Investment Cost of Small Town Water Supply Schemes in the Greater Accra Region

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Investment Cost of Small Town Water Supply Schemes in the Greater Accra Region

By

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CERTIFICATION

I hereby declare that this submission is my own work towards the MSc. 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 other degree of the University, except where due acknowledgement has been made in the text.

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DEDICATION

Glory, Honour, Blessing, Prosperity, Power and Boundlessness truly belongs to You JEHOVAH!

Specially Dedicated to

The Holy Ghost

and

My Loving Family

"But as it is written, Eye hath not seen, nor ear heard, neither have entered into the heart of man, the things which God hath prepared for them that love Him."

1Corinthians 2:9 (KJV)

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ABSTRACT

Ghana in line with the world community has committed itself to meet the water component of the MDG target. The low water coverage (59% urban in 2008 and 54.86% rural in 2007) suggests the need for more investments in water supply provision. Meanwhile there is lack of disaggregated investment cost dataand the understanding of the key factors that influence costs especially of Small Town Water Supply Schemes (STWSSs). The objective of this study is to determine the investment cost of STWSSs and identify key factors that influence cost to help inform planning and decision-making. The study was based on completed STWSSs (7 systems) investment cost in the Greater Accra region. The investment cost data excluding programme cost were obtained from payment certificates, bill of quantities, financial contract management forms and contract commitment reports. The investment cost of the various water schemes were adjusted for inflation using the Prime Building Cost Index (PBCI) from the Ghana Statistical Service. Interviews with key informants were conducted for the information on the key factors that influence investment cost. The effects of these factors were examined on the seven water schemes. The results indicated that investment cost of all the water schemes ranged between 58 and 151 GH¢ per capita for the year 2008 as the base year. Cost adjustments with the PBCI were higher than the general inflation. The key factors identified to influence the investment cost of the water schemes in this study were the scale or scope of the schemes; inflation rates; and delays associated with water schemes' construction. Although hydrogeological conditions of a project area could be identified as a key factor but did not show to influence significantly the investment cost in Greater Accra region.

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LIST OF ACRONYMS

AFD	Agence Francaise de Développement
APR	Annual Progress Report
BoG	Bank of Ghana
BoQ	Bill of Quantities
CCI	Construction Cost Index
CIDA	Canadian International Development Agency
CMUs	Centralized Maintenance Units
CPI	Consumer Price Index
CSOs	Civil Society Organizations
CWS	Community Water Supply
CWSA	Community Water and Sanitation Agency
CWSA-GAR	Community Water and Sanitation Agency, Greater Accra Region
CWSA-HQ	Community Water and Sanitation Agency, Headquarters
CWSD	Community Water and Sanitation Division
DALYs	Disability –Adjusted – Life – Years
DANIDA	Danish International Development Agency
DAs	District Assemblies
DFID	UK Department for International Development
DOs	Donor Organizations
DRA	Demand Responsive Approach
EC	European Commission
EPA	Environmental Protection Agency
ESAs	External Support Agencies
EU	European Union
GAR	Greater Accra Region
GLAAS	Global Annual Assessment of Sanitation and Drinking-Water
GoG	Government of Ghana
GPRS II	Growth and Poverty Reduction Strategy
GSB	Ghana Standard Board
GSS	Ghana Statistical Service
GTZ	The German Agency for Technical Cooperation
GWCL	Ghana Water Company Limited
GWSC	Ghana Water and Sewerage Corporation
HDPE	High Density Polyethylene
IDA	International Development Association
JICA	Japanese International Cooperation Agency

JMP	WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation
KfW	The German Kreditanstalt für Wiederaufbau
KNUST	Kwame Nkrumah University of Science and Technology
M/DAs	Municipal/District Assemblies
MDG(s)	Millennium Development Goal(s)
MoH	Ministry of Health
MWH	Ministry of Works and Housing
MWRWH	Ministry of Water Resources Works and Housing
NCWSP	National Community Water Supply Programme
NDPC	National Development and Planning Commission
NGOs	Non-Governmental Organization
NYBC	New York Building Congress
NYBF	New York Building Foundation
OECD	Organization for Economic Cooperation and Development
PBCI	Prime Building Cost Index
PS	Private Sector
PURC	Public Utility Regulatory Commission
PVC	Polyvinylchloride
RCCs	Regional Coordinating Councils
RWD	Rural Water Department
SIP	Strategic Investment Plan
SSF	Slow Sand Filtration
STWSSP	Small Town Water Supply and Sanitation Project
STWSSs	Small Town Water Supply Schemes
UN	United Nations
UNICEF	United Nations Children's Fund
USDoL	United States Department of Labour
WASH	Water Supply, Sanitation and Hygiene
WASHCost	Water Sanitation and Hygiene Service Cost Project
WATSAN	Water and Sanitation
WHO	World health Organization
WSDB	Water and Sanitation Development Board
WSS(s)	Water Supply Scheme(s)
WSP	Water Supply Project

CHAPTER ONE

1.0 INTRODUCTION

The introduction provides the background of this study, problem statement, justification, research objective, and the scope of study.

1.1 Background

Water is essential to the existence of man and all living things. Because of this the World Community according to the report of World Health Organization (WHO, 2005) committed itself to halve by 2015 the proportion of people without access to safe water and sanitation. The world, except sub-Saharan Africa, is on track to meet the target of halving the proportion of people without access to safe drinking water. The estimated total investment excluding programme cost required in developing countries to meet the water component of the Millennium Development Goal (MDG) target is US$ 42 billion (Guy and Jamie, 2008a).

Water is a cross-cutting element of the Growth and Poverty Reduction Strategy (GPRS II) of the Republic of Ghana and is linked to all eight of the MDGs (GoG, 2007a). Ghana has set an ambitious MDG target for water coverage of 85% to be achieved by 2015 and the water coverage for the urban areas as at 2008 was 59% (Quaye, 2008) while the rural water coverage (i.e. rural and small towns) was 54.86% as at 2007 (CWSA, 2008). Sophie and Teshamulwa (2007) reported that the major cause of diarrheal disease is lack of adequate sanitation and safe drinking water and further indicated that after Sudan, Ghana has the highest incidence of guinea worm disease (dracunculiasis) in the world.

This situation suggests the need to invest more in the water supply sector to increase the scope of water coverage in the country.

However, the 2007 report on GPRS II indicated that Ghana compared with other African countries over the past six years has the highest sector investment approximately US$ 134 million and reached a water supply coverage of about 53% (in 2006) which showed a slow progress (GoG, 2007d). In addition, the corporate brochure of the CWSA (2007) indicated that US$756 million was needed to implement the Strategic Investment Plan (SIP) and already there are funds deficit for the first package covering 2008 – 2012. The amount for the SIP is the aggregate costs comprising sanitation, water supply and programmes costs. Government of Ghana on the other hand lacks the funds to implement water projects and has therefore consistently depended predominantly on donors and development partners.

The small town water supply schemes (STWSSs) are piped water schemes provided for populations above 2000 (CWSA, 2007). The CWSA in a presentation at the Annual Joint GoG/Development Partners Review Conference on Water and Sanitation (2008) indicated that the national small town water supply coverage is 55.67% with Greater Accra region alone standing at 52.71%. According to the news release of World Bank (World Bank, 2007a), a focus on STWSSs given the right approach and adequate investments has tremendous potential to significantly increase water supply access in rural Ghana and enhance the possibility of meeting the MDG target for water.

Nevertheless, some of the questions that need to be answered are: how much does it really cost to provide a complete system such as a small town water supply scheme (STWSS); how does the investment cost vary over time; and what are some of the key factors that influence the investment costs? The investment (capital) cost of the STWSSs in this study is the total costs to provide the complete facility and the costs comprising hardware (construction activities) and software (consultancy activities) costs but excluding administrative or programme cost. The software costs also include components like community mobilization, training of WSDB/WATSAN committees, sanitation and hygiene promotion; monitoring and evaluation costs.

1.2 Problem Statement

There is lack of disaggregated investments cost data and understanding on the key factors that influence the investment costs of water supply schemes like small town water supply systems. Cost data available exist in the aggregated forms (as water, sanitation, and programmes costs). Moreover, there has been no similar research work on the investment costs and the key factors that influence the costs pertaining to small town water supply schemes in the country.

1.3 Justification

There is the need to disaggregate investment costs data to help identify the key cost components and the factors influencing costs to help inform planning and decision-making to reduce future investment costs since the costs of providing water supply facilities especially the STWSSs have been high. The knowledge from the study could inform stakeholders to make judicious investments with limited funds available as against the fact that the government lacks the needed funds. The study on the STWSSs is necessitated by the potential of STWSSs to increase rural water coverage and enhance the possibility of meeting the MDG target for water (World Bank, 2007a). Moreover, this study also provides the basis for future research work.

