/Wt 03A-0048	Nyanko Nsuo (Water)	Jusbro Trading Enterprise., Kumasi
70.	FDB/Wt 03A-0049	Nkwa Treated Water	Opoku Mensah Ent., New Tafo, Kumasi
71.	FDB/Wt 03A-0050	Juliet Filtered Water	Mugoba Enterprise, Pankrono, A/R
72.	FDB/Wt 03A-0051	Kofidi Filtered Water	Kofidi Enterprise, UST - Kumasi
73.	FDB/Wt 03A-0052	Bedpok Filtered Water	Bediako Poku Ent., Kumasi
74.	FDB/Wt 03A-0053	Asuoba Filtered Water	Daatweereb Ent., Kumasi
75.	FDB/Wt 03A-0054	Oboadee Drinking Water	Ashanti Pride Enterprise, Kumasi
76.	FDB/Wt 03A-0055	Splash Filtered Water	Splash Ventures Ent., Kumasi

	FDA Registration No.	Product Name	Company Name & Location
77.	FDB/Wt 03A-0056	Sweetlife Filtered Water	IKELIZ Ent., Kumasi
78.	FDB/Wt 03A-0057	Agabo Filtered Water	Agabo Enterprise, Kumasi
79.	FDB/Wt 03A-0058	Yayeb Filtered Water	Yayeb Enterprise, Kumasi
80.	FDB/Wt 03A-0059	Novena Filtered Water	Santo Jeff Ent., Kumasi
81.	FDB/Wt 03A-0060	Quench De Original Drinking Water	Quench Global Ent., Kumasi
82.	FDB/Wt 03A-0061	Bernard Drinking Water	Wember Enterprise, Ashanti
83.	FDB/Wt 03A-0062	Ahenfie Nsuo Filtered Water	Kwaku Anto Tabri Co. Ltd., Kumasi
84.	FDB/Wt 03A-0063	S & M Filtered Water	K. D. B. Ventures, Kumasi
85.	FDB/Wt 03A-0067	Brenda Drinking Water	Public Interest Enterprise, Kumasi
86.	FDB/Wt 03A-0068	Champion Man Filtered Water	Champion Man Company Ltd., Kumasi
87.	FDB/Wt 03A-0069	Blue Skies Filtered Water	Kuffour Enterprise, Kumasi
88.	FDB/Wt 04A-0026	Century Drinking Water	Century Investment Limited, Kumasi
89.	FDB/Wt 04A-0027	Eden Filtered Water	Eden Ventures,Kumasi
90.	FDB/Wt 04A-0028	Jossey Filtered Water	Jesus Saves Enterprise, Kumasi
91.	FDB/Wt 04A-0029	Americanos Drinking Water	American Taste Enterprise, Kumasi
92.	FDB/Wt 04A-0030	Exodusco Drinking Water	Ansah & Co Ltd., Kumasi
93.	FDB/Wt 04A-0031	Dorin Treated Water	Dorin Enterprise, Kumasi
94.	FDB/Wt 04A-0032	Awareso Filtered Water	Awareso Enterprise, Kumasi
95.	FDB/Wt 04A-0033	Kabaas Drinking Water	Kabaas Stores Enterprise, Kumasi
96.	FDB/Wt 04A-0034	Yiadom Filtered Water	I.Y.B. Enterprise, Kumasi
97.	FDB/Wt 04A-0035	OH YES Drinking Water	Akufric Trading Enterprise, Kumasi
98.	FDB/Wt 04A-0036	Silverstone Filtered Water	Ahinyak Company Limited, Kumasi
99.	FDB/Wt 04A-0037	Dorjo Filtered Water	Doreido Enterprise, Kumasi
100.	FDB/Wt 04A-0038	Gofex Filtered Water	Good First Engineering Limited, Kumasi
101.	FDB/Wt 04A-0039	Lords Filtered Water	Lord's Enterprise, Kumasi
102.	FDB/Wt 04A-0040	Prepjel Treated Water	Prepjel Treated Water Enterprise, Kumasi
103.	FDB/Wt 04A-0041	Make Sure Filtered Water	Lee Jay Frans Enterprise, Kumasi

	FDA Registration No.	Product Name	Company Name & Location
104.	FDB/Wt 04A-0014	Cool Pac Treated Water (Koforidua)	Voltic Ghana Ltd., Accra
105.	FDB/Wt 04A-0042	Hi-Bee Treated Water	Hi-Bee Enterprise, Kumasi
106.	FDB/Wt 05A-0007	Yaapsa Filtered Water	Yaapsa Ent., Ahinsan Estate, Kumasi
107.	FDB/Wt 05A-0008	Solidad Drinking Water	Solidad Enterprise, Kumasi
108.	FDB/Wt 05A-0009	Silos Filtered Water	Silos Enterprise, Kumasi
109.	FDB/Wt 05A-0010	Valor Drinking Water	Gows Marketing Consult
110.	FDB/Wt 05A-0011	Jimmy Filtered Water	Jimmy Spring Water Co.Ltd, Ayeduase, Kumasi
111.	FDB/Wt 05A-0012	Jofrem Drinking Water	Enye Mahooden Enterprise, Abompekrom-Obuasi
112.	FDB/Wt 05A-0013	Debiorah Drinking Water	Angels Fountain Waters, Anwonmaso, Kumasi
113.	FDB/Wt 05A-0014	Thirsty Tasty Drinking Water	Appason Enterprise, Obuasi
114.	FDB/Wt 05A-0015	Obey Your Thirst Drinking Water	Fenaboat Ventures, Daban, Kumasi
115.	FDB/Wt 05A-0016	Obaapa Filtered Drinking Water	First Watch Limited, Ashanti Region
116.	FDB/Wt 05A-0017	Sam Dot Filtered Water	Samhaco Ent., Kumasi
117.	FDB/Wt 05A-0018	Sir Joe Drinking Water	Sir Joe Mineral Water Co.Ltd., Kumasi
118.	FDB/Wt 05A-0019	Hyeden Filtered Water	Hyeden Ventures, Old Tafo, Kumasi
119.	FDB/Wt 05A-0020	Ellena Drinking Water	Ellena Flora Centre, Ahinsan, Kumasi
120.	FDB/Wt 05A-0021	Manigold Filtered Water	Eelac Ventures, Deduako-Kodiekrom, Kumasi
121.	FDB/Wt 05A-0022	Girls Girls Drinking Water	Kwaku Antwi Enterprise, Plt 5 Blk C, Kronum, Kumasi
122.	FDB/Wt 05A-0023	4 Ever Filtered Water	Technology World Limited, Plt 2A AAII Street SECII, Fumesua, Kumasi
123.	FDB/Wt 05A-0024	Abodwosuo Filtered Water	Okoafre Enterprise, Asafo-Kumasi
124.	FDB/Wt 06A-0002	Lily Filtered Water	K. Bermour Enterprise, Kumasi
125.	FDB/Wt 06A-0003	Freeman Filtered Water	Kath Construction and Trading Enterprise, Kumasi
126.	FDB/Wt 06A-0004	Sola Treated Water	Reginus Ent., Kumasi
127.	FDB/Wt 06A-0005	Konas Drinking Water	Konas & Co Limited, Mampongteng, Ashanti
128.	FDB/Wt 06A-0006	Aqualy Filtered Water	K.O. Apuu Company Ltd., UST, Kumasi
129.	FDB/Wt 06A-0007	Dominion Drinking Water	Dominion Chapel Enterprise
130.	FDB/Wt 06A-0008	Kofcee Filtered Water	Kofcee Enterprise, Kumasi

	FDA Registration No.	Product Name	Company Name & Location
131.	FDB/Wt 06A-0009	U3 Drinking Water	Notre Dame Industry, Kumasi
132.	FDB/Wt 06A-0010	Maame Dora Drinking Water	Maame Dora Drinking Water, Kumasi
133.	FDB/Wt 06A-0011	Zoe Filtered Water	Life Establishment and Services Ltd., Kumasi
134.	FDB/Wt 06A-0012	Gentle Dove Treated Water	Adford Enterprise Limited, Kumasi
135.	FDB/Wt 06A-0013	Ekuona Filtered Water	Ekuona Filtered Water Enterprise, Kum
136.	FDB/Wt 06A-0014	Lisa Filtered Water	Kes-Bana Enterprise, Kumasi
137.	FDB/Wt 06A-0015	Hudson Drinking Water	Party Essentials Enterprise, Ejisu
138.	FDB/Wt 06A-0016	Abaawa Filtered Water	Naomi Eyifah Enterprise, Kumasi
139.	FDB/Wt 06A-0017	Agyengo Drinking Water	E. K Agyeman Enterprise, Kumasi
140.	FDB/Wt 06A-0018	Good Tree Filtered Water	B. B. S Enterprise
141.	FDB/Wt 06A-0019	Betenase Filtered Water	Betenase Euro Ventures, Kumasi
142.	FDB/Wt 06A-0020	Yen Ara Asase Ni Drinking Water	Loob Company, Kumasi
143.	FDB/Wt 06A-0021	Kay Filtered Drinking Water	Caritas Ventures, Kumasi
144.	FDB/Wt 06A-0022	Choice Filtered Water	Safe Wheels Enterprise, Kumasi
145.	FDB/Wt 06A-0023	Frevacs Filtered Water	Adube Ventures, Obuasi
146.	FDB/Wt 06A-0024	Agyapa Filtered Water	Anamon Hyeren Ventures, Obuasi
147.	FDB/Wt 06A-0026	Transitional Drinking Water	Owusu Danso Lydia Ent., Kumasi
148.	FDB/Wt 06A-0027	Pev Natural Mineral water	Peevic Ent., Obuasi
149.	FDB/Wt 06A-0028	Rich Drinking Water	Rich Dua Ent., Kumasi
150.	FDB/Wt 06A-0029	Tot Way Drinking Water	Totway Communications, Kumasi
151.	FDB/Wt 06A-0030	Uncle Willie Filtered Drinking Water	Uncle Willie Natural Water, Ejisu
152.	FDB/Wt 06A-0031	Adepa Filtered Water	Adepa Filtered Water, Kumasi
153.	FDB/Wt 06A-0033	Adukromu Nsuo	Fusspots Ent., Kumasi
154.	FDB/Wt 06A-0048	Sanat Filtered Drinking Water	Abdulai Seini Sanat Enterprise, Kumasi
155.	FDB/Wt 06A-0049	Mr. King's Filtered Drinking Water	Domonion Company Limited, Kumasi
156.	FDB/Wt 06A-0050	Bubbles Filtered Drinking Water	Bubbles Production Enterprise, Kumasi
157.	FDB/Wt 07A-0007	Aqua Yuba Filtered Water	Aqua Vitae Co Ltd., Box SE 889, Kumasi

	FDA Registration No.	Product Name	Company Name & Location
158.	FDB/Wt 07A-0009	Nafran Filtered Water	Nafranina Enterprise, Kumasi
159.	FDB/Wt 07A-0012	Model Drinking Water	Conata Enterprise, Kumasi
160.	FDB/Wt 07A-0013	Johet Drinking Water	Johet Transport and Trading Enterprise, Kumasi
161.	FDB/Wt 07A-0014	Dorcstev Treated Ventures	Dorcstev Ventures, P.O. Box 42 Japekrom-Brong Ahafo
162.	FDB/Wt 07A-0015	Pasky Drinking Water	Don - Hel Ent, Kumasi
163.	FDB/Wt 07A-0016	Sweet Mother Drinking Water	Sweet Mother Divine Ventures, Kumasi
164.	FDB/Wt 07A-0017	Promise Filtered Drinking Water	Namosaa Ultimate and Trading Ent., Kumasi
165.	FDB/Wt 08A-0002	Tinex Filtered Drinking Water	J. T. Osei & Co. Ltd., Kumasi
166.	FDB/Wt 08A-0018	Okofo Filtered Water	Okofo Boampong Ent. P.O Box 58, Nsuta- Ashanti
167.	FDB/Wt 08A-0019	Go Filtered Water	Gogosag Company Ltd. P.O Box S A 174, Kumasi
168.	FDB/Wt 08A-0020	Odo Nsuo Natural Spring Water	Ado- Dap company Ltd, P.O Box SE 1693, Suame Kumasi
169.	FDB/Wt 08A-0021	Spa Filtered Water	Ado- Dap company Ltd, P.O Box SE 1693, Suame Kumasi
170.	FDB/Wt 08A-0022	Ado- Dap Natural Mineral Water	Ado- Dap company Ltd, P.O Box SE 1693, Suame Kumasi
171.	FDB/Wt 08A-0029	Greenland Filtered Water	Greenland Pure Water Co. Ltd P.O Box 101 Kumasi
172.	FDB/Wt 08A-0032	Downtown Filtered Drinking Water	Aspirations Ventures, Kumasi
173.	FDB/Wt 08A-0033	Ameena Drinking Water	Pokuase 3000 Ltd Kumasi
174.	FDB/Wt 08A-0034	Benak Drinking Water	It's Jehova Motors And Trading Ltd, Kumasi
175.	FDB/Wt 08A-0035	Jilac Drinking Water	Fenimens Co. Ltd.,Obuasi
176.	FDB/Wt 08A-0036	Ahwenepa Drinking Water	Ahwenepa Ventures Konongo
177.	FDB/Wt 08A-0037	Nkrabea Drinking Water	Nkrabea Memorial Farm and General Merchandise
178.	FDB/Wt 08A-0038	Pearl Drops Filtered Drinking Water	Great Amazing Ventures
179.	FDB/Wt 08A-0039	Trust Me Drinking Water	Trust and Favour Ltd Akutuase, Konongo
180.	FDB/Wt 08A-0040	Nyarko Nsuo	Nyarko Memorial Ventures, Ejisu Ashanti
181.	FDB/Wt 08A-0041	Amrita Natural Mineral Water	Zichen Investment Company Ltd, Kumasi
182.	FDB/Wt 08A-0042	Meros Drinking Water	Busy Hands Ent, Old Tafo Kumasi
183.	FDB/Wt 08A-0043	DKN Filtered Drinking Water	MNS Enterprise