1.4 Objective

The main objective of this study is to determine the investment cost of STWSSs and the key factors influencing the costs.

The specific objectives of the study are to:

- determine the investment cost and the cost trend of STWSSs
- identify the key factors that influence the investment cost of the STWSSs.

1.5 Scope and Limitation of Study

The research work considered the investment cost of seven completed small town water supply schemes facilitated by the CWSA in the Greater Accra region. The study also through interviews with some key informants (from CWSA, WaterAid-Ghana, consultants and contractors) looked at the key factors that influence investment cost of STWSSs. The outcomes of the study are based on the limited data that were available.

1.6 Structure of the Thesis

This thesis comprises Six Chapters. Chapter One, which is the introduction provides the background; problem statement; justification; objectives; the scope and limitation of the study. Chapter Two concentrates on literature review relevant to the study. Chapter Three presents the overview of the study area. Chapter Four, which is the research methodology, looks at how the study was carried out. Then Chapter Five presents and discusses the results of the study. Finally, the Sixth Chapter centres on the conclusion and recommendations drawn from the study.

CHAPTER TWO

2.0 LITERATURE REVIEW

The literature review looks at water supply from the global and local perspectives. The chapter gives accounts on usefulness of water supply, historical backgrounds, definitions and coverage, costs and financing, investment cost and time, and the factors influencing investments.

2.1 Global Perspective of Water Supply and Coverage

Franceys and Gerlach (2008) assert that water is an economic good as well as a basic need critical for health and social welfare. The World Community committed itself to halve by 2015 the proportion of people without access to safe water and sanitation at the World Summit in Johannesburg in September 2002 (WHO, 2005). From 1990 to 2006, approximately 1.56 billion people gained access to improved drinking-water sources. Currently 87% of the world uses drinking-water from improved sources, as compared to 77% in 1990. Moreover, while the world is on track to meet the MDG drinking-water supply target by 2015 at the global level, many countries in sub-Saharan Africa and in Oceania are currently projected to miss MDG country targets, leaving significant portions of the population without access to improved drinking-water supplies (UN, 2008). Reasonable access to water supply was defined by Cairncross and Valdmanis (2006) as the availability of at least 20 liters per capita per day from a source within 1 kilometer of the user's dwelling. Moreover, within the broad category of those with reasonable access to an improved water supply, two significantly different levels of service can be distinguished: house connections and public or community sources.

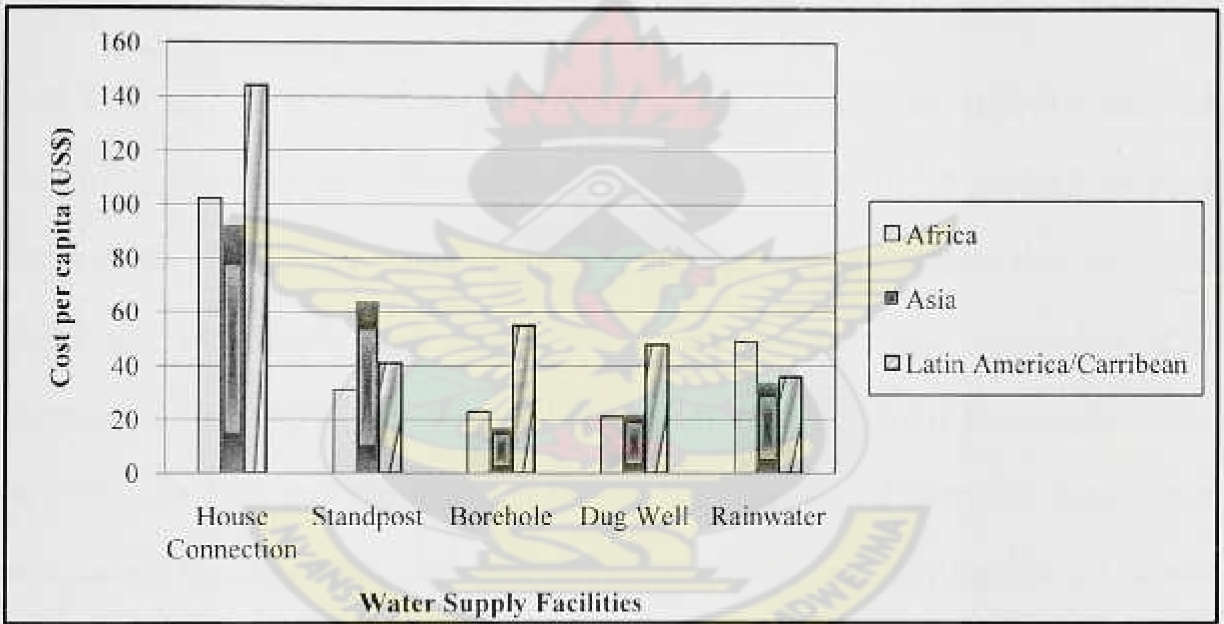
Dirty water and inadequate sanitation kill over 4,100 children everyday. At any one time, half the people in the developing world are suffering from diseases associated with inadequate water supply and sanitation services and more than half of hospital beds in the world are filled with people suffering from water related diseases (DFID, 2009). WHO data on the burden of disease shows that "approximately 3.1% of deaths (1.7 million) and 3.7% of disability-adjusted-life-years (DALYs) (54.2 million) worldwide are attributable to unsafe water, sanitation and hygiene." In Africa and developing countries in South East Asia, 4 8% of all disease burdens are attributable to these factors. Over 99.8% of all the deaths attributable to these factors occur in developing countries and 90% are deaths of children (WHO, 2005). Since the effect associated with unsafe water or lack of it has been felt worldwide, there have been a number of policies and programme interventions at the global and local fronts to remedy the situation.

2.1.1 Financing and Investment Cost

Overall, the financial capacity of countries was reported as the weakest link in making progress in the drinking-water sector. Countries may have significant funds for new capital investment but are likely to lack stable mechanisms for financing recurrent costs, such as operation and maintenance costs (UN, 2008). WHO estimates that US$1 invested in water and sanitation would give an economic return of between US$3 and US$34, depending on the region (Franceys and Gerlach, 2008). Achieving the global water targets would require an estimated additional investment of around US$11.3 billion per year over and above current investments. The benefits would include an average global reduction of diarrhoeal episodes of 10 per cent and a total annual economic benefit of US$84 billion (Franceys and Gerlach, 2008).

However, the estimated spending required in developing countries to provide new coverage to meet the MDG target is 42 billion United States dollars (US$) and the cost of maintaining existing services totals an additional US$ 322 billion for water supply. Spending for new coverage is focused mainly on rural areas (64%), whereas spending for maintaining existing coverage is focused mainly on urban areas (73%). Additional programme costs–incurred administratively outside the point of delivery of interventions of between 10% and 30% are required for effective implementation (Guy and Jamie, 2008b). International Development Association (IDA), the concessional lending arm of the World Bank, has been working to improve access to water and sanitation in the world's poorest countries and it has seen real progress in the last 15 years. Overall, access to improved water sources in IDA countries rose from 65 percent in 1990 to 75 percent in 2004. Planned investments for Water Supply Schemes (WSS) in 2007 are US$1.6 billion, almost double the investments made during 2005. IDA lending has been concentrated in Africa, which has received about half of the IDA commitments to the water supply sector since 1998. World Bank estimates that expanding water supply access costs on average US$55 per capita (World Bank, 2007a).

Cairncross and Valdmanis (2006) cited that the Global Water Supply and Sanitation Assessment 2000 Report gave median costs per person served for the various technologies in the three main regions of the developing world: Africa; Asia; and Latin American and the Caribbean as shown in Figure 1 below. The cost of house connections may be representative in Latin America and the Caribbean, where they are often provided in rural areas. In Asia and Africa, the reported costs of house connections relate almost exclusively to urban areas because such connections are rarely provided in smaller communities. The smaller sizes of rural communities mean that piped systems in general, and house connections in particular will tend to be more expensive than in urban areas. An overall unit cost figure of US$150 per capita, just above the highest of the three continental medians, is therefore taken for house connections in the cost-effectiveness calculations. Public water points corresponding to improved water supply can vary between US$15 and US$65 or more, depending on local conditions (Cairncross and Valdmanis, 2006).



Source: Cairncross and Valdmanis (2006).

Figure 1: The Median Construction Cost Per Capita of Water Supply Facilities for the Three Regions of the Developing World

2.2 Water Supply in Ghana

This section looks at the water supply in Ghana by considering brief historical background; definitions and coverage; the small town water supply; water supply costs and financing; and the key actors in the subsector. The water subsector in Ghana like other countries has programmes combined with that of sanitation and hygiene promotion. The Community Water and Sanitation (CWSA) which is a government agency considers hygiene education as an important component of water and sanitation projects as it maximizes the potential benefits of improved water supply and sanitation facilities. The UN-Water Global Annual Assessment of Sanitation and Drinking-Water (GLAAS) report (UN, 2008) also indicated that sanitation and drinking–water sectors are usually combined in the same projects or programmes, and data are generally maintained to meet Organisation for Economic Co-operation and Development (OECD) guidelines (which require aggregated instead of disaggregated data reports for the two sectors).

2.2.1 Historical Background

Until the early 1990s, the Ghana Water and Sewerage Corporation (GWSC) had been responsible for urban and rural water supply since 1965. From 1965 to 1985 not much attention was paid to rural water supply. For instance, it was estimated that within this period only 28% of the rural population had access to improved water while urban coverage was over 60%. This led to the creation of the Rural Water Department within the GWSC in 1986 to focus more attention to the provision of water and sanitation to rural people. Some facilities were provided but these could not be sustained due to non-payment of tariffs by beneficiary communities resulting in little or no maintenance of the facilities by the Centralized Maintenance Units of GWSC. The United Nations General Assembly declared the period 1981 – 1990 as the International Drinking Water and Sanitation Decade to ensure that nations made significant strides in the delivery of water and sanitation facilities to their populace. The Ghana Government, in line with the agenda for the decade initiated a review of its policies on water and sanitation provision to keep pace with the changing conditions in the country and on the international scene (CWSA, 2007).

The National Community Water and Sanitation Programme (NCWSP) was launched in 1994 in line with the Government's decentralization policy. This culminated in the creation of the community Water and Sanitation Division (CWSD), a semi autonomous Unit within the then GWSC to manage rural water and sanitation delivery. After four years of existence, it was deemed necessary to grant complete autonomy to the Division to give greater impetus to its work. Subsequently, the Division was transformed into the Community Water and Sanitation Agency (CWSA) by an Act of Parliament, Act 564 in December 1998, with the mandate to facilitate the provision of safe drinking water and related sanitation services to rural communities and small towns in Ghana. The CWSA has since been facilitating the implementation of the NCWSP using the decentralized structures at the district and community levels as prescribed in the Act (CWSA, 2007).

The NCWSP in line with the decentralization policy places emphasis on the district/community active participation in the planning, implementation and management of safe water supply and improved sanitation services. The policy seeks to ensure sustainability of investment in water and sanitation by making beneficiary communities the primary focus. User communities are to be initiators, planners, implementers, managers and owners of the service (GoG, 2005).

The World Bank implemented the National Community Water and Sanitation Programme (NCWSP) in collaboration with other potent donor organisations such as the Danish

International Development Agency (DANIDA), Canadian International Development Agency (CIDA), European Commission (EC), the German Kreditanstalt für Wiederaufbau (KfW) in cooperation with the German Agency for Technical Cooperation (GTZ), Japanese International Cooperation Agency (JICA), Agence Francaise de Développement (AFD), and others. With varying priorities, the World Bank, DANIDA, CIDA and KfW were considered to have been the "lead donors" contributing to the NCWSP over the period (1994 – 2004) under review (Veronika, 2005). The Donor Organizations (DOs) have been key contributors in terms of financial support in the water subsector through policies and programmes undertaken by the country. The DOs contributed 90% in 2003, increased to 92.7% in 2005 and over 88% of investment funding in 2006 (GoG, 2007b).

2.2.2 Definitions

Joint Monitoring Programme (JMP) for Water Supply and Sanitation of WHO and UNICEF classifies water supply as "improved" and "unimproved" based on their definitions and to be classified as improved, the water supply must provide at least 20 litres per capita per day from a protected source within 1 km of the user's dwelling (Guy and Jamie, 2008b).

Table 1: Definitions of "improved" and "unimproved" water supply

Intervention	Improved	Unimproved
Water Supply	• Piped water into dwelling, plot or yard • Public tap/ standpipe • Tube well/ borehole • Protected dug well • Protected spring • Rainwater collection	• Unprotected dug well • Unprotected spring • Cart with small tank/ drum • Tanker truck • Bottled water • Surface water (river, dam, lake, pond, stream, canal, irrigation channels)

Source: Guy and Jamie (2008b).

In Ghana, communities are classified into three categories of settlement types based on the CWSA guidelines as follows: rural for a population of 75 – 2000; peri-urban (small town) for population of 2001 – 5000; and urban for population of 5000 and above (Unihydro Ltd, 2003a). According to Nyarko (2007), a small town is defined in the CWSA Act as "a community that is not rural but is a small urban community that has decided to manage its own water and sanitation systems". The CWSA policy defines a small town water system as a piped system serving communities of between 2000 and 50000 inhabitants who are prepared to manage their water supply systems in an efficient and sustainable manner (Nyarko, 2007).

The CWSA has different water supply technological options considered as improved water supply for the population groups as indicated in Table 2 below.

Table 2: Different types of water supply options for the population groups

Population / Options	Small Communities	Small Towns
Population	• Population up to 2000	• Population above 2000
Water Supply Options	• Hand dug well fitted with hand pump • Spring development • Tube well/ borehole fitted with hand pump • Mechanized borehole with limited distribution • Rainwater harvesting	• Ground water based piped schemes • Spring or highland gravity water supply schemes • Surface water with minimal conventional treatment schemes • Other technologies based on ground conditions

Source: Compiled from CWSA (2007).

Water supply coverage in Ghana is defined within the NCWSP as follows (CWSA, 2007):

- Water facility must provide all year round potable water to community members.
- Each person must have access to a minimum, 20 litres of water per day.
- Each spout of a borehole /standpipe must serve a maximum of 300 persons and a hand-dug well 150 persons.
- The maximum walking distance to a water facility must be equal to or less than 500 meters.
- The water system is owned and managed by the community through established structures.

In fact, differences exist between the coverage definitions used by the JMP of WHO/UNICEF and the country. For instance, while JMP considers maximum distance to a water facility to be 1 km, Ghana defines it to be equal or less than 0.5 km. According to the pilot report (GLAAS) (UN, 2008), Ghana has already achieved MDG water coverage target with figures of 90% and 71% for urban and rural respectively. But the same report also indicated country – reported coverage of 57% and 53% for the urban and rural respectively showing that Ghana is off target. However, the GLAAS report (UN, 2008) further admitted that the differences in reported JMP and country – reported figures resulted from differences in definitions, statistical methods and data sources used. JMP is currently engaging with countries to study the differences in reporting methods, with the aim of reconciling the coverage figures (UN, 2008).

2.2.3 Water Coverage in Ghana

The rural water coverage (rural communities and small towns) has increased but not to the extent anticipated. From 46.3 per cent in 2003, coverage increased to 51.1 per cent in 2004 and to 51.9 per cent in 2005. By 2006, coverage had increased to 52.86 per cent but lower than the 57.2 per cent that was projected in the Strategic Investment Plan (SIP) of the CWSA. The national rural water coverage for the year 2007 is 54.86% as shown in Table 3 below. In fact, progress towards achieving the ambitious water sector target of 85% by 2015 remains slow (this target is set higher than the MDG target of 73% by the World Community) and to achieve the target of halving the un-served population by 2015, Ghana needs to reduce the un-served rural population by half (that is, 23.57 per cent). The target for rural water coverage is thus 75.43 per cent, approximated to 76 per cent (GoG, 2007b; World Bank, 2007b; and CWSA, 2008).

Table 3: National Rural Water Coverage for the Year 2007

Region	No. Communities	Total Population	No Boreholes	No. of Hand-dug Wells	Piped Systems	Total Population Served	% Coverage
Ashanti	2,753	2,939,512	4,709	939	43	1,846,526	62.82
B. Ahafo	2,639	1,793,868	2,250	503	29	976,525	54.44
Central	3,114	1,441,734	1,249	275	25	704,512	48.87
Eastern	3,215	1,832,029	2,263	1,123	28	909,550	49.89
G. Accra	848	613,949	213	65	8	351,362	57.23
Northern	3,855	1,919,293	3,477	435	32	1,142,525	59.53
U. East	1,912	1,017,124	1,633	434	6	534,019	52.50
U. West	929	586,621	1,657	161	12	458,944	78.24
Volta	2,722	1,458,169	1,757	52	85	740,914	50.81
Western	1,739	1,486,466	1,040	418	26	608,433	40.93
Grand Total	23,726	15,079,765	20,248	4,405	294	8,273,310	**54.86**

Source: CWSA, (2008)

Moreover, the urban water supply coverage currently stands at 59% where GWCL considers access to basic service of water supply to mean year – round supply of at least 20 litres of safe water per capita per day, preferably within 500 meters for all households and serving not more than 300 persons per water outlet (Quaye, 2008).