	FDA Registration No.	Product Name	Company Name & Location
184.	FDB/Wt 08A-0044	Abrempong Nsuo	J. T. Osei & Co. Ltd., Kumasi
185.	FDB/Wt 08A-0045	Erigi Filtered Water	Erigi Ventures KNUST Kumasi
186.	FDB/Wt 09A- 0048	Complex Filtered Drinking Water	Complex Communication Centre, Kumasi
187.	FDB/Wt 09A -0113	Pelikan Filtered Drinking water	Pelikan Manor Co., ltd
188.	FDB/Wt 09A-0002	Maxima Filtered Drinking water	Gymboat Company Ltd,Kumasi
189.	FDB/Wt 09A-0004	Hillbacai Filtered Water	Hillbacai Ent.,Kumasi
190.	FDB/Wt 09A-0007	Jefkef Filtered Water	Jefkef Ventures
191.	FDB/Wt 09A-0009	Yarmens Filtered Drinking Water	Yarmens Enterprise, Suame, Kumasi
192.	FDB/Wt 09A-0018	Snow White Filtered Drinking Water	A.Y Frempong Ventures, Kumasi
193.	FDB/Wt 09A-0084	Grafton Natural Mineral Water	Intrapex Ghana Ltd., Tema
194.	FDB/Wt 09A-0021	Maame Akoma Drinking Water	Daasebre Pharmacy Company Limited, Konongo-Ashanti
195.	FDB/Wt 09A-0039	Atta-Dor Drinking Water	Atta-Dor Enterprise, Kumasi
196.	FDB/Wt 09A-0042	Ropa Filtered Water	Osjei Enterprise, Kumasi
197.	FDB/Wt 09A-0046	Kwaboat Drinking Water	Sunkwa Filtered Water Ent., Offinso New Town, Kumas
198.	FDB/Wt 09A-0047	Elipah Drinking Water	Adwoa Konadu Ent., Kumasi
199.	FDB/Wt 09A-0050	Seven Sister Filtered Drinking Water	Nana Kofi Ansah Ent.
200.	FDB/Wt 09A-0051	Jefas Drinking Water	Jeff A. Asare Ent.
201.	FDB/Wt 09A-0052	Nanark Filtered Drinking Water	Nanark Ventures Ashanti region
202.	FDB/Wt 09A-0055	Thirstgo Crystal Water	Thirstgo Crystal Waters
203.	FDB/Wt 09A-0063	Jonasy Drinking Water	J. Anim Ent., Nkawkaw
204.	FDB/Wt 09A-0070	Breeze Natural Mineral Water(Satchet)	Paramount Distilleries Ltd., Kumasi
205.	FDB/Wt 09A-0074	Mesa Filtered Drinking Water	Stephen Akuoko Trading & Local Soap Manufacturing Ent
206.	FDB/Wt 09A-0076	Sweet Life Filtered Drinking Water	I.Y.B. Enterprise, Kumasi
207.	FDB/Wt 09A-0077	B2O Drinking Water	Adjei Brobbey Ventures
208.	FDB/Wt 09A-0096	La Vie Filtered water	F-Factor Ltd., Obuasi
209.	FDB/Wt 09A-0101	Bana and Bata Drinking water	Bana and Bata Ent

	FDA Registration No.	Product Name	Company Name & Location
210.	FDB/Wt 10A-0002	Skywalker Drinking water	Skywalker Co. Ltd., Kumasi
211.	FDB/Wt 10A-0010	Rivercrest natural mineral water	Rivercrest Co. Ltd., Kumasi
212.	FDB/Wt 10A-0011	Passion Treated drinking water	Rivercrest Co. Ltd., Kumasi
213.	FDB/Wt 10A-0012	Adolan filtered water	Truth Waters, Kumasi
214.	FDB/Wt 10A-0014	Rainbow filtered water	Rainbow filtered water Ent
215.	FDB/Wt 10A-0015	Go Tango filtered drinking water	Go Tango Co. Ltd., Kumasi
216.	FDB/Wt 10A-0016	Companion drinking water	Eden Springs Resources, Kumasi
217.	FDB/Wt 10A-0020	Liwat Filtered water	Living Water Chapel Filtered Water Co. Ltd., Kumasi
218.	FDB/Wt 10A-0026	Dimples Filtered drinking water	K.B Agyapong Ent., Kumasi
219.	FDB/Wt 10A-0036	Mount C Filtered water	MT Carmel Resort ltd
220.	FDB/Wt 10A-0037	Nayas Filtered Water	Sweet Achiaa Ent., Kumasi
221.	FDB/Wt 10A-0040	Nakmad Filtered Drinking water	Nakmad Ent., Kumasi
222.	FDB/Wt 10A-0041	S.A.J Filtered water	S.A.J Timber and Construction ltd
223.	FDB/Wt 10A-0042	Everfresh Filtered Drinking water	Everfresh Drinking Water, Adum Kumasi
224.	FDB/Wt 10A-0043	Still P.D filtered drinking water	Still P.D Ebenezer
225.	FDB/Wt 10A-0044	O-Beng Drinking Water	O-beng Ventures
226.	FDB/Wt 10A-0048	Boafowah Nsuo filtered drinking water	Glani-Sarp Farms and Trading Ent
227.	FDB/Wt 10A-0051	Nivana Filtered Water	Jerry Boakye Ansa Ventures
228.	FDB/Wt 10A-0054	Joetess Drinking water	AM-Joetess Business Ent
229.	FDB/Wt 10A-0055	Connie's Drinking water	Connie's Health water and general trading
230.	FDB/Wt 10A-0059	Be-First Filtered drinking water	Be-First Enterprise, Kumasi
231.	FDB/Wt 10A-0061	Opponak Drinking water	Oppong Nyantakyi Ent
232.	FDB/Wt 10A-0062	Nyakus Drinking water	Nyakus Ent., Kumasi
233.	FDB/Wt 10A-0063	Obaa Yaa Filtered drinking water	Obaa Yaa Mineral Water
234.	FDB/Wt 10A-0065	Emas Drinking Water	E-Agyemens Ventures
235.	FDB/Wt 10A-0066	Be Jay Drinking water	Anointing Mineral Water

	FDA Registration No.	Product Name	Company Name & Location
236.	FDB/Wt 10A-0067	Tashna Drinking water	Tashna Ventures, Kumasi
237.	FDB/Wt 10A-0068	KAB Filtered water	KAB Filtered Water, Kumasi
238.	FDB/Wt 10A-0070	OA Filtered drinking water	OA Mineral water
239.	FDB/Wt 10A-0073	Olive Treated drinking water	Olive Treated Water and trading Ent
240.	FDB/Wt 10A-0074	Cobb-Ji drinking water	Cobisco Ent., Kumasi
241.	FDB/Wt 10A-0075	Enumafield filtered water	Enumafield Co. Ltd., Kumasi
242.	FDB/Wt 10A-0076	Ernogyan Filtered drinking water	Ernogyan Co. Ltd., Kumasi
243.	FDB/Wt 10A-0077	Asukokyeaa drinking water	Asik'm Ent., Kumasi
244.	FDB/Wt 10A-0078	Mannam Filtered water	Manna Pavement block works
245.	FDB/Wt 10A-0079	Hanmoro Filtered water	Hanmoro Filtered water, Kumasi
246.	FDB/Wt 10A-0080	Dam Fresh water	Prince Yaw Damoah Ent
247.	FDB/Wt 10A-0081	Romis Filtered drinking water	Romis Drinking water
248.	FDB/Wt 10A-0082	Lee Filtered drinking water	Margaret Konadu Kankam Ent., Kumasi
249.	FDB/Wt 10A-0083	Vineyard Filtered water	Vineyard Spring Ent., Kumasi
250.	FDB/Wt 10A-0084	Cox-long drinking water	Coxlong Ent., Kumasi
251.	FDB/Wt 10A-0085	Blue Moon filtered water	Crystal Joy Spring Water Ent., Konongo
252.	FDB/Wt 10A-0086	Big K filtered water	Big K Ventures, Konongo
253.	FDB/Wt 10A-0087	Ghafas filtered water	Kingy Engineering and Construction
254.	FDB/Wt 10A-0088	Anso Vital Water	Anso Vital water Co., ltd
255.	FDB/Wt 10A-0089	Ekuoba drinking water	Grace F. Mart Ent., Kumasi
256.	FDB/Wt 10A-0090	Vespring Drinking water	Vespring Co. Ltd., Kumasi
257.	FDB/Wt 10A-0091	ACME filtered water	ACME Filtered
258.	FDB/Wt 10A-0092	Sanapac mineral drinking water	Sanapaac mineral water Ent
259.	FDB/Wt 10A-0093	Alberta Treated drinking water	Naa Sab Enterprise, Kumasi
260.	FDB/Wt 10A-0094	Auntie Julie drinking water	Jot Ent., Suame Kumasi
261.	FDB/Wt 10A-0095	Prince drinking water	Oheneba Fobi Ventures, Kumasi
262.	FDB/Wt 10A-0098	Sukyeremma Treated water	Nowasa Ent., Ash Town Kumasi

	FDA Registration No.	Product Name	Company Name & Location
263.	FDB/Wt 10A-0099	FM filtered water	Frikkias Motors, Kumasi
264.	FDB/Wt 10A-0100	Milanese filtered drinking water	Dannyrosa Joy Ventures, Kumasi
265.	FDB/Wt 10A-0102	Ahenanan filtered water	Aiksarp Ventures
266.	FDB/Wt 10A-0106	Camelot filtered drinking water	Baqkiro Co. Ltd., Ejisu
267.	FDB/Wt 10A-0110	Eco Filtered Drinking Water	Essase Christian Orphanage, Kumasi
268.	FDB/Wt 10A-0111	Benny Drinking Water	Down River Enterprise
269.	FDB/Wt 10A-0116	Tyburn Drinking Water	Tyburn Martyrs Ventures
270.	FDB/Wt 10A-0117	Nana Achiaa Filtered Drinking Water	Nana Achiaa Memorial Filtered Water
271.	FDB/Wt 10A-0119	Davis Filtered Water	Davis Farms & Trading Ent.
272.	FDB/Wt 10A-0202	Wisdama Filtered Drinking Water	Wisdama Enterprise, Suame Kumasi
273.	FDB/Wt 10A-0204	Olivetan Drinking Water	Olivetan Mineral Water Ent., Kumasi
274.	FDB/Wt 10A-0205	Hello Drinking Water	Donakon Enterprise, Kumasi
275.	FDB/Wt 10A-0210	Artic Water	Artic Investment Ltd.
276.	FDB/Wt 10A-0219	Macfreda Drinking Water	Macfreda Ent., Kumasi
277.	FDB/Wt 10A-0221	Kak Water	Marvin-T Ent., Kumasi
278.	FDB/Wt 10A-0222	Cadpure Filtered Water	Ceaser And Cad Ltd.
279.	FDB/Wt 10A-0229	Madam Catherine Drinking Water	Rocky Crystal Ventures
280.	FDB/Wt 10A-0237	Atlas Drinking Water	Boateng & Family Company Limited
281.	FDB/Wt 10A-0239	Truestar Filtered Water	True Star Mineral Water
282.	FDB/Wt 10A-0240	Timeless Drinking Water	Apranaa Ventures, Kumasi
283.	FDB/Wt 10A-0241	Eddyrose Filtered Drinking Water	Jevefra Ent., Kumasi
284.	FDB/Wt 10A-0244	Kosarbs Filtered Drinking Water	Kosarb Enterprise, Old Tafo Kumasi
285.	FDB/Wt 10A-0245	Aboagyewaa Filtered Water	Bemawus Ent., Kumasi
286.	FDB/Wt 10A-0246	Iroc M Filtered Water	S.S.B.S. Enterprise,Kumasi
287.	FDB/Wt 10A-0248	Amkess Filtered Drinking Water	Amkess Ventures, Kumasi
288.	FDB/Wt 10A-0249	Almoc Filtered Drinking Water	Almoc Pharmacy Limited