Table 4: Regional Coverage in Urban Water Supply (2008)

REGION	Population	Demand (m^3/day)	Supply (m^3/day)	Coverage %
ASHANTI	2,000,728	187,118	91,500	49
BRONG-AHAFO	602,840	48,125	14,385	30
CENTRAL	1,129,733	90,225	38,415	43
EASTERN	1,015,155	77,995	21,470	28
GREATER ACCRA	3,837,236	532,570	401,800	75
NORTHERN	560,820	44,449	20,375	46
UPPER-EAST	172,168	13,239	5,665	43
UPPER-WEST	106,735	8,539	1,180	14
VOLTA	575,287	43,974	17,115	39
WESTERN	694399	54,799	34,535	63
NATIONAL	**10,689,366**	**1,101,032**	**646,494**	**59**

Source: Quaye, (2008)

2.2.4 Small Town Water Supply

The Small Towns Water Supply and Sanitation Project (STWSSP) in Ghana is a water sector operation contributing to the overall water sector effort to accelerate access to water and sanitation services, keeping in view the need to achieve the MDG targets. The important contribution water and sanitation plays in achieving other MDG targets include reduction in infant under-five mortality rates and enhancing enrolment rate of girls in basic schools (World Bank, 2007b). It has become evident that majority of the small towns in Ghana are not significantly different from the small communities in terms of geographical space, population size as well as socio-economic and political make-up (Nedjor and Soley, 2008).

2.2.4.1 Small town water coverage

Small towns' water coverage as at December 2006 was 55.80% and 1,537,728 people have been served with potable water (CWSA, 2007). According to a news release of the World Bank (World Bank, 2007a), focus on small towns water supply given the right approach and adequate investments, has tremendous potential to significantly increase water supply access in rural Ghana and enhance the possibility of meeting the MDG target for water. In Ghana, it is estimated that about 6.7 million or 32 percent of the population reside in small towns (with a population of 2,000 to 50,000 inhabitants). As in other countries in the sub-region, small towns have not received focused and adequate attention in the context of water supply and sanitation. Recognizing the trend of rural migration to towns and cities in Ghana, focused attention to the needs of small towns remains critical (World Bank, 2007a).

2.2.4.2 Characteristics of small town water supply schemes

A typical small town water supply system consists of a source (usually a mechanized borehole), pump house (a submersible pump powered by a 3 – phase voltage transformer), source of power (AC power from the national grid, local diesel power generator or solar panels (only few cases in the Northern region), pipelines (transmission and distribution pipes made of PVC and HDPE), an elevated reservoir, standpipes and appurtenances (Nyarko, 2007). The Oyibi water supply scheme design report (Unihydro Ltd, 2003b) indicated that based on the CWSA guidelines and the technical manual of DANIDA, the schemes are predominantly public connections (about 80% and above) with the remaining allocation for private (household) connections. In this case, the schemes may be considered for public standpost cost according to Cairncross and Valdmanis (2006) and even based on the fact that private connection (household connection) costs are not borne by the project according to the CWSA.

Moreover, Attakora (2006) cited that according to the small town policy, the general design period for construction or rehabilitation of a small town water supply system is 10 years from the time of commissioning but individual components may have varying design periods as shown below.

Table 5: Design periods of component of a small town water system

System components	**Design period**
Reservoirs/tanks	
Volume (sizing)	10 years
Transmission mains	10 years
Distribution	
- Mains	15 years
- Branches	10 years
Public standpipes	10 years
Pumps	10 years
Transformers	15 years
Source (water)	15 years

Source: Attakora, (2006).

2.2.5 Water Supply Costs and Financing

Cardone and Fonseca, (2003) suggested the total costs of water services delivery summarized in the Table 5 shown below and the capital costs specifically for water supply other than sanitation involves the costs of water resources facilities, water distribution mains, pumping stations and water treatment works.

Table 6: Identifying Costs

Total Costs of Service Provision		
Financial Costs	**Economic Costs**	**Costs of Sustaining the Service**
• Capital costs • Operation and maintenance costs • Servicing capital costs	• Environmental cost • Opportunity costs	• Institutional capacity building and skills training • Monitoring and assessment • Policy and enabling environment

Source: Cardone and Fonseca (2003)

The report on proposed additional financing credit to Ghana (World Bank, 2007b) for a STWSSP (four year duration ending 2009) indicated that the (unit) cost of investment in Ghana which is the cost to provide a complete water scheme involves the construction and engineering services, software activities (community mobilization, hygiene, training, monitoring and evaluation) and CWSA project management costs. The unit cost of investment projection used for the planning of the small town water supply project was an average figure of US$52 per capita. Because of economies of scale, the average investment cost per person was to run on a scale from US$55 per person in the smallest towns to US$45 per person in the larger towns (World Bank, 2007b). The document also indicated that unit cost of investment (i.e. per capita cost of investment) for towns with smaller population sizes are always much higher than for towns with larger population sizes as there are fixed costs associated with the implementation of the piped water schemes regardless of the size. Higher unit costs ranging from 36-84 Euros per capita (US$47-110 per capita) estimated for 40 small town systems funded by the EU in the two regions Western and Central Regions has also been attributed to smaller population towns (World Bank, 2007b).

Table 7: Population sizes with the corresponding investment costs for STWSSs in Ghana

Population Ranges	Per Capita Investment Cost (US$)
Population > 10,000	37 – 43
Population < 10,000	50 – 54

Source: Adapted from World Bank (2007).

The World Bank report (World Bank, 2007b) further illustrated that the additional funding was sourced from the World Bank for the STWSSP due cost overruns as a result of higher investment cost emanating from the predominance of small population towns in the schemes requiring the average per capita cost level of US$ 52 not the previously estimated cost of US$ 37. The US$ 37 per capita cost level assumed populations greater than 10,000 for the schemes. The paper by Nedjor and Soley, (2008) also indicated the predominance of rural nature of Ghana by illustrating that the population range of 2000 to 5,000 is most common and most small towns exhibit the poor and deprived characteristics typical of small communities.

Nyarko (2007) indicated that, according to the national community water and sanitation project, the financing arrangements for capital cost of small town water supply are: External Support Agencies (ESAs) 90%, District Assembly 5% and community members 5%. The community contribution according to the report has been reduced to 2.5% due to concerns about the ability to pay by small towns. As such, most of the investments in the small town water sector are from the ESAs. After the separation of community water supply from urban water supply the support from the ESAs were directed to either urban or community. Most ESAs, with the exception of DFID have paid more attention to providing support for potable water supply in communities compared to the urban water sector. The state of poverty in rural areas has been a major reason for this development (Nyarko, 2007).

Table 8: Capital cost contribution arrangements for small town water supply in Ghana

Development Partners	**Development Partners**	**DAs**	**Community**	**Remarks**
World Bank, KfW/GTZ	90%	5%	5%	
DANIDA	95%		5%	
EU, CIDA, AFD	100%			CWSA is allowed to collect upp to 5% community contribution as a prerequisite to pump installation for point sources and construction for pipe schemes.
JICA	100%			CWSA is allowed to collect up to 5% community contribution but not as a pre-requisite

Source: Nyarko (2007).

A number of projects that were on-going as at 2007 with the investment (capital) costs supported by the Government of Ghana and external support agencies in the community water and sanitation sub-sector included the following according to the CWSA, (2007):

- CIDA intervention in seven districts in the eastern corridor of the Northern region – Northern Regional Rural Water and Sanitation Project (NORWASP) for the provision of 700 water points and 7,000 household sanitation facilities and to strengthen support institutions for the sustainability of delivered facilities: 2002 – 2006 at the cost of Canadian $16,768 million

- † EU supported 500 water points and 2000 sanitation facilities in the East and West Gonja and West Mamprusi in the Northern region which are guinea-worm endemic areas at the cost of 14.5 million Euros: 2002 – 2007.
- † EU support for the construction of some 40 small towns piped water systems and sanitation facilities in the Western and Central regions at 24.99 million Euros: 2007 – 2009.
- † AFD water supply and sanitation project to construct 235 point sources, 7 piped schemes, 2000 households and 72 institutional latrines in districts in the Western corridor in the Northern region at 9 million Euros: 2002 – 2006.
- † IDA small towns water and sanitation for the Upper East, Upper West, Brong-Ahafo, Ashanti, Western and Central regions for pipe water supply and hygiene promotion for 500,000 people at US$ 26 million: 2004 – 2009.
- † KfW RWSP4 10.2 million Euros support for the drilling of 1000 boreholes and 2000 latrines in the Ashanti region: 2004 – 2008.
- † DANIDA district based water and sanitation component of the Water and Sanitation Sector Programme Support Phase II (WSSPS II) for Eastern, Volta, Central and Greater Accra regions for the construction of 1,255 point sources, 20 piped schemes and 20,000 latrines at DKK 271.7 million: 2004 – 2009.
- † DANIDA/DFID/GoG 3 – Districts Water Supply Scheme to serve 108 communities in the Dangme East, Dangme West in ghe Greater Accra region and North Tongu in the Volta region at a cost of US$ 9 million: 2002 – 2008.
- † ADB support for the delivery of 806 water points and 2-piped schemes in five districts in Ashanti region at US$ 19.7 million: 2004 – 2008.

† GoG releases for Guinea Worm Eradication in the Northern, Brong-Ahafo, Upper West, Upper East and Volta regions at ¢36 billion i.e. the current GH¢3.6 million :2002 – 2005.

2.2.6 Unit cost study scan

CWSA which was the then CWSD carried out a first unit cost study on water and sanitation facilities in 1999. The study specifically was to determine the ideal unit cost structure of different subproject components and develop a database. According to the report (CWSD, 1999), the study focused on IDA funded projects in four regions in the country excluding Greater Accra region and compared cost of these with projects of other funding agencies. The study provided some average regional unit cost (i.e. cost per borehole or hand-dug well) and the costs of the subcomponents (as labour, materials, administrative, etc) (CWSD, 1999) but were not schemes specific. The unit cost study on water supply involved boreholes and hand-dug wells but not small town water supply schemes. According to the consultants (CWSD, 1999), the terms of reference referred to a comparative cost analysis of different regional water and sanitation projects (by different funding agencies) as well as assessing the effectiveness of costing procedures for the IDA projects.

A second study conducted by the CWSA was the development and implementation of a unit cost database facility in 2002 to provide the framework for establishing uniform procedures and controls for the procurement cycle or budgeting (CWSA, 2002). The study involved the review of existing database from the 1999 unit cost study and the development of the unit cost database facility including installation and training of users.

The report (CWSA, 2002) indicated that STWSSs had not been standardized and therefore could not be fed into the database.

These studies so far were for the purposes of budgeting and there had not been clear indications of the real costs of water supply schemes especially STWSSs and key factors that influence investment costs of such water schemes.

2.2.7 Key Actors of the Water Sub-sector

The key actors in the sub-sector are not separate from those in the WASH (Water Supply, Sanitation and Hygiene) sector and they include ministries, departments, agencies and institutions like the following according to GoG, (GoG, 2007d):

- Ministry of Water Resources, Works and Housing (MWRWH)
- Ministry of Health (MoH)
- Community Water and Sanitation Agency (CWSA)
- National Development Planning Commission (NDPC)
- Regional Coordinating Councils (RCCs) and Municipal/District Assemblies (M/DAs)
- Ghana Standards Board (GSB), Environmental Protection Agency (EPA) and the Public Utility Regulatory Commission (PURC).
- Civil Society Organisations (CSOs) like international and local NGOs.
- The Private Sector (PS) including consultants, contractors and suppliers.

The key actors directly involved with the investment costs of community water supply infrastructure provision are the main government-implementing agency CWSA; CSOs and the PS. The other stakeholders are in one way or the other directly responsible for formulation, implementation, monitoring and evaluation of policies, programmes and regulations.

2.3 Investment Cost and Time

Time value of money is the concept of measuring the value of money over time and because value of money changes with time and it is crucial to the analysis of investment to be able to measure and solve for those changes. Present value defines what a dollar is worth today and future value defines the worth of a dollar at some future time (Kobzeff, 2008). Over time, as cost of goods and prices increase, the value of the dollar decreases as you get less with the dollar than what you did a while ago (Stockerati, 2008). Nam *et al.*, (2007) indicated that labour, materials and equipment costs tend to rise over time and that construction costs can vary over time with changes in demand, economic conditions, prices etc.

These statements therefore give room to ask questions as to what trend could the investment cost of STWSSs depict. Would it be doubling or tripling every year or otherwise or in simple terms what has been the percentage increase over time?

2.4 Factors that Influence Investment Cost of Projects

The initial project costs (investments) are the costs associated with initial design and construction of the facility. Construction costs include costs of labour, material, equipment, general conditions (job overhead), contractor's main office overhead and profit. Other costs include those for design as well as special studies, and tests, land, project administration, construction insurance, permits, fees, financing etc (Kirk and Dell'Isola, 1995).

It is important when examining bills of quantities to understand the conditions that influence the rates and prices change. Variations in rates may be due to the following factors: size of project; type of project; regional location of project; contract conditions; market conditions prevalent at the time of tender; and contract implications, particularly those affecting the contract period and the account to be taken for inflation (Ashworth, 1994). The capital cost of small town water supply projects is influenced by various factors such as the complexity of the design, energy source used (i.e. National Grid/Hydro-Electric Power or Solar), settlement pattern of the community (whether it is scattered or nucleated), the proximity of the water source (mostly borehole) to the community and the quality/types of pipes and fittings used. Some designs of water supply schemes may also be unnecessarily ambitious for the communities. The factors that influence the investment costs of the water supply projects are not the same for all communities (Nedjoh and Soley, 2008). Cairncross and Valdmanis (2006) also agree with the others that the local conditions such as the size of the community to be served and the presence of suitable aquifers can cause tremendous variations in the unit cost of water supply.

The report by NYBC and NYBF (2008) suggested that inflationary pressures also account for a portion of the increased cost of contractors, subcontractors and skilled labour, the cost of land, fuel prices and the cost of compliance with environmental regulations. Adding to overall inflation, the high price of oil has a significant direct and indirect impact on construction operations and materials. As the price of oil increases, so does the cost of operating on-site machinery, which includes excavators, pumps, generators and heaters. The costs of petroleum by-products, like plastics, rubber, roofing materials etc, also move with the price of oil (NYBC and NYBF, 2008).

CHAPTER THREE

3.0 STUDY AREA

This chapter gives brief description of the study area and the basic characteristics of the small town water supply schemes.

3.1 Study Area

The Greater Accra Region is the smallest of the 10 administrative regions in terms of area, occupying a total land surface of 3,245 square kilometers or 1.4 per cent of the total land area of Ghana. In terms of population, however, it is the second most populated region, after the Ashanti Region, with a population of 2,905,726 in 2000, accounting for 15.4 per cent of Ghana's total population. The political administration of the region is through the local government system. Under this administration system, the region is divided into five districts namely, Accra Metropolitan Area, Tema Municipal Area, Ga East District, Ga West District, Dangme West District and Dangme East District. Each District, Municipal or Metropolitan Area, is administered by a Chief Executive, representing central government but deriving authority from an Assembly headed by a presiding member elected from among the members themselves (Ghana Districts, 2008).

3.2 CWSA-GAR Piped Water Schemes

CWSA-GAR is one of the ten regional offices of the CWSA in the country. It has the overall responsibility for programme implementation and management at the regional level and facilitating the work of other players including the District Assemblies (CWSA, 2007). The CWSA-GAR seven piped water schemes out of eight considered for the study are Oyibi Area Small Town Water Supply Scheme, Ashalaadza Area Water Supply Scheme, New Kweiman Area Water Supply Scheme, Asutsuare Area Water Supply

Scheme, Abokobi Area Water Supply Scheme, Pantang Area Water Supply Scheme and the Selected Communities Connection to the GWCL System as show in the Figure 2 below. The eighth scheme known as the Three-district (3-D) water supply project was not considered because it had not been completed for the cost data to be available at the time of this study.