	FDA Registration No.	Product Name	Company Name & Location
289.	FDB/Wt 10A-0250	Bafman Drinking Water	Bafman Ltd., Kumasi
290.	FDB/Wt 10A-0253	Mabon Filtered Water	Kraptus Enterprise
291.	FDB/Wt 10A-0255	Agya Pete Drinking Water	Peedampts Ventures, Kumasi
292.	FDB/Wt 10A-0258	Bota Filtered Drinking Water	Bota Drinking Water
293.	FDB/Wt 10A-0259	Nipak Drinking Water	Onipa Nkwa Hohia Enterprise, Konongo
294.	FDB/Wt 10A-0260	Big Time Filtered Water	Jeffrey Owusu Ent., Kumasi
295.	FDB/Wt 10A-0262	Barfour Drinking Water	Osakpon Farms Company
296.	FDB/Wt 10A-0263	Gyasons Filtered Water	G. Gyasons Enterprise
297.	FDB/Wt 10A-0265	BG Geobeck Filtered Water	Beckgeo Ventures, Kumasi
298.	FDB/Wt 10A-0266	Trimude Filtered Drinking Water	Trimudehene Investment Centre
299.	FDB/Wt 10A-0267	Joe Filtered Drinking Water	Joe's Dignity Enterprise
300.	FDB/Wt 10A-0270	Eddy-Sa Drinking Water	Eddy Sarp Enterprise
301.	FDB/Wt 10A-0271	Madame Filtered Water	Doris One Ent., Kumasi
302.	FDB/Wt 10A-0272	Active Drinking Water	Ghaireland Ltd., Tamale
303.	FDB/Wt 10A-0273	Kanaz Drinking Water	Kanaz Company Limited
304.	FDB/Wt 10A-0275	Kandeglo Drinking Water	Kandeglo Ent., Kumasi
305.	FDB/Wt 10A-0276	Fonty Filtered Drinking Water	Ebentet Enterprise
306.	FDB/Wt 10A-0278	Alfa Drinking Water	Boakap Ent., Kumasi
307.	FDB/Wt 10A-0279	Jebet Filtered Drinking Water	Baffour Asafo Adjei Enterprise, Kumasi
308.	FDB/Wt 10A-0280	New Age Filtered Water	First New Age Limited, Ash-Town Kumasi
309.	FDB/Wt 10A-0281	Fendy Filtered Drinking Water	Fendimore Ventures, Bantama Kumasi
310.	FDB/Wt 10A-0282	Uncle Sark Drinking Water	Uncle Sark Enterprise, Kumasi
311.	FDB/Wt 10A-0287	Saba Drinking Water	Ginadai Ent., New Tafo Kumasi
312.	FDB/Wt 10A-0288	Aqua Link Filtered Drinking Water	Frontline Beverage Enterprise
313.	FDB/Wt 10A-0290	Mountain View Filtered Water	Selo - Jay's Company Limited
314.	FDB/Wt 10A-0294	Erimil Drinking Water	Dovewell Co. Ltd., Kumasi
315.	FDB/Wt 10A-0295	Skyy Cool Filtered Water	Nkronkron Nsuo Ent., Kumasi

	FDA Registration No.	Product Name	Company Name & Location
316.	FDB/Wt 10A-0296	Lom Filtered Drinking Water	Nhyira Nsuo, Kumasi
317.	FDB/Wt 10A-0297	Bro. Yaw Filtered Water	Selwus Ent., Kumasi
318.	FDB/Wt 10A-0298	Angel Ben Filtered Drinking Water	Angelben Ent., Kumasi
319.	FDB/Wt 10A-0299	Vangies Filtered Drinking Water	Marisca Ent., Kumasi
320.	FDB/Wt 11A-0001	Prema Filtered Drinking Water	Matprin Ent., Ahinsan Kumasi
321.	FDB/Wt 11A-0002	F & GE Filtered Water	Fran "O" Ford Co. Ltd
322.	FDB/Wt 11A-0005	Princess Drinking Water	Kosesa Enterprise, Ejura-Ashanti
323.	FDB/Wt 11A-0006	Andes Filtered Water	Aqua Vera Ventures, Kumasi
324.	FDB/Wt 11A-0007	Shirleysco Drinking Water	Shirleysco Enterprise, Kumasi
325.	FDB/Wt 11A-0008	Patmos Drinking Water	K-Sarbee Enterprise
326.	FDB/Wt 11A-0009	Next Filtered Drinking Water	Koaklina Enterprise, Adum Kumasi
327.	FDB/Wt 11A-0010	Augva Mineral Water	Augva Mineral Water, Kumasi
328.	FDB/Wt 11A-0011	Lady Dina Filtered Water	Johnsteyn's Ent
329.	FDB/Wt 11A-0012	Ozrock Drinking Water	Zealous Marketing Enterprise
330.	FDB/Wt 11A-0013	Aqua Clear Drinking Water	Quality Health Care Ltd., Kumasi
331.	FDB/Wt 11A-0014	Bless Drinking Water	Kac-B Enterprise, Ejisu Kumasi
332.	FDB/Wt 11A-0016	Good News Drinking Water	Josrita Ent., Kumasi
333.	FDB/Wt 11A-0020	A1 Filtered Water	A1 Purified Water, Accra
334.	FDB/Wt 11A-0022	Oforisuo Filtered Water	Nsuo Mu Nsuo Ent., Fomena Adansi
335.	FDB/Wt 11A-0024	Agya Koo Filtered Water	Gyamalex Ent., Kumasi
336.	FDB/Wt 11A-0025	Eagle Filtered Water	Yaw Barimah Farms
337.	FDB/Wt 11A-0035	Big Osei Filtered Drinking Water	Agya Sei Filtered Drinking Water
338.	FDB/Wt 11A-0036	Raemako Filtered Drinking Water	Raemako Co. Ltd., Kumasi
339.	FDB/Wt 11A-0037	KuulJoy Drinking Water	Papakiano Ventures, Kumasi
340.	FDB/Wt 11A-0039	Kofas Drinking Water	Kofas Mineral Water Co. Ltd., Kumasi
341.	FDB/Wt 11A-0040	Gate Way Filtered Water	Bomathsent Ent., Suame Kumasi
342.	FDB/Wt 11A-0043	Joo Filtered Water	His Grace Mineral Water, Effiduase Sekyere

	FDA Registration No.	Product Name	Company Name & Location
343.	FDB/Wt 11A-0044	Maa Filtered Drinking Water	Tawiah Purified Drinking Water
344.	FDB/Wt 11A-0045	Momee Filtered Water	Purepac Enterprise, Ahinsan Kumasi
345.	FDB/Wt 11A-0046	Focus Filtered Drinking Water	A&B Pure Rock Ltd.
346.	FDB/Wt 11A-0047	Sunny Day Filtered Drinking Water	Napadd Limited
347.	FDB/Wt 11A-0058	Dan Dee Drinking Water	D.B Kids Enterprise
348.	FDB/Wt 11A-0061	Fontomfrom Drinking Water	Ahinasa Fontmfrom Ent., Akrokerri Adansi
349.	FDB/Wt 11A-0062	Aco Filtered Water	Agya Nti Pharmacy, Tepa A/R
350.	FDB/Wt 11A-0066	Adom Nkoa Filtered Water	Ado Nkoa Ent., Kumasi
351.	FDB/Wt 11A-0071	Oshi Filtered Water	Obetwum Ent., Kumasi
352.	FDB/Wt 11A-0075	Philips Filtered Drinking Water	Philips Obeng Ent. Bekwai- Ashanti
353.	FDB/Wt 11A-0076	A-C Filtered Water	A-C Consult Ltd, Kumasi, A/R
354.	FDB/Wt 11A-0077	Royal Drinking Water	Royal Delivery Limited, Kumasi
355.	FDB/Wt 11A-0080	Bumper to Bumper Filtered Water	Okumanim Royals Ent., Ashanti
356.	FDB/Wt 11A-0083	Adwubi Kete Filtered Water	O.K. Mineral Water Works, Kumasi
357.	FDB/Wt 11A-0086	Naadom Drinking Water	Alex K. Appiah Engineering Service, KNUST-Kumasi
358.	FDB/Wt 11A-0088	Mege Natural Mineral Water	St. Patrick Co. Ltd., Kumasi
359.	FDB/Wt 11A-091	Modern Drinking Water	Arhinkus Enterprsie
360.	FDB/Wt 11A-092	S.M Filtered Water	K.D.B Ventures
361.	FDB/Wt 11A-094	Real Filtered Water	Real Filtered Water and Trading Ent.
362.	FDB/Wt 11A-095	Sweet Mother Drinking Water	Sweet Mother Divine Ventures, Kumasi
363.	FDB/Wt 11A-104	Emmanuel's Filtered Drinking Water	Emmanuel's Hygienic Water Ent.
364.	FDB/Wt 11A-106	Gentle Dove Filtered Water	Adford Ent.
365.	FDB/Wt 11A-107	Gina Filtered Drinking Water	Ginamanuel Ent.
366.	FDB/Wt 11A-109	S. Thomas Filtered Drinking Water	St Thomas Co-operative Credit Union Ltd.
367.	FDB/Wt 11A-110	Nafran Filtered Water	Nafranina Ent.
368.	FDB/Wt 11A-111	Allied Filtered Water	Nana Amakye Gas
369.	FDB/Wt 11A-112	Kina Drinking Water	Awo Kina 7983

	FDA Registration No.	Product Name	Company Name & Location
370.	FDB/Wt 11A-113	B. Filtered Water	Menab Ventures
371.	FDB/Wt 11A-114	Tegola Aqua Drinking Water	Tegola Aqua Ent.
372.	FDB/Wt 11A-124	Mama Stella Filtered Water	Gyellack Enterprise
373.	FDB/Wt 11A-128	Margra Filtered Water	Margra Ent.
374.	FDB/Wt 11A-129	Alberto-Ans Drinking Water	Alberto-Ans Ent.
375.	FDB/Wt 11A-130	Aqua Benaf Filtered Drinking Water	Fasonda Ventures
376.	FDB/Wt 11A-131	Ohili Filtered Drinking Water	Al Shaili Ent.
377.	FDB/Wt 11A-132	Hop Filtered Drinking Water	H.O.P Filtered Drinking Water
378.	FDB/Wt 11A-133	Charity Drinking Water	Centrack Ventures
379.	FDB/Wt 11A-137	Genephil Filtered Drinking Water	Genephil Enterprise, Kumasi
380.	FDB/Wt 11A-139	Gyamkofa Filterd Drinking Water	Gyamkofa Ent.
381.	FDB/Wt 11A-140	Chrysmar Filtered Water	Kofboat Business Services
382.	FDB/Wt 11A-141	A.L. Drinking Water	Neach Ventures
383.	FDB/Wt 11A-142	G-Life Drinking Water	St. Mary's Bakery
384.	FDB/Wt 11A-147	Rean Filtered Water	Reanstar Ventures, Kumasi
385.	FDB/Wt 11A-152	Lina Drinking Water	Lina Filtered Water
386.	FDB/Wt 11A-155	Dwaagu Filtered Drinking Water	Dwaagu Ent. Ltd., Adum Kumasi
387.	FDB/Wt 11A-185	Liet Filtered Drinking Water	Kasana-Liet Ent.
388.	FDB/Wt 11A-187	Geert Poles Filtered Drinking Water	Seinti Hotel Ltd.
389.	FDB/Wt 11A-188	Oheneba Nsuo Filtered Water	Prince Poly Ent.
390.	FDB/Wt 11A-189	Joetick Filtered Drinking Water	Joseph Adjei Williams Ent.,Ahinsan Kumasi
391.	FDB/Wt 11A-190	Aniwaa Drinking Water	Sarps Agency
392.	FDB/Wt 11A-202	Nak's Drinking Water	Kopnak Ventures
393.	FDB/Wt 11A-214	Ennisco Drinking Water	Ennisco Drinking Water, Kumasi
394.	FDB/Wt 11A-215	Fragobeng Drinking Water	Fragobeng Limited
395.	FDB/Wt 11A-216	Sparks Filtered Drinking Water	Leefizzi Enterprise