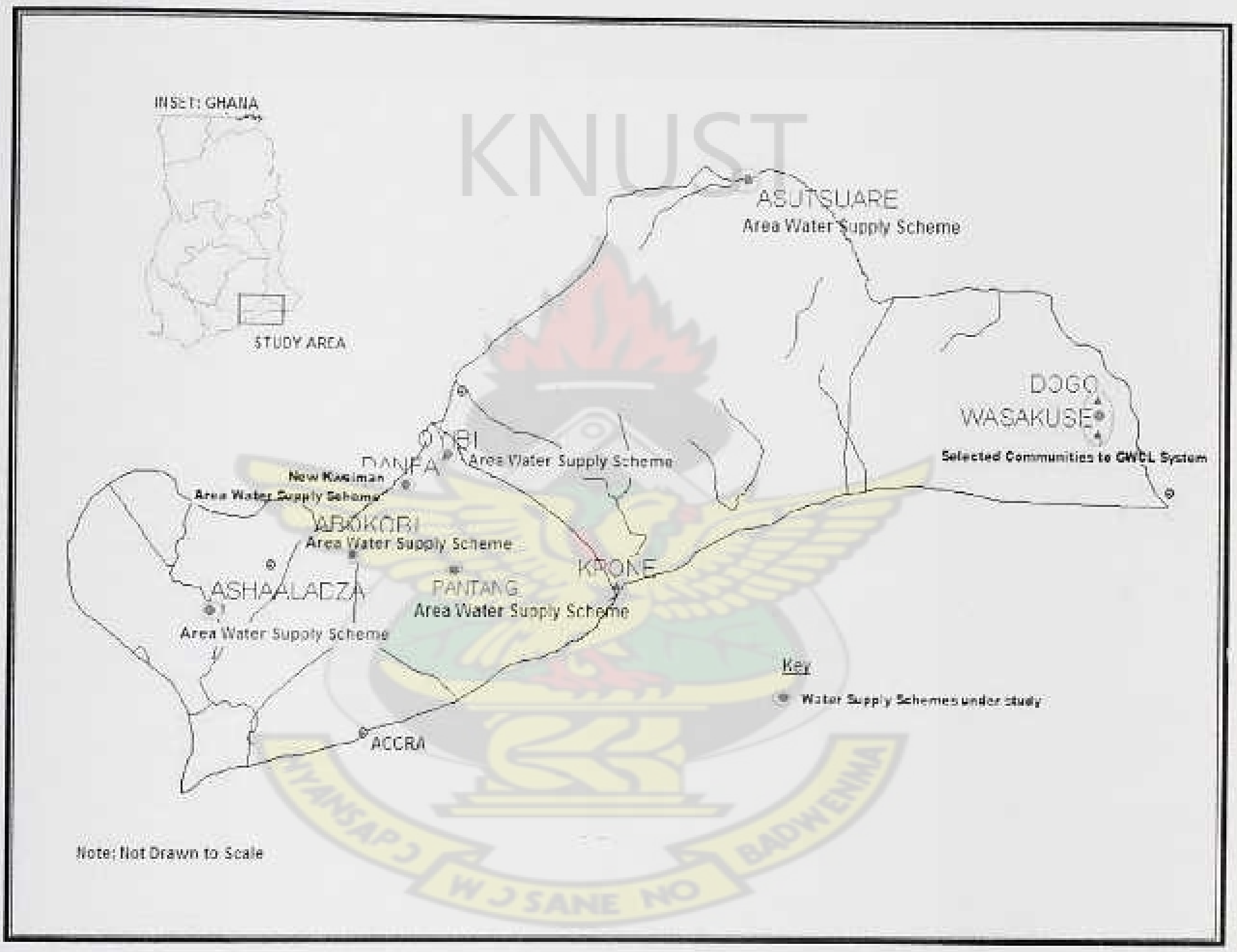


Figure 2: A map of the study area showing the seven water supply schemes

However, these schemes were provided to the communities with the support from the Community Water and Sanitation components of the comprehensive Sector Programme Support, which is an agreement between the Governments of Ghana and Denmark

(DANIDA). In 2000, the two governments introduced one more component to supplement the CWS components by supporting the provision of services to small towns in the Greater Accra region. The DAs and beneficiary communities were required to make financial contribution of 5% and 2.5% respectively towards the capital cost of the projects and on completion the communities own the schemes and become fully responsible for its operation and maintenance (CWSA, 2003).

CHAPTER FOUR

4.0 Research Methodology

This section gives account of how the entire research work was carried out leading to the achievement of the specific objectives.

4.1 Desk Study and Data Collection

The desk study reviewed literature and investment costs data relevant to this study. Investment cost data of the completed piped water supply schemes were extracted from several documents (contract documents, tender documents, financial contract management forms, payment certificates, contract commitment reports) from the library records and project finance office of the CWSA-GAR. In addition, complete project design documents were available for two water schemes (Oyibi and Ashalaadza). The investment costs data of the schemes were disaggregated at the levels of hardware costs (i.e. cost associated with construction) and software costs (i.e. cost associated with consultancy services). Other relevant information relating to the schemes were obtained from the water supply and environmental sanitation engineering department.

4.1.1 Selected Schemes and Characteristics

The water schemes that were fully constructed with available cost data were selected for this study. CWSA-GAR has facilitated eight STWSSs in the GAR. Seven of these water schemes had been fully constructed and were therefore selected for the study. The remaining water scheme (the three – district WSP) was still under construction at the time of this study and hence cost data were not available. The Table 9 below gives the basic characteristics of the water schemes considered for this study.

Characteristics	Ashalaadza WSS	Oyibi WSS	Selected Comm. to GWCL	Abokobi WSS	Pantang WSS	New Kweiman WSS	Asutsuare WSS
Population (designed)	2,968	6,651	9,634	9,032	12,758	7,138	9,564
Communities	4	9	11	3	13	10	4
Water supply options	Ground water based piped scheme	Ground water based piped scheme	Connection to GWCL System	Ground water based piped scheme	Ground water based piped scheme	Ground water based piped scheme	Surface water with SSF piped scheme
Pumps control panel	One submersible	Two submersibles, two generator sets	None	One submersible	One submersible	Two submersibles	Three pumps (1 submersible)
- Pipelines length (Transmission and Distribution) - Sizes (mm)	0.8 km 45 mm 50 mm 75 mm	15 km 50 mm 75 mm 100 mm	11.5 km Not available	18.6 km 50 mm/75 mm 100 mm 150 mm	19.4 km 50 mm/75 mm 100 mm 150 mm	13.8 km 50 mm/75 mm 100 mm	12.9 km 50 mm/75 mm 100 mm 150 mm
Reservoir (s) FD(fill and draw), FtS(floating) System	30 m^3 RC (elevated), FDS	120 m^3 RC (elevated), FtS	No reservoir	150 m^3 RC (ground), FDS	200 m^3 RC (ground) FDS	80 m^3 RC (ground) FDS	Rehab 200 m^3 RC (ground), FDS
Water source (Borehole/other)	Borehole (1 No.)	Boreholes (2 No.)	Bulk water from GWCL	Borehole (1 No.)	Borehole (1 No.)	Boreholes (2 No.)	Surface water
Standpipes (Number)	5	14	18	26	22	15	20

Source: Compiled from CWSA-GAR

Table 9: Some characteristics of water schemes under study

4.2 Interviews

Interviews were conducted with some key informants from CWSA, WaterAid-Ghana, contractors and consultants. The interviews were conducted with the key informants purposely to identify key factors that influence the investment costs (all persons that were contacted for the interviews are listed in Appendix 2).

4.3 Data analysis

The investment costs of the seven STWSSs considered were converted to their corresponding per capita cost (unit cost of investment). This unit cost (As Built cost) included all variations and fluctuations paid on the schemes. The disaggregated investment costs as software cost, hardware cost, fluctuations and variations were expressed as percentages to determine their contributions to the total as built cost. The various unit costs (as built) of the schemes were compared based on the available disaggregated costs data after the unit costs were adjusted to the common base year 2008 using the Ghana Statistical Services price index for construction industry (PBCI) as inflation adjustment factor. The approach used for the unit cost adjustments to the common base year (2008) was the same used for all cost adjustments to illustrate the trend over the four years (Table 4A.3).

In the analysis of investment costs trend over time, only one water scheme was used for the purpose of illustration because of the common inflation adjustment factor. Because the Prime Building Cost Index (PBCI) document that was available for the study had cost index figures from the year 2004, one of the schemes that was tendered for in the year 2004 was used in the cost trend analysis. Nam *et al.*, (2007) suggested that the

Construction Cost Index (CCI) is a kind of price index for the construction industry widely used (for its ability, simplicity, and representative of construction cost changes) to convert the present construction cost to the future or the past. However, the PBCI document (GSS, 2008) indicated that the PBCI measures the changes in the prices of materials and labour for the construction industry in Ghana. Moreover, according to the CWSA, WaterAid-Ghana, the water sector consultants and contractors, the PBCI is the main index used in all the water supply and sanitation projects to make cost adjustments. Because of this, a clause is provided in contracts documents of water schemes regarding the index to be used in the payments like fluctuations (Appendix 3). BoG (2004) and USDoL (2008) indicate that general inflation is the change in consumer price index (CPI) and the CPI is a measure of the average change in prices over time of goods and services purchased by households (i.e. CPIs are based on prices of food, clothing, shelter, transportation fares, charges for doctors' and dentists' services, drugs, and other goods and services that people buy for day-to-day living). This means that the CPI or the general inflation may not be a useful index for the construction sector like the water supply infrastructure provision.