	FDA Registration No.	Product Name	Company Name & Location
396.	FDB/Wt 11A-217	Sika Gyiri Filtered Drinking Water	S.K Gyiri Ventures
397.	FDB/Wt 11A-218	Favour Filtered Drinking Water	Favour Mineral Water & Fruit Juice Ventures
398.	FDB/Wt 11A-225	Queens Filtered Water	The Queen's Maternity Home
399.	FDB/Wt 11A-226	Frankies Filtered Drinking Water	Akwasi Fosu Company Ltd.
400.	FDB/Wt 11A-230	J.M Filtered Water	Joemanu Ventures, Kumasi
401.	FDB/Wt 11A-231	Elvis Filtered Water	Elvis Filtered Water, Kumasi
402.	FDB/Wt 11A-232	Drinkull Drinking Water	G-Gabs Enterprise
403.	FDB/Wt 11A-234	Novena Drinking Water	Santo Jeff Enterprise, Kumasi
404.	FDB/Wt 11A-242	A Star Filtered Drinking Water	Star Adom Ent.
405.	FDB/Wt 11A-243	Kaskala Drinking Water	Kaskala Herbal Centre
406.	FDB/Wt 11A-244	Paulina Drinking Water	Animuonyam Nka Nyame Filtered Water
407.	FDB/Wt 11A-248	Adwoa Konadu Filtered Water	Ojoo Holland Ent.
408.	FDB/Wt 11A-250	M.S.K. Filtered Water	Manso Konte Co. Ltd.
409.	FDB/Wt 11A-253	Summer Filtered Drinking Water	Landark Ent.
410.	FDB/Wt 11A-255	Pishon Drinking Water	Super Big Kay Ent.
411.	FDB/Wt 11A-256	Teddy Filtered Water	Lord Winner Investments Ltd., Kumasi
412.	FDB/Wt 11A-257	Ikhlass Drinking Water	Ikhlass Ent. Aboaso- Ashanti
413.	FDB/Wt 11A-278	18th Golden Drinking Water	18th Rock Of Golden Enterprise
414.	FDB/Wt 11A-286	Gratis Aqua Filtered Drinking Water	Smooth Enterprise
415.	FDB/Wt 11A-297	Blue Skies Filtered Water	Kuffour Ent.
416.	FDB/Wt 11A-298	Julie's Filtered Water	Nhyira Star Filtered Water Enterprise, Adum-Kumasi
417.	FDB/Wt 11A-303	Adukromu Nsuo	Fusspot Ent., Kumasi
418.	FDB/Wt 11A-315	Apak Filtered Drinking Water	Alberta G. Ventures
419.	FDB/Wt 11A-323	Young Man Drinking Water	Youngman Nathan Ent., Kumasi
420.	FDB/Wt 11A-324	Mabi Drinking Water	Fabs De Christ Co. Ltd., Kumasi
421.	FDB/Wt 11A-325	Totway Drinking Water	Totway Foods, Kumasi
422.	FDB/Wt 11A-326	Erfect Drinking Water	Margaret Yeboah Asiamah Ent., Kumasi

	FDA Registration No.	Product Name	Company Name & Location
423.	FDB/Wt 11A-328	Jaevab Drinking Water	Jeavab Ent., Kumasi
424.	FDB/Wt 11A-329	C.F.P Filtered Drinking Water	Celike Drinking Water, Kumasi
425.	FDB/Wt 11A-330	Willico Filtered Drinking Water	Cobbiwilliams Ent., Kumasi
426.	FDB/Wt 11A-333	Bamba Filtered Water	Bamba Ent., Kumasi
427.	FDB/Wt 11A-336	k. Naboat Drinking Water	K. Naboat Enterprise
428.	FDB/Wt 11A-337	Uncle George Drinking Water	Pasark Enterprise
429.	FDB/Wt 11A-340	Aqua Dio Filtered Drinking Water	Aqua Dio Filtered Drinking Water
430.	FDB/Wt 11A-341	Second In Life Filtered Drinking Water	Second In Life Ent., Kumasi
431.	FDB/Wt 11A-342	Ateasefo Drinking Water	Ateasefo Drinking Water Ltd., Obuasi
432.	FDB/Wt 11A-344	Asum Drinking Water	Asum Investment Ltd., Kumasi
433.	FDB/Wt 11A-351	Raifmon Drinking Water	Raifmon Enterprise
434.	FDB/Wt 11A-354	Tessfo Filtered Drinking Water	Tessfo Enterprise, Kumasi
435.	FDB/Wt 11A-364	Samson Filtered Drinking Water	Sukkott Limited, Kumasi
436.	FDB/Wt 11A-365	Anaco Filtered Drinking Water	Nasavan Ventures
437.	FDB/Wt 11A-367	Ole Drinking Water	Benito Menni Health Centre, Dompoase-Adansi,Obuasi
438.	FDB/Wt 11A-368	Shabath Drinking Water	Nak Hasen Works, Kumasi
439.	FDB/Wt 11A-369	Mama Mercy Drinking Water	Mama Mercy Ent., Kumasi
440.	FDB/Wt 11A-370	Gabb Filtered Drinking Water	Mary Brobbey Ent., Kumasi
441.	FDB/Wt 11A-379	My Shield Drinking Water	Paulfel Services Limited, Kumasi
442.	FDB/Wt 11A-380	Abrefi Drinking Water	Kumasi Gilead Academy, Kumasi
443.	FDB/Wt 11A-381	Able Filtered Drinking Water	Nea Nyame Tumi Ye Ltd., Kumasi
444.	FDB/Wt 11A-382	Agonaman Nsuo Drinking Water	Agonaman Plus Investment, Kumasi
445.	FDB/Wt 11A-383	Levissima Filtered Water	Levissima Drinking Water and Trading Enterprise, Kumasi
446.	FDB/Wt 11A-384	Rosmat Filtered Water	Davglad Ventures, Kumasi
447.	FDB/Wt 11A-388	Philjoy Filtered Water	Ayabena Co. Ltd., Kumasi
448.	FDB/Wt 11A-389	Castro Drinking Water	Nollvic Enterprise, Kumasi

	FDA Registration No.	Product Name	Company Name & Location
449.	FDB/Wt 11A-390	Gyasik Drinking Water	Bakasek Enterprise, Kumasi
450.	FDB/Wt 11A-391	Fauzi Filtered Drinking Water	Fauziya Enterprise, Kumasi
451.	FDB/Wt 11A-392	Samic Drinking Water	Samic Enterprise, Kumasi
452.	FDB/Wt 11A-401	Niva Drinking Water	Ganaf Enterprise, Kumasi
453.	FDB/Wt 11A-402	Vivita Filtered Drinking Water	Aquavita Ventures, Kumasi
454.	FDB/Wt 11A-416	Abokyi Drinking Water	Old Dominion Enterprise, Kumasi
455.	FDB/Wt 11A-417	Ohene Filtered Drinking Water	Ohene B Enterprise, Konongo
456.	FDB/Wt 11A-418	Franko Filtered Water	Franko Divine Ventures, Kumasi
457.	FDB/Wt 11A-424	Hanny's Drinking Water	Job-Dhan Co. Ltd., Kumasi
458.	FDB/Wt 11A-426	Naspaw Drinking Water	Wapman Filtered Water & Trading Enterprise, Kumasi
459.	FDB/Wt 11A-427	Diamond Filtered Water	Kinsmat Communication and Business Service
460.	FDB/Wt 11A-428	Ella Drinking Water	Emmanuel Owusu Enterprise
461.	FDB/Wt 11A-429	Appico Drinking Water	Opanin Kwabena Appiah Enterprise, Kumasi
462.	FDB/Wt 11A-430	Musdina Drinking Water	Musdina Enterprise, Mim
463.	FDB/Wt 11A-431	Berfi Nsuo Filtered Water	Berfico Limited
464.	FDB/Wt 11A-434	Maantewaa Filtered Water	Maantewaa Filtered Water, Kumasi
465.	FDB/Wt 11A-435	Liberty Filtered Drinking Water	Ceecom Entreprise
466.	FDB/Wt 11A-508	K. Poly Filtered Water	Glomas Company Ltd, Adum Kumasi
467.	FDB/Wt 11A-509	Yeboss Filtered Drinking Water	Yeboss Standard Mineral Water
468.	FDB/Wt 11A-510	Ahoofe Drinking Water	N. Y. Agyemang Company Limited
469.	FDB/Wt 11A-511	Rebbek Filtered Drinking Water	Numafo Products Limited
470.	FDB/Wt 11A-512	Eliya Filtered Drinking Water	Jeligsha Enterprise
471.	FDB/Wt 11A-513	Sikanat Drinking Water	Yebonat Enterprise
472.	FDB/Wt 11A-514	Dansabon Filtered Water	Dansabon Filtered Water Company Limited
473.	FDB/Wt 11A-516	Blueland Drinking Water	Blue Land Company Ltd, Bekwai - Asante
474.	FDB/Wt 11A-517	Baroko Filtered Water	Tanbok Enterprise. Asuoyeboah, Kumasi
475.	FDB/Wt 11A-521	Samass Drinking Water	Agonana Ventures. Suame- Kumasi

	FDA Registration No.	Product Name	Company Name & Location
476.	FDB/Wt 11A-522	Boas 'V' Filtered Drinking Water	Boas Ventures. Kumasi
477.	FDB/Wt 11A-523	Sure Cool Filtered Water	Jefrante Company Limited
478.	FDB/Wt 11A-526	Sakk Filtered Water	Sakof Enterprise
479.	FDB/Wt 11A-527	Jodi Drinking Water	Jodi Guest House, Kumasi
480.	FDB/Wt 11A-537	Happy Time Filtered Drinking Water	Revelation Filtered Water and Trading Enterprise
481.	FDB/Wt 11A-558	Agyenak Drinking Water	Agyenak Company Ltd
482.	FDB/Wt 11A-560	Gempic Drinking Water	Gempic B. Kay Ent., Obuasi
	BRONG AHAFO REGION		
	Bottled Water Producers		
483.	FDB/Wt 03B-0014	Eusbett Water	Eusbett Hotel, Sunyani, Brong Ahafo
	Sachet Water Produceers		
484.	FDB/Wt 05B-0046	Water Universe	Semex Ghana Ltd., Sunyani
485.	FDB/Wt 02B-0051	Encore Filtered Water	Cydond Company Ltd., Sunyani
486.	FDB/Wt 02B-0052	Mayfair Drinking Water	Mayfair Abandenden Enterprise, Sunyani
487.	FDB/Wt 02B-0053	Aspet A Drinking Water	Aspet 'A' Enterprise, Techiman Aduana, B/A
488.	FDB/Wt 02B-0054	Zam Zam Drinking Water	Seedi T-T Enterprise, Wenchi, Brong Ahafo
489.	FDB/Wt 02B-0055	Dero Drinking Water	Dero Enterprise, Kumasi
490.	FDB/Wt 03B-0001	Tabiri & Co Filtered Water	Biareck Enterprise, Berekum- B/A
491.	FDB/Wt 03B-0012	Hapon Filtered Water	Hapon Company Ltd., Berekum, Brong Ahafo
492.	FDB/Wt 03B-0013	Mart K Filtered Water	Mart K Enterprise, Berekum, Brong Ahafo
493.	FDB/Wt 03B-0015	Kwapong Filtered Water	Kwapong Pharmacy, Attebuba, Brong Ahafo
494.	FDB/Wt 03B-0016	Brijia Filtered Water	Brijia Enterprise, Sunyani, Brong Ahafo
495.	FDB/Wt 03B-0017	Aduana Abodwo Insuo	Beckgea Enterprise, Dormaa Ahenkro, Brong Ahafo
496.	FDB/Wt 03B-0018	Napas Filtered Water	Napas Enterprise, Techiman, Brong Ahafo
497.	FDB/Wt 03B-0019	D. W. Filtered Water	Divine Enterprise, Techiman, Brong Ahafo
498.	FDB/Wt 03B-0020	Yabs Filtered Water	Dymens Enterprise, Techiman, Brong Ahafo
499.	FDB/Wt 03B-0064	Aamco Filtered Waterf	Aamco Farm Complex Ltd., Techiman - B/A

	FDA Registration No.	Product Name	Company Name & Location
500.	FDB/Wt 05B-0025	Fradesa Filtered Water	Francis De Sales Ltd., Dormaa Ahenkro
501.	FDB/Wt 05B-0026	Queen Elizabeth Filtered Water	Queen Elizabeth Enterprise, Berekum, B/A
502.	FDB/Wt 05B-0027	Pauluus Filtered Water	Paul De Saint Enterprise, Techiman, B/A
503.	FDB/Wt 05B-0028	A-90 Filtered Water	Napok Enterprise, Nkoransa, Brong Ahafo
504.	FDB/Wt 05B-0029	Asomdwe Nsuo (Water)	Christian Health Association of Ghana, Dormaa Ahenkro, B/A
505.	FDB/Wt 05B-0030	Beampo Filtered Water	Beampo Enterprise, Sunyani
506.	FDB/Wt 05B-0031	Fatima Filtetered Water	Wenchi Water Project, Our Lady of Fatima Parish, B/A
507.	FDB/Wt 05B-0032	Susu Gold Drinking Water	Susu Gold Ent., Sunyani.
508.	FDB/Wt 05B-0033	Adu's Drinking Water	Bakwadu Enterprise, Sunyani
509.	FDB/Wt 06B-0032	Opoyeb Nsupa	Opoyeb Ent., Wenchi
510.	FDB/Wt 06B-0034	Precious Drinking Water	Precious Mann. Company Ltd., Dwenase Boma. B/A
511.	FDB/Wt 06B-0035	Managye Filtered Water	Managye Spot and Catering Services, Wenchi
512.	FDB/Wt 06B-0036	Mart B. Filtered Water	Mart B. Ent., Penkwasi, Sunyani
513.	FDB/Wt 06B-0037	Odregina Filtered Drinking Water	Odregina Enterprise, Techiman
514.	FDB/Wt 06B-0038	Miaw Drinking Water	Miaw Ent., Techiman
515.	FDB/Wt 06B-0039	E.K.G. Filtered Water	E.K.G. Food And Beverages Industry Ltd., Sunyani
516.	FDB/Wt 06B-0040	Vanket Filtered Water	Vanket Communications and Business Services, Seikwa, B/A
517.	FDB/Wt 06B-0041	Nkonimdi Nsuo	Medimafo Ne Awurade Enterprise, Nkoranza-Brong Ahafo
518.	FDB/Wt 06B-0042	Kasfred Filtered Water	Kasfred Ltd., Techiman
519.	FDB/Wt 06B-0043	Our Lady Nsupa	Our Lady of Fatima Catholic Church, Wenchi
520.	FDB/Wt 06B-0044	Sunkwa Filtered Water	Lady Galaxy Ent., Sunyani
521.	FDB/Wt 07B-0010	George Baryeh Filtered Water	George Baryeh Company Ltd., Goaso, Brong-Ahafo.
522.	FDB/Wt 09B-0033	Angliba Drinking Water	Anglican Diocese of Sunyani
523.	FDB/Wt 09B-0036	Engedi Filtered Drinking Water	Pee Wees Business Venture Ltd., Kintampo
524.	FDB/Wt 09B-0068	Abusua Akwaaba Filtered Drinking Water	Kaan Investment, Berekum, B/A
525.	FDB/Wt 09B-0069	Bootsma Filtered Drinking Water	Mawuli Obaa Ent.

	FDA Registration No.	Product Name	Company Name & Location
526.	FDB/Wt 10B-0009	Lovers Filtered drinking water	Alice Twum Antwi Trading Ent
527.	FDB/Wt 10B-0017	Akodeb Filtered Drinking water	Akodeb Ltd., Sunyani
528.	FDB/Wt 10B-0018	Rufam Filtered drinking water	Rufam Co. Ltd., Techiman
529.	FDB/Wt 10B-0019	Tonney Filtered drinking water	Kwayaco Ent., Techiman
530.	FDB/Wt 10B-0056	Snat Drinking water	Snat Co., Ltd., Techiman
531.	FDB/Wt 10B-0060	Cayouth Filtered drinking water	WWP Co., Ltd., Sunyani
532.	FDB/Wt 10B-0231	Life And Living Natural Mineral Water	Life And Living Ent., Sunyani
	CENTRAL REGION		
	Sachet Water Producers		
533.	FDB/Wt 04C-0004	Law Filtered Drinking Water	Law-Enchi Electrical Ent., Mankessim, Central Region
534.	FDB/Wt 04C-0015	Cool Pac Treated Water (Cape Coast)	Voltic Ghana Ltd., Accra
535.	FDB/Wt 04C-0025	Gloria Drinking Water	Kasane Enterprise, Saltpond
536.	FDB/Wt 04C-0045	Dandetex Waters	Dandetex Enterprise, Cape Coast, Central Region
537.	FDB/Wt 04C-0049	Mega Filtered Water	Elcam Ent., Cape Coast
538.	FDB/Wt 05C-0003	Sadico Filtered Water	Sadico Filtered Water, Padu Estate, Cape Coast
539.	FDB/Wt 05C-0034	Aubsel Drinking Water	Aubsel Company Ltd,Cape Coast
540.	FDB/Wt 05C-0064	Coastal Clean Water	Coastal Clean Water, Savoy Hotel-Cape Coast
541.	FDB/Wt 05C-0065	Day By Day Filtered Drinking Water	Wilsapark Trading Enterprise, Hse No 2BLK 5+, Krofa Road, Mankessim
542.	FDB/Wt 05C-0067	Anet Filtered Drinking Water	Pedu Soft Drink Industries, Hno 142 Pedu Estate
543.	FDB/Wt 06C- 0054	Lovely Filtered Drinking Water	Susaban Enterprise, Hse No A65/2, Tantri, Cape Coast
544.	FDB/Wt 06C-0045	Stephen's Drinking Water	J. Akono Co. Ltd., Dunkwa-On-Offin
545.	FDB/Wt 07C-0005	Hasna Filtered Drinking Water	Hasna Water Cape Coast, opp Ackon Clinic Industrial Area, Cape Coast
546.	FDB/Wt 07C-0006	The Cloud Filtered Drinking Water	Sod-Hab Enterprise, Takoradi
547.	FDB/Wt 08C-0004	Glad Drinking Water	Gladlife Ent.,Seventh Day Adventist Church, Ajumako
548.	FDB/Wt 08C-0023	Kings Aquabetic Water	Abura Kingsway Enterprise
549.	FDB/Wt 08C-0027	Boss Filtered Drinking Water	Hasrob Co LtdP.O Box 618 Cape Coast

	FDA Registration No.	Product Name	Company Name & Location
550.	FDB/Wt 09C-0014	Aqua Belle Filtered Water	Aqua Belle Ventures, Anyinase
551.	FDB/Wt 09C-0023	Gracious Drinking Water	Exclusive Touch Ventures, Agona Swedru
552.	FDB/Wt 09C-0044	Dam's Filtered Water	Daniel Atta Mills Ent., Mankessim
553.	FDB/Wt 09C-0045	Edmarad Filtered Drinking Water	Edmarad Filtered Drinking Water
554.	FDB/Wt 09C-0078	Omega One Filtered Drinking Water	Omega One Filtered Drinking Water Co. Ltd
555.	FDB/Wt 10C-0215	A&H Filtered Drinking Water	A & H Business Services Ltd.
556.	FDB/Wt 10C-0217	The Sun Filtered Drinking Water	Hanson Ent., Cape Coast
557.	FDB/Wt 10C-0224	Mars Spring Filtered Drinking Water	Cinterko Ventures, Cape Coast
558.	FDB/Wt 10C-0236	Sanikwad Filtered Drinking Water	Sanikwad Ent., Breman Esikuma
	EASTERN REGION		
	Bottled Water Producers		
559.	FDB/Wt 04E-0048	Astek Nsu Natural Mineral Water	Astek Fruit Processing Ltd, Nsawam
560.	FDB/Wt04E-0035	Aquafill Natural Mineral Water	Highland Springs (GH) Limited, Dobro
561.	FDB/Wt 02E-0013	Smile Natural Mineral Water	Shaaba Enterprise, Accra
	Sachet Water Producers		
562.	FDB/Wt 04E-0048	Astek Nsu Natural Mineral Water	Astek Fruit Processing Ltd, Nsawam
563.	FDB/Wt 02E-0013	Smile Natural Mineral Water	Shaaba Enterprise, Accra
564.	FDB/Wt 04E-0058	Everyday Drinking Water	Owusuco Trading Enterprise, Mpraeso
565.	FDB/Wt 08E-0025	Sparrow Filtered Drinking Water	Javs Enterprise P.O Box 169 Odumase, Krobo
566.	FDB/Wt 08E-0031	Starco Drinking Water	Starco Ventures Limited, Koforidua
567.	FDB/Wt 08E-0046	Akono Nsupa Drinking Water	Kabview Ventures, Aburi-Akuapem
568.	FDB/Wt 08E-0048	Henry's Filtered Drinking Water	Henry's Pure Waeter Ent, Koforidua
569.	FDB/Wt 09E-0003	Hisae Cool Filtered Drinking Water	Hisae Co.Ltd, Akosombo
570.	FDB/Wt 09E-0031	Asase Aban Drinking Water	Dase Aban Enterprise
571.	FDB/Wt 09E-0064	CSIR Sircool Treated Natural Water	CSIR Mineral Water Co., Ltd.

	FDA Registration No.	Product Name	Company Name & Location
572.	FDB/Wt 09E-0066	Salv Filtered Drinking Water	Rafka Ventures
573.	FDB/Wt 09E-0092	Nsuo Ye Filtered Drinking Water	Nsuo Ye Nkwa Company Limited
574.	FDB/Wt 09E-0093	Domeabra Drinking Water	Domeabra Mineral Water Ent.
575.	FDB/Wt 09E-0102	Diplomatic Filtered Drinking water	Dakoba Farms and Industries
576.	FDB/Wt 09E-0104	Start Filtered Drinking Water	Bea-Newt Ent., Koforidua
577.	FDB/Wt 09E-0105	New Era Filtered Drinking water	Kansa Ltd., Nkawkaw
578.	FDB/Wt 09E-0111	Fenhac Drinking water	F.N.Hackman Co., ltd
579.	FDB/Wt 09E-0112	Liahona Filtered Water	Andyjay Ent., Cape Coast
580.	FDB/Wt 10E-0005	Welcome filtered water	Aquaba Purified Water, Kade
581.	FDB/Wt 10E-0007	Unity Filtered drinking water	Unity Purification Water Company, Odumase Krobo
582.	FDB/Wt 10E-0023	Paradi Filtered drinking water	JJEP Ent., Nkawkaw
583.	FDB/Wt 10E-0024	Akosombo Lina Filtered Drinking Water	Danstex Ent., Akosombo
584.	FDB/Wt 10E-0025	Nhyiramma Filtered Drinking water	U-Love Ventures
585.	FDB/Wt 10E-0028	Fresto Filtered Drinking water	Fresto Ent., Afiduase Koforidua
586.	FDB/Wt 10E-0030	Nomnsu Filtered drinking water	Nomnsu Ent., Somanya
587.	FDB/Wt 10E-0031	Nom Nsu Pa Filtered drinking water	Conek Ventures, New Akrade
588.	FDB/Wt 10E-0032	Sovi Filtered Drinking water	Kateben Ent., New Akrade
589.	FDB/Wt 10E-0033	One Step Filtered Drinking water	One Step Ent., Accra
590.	FDB/Wt 10E-0035	Standwater filtered drinking water	Standfirma Ent., Koforidua
591.	FDB/Wt 10E-0045	Shepherd King filtered drinking water	True Good Shepherd Ventures, Koforidua
592.	FDB/Wt 10E-0047	Vidi Aquam filtered water	Catholic Diiiociesie of Koforidua
593.	FDB/Wt 10E-0049	T.K. Filtered Drinking water	Gbegbe Tettey-Kwame
594.	FDB/Wt 10E-0072	Royal Filtered drinking water	Joe Trading Enterprise, Akosombo
595.	FDB/Wt 10E-0105	B Choice filtered drinking water	Stemilright Ltd. Nsawam
596.	FDB/Wt 10E-0107	Zion filtered drinking water	Vic'mike Co. Ltd., Ashanti Region
597.	FDB/Wt 10E-0113	Smiling Filtered Drinking	A. P. Ent., Kpongunor