Based on the practices of the use of the PBCI rather than CPI (general inflation rates) by CWSA, WaterAid-Ghana, consultants and contractors of the water sector and the explanations from Nam *et al.*, (2007), GSS (2008), BoG (2004), and USDoL (2008), the PBCI from the GSS was used for the investment costs projections to illustrate the costs trends over the four years. However, the investment cost was also adjusted with the general inflation rate for comparison with that of the construction industry inflation. The projected costs were determined by multiplying the inflation factor (calculated from the PBCI) by the cost figure to be adjusted. The approach used in the investment costs adjustment including the formular is shown in Table 4A.3 and Table 4A.5.

The knowledge on the identified key factors based on the interviews with the key informants was explored on the disaggregated investment costs data of the water schemes for their significance on the schemes. The criteria that were used for this analysis is shown in the Table 10 below.

Table 10: Criteria used to develop a matrix table for factors' significance on the water scheme

Key factors	Parameters
1. The Scale or scope of the scheme	Relationship between cost and population Relationship between cost and total pipe length per capita
2. Project area conditions with respect to the hydrogeology	Contribution of water source (borehole or an alternative) development cost to total cost
3. Unstable and high inflation rates	The trend of scheme cost over time Contribution of fluctuations and variations to total cost
4. Delays associated with land release and procurement processes	Any delays as a result of land release problems Any delays as a result of procurement processes

CHAPTER FIVE

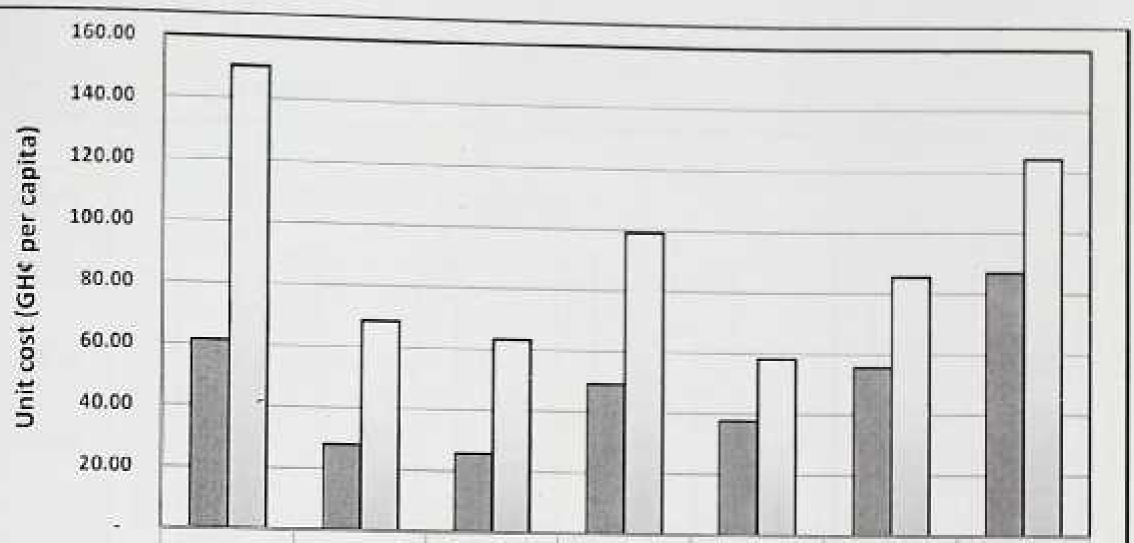
5.0 RESULTS AND DISCUSSIONS

The chapter discusses the results of this study by explaining the disparities in investment cost of the water schemes, trend in investment cost and as well as the understanding of identified key factors influencing investment cost and their significance on the water schemes.

5.1 The investment cost of the STWSSs

The investment cost of even similar small town water supply schemes may vary because the factors that influence the investment cost of water supply projects may not be the same for all communities. However, knowledge of the reasons for the cost disparities could inform planning and decision-making.

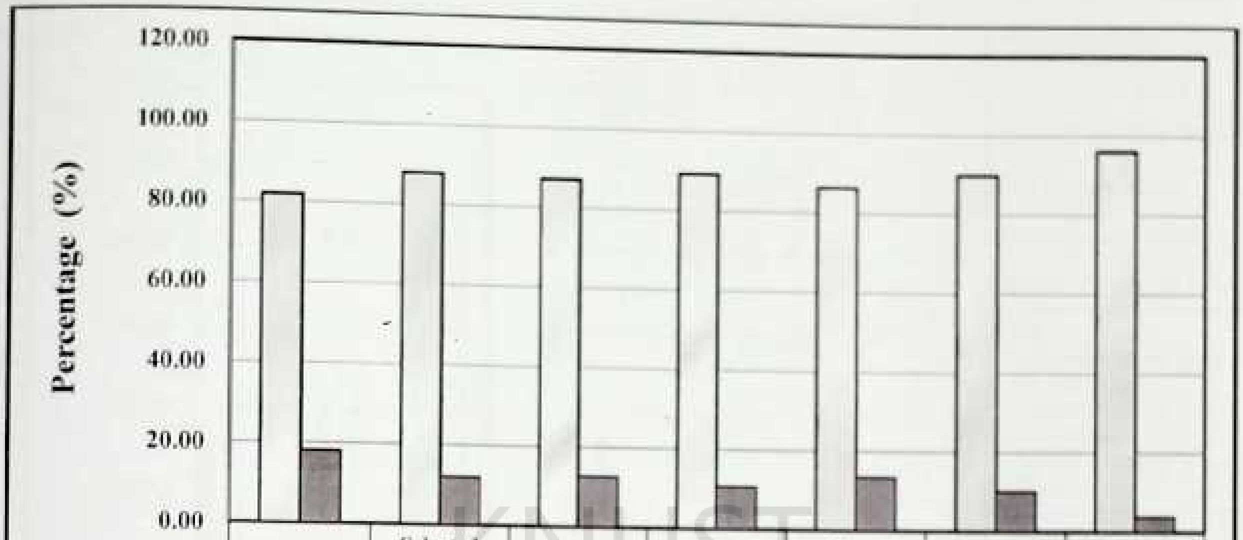
The as built unit cost (i.e. as built investment cost per capita) of the seven schemes ranged between 25.87 and 87.05 GH¢ as shown in Figure 3 below and in Table 4A.4. When these as built costs were adjusted to the common base year 2008 using the price index commonly used in the water supply infrastructure provision sector, the unit costs ranged between 58.33 and 150.55 GH¢ per capita as shown in Figure 3 below and in Table 4A.4. The common base year costs provided a common time platform for schemes comparison.



	Oyibi WSS	Ashalaadza WSS	Selected Comm. to GWCL	Abokobi WSS	Pantang WSS	New Kweiman WSS	Asutuare WSS
As Built Cost	61.41	27.99	25.87	49.22	37.91	55.67	87.05
Base Year 2008	150.55	68.62	63.42	99.28	58.33	85.66	124.43

Figure 3: The unit costs of investment of the water schemes (As Built and Common-base–year Adjusted Costs)

The investment cost disaggregation at the level of hardware (i.e. construction components) and software (i.e. consultancy services component) costs showed that the hardware cost dominated the total cost of the schemes. While the software costs were below 20%, the hardware costs were above 80% of the total cost as shown below in Figure 4. Higher proportions for hardware cost is normally expected because of the high materials, labour and equipment based inputs unlike the software component. There were also contributions to this development from the amount of fluctuations and variations which were predominantly associated with the hardware costs of the schemes as shown in Table 4A.1 of Appendix 4. This was particularly significant in the Asutsuare scheme where the software cost ~~ended up~~ less than 5%. This suggested that discussions on the schemes' costs disparities could be dwelled on the hardware component of investment costs.



	Ashalaadza WSS	Selected Comm to GWCL	Oyibi WSS	Abokobi WSS	New Kweiman WSS	Pantang WSS	Asutsuare WSS
Hardware (%)	81.82	87.93	87.24	89.24	86.46	89.87	96.13
Software (%)	18.18	12.07	12.76	10.76	13.54	10.13	3.87

Figure 4: The hardware and software as built costs of the seven water schemes

Moreover, hardware components analyses (Table 4A.8) indicated that generally the significant contributors to total investment costs of all the schemes were works associated with pipes; pump installation and control panel; and to some extent reservoirs as shown in the Figure 5 below. Treatment plant was particularly significant for the only scheme (Asutsuare WSS) which is based on the technology of slow sand filtration.