	FDA Registration No.	Product Name	Company Name & Location
		Water	
598.	FDB/Wt 10E-0203	Olisa Filtered Drinking Water	Olisa Ent., Akyem Abuakwa
599.	FDB/Wt 10E-0211	Aqua Nobel Filtered Drinking Water	Bermac O9 Enterprise, Maase
600.	FDB/Wt 10E-0216	Danlite Cools Hearts Drinking Water	Danlite Trading Enterprise
601.	FDB/Wt 10E-0220	Ultima Drinking Water	Ultimate Drinking Water, Odumase Krobo
602.	FDB/Wt 10E-0226	Angelo Filtered Drinking Water	Perimeter Ent., Accra
603.	FDB/Wt 10E-0227	Steward Filtered Drinkiong Water	Geojoe Ent., Nkawkaw
604.	FDB/Wt 10E-0230	Maltic Filtered Water	B.M. Maltic Enterprise
605.	FDB/Wt 10E-0254	J K Filtered Drinking Water	Jacob Kweku Padi Enterprise
606.	FDB/Wt 10E-0256	Casante Filtered Water	Vicalos Ventures, Koforidua
607.	FDB/Wt 10E-0257	Osab Filtered Drinking Water	Osab Ent., Nkawkaw
608.	FDB/Wt 10E-0261	First Star Filtered Drinking Water	S.O. First Star Enterprise
609.	FDB/Wt 10E-0269	Major Filtered Drinking Water	Odda Enterprise
610.	FDB/Wt 10E-0277	Vitakings Filtered Drinking Water	Vitakings Company Ltd.
611.	FDB/Wt 10E-0289	Ernesto Filtered Drinking Water	Ernest Agyei Apeadu's Ent., Mpraeso
612.	FDB/Wt 10E-0291	Eye Aseda Filtered Drinking Water	Grace Filtered Water & Lollies Ventures, Akwatia
	GREATER ACCRA REGION		
	Bottled Water Producers		
613.	FDB/Wt 03G-0011	Dasani Purified Water	The Coca-Cola Bottling Co. of Gh. Ltd., Accra
614.	FDB/Wt 04G-0018	Ice Cool Purified Water	Ice Cool Purified Water Ltd., Tema
615.	FDB/Wt 07G-0006	Aquasplash Purified Non-Carbonated Drinking Water	SBC Beverages Ghana Ltd.
616.	FDB/Wt 07G-0004	Mobile Refreshing Natural Mineral Water	Magvlyn Industries Limited, Tema Light Industrial Area, behind Mac Baron Hotel, Aflao Rd
617.	FDB/Wt 08G-0028	Voltic Natural Mineral Water	Voltic Ghana Ltd., MF, Accra
618.	FDB/Wt 10G-0228	Yes Natural Mineral Water	Yes Natural Mineral Water
619.	FDB/Wt 02G-0006	Standard Drinking Water	Cob-A Industries, Accra
620.	FDB/Wt 09G-0035	Everpure Purified Drinking	Everpure Ghana Ltd., Accra

	FDA Registration No.	Product Name	Company Name & Location
		Water	
621.	FDB/Wt 09G-0010	Safina Natural Mineral Water	Sun Ridge Company Ltd., Accra
622.	FDB/Wt 09G-0061	Bon Aqua Premium Drinking Water	The Coca Cola Bottling Company Gh. Ltd., Accra
623.	FDB/Wt 11G-483	Special Ice Natural Mineral Water	Special Ice Mineral Water, Accra
624.	FDB/Wt 11G-553	Belaqua Mineral Water	Blowchem Industries Limited, Accra
625.	FDB/Wt 11G-0038	Ice Pak Mineral Water	Baron House Limited, Accra
626.	FDB/Wt 02G-0012	Meridian Filtered Water	GIHOC Distilleries Co. Ltd., Accra
627.	FDB/Wt 02G-0014	Divine Aqua	Divine Aqua Enterprise, Accra
628.	FDB/Wt 08G-0045	Aqua-in Natural Drinking Water	Aqua-in Ltd. Tema
	Sachet Water Producers		
629.	FDB/Wt 02-0007	Two Doves Filtered Water	Two Doves Ventures, Accra
630.	FDB/Wt 05-0039	Ste-Sophie Cristaline Natural Spring Water	Eurofood Ghana Limited, Accra
631.	FDB/Wt 02G-0001	Diamond Crystal Water	Dans Fabrics Enterprise, Accra
632.	FDB/Wt 02G-0002	Kasa Ahomka Nsuo	Kasapreko Co. Ltd., Accra
633.	FDB/Wt 02G-0003	Pure Joy Filtered Water	Edcom Investments, Accra
634.	FDB/Wt 02G-0004	Gift Filtered Water	Giftmon Enterprise, Accra
635.	FDB/Wt 02G-0005	Brensuo Drinking Water	Basfos Enterprise, Legon, Accra
636.	FDB/Wt 04G-0018	Ice Cool Purified Water	Ice Cool Purified Water Ltd., Tema
637.	FDB/Wt 02G-0007	Rock Filtered Water	Riyok Enterprise, Kodiabe, Accra
638.	FDB/Wt 02G-0008	Water King Filtered Water	Water King Ltd., Accra
639.	FDB/Wt 02G-0009	Alpine Drinking Water	Alpine Chest Ventures, Accra
640.	FDB/Wt 02G-0011	Bride of Kings Filtered Drinking Water	Ndibo Enterprise, Tema
641.	FDB/Wt 02G-0012	Meridian Filtered Water	GIHOC Distilleries Co. Ltd., Accra
642.	FDB/Wt 02G-0014	Divine Aqua	Divine Aqua Enterprise, Accra
643.	FDB/Wt 02G-0015	King of Kings Filtered Natural Water	Codabra Ventures, Ashiaman, Tema
644.	FDB/Wt 03G-0004	Brent Filtered Water	Brent Services Ltd., Accra

	FDA Registration No.	Product Name	Company Name & Location
645.	FDB/Wt 03G-0005	Paradise Filtered Water	Paradise Enterprise, Accra
646.	FDB/Wt 03G-0006	Soif-Sukom Drinking Water	Spadjeg Enterprise, Accra
647.	FDB/Wt 03G-0007	Shekinah Glory Drinking Water	Lady Nightingale's Ent., Accra
648.	FDB/Wt 03G-0008	Living Water	Nifesco Ventures, Accra
649.	FDB/Wt 03G-0009	Patty Filtered Water	Maame Sassoulo Ltd., Accra
650.	FDB/Wt 03G-0010	Bells Filtered Drinking Water	MacBells Company Ltd., Accra
651.	FDB/Wt 07G-0004	Mobile Refreshing Natural Mineral Water	Magvlyn Industries Limited, Tema Light Industrial Area, behind Mac Baron Hotel, Aflao Rd
652.	FDB/Wt 03G-0065	Alba Drinking Water	Albatross Impex, Accra
653.	FDB/Wt 03G-0066	Cana Filtered Water	You Quot Ventures, Accra
654.	FDB/Wt 03G-0070	Awa Drinking Water	Salligent Ventures, Accra
655.	FDB/Wt 04G-0001	Bless Drinking Water	Deeko Ghana Limited, Accra
656.	FDB/Wt 04G-0003	Basic Victory Filtered Water	Basic Victory Enterprise, Accra
657.	FDB/Wt 04G-0010	Thy Grace Living Drinking Hygienic Water	Gbadey Limited, Tema
658.	FDB/Wt 04G-0012	Cool Pac Treated Water	Voltic Ghana Ltd., Accra
659.	FDB/Wt 09G-0035	Everpure Purified Drinking Water	Everpure Ghana Ltd.
660.	FDB/Wt 04G-0022	Southern Drinking Water	Rubash Ventures, Accra
661.	FDB/Wt 04G-0043	Star Fresh Water	Regies Enterprise, Accra
662.	FDB/Wt 04G-0046	Trust Drinking Water	Estorm Enterprise, Tema
663.	FDB/Wt 04G-0047	Gedlet Drinking Water	Gedlet Ventures, Tema
664.	FDB/Wt 04G-0050	Perfect Peace Drinking Water	Shai Hill Motel, Accra
665.	FDB/Wt 04G-0053	Stay Awake Filtered Water	Stay Awake Enterprise,Accra-North, GR
666.	FDB/Wt 05G-0001	Ist Foundation Filtered Drinking Water	Ist Foundation Enterprise, Nungua, Accra
667.	FDB/Wt 05G-0002	Jal Filtered Water	Lok Marketing Venture, Accra
668.	FDB/Wt 05G-0036	Oasis Drinking Water	Oasis Lifeline Ventures Limited, Tema
669.	FDB/Wt 05G-0037	Akweley Suma Drinking Water	Beak Paper Company, Accra
670.	FDB/Wt 05G-0038	Comforter Drinking Water	Comforter Enterprise,Accra
671.	FDB/Wt 05G-0042	Adelom Filtered Drinking	Adelom Fresh Water, Tema

	FDA Registration No.	Product Name	Company Name & Location
		Water	
672.	FDB/Wt 05G-0043	Goshdel Drinking Water	Goshdeldal Ventures, Teshie-Nungus, Accra
673.	FDB/Wt 05G-0044	Kushea Esreal Nsuo	Industrial and Engineering Services Gh Ltd, Accra
674.	FDB/Wt 05G-0048	Classic Drinking Water	Classic Beverages Ltd., Regimanuel Est., Accra
675.	FDB/Wt 05G-0049	Global Drinking Water	Global Springs Company Ltd., Accra
676.	FDB/Wt 05G-0050	King David Filtered Drinking Water	CodaVok Enterprise,Teshie, Accra
677.	FDB/Wt 05G-0051	Long Life Filtered Drinking Water	God & Angels Ent. Ltd., Tema
678.	FDB/Wt 05G-0057	Amoo Drinking Water	Amoo Enterprise, Tema
679.	FDB/Wt 05G-0060	Go-Cool Non-carbonated Purified Drinking Water	Deejay Beverages Ltd, Tema
680.	FDB/Wt 05G-0061	Safeway Drinking Water	Sakisco Enterprises Limited, Hse No 504, Haatso Agbogba Junction, Accra
681.	FDB/Wt 05G-0068	Spak Treated Drinking Water	Soham Ions Ghana Ltd., Hse No 6 Asante Avenue DTD, West Legon
682.	FDB/Wt 05G-0069	Sip Drinking Water	Ocran and Ocran Co.ltd, Accra
683.	FDB/Wt 06G-0052	Sultan Filtered Water	Sultan Refined Water Co.,Accra
684.	FDB/Wt 11G-483	Special Ice Natural Mineral Water	Special Ice Mineral Water, Accra
685.	FDB/Wt 11G-0038	Ice Pak Mineral Water	Baron House Limited, Accra
686.	FDB/Wt 07G-0008	Jeps Filtered Drinking Water	Jepasoa Enterprise, New Asawman Blue Kiosk
687.	FDB/Wt 08G-0001	Trust Drinking Water	Estom Enterprise,Tema
688.	FDB/Wt 08G-0003	Yayra Drinking Water	Jonyato Enterprise, Tema
689.	FDB/Wt 08G-0007	Go Fresh Pure Water	Sanshie E-Bonsu Ent., Accra
690.	FDB/Wt 08G-0009	Party Ice Cubes	Panda Investments Ltd. La Accra
691.	FDB/Wt 08G-0013	Richbi Mineral Water	Richbi Ventures, Accra Central
692.	FDB/Wt 08G-0015	Royal Falls Mineral Water	Royal Falls company Ltd, Accra- North
693.	FDB/Wt 08G-0016	Bride of King Drinking Water	Indibo Enterprise, Accra.
694.	FDB/Wt 08G-0017	Body Choice Filtered Drinking Water	Zakpa Company Ltd
695.	FDB/Wt 08G-0026	Flamingo Special Filtered Water	More Western Ent P.O Box 199, Nungua Accra
696.	FDB/Wt 10G-0228	Yes Natural Mineral Water	Yes Natural Mineral Water

	FDA Registration No.	Product Name	Company Name & Location
697.	FDB/Wt 08G-0030	Golden Pot Drinking Water	Hansen Water Services, Osu Accra
698.	FDB/Wt 08G-0049	Agua Filtered Water	Royal Sweets, Accra
699.	FDB/Wt 08G-0050	Sedaqua Filtered Drinking Water	Sedaqua Ent., P O Box 20700, Aiport Accra
700.	FDB/Wt 09G-0001	Aquatork Filtered Drinking Water	Rehoboth Goshen Ventures,
701.	FDB/Wt 09G-0005	Steral H_2O	Steral Co., Osu Accra
702.	FDB/Wt 09G-0012	Agua Filtered Water	Royal Oasis Co. Ltd.
703.	FDB/Wt 09G-0016	Trumpet Drinking Water	Abogate Enterprise, Accra
704.	FDB/Wt 09G-0019	Waves Natural Mineral Water	Sun Ridge Company Ltd.,
705.	FDB/Wt 09G-0026	Kann Filtered Water	Faskann Ventures, Ltd., Comm 20, Tema
706.	FDB/Wt 09G-0030	Little Drops Drinking Water	Zerb Trading Company, Accra
707.	FDB/Wt 09G-0032	Aqua Darling Filtered Water	Kwaryat Ventures, Accra.
708.	FDB/Wt 09G-0034	Harlem Filtered Drinking Water	Harlem Town Co., Ltd
709.	FDB/Wt 09G-0038	Agya Appiah Mineral Water	Agya Appiah Alternative Herbal Medicine
710.	FDB/Wt 09G-0040	Marss Drinking Water (Cape Coast)	Marss Processing Co. Ltd., Tema
711.	FDB/Wt 09G-0043	Eliak Filtered Water	Eliak Ventures, Dansoman, Accra.
712.	FDB/Wt 09G-0049	Frost Drinking Water	Clean Shine Ltd, Cantonments-Accra
713.	FDB/Wt 09G-0054	Polar Crystal Ice Cubes	Always Easy Party Rentals
714.	FDB/Wt 09G-0058	Chicago Filtered Drinking Water	Treasure Mind Ventures
715.	FDB/Wt 09G-0060	Aqua Ware Natural Mineral Water	Alex Oware Ent. Ltd., Accra
716.	FDB/Wt 09G-0071	Aqua Best Filtered Drinking Water	Trinessh Ent., Tema
717.	FDB/Wt 09G-0073	Aquarius Drinking Water	Halleluya in Numbers Ent.
718.	FDB/Wt 09G-0079	ACS Filtered Drinking Water	Agro-Catering Services, Accra
719.	FDB/Wt 09G-0081	Tik Tak Drinking Water	Pro-Bio Laboratories, Accra
720.	FDB/Wt 09G-0085	Starsplash Mineral Water	StandStill Farms & Trading Ent., Ayigya, Kumasi
721.	FDB/Wt 09G-0086	Jenna Natural Mineral Water	KSMK Ltd., Accra
722.	FDB/Wt 09G-0087	Fedek Pure Water	Fedek Ventures Ltd., Accra

	FDA Registration No.	Product Name	Company Name & Location
723.	FDB/Wt 09G-0088	Ntipet Drinking Water	Ntipet Enterprise, Accra
724.	FDB/Wt 09G-0090	Verge Filtered Water	Verge Fresh Ventures
725.	FDB/Wt 10G-0001	OneGoal Natural Mineral Water	Mighty JKB Co., ltd Weija
726.	FDB/Wt 10G-0003	Golf Fresh Filtered drinking water	Abuyankowa Co. Ltd., Tema
727.	FDB/Wt 10G-0006	Cool-Berg Purified Drinking water	Hanlex Co. Ltd., Accra
728.	FDB/Wt 10G-0046	Adwene Nsuo filtered drinking water	Akyempim Dreams Ent., Accra
729.	FDB/Wt 10G-0096	El-Elyon filtered drinking water	Eleoni Ent. Kanda Accra
730.	FDB/Wt 10G-0097	Starsplash natural mineral water	Starsplash Co. Ltd., Achimota Accra
731.	FDB/Wt 10G-0101	Samma Aqua filtered drinking water	Sam Ritty Ventures
732.	FDB/Wt 10G-0118	Sibi's Mineral Water	Zooland Enterprise, Accra
733.	FDB/Wt 10G-0208	Big Ben Natural Mineral Water	Big Ben Investment Limited, Accra
734.	FDB/Wt 10G-0209	Delta Drinking Water	Emma Boaff Ent., Tema
735.	FDB/Wt 10G-0232	Deona Filtered Drinking Water	Deona Company Limited
736.	FDB/Wt 10G-0234	Neddok Filtered Water	Neddok Ventures, Accra
737.	FDB/Wt 10G-0238	Fontanis Filtered Drinking Water	Nayewa Ent., Taifa Accra
738.	FDB/Wt 10G-0242	Eno's Classic Natural Mineral Water	Eno's Classsic Ghana Ltd
739.	FDB/Wt 10G-0243	Spalife Mineral Water	Sonaspa Company Ghana Limited
740.	FDB/Wt 10G-0252	Dorika Drinking Water	Dorika Crystals, Tema
	NORTHERN REGION		
	Sachet Water Producers		
741.	FDB/Wt 04N-0013	Cool Pac Treated Water (Kumasi)	Voltic Ghana Ltd., Accra
742.	FDB/Wt 05N-0055	Divine Love Filtered Water	Lady D's Divine Love Enterprise, Tamale,N/R
743.	FDB/Wt 08N-0006	Kosung Drinking Water	Kosung Ent., Tamale
744.	FDB/Wt 08N-0012	Aqua-ba Filtered Drinking Water	Malakite (Ghana) Ltd., Plot # 252, West Gurugu, Residential Area, Tamale
745.	FDB/Wt 10N-0038	Batachuo filtered drinking water	Kumbata Chuo, Tamale

	FDA Registration No.	Product Name	Company Name & Location
	VOLTA REGION		
	Sachet Water Producers		
746.	FDB/Wt 06V-0056	Be Still Filtered Drinking Water	Be Still Enterprise Ltd., Ho
747.	FDB/Wt 06V-0058	Mount Zion Filtered Drinking Water	Victorious Mount Zion Ent., Ho
748.	FDB/Wt 08V-0008	Two Streams Filtered Drinking Water	Two Streams Ent.Apesokubi, Volta Region
749.	FDB/Wt 08V-0010	Emros Drinking Water	God is So Great Enterprise, Ho
750.	FDB/Wt 09V-0008	Cosfil Drinking Water	Cosfil Pure Water Co.Ltd.,
751.	FDB/Wt 09V-0017	Fifo Drinking Water	Fifo Drinking Water Enterprise, Hohoe-V/R
752.	FDB/Wt 09V-0029	Brensk Filtered Water	Brensk Enterprise, Ho.
753.	FDB/Wt 09V-0041	All Nice Filtered Drinking Water	All Nice Drinking Water
754.	FDB/Wt 09V-0053	Standard Drinking Water	Cob-A Industries, Accra
755.	FDB/Wt 09V-0057	Big Jay Filtered Drinking Water	Big Jay Ventures, Ho
756.	FDB/Wt 09V-0059	Eno Filtered Drinking Water	St. Maria Gorreti Ventures, Juapong
757.	FDB/Wt 09V-0072	Vic-Ana Filtered Water	Vicana Ent., V/R
758.	FDB/Wt 09V-0082	Crystal String Filltered Drinking Water	Crystal Spring Water
759.	FDB/Wt 09V-0083	Steward Filtered Drinking Water	Gedlet Ventures, Tema
760.	FDB/Wt 09V-0100	Aqua Berto Drinking water	Alberto and sons Ltd., Sogakope
761.	FDB/Wt 09V-0103	Double AA Wasser Drinking Water	Double AA Wasser ltd
762.	FDB/Wt 10V-0021	Jeps Filtered Drinking Water	Jepasoa Enterprise, Nungua Accra
763.	FDB/Wt 10V-0022	Roeliza Filtered drinking water	Roeliza Filtered Drinking Water
764.	FDB/Wt 10V-0027	Shiloh Fresh Filtered drinking water	Shiloh Fresh Ventures, Sogakope
765.	FDB/Wt 10V-0029	Milinda Filtered drinking water	Akyem Process Co. Ltd., Akim Oda
766.	FDB/Wt 10V-0034	Abba Filtered Drinking water	Habitat Pure Co., ltd
767.	FDB/Wt 10V-0050	Akpe Filtered Drinking water	Dew Fresh Ventures
768.	FDB/Wt 10V-0052	Stay Cool Filtered Drinking	Elite Volta Co.ltd

	FDA Registration No.	Product Name	Company Name & Location
		water	
769.	FDB/Wt 10V-0053	Tel Aqua Filtered Drinking water	Life Aqua Co. Ltd., Ho
770.	FDB/Wt 10v-0058	Constant Filtered drinking water	Constant Aluminium Fabrication Ent
771.	FDB/Wt 10V-0064	JJ3 Filtered Drinking Water	JJ3 Ent., Sogakope
772.	FDB/Wt 10V-0069	Lawrenda Filtered drinking water	Christ Resurrection Enterprise
773.	FDB/Wt 10V-0103	Appex filtered drinking water	Appex Global (GH) co. ltd
774.	FDB/Wt 10V-0104	Voltaqua filtered drinking water	CDB Ltd., Nii Boiman Accra
775.	FDB/Wt 10V-0108	Volta Frigo filtered drinking water	Volta Frigo Ltd., Ho
776.	FDB/Wt 10V-0112	Honesty Filtered Drinking Water	Grace Honesty Co. Ltd., Sogakope
777.	FDB/Wt 10V-0114	Fresh Alexander Filtered Drinking Water	Saparlex Ventures, Ho
778.	FDB/Wt 10V-0115	Peagad Filtered Drinking Water	G-Life Enterprise
779.	FDB/Wt 10V-0200	Papat Filtered Drinking Water	Papat Enterprise Ltd.
780.	FDB/Wt 10V-0201	Elorm Filtered Drinking Water	Micmor Ventures, Ho
781.	FDB/Wt 10V-0206	Rose Filtered Drinking Water	Ropors Ent., Ho
782.	FDB/Wt 10V-0207	Faafa Filtered Drinking Water	Faafa Spring Water
783.	FDB/Wt 10V-0212	Amenuveve Filtered Drinking Water	Adhohac Ent., Accra
784.	FDB/Wt 10V-0225	Mawuko Filtered Drinking Water	Noah's Ark Ent., Ho
785.	FDB/Wt 10V-0251	Majet Filtered Drinking Water	Destiny Stores, Anloga
786.	FDB/Wt 10V-0268	Prosta Filtered Drinking Water	Prosta Mineral Water, Ho
787.	FDB/Wt 10V-0274	May Filtered Drinking Water	Temako Haleluya Enterprise
	WESTERN REGION		
	Sachet Water Producers		
788.	FDB/Wt 04W-0002	Thanks Filtered Drinking Water	Thanks Enterprise, Takoradi
789.	FDB/Wt 04W-0005	Ogye Nsu Filtered Water	Admaben Enterprise, Takoradi
790.	FDB/Wt 04W-0006	Lucky Sparks Filtered Drinking Water	Lucky Kazat Enterprise, Takoradi

	FDA Registration No.	Product Name	Company Name & Location
791.	FDB/Wt 04W-0007	Sobak 69 Filtered Water	Sobak 69 Limited, Takoradi
792.	FDB/Wt 04W-0008	Frakam Filtered Water	Frakam Enterprise, Takoradi
793.	FDB/Wt 04W-0009	Calm Waters Drinking Water	Rebdark Enterprise, Takoradi
794.	FDB/Wt 04W-0011	Aqua Pura Water	Granmate Company Ltd., Efiakuma, Takoradi
795.	FDB/Wt 04W-0019	Sompa Filtered Water	Sompa Plaza, Tarkwa
796.	FDB/Wt 04W-0020	Idan Filtered Water	Idan Industries,Takoradi
797.	FDB/Wt 04W-0021	Chako's Filtered Water	Chako Enterprise,Takoradi
798.	FDB/Wt 04W-0023	Akyemfo Birefi Filtered Drinking Water	Akyemfo Birefi Nsu Co., Saltpond
799.	FDB/Wt 04W-0024	Aduss Filtered Water	Emmanuel '93 Ent., Takoradi
800.	FDB/Wt 04W-0044	Millenial Joy Drinking Water	Millenial Kingdom Enterprise, Tarkwa
801.	FDB/Wt 04W-0051	Mina-Mina Filtered Water	Mina-Mina Filtered Water,Takoradi
802.	FDB/Wt 04W-0052	Tarkwa Nsu Dew Filtered Water	Amonoo Memorial Ent,Market circle-Tarkwa
803.	FDB/Wt 04W-0054	Adom Wo Wim Water	M. K. Adom Wo Wim Ent., Plot 73, West Tanokrom
804.	FDB/Wt 04W-0055	Victory Filtered Drinking Water	Victory Product Ent.
805.	FDB/Wt 04W-0056	Kings Water	Abura Kingsway Enterprise
806.	FDB/Wt 04W-0057	Ahomka Drinking Water	Providence Enterprise,Old Afra Market, Effia Kuma , Tarkoradi
807.	FDB/Wt 05W-0004	All Clean Drinking Water	Moonlight Catering Services, Tamso, Tarkwa
808.	FDB/Wt 05W-0005	Hansim Filtered Water	Hansim Ventures, Anaji Hills, Tarkoradi
809.	FDB/Wt 05W-0006	Philbeth Filtered Water	Philbeth Enterprise, Tarkwa
810.	FDB/Wt 05W-0040	Refreshing Waters	Gillimok Enterprise, Ketan Road Estates, Sekondi
811.	FDB/Wt 05W-0041	Nyame Yie Filtered Water	Mandela Enterprise, Takoradi
812.	FDB/Wt 05W-0045	Halleluyah Filtered Water	Menstack Enterprise, Kweikuma, Takoradi
813.	FDB/Wt 05W-0047	Menko Filtered Drinking Water	Menko Water, Kokompe, Takoradi
814.	FDB/Wt 05W-0056	Joy Filtered Water	Men-Tek Ventures, Takoradi
815.	FDB/Wt 05W-0070	Akwaaba Pa Filtered Water	Clafil Trading Ent., P'T 134 West Tanokrom. Tadi
816.	FDB/Wt 06W- 0055	Ohenpon Nsu Filtered Drinking Water	House of Elegance Co. Ltd., Takoradi

	FDA Registration No.	Product Name	Company Name & Location
817.	FDB/Wt 06W-0001	Pearls Drinking Water	Western Pearls Ltd.,# NT 13C, New Layout, Tarkwa
818.	FDB/Wt 06W-0051	Aseda Nsuo Drinking Water	Mekra Do Awurade,Komenda
819.	FDB/Wt 07W-0001	Graceland Filtered Drinking Water	Gak-Graceland Enterprise, Takoradi
820.	FDB/Wt 07W-0002	40 Filtered Drinking Water	40th Enterprise, Elubo
821.	FDB/Wt 08W-0011	Aseda Ben Filtered Water	John Afadu Enterprise, Tarkwa
822.	FDB/Wt 08W-0014	Jim Drinking Water	Jim Filtered Water, H/No. T/E 41, Windy Ridge, Takoradi
823.	FDB/Wt 08W-0024	Pentclean Filtered Drinking Water	Pentclean Filtered Water Ltd P.O Box 37 Assin Fosu
824.	FDB/Wt 08W-0047	City Bell Filtered Drinking Water	Gofra Co. LTD P. O. Box 496 Sekondi
825.	FDB/Wt 09W-0011	Akwaaba Pa Filtered Waater	Clafil Trading Ent., P'T 134 West Tanokrom. Tadi
826.	FDB/Wt 09W-0013	Thess Aqua Ice	Thessalummex West Africa Ltd., Takoradi
827.	FDB/Wt 09W-0015	Agisol Filtered Water	Agisol Ventures
828.	FDB/Wt 09W-0020	Mobile Refreshing Drinking Water	Magvlyn Industries Limited, Tema Light Industrial Area, behind Mac Baron Hotel, Aflao Rd
829.	FDB/Wt 09W-0022	Zionex Filtered Water	Zion- Ex Catering Services, Takoradi
830.	FDB/Wt 09W-0024	Step- Cell Treated Water	Step-Cell Filtered Water, Tarkwa
831.	FDB/Wt 09W-0025	Unique Filtered Drinking Water	Unique Mineral Water,Wassa-Damang
832.	FDB/Wt 09W-0027	Tomaclem Filtered Drinking Water	Tomaclem Standard company Limited, Takoradi
833.	FDB/Wt 09W-0028	Yoofii Filtered Drinking Water	Eden Frandorp Ventures, Takoradi
834.	FDB/Wt 09W-0037	Dzinpa Filtered Drinking Water	Speak Easy Company
835.	FDB/Wt 09W-0062	AG Filtered Drinking Water	Ask God Motors, Takoradi
836.	FDB/Wt 09W-0065	Soko Filtered Drinking Water	Soko Global Ent., Nzema
837.	FDB/Wt 09W-0067	Eye Adom Filtered Drinking Water	Thers-An Ventures, Elubo
838.	FDB/Wt 09W-0075	Gold Pure Crystal Clear Purified Water	Nas-Matson Industries, Takoradi
839.	FDB/Wt 09W-0091	7 Plus Filtered Drinking Water	His Divine Favour Ventures
840.	FDB/Wt 09W-0095	Peace "N" Love Filtered drinking water	Andreas Mannas Foundation
841.	FDB/Wt 09W-0097	Gado Filtered Water	Algo Nuevo Ventures

	FDA Registration No.	Product Name	Company Name & Location
842.	FDB/Wt 09W-0098	Life line filtered drinking water	Emivic Ventures, Takoradi
843.	FDB/Wt 09W-0110	Shalom Filtered Drinking water	Sabad Ventures, Sefwi-Boako, W/R
844.	FDB/Wt 09W-0114	Morila Filtered Drinking water	Mo Maria Enterprise, Abrepo-Kumasi
845.	FDB/Wt 09W-0115	Turks Drinking Water	Ndu-Turks Ent., Enchi, W/R
846.	FDB/Wt 10W-0008	MTL Mackay drinking water	Mining technology Lining(MTL), Tarkwa
847.	FDB/Wt 10W-0013	S.B.H Filtered water	SBH Ventures, Takoradi
848.	FDB/Wt 10W-0039	Jemi Filtered drinking water	Jemilove Ent., Bibiani
849.	FDB/Wt 10W-0071	A & A Filtered Drinking water	Lawgloss Co. Ltd., Sefwi Bekwai
850.	FDB/Wt 10W-0213	Metro Filtered Drinking Water	Stamford Hill Ventures, Takoradi
851.	FDB/Wt 10W-0214	Everlasting Filtered Drinking Water	Emmajoe Investments Ltd., Aiyinase Nzema
852.	FDB/Wt 10W-0218	Glada Filtered Water	Glada Filtered Water, Takoradi
853.	FDB/Wt 10W-0223	Jahan Tasty Filtered Water	Jahan Ent., Takoradi
854.	FDB/Wt 10W-0233	Blue Wave Filtered Drinking Water	Petliz Trading Ent., Takoradi
855.	FDB/Wt 10W-0235	Royal Crown Filtered Water	Joejay Enterprise, Takoradi
856.	FDB/Wt 10W-0247	D & L Filtered Water	Dew Of Life Company Limited
857.	FDB/Wt 10W-0264	Hilltop Filtered Drinking water	Prince John Brentum Ent., Enchi
858.	FDB/Wt 10W-0283	Wespring Filtered Water	Wespring Co. Ltd., Kumasi
859.	FDB/Wt 10W-0284	Danlit Filtered Drinking Water	Danlit Hebron Enterprise, Takoradi
860.	FDB/Wt 10W-0285	Suvic Filtered Drinking Water	Suvic Ventures, Takoradi
861.	FDB/Wt 10W-0286	Willisey Drinking Water	Joewams Ltd., Tarkwa
862.	FDB/Wt 10W-0292	Bless Me Drinking Water	Bless Me Enterprise
863.	FDB/Wt 10W-0293	Aqua Vitae Filtered Water	ESS-ANN Ltd., Takoradi
	UPPER EAST REGION		
	Sachet Water Producers		
864.	FDB/Wt 05UE-0052	Tahco Filtered Water	Tahco Ent., Bawku
865.	FDB/Wt 05UE-0053	Our's Filtered Drinking Water	Big Tanko Limited, Bolgatanga

	FDA Registration No.	Product Name	Company Name & Location
866.	FDB/Wt 05UE-0054	Aqua Filtered Drinking Water	Esther Awuni Enterprise, Bolgatanga
867.	FDB/Wt 05UE-0058	Shinning Star Filtered Water	Shinning Star Enterprise, Bolgatanga
868.	FDB/Wt 05UE-0059	Ernesto Filtered Water	Ernesto Innovative Ventures, Bolgatanga
869.	FDB/Wt 06UE-0046	Sakande Filtered Drinking Water	Sakande Co. Ltd., Bolgatanga
870.	FDB/Wt 06UE-0047	Pearl-Ma Filtered Drinking Water	Viyah's Ent., Bolgatanga
871.	FDB/Wt 08UE-0005	Naelsa Filtered Drinking Water	Hajj-Sandasco Ent Ltd., Bolgatanga
	UPPER WEST REGION		
	Sachet Water Producers		
872.	FDB/Wt 06UW- 0053	White Rock Natural Mineral Water	La Frans Enterprise, WA
873.	FDB/Wt 09UW-0080	Upper Spring Natural Water	Unique Agro Trading Ent., Ltd, Wa

(Source: Food and Drugs Authority Website, 2013)

Appendix 2: Questionnaire Administered to Respondents

UNIVERSITY OF GHANA
INSTITUTE OF ENVIRONMENT AND SANITATION STUDIES

Dear Respondent, I am a Master of Philosophy (Environmental Science) student of the Institute of Environment and Sanitation Studies at the University of Ghana, Legon. This questionnaire is being administered as part of a study on ***Management of Waste Plastic Bottles: A Case Study of the Ayawaso West Sub-metro.*** I would be grateful if you would take time out of your busy schedule to respond to the questions below as openly and as candidly as possible. Please be assured the information you provide is purely for academic purposes and will be treated with utmost confidentiality.

SECTION A: DEMOGRAPHIC DATA

1. Gender: a) Male ☐ b) Female ☐

2. Please state your date of birth.....

3. Education: a) None ☐
   b) Primary/JHS ☐
   c) Secondary ☐
   d) Tertiary ☐

4. Employment: a) Unemployed ☐ b) Student ☐ c) Employed ☐

4a. If Employed, what is your occupation.....

4b. If Employed, Income Range (GHc) : a) <100 ☐
   b) 100 – 500 ☐
   c) 500 -1000 ☐
   d) >1000 ☐

5. Residential Area:.....

5a.Type of Residence:

a) Student Hostel ☐
b) Single/Chamber & Hall (shared facilities) ☐
c) Single/Chamber & Hall (self –contained) ☐
d) Self-contained House (≥ two bedrooms) ☐

SECTION B: CURRENT SOLID WASTE MANAGEMENT SYSTEM

6. What kind of waste collection/disposal system is operating in your area?

a) Door to Door Trucks ☐
b) Door to Door Tricycles ☐
c) Central Waste Containers ☐
d) Open dump ☐
f) Other.....

7. How much do you pay for collection/disposal? .....

8. How efficient is the system?

a) Very Good ☐ b) Good ☐ c) Fair ☐ d) Poor ☐ e) Very Poor ☐

8a. Why.....

9. Please state how the current handling of solid waste has impacted on your area

.....

.....

.....

10. Since when did you make this observation?.....

11. In your opinion, how can the situation be improved?

.....

.....

.....

12. How do you dispose of your plastic waste bottles? (Please tick as many as applicable)

a) Reuse at home ☐
b) In a bin at home ☐
c) Sell to reusers ☐
d) In the nearest bin anywhere ☐
e) Leave it wherever I finish drinking ☐
f) Other.....

13a. If you sell, how much (GHc) per bottle?

.....

14. What are the current uses of plastic waste bottles in your area? (Please tick as many as applicable)

a) Reused for local beverages for sale ☐
b) Reused for cooking oil (palm oil etc.) ☐
c) Reused for kerosene ☐
d) Sold to reusers ☐
e) No use (disposal) ☐
f) Other.....

15. Do you patronize cooking oil in reused bottles?

a) Yes ☐ b) No

15a. If No, why.....

15b. If Yes, have you experienced any health problems after using it?

a) Yes ☐ b) No ☐

16. Do you patronize beverages in reused bottles (e.g. ice kenkey, local drinks etc.)?

a) Yes ☐ b) No ☐

16a. If No, why?

a) May not be prepared hygienically ☐
b) The bottles may not be cleaned well ☐
c) I just don't like local drinks ☐
d) Other.....

16b. If Yes, have you experienced any health problems after drinking any of these?

a) Yes ☐ b) No ☐

16c. If yes, please indicate the type of health problem.....

.....

17. If the safety (health wise) of the reused bottles was assured, would you patronize products packaged in them?

a) Yes ☐ b) No ☐

SECTION C: LEVEL OF PATRONAGE OF WATER/BEVERAGES IN PLASTIC BOTTLES

18. Which of these do you prefer? a) Tap water ☐
b) Sachet Water ☐
c) Bottled water ☐

18a. Why?.....

18b. Do you drink bottled water at all? a) Yes ☐ b) No ☐

18c. On the average, how many bottles do you drink in a day (Please indicate size of bottle i.e. 500ml, 1L, 1.5L etc.)?.....

18d. If the quality of tap water was assured would this be your preferred option?

a) Yes ☐ b) No ☐

19. Which type of soft drink packaging do you prefer?

a) Returnable glass bottles ☐
b) Take-away plastic bottles ☐

19a. Why?.....

19b. Do you patronize soft drinks in plastic bottles at all?

a) Yes ☐ b) No ☐

19c. On the average, how many do you drink in a day?.....

SECTION D: ASSESSMENT OF MANAGEMENT OPTIONS FOR PLASTIC WASTE BOTTLES

20. In your opinion, what do you think is the best way to handle plastic waste bottles?

a) Reuse ☐
b) Recycle ☐
c) Burn/Incinerate ☐
d) Disposal at Landfills ☐
e) Other.....

21. In your opinion, whose responsibility is it to ensure that plastic waste bottles are properly handled?.....

22. What role do you think the Assembly is supposed to play to ensure that plastic waste bottles are properly handled?

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23. What role do you think plastic bottle manufacturers are supposed to play to ensure that plastic waste bottles are properly handled?

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24. What role do you think NGO's/CBO's are supposed to play to ensure that plastic waste bottles are properly handled?

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25. What role do you think residents are supposed to play to ensure that waste plastic bottles are properly handled?

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26. Who should be financially responsible for plastic waste management?

.....

27. Are you willing to separate your plastic bottles at home for collection?

a) Yes ☐ b) No ☐

27a. If No, why?

a) Don't have the time ☐

b) Don't believe in recycling/reuse ☐

c) If only I get paid to do it ☐

d) Other.....

27b. What role are you willing to play towards improving the handling of waste plastic bottles?

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28. In your opinion, what should be done to solve the problem of waste plastic bottles in your area?

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