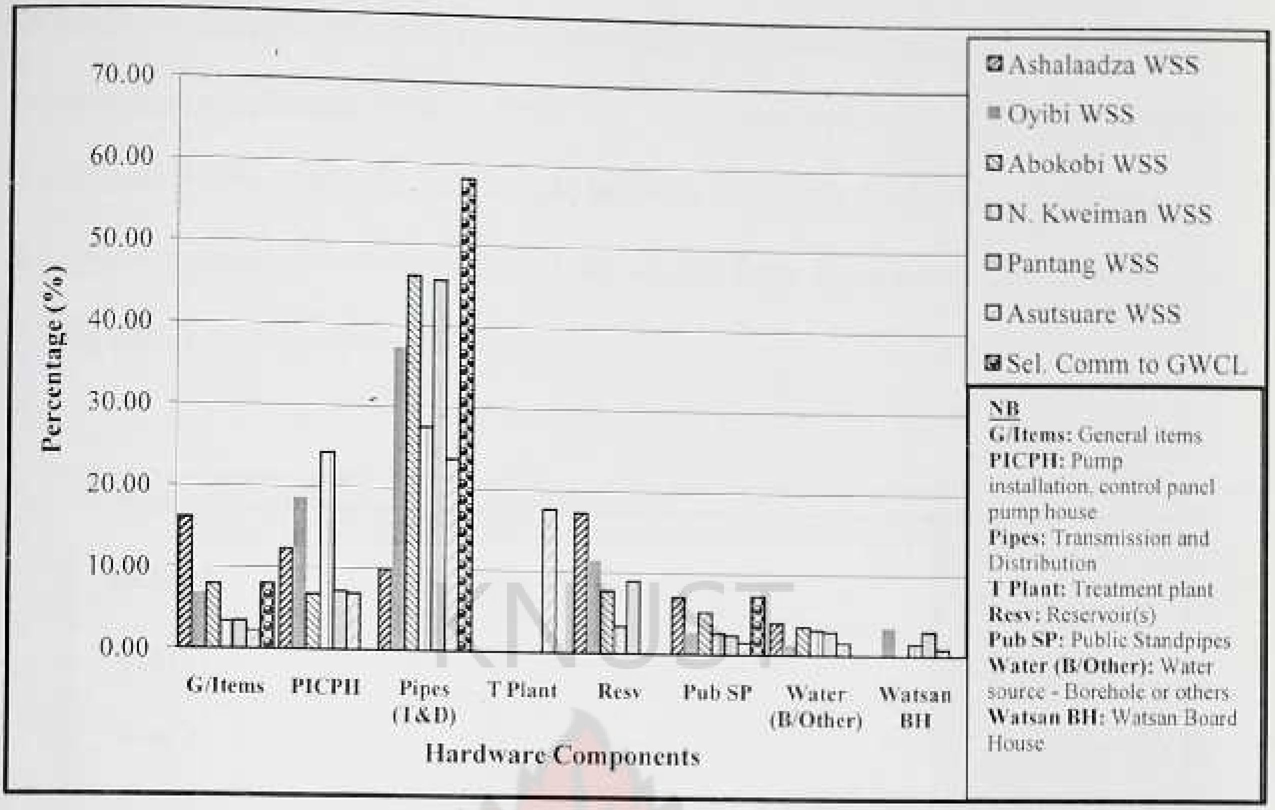


Figure 5: The disaggregated hardware costs of the water schemes.

Interestingly, it could be suggested with the data available that there exists some level of economies of scale among the five ground water based piped schemes. When a scatter plot of costs against populations of all the seven schemes was analysed, the R^2 value (0.3917) indicated weak relationship as shown in Appendix 6. However, when the two schemes Asutsuare WSS and Selected Community to GWCL system were considered outliers (because of their different basic characteristics from the others), the R^2 value (0.5905) then indicated a relationship between cost and population as shown in Appendix 6. The Asutsuare WSS was a surface water based and the Selected Community t o GWCL was just connecting a distribution network to an existing GWCL system. Moreover, when the Oyibi WSS was removed from the scatter plot, the R^2 value in Figure 6 below suggested a stronger relationship where 86% of investment cost variability is "explained" by the population. This relationship suggested cost ranges as follows: for populations 3000 – 7600, the cost range was GH¢ 68 – 96; and for populations 7600 – 1300, the cost ranged between 96 and 60 GH¢. The graph suggested the optimum population to be 7600 and above this, there is economies of scale as cost tend to decrease with population increase.

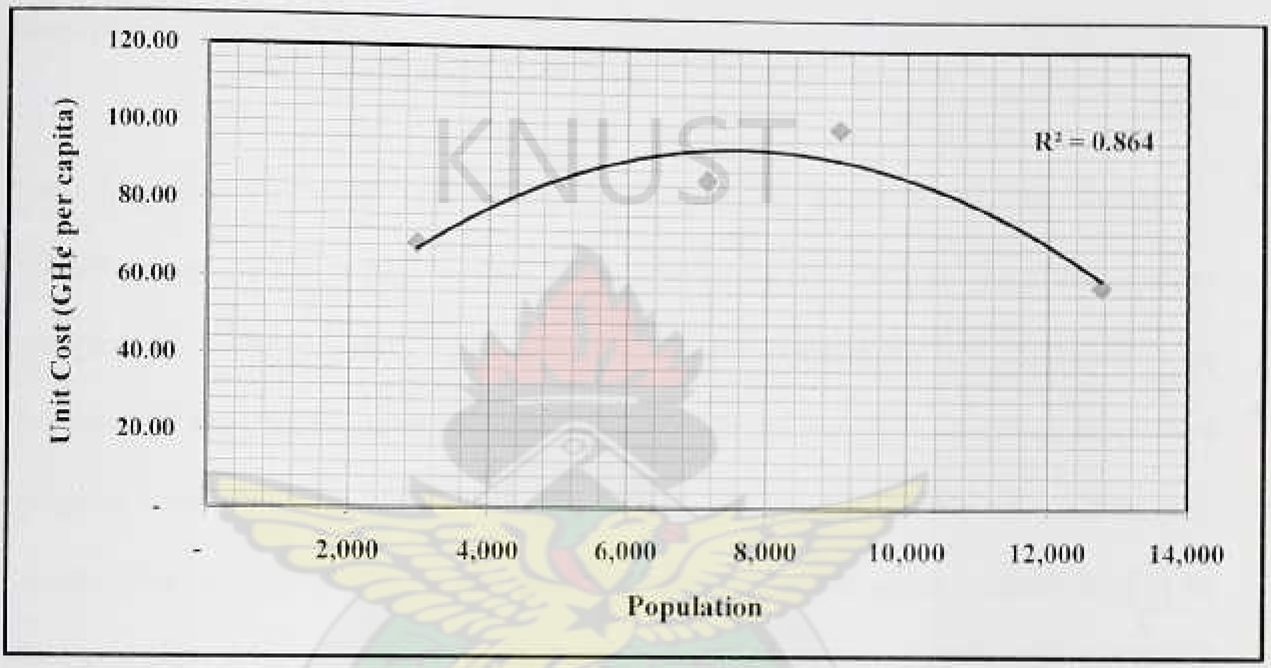


Figure 6: Relationship between investment cost and population

On the basis of the common-base-year 2008 costs as shown in Figure 3, the schemes with the highest and lowest investment costs were the Oyibi WSS (GH¢ 150.55) and Pantang WSS (GH¢ 58.33) respectively. When the costs of the schemes were compared with the 2008 year planning figure of CWSA for STWSSs which is GH¢ 100 – 120, five of the schemes were far outside this range except Abokobi (GH¢ 99.28) and Asutsuare (GH¢ 124.43) schemes which were quite close. In fact, it was expected that the cost of the Selected Community to GWCL system would be outside this range and even at the lower side because it was primarily connecting a distribution network with standpipes to an existing GWCL main line. For the Asutsuare scheme, the investment cost was anticipated to be above the range because of the high cost associated with surface water source piped schemes (in this case treatment plant alone accounted for approximately 18% of total cost). The cost could not have been significantly higher above the GH¢ 120 because some aspects of the work involved were rehabilitation of existing intake structures for the raw water and the reservoirs.

Apart from the population suggested to be "explaining" some of the cost variability, differences to some extent in the disaggregated costs details suggested further explanations. Comparatively, the Ashalaadza scheme would have been expected to be cheaper than the Pantang scheme but it was otherwise (Figure 3). Meanwhile there were no special characteristics attributed to the Ashalaadza scheme for this observation. The reason could be associated with cost optimization where piped water schemes tend to be more expensive for a very small population. As also indicated by the World Bank (World Bank, 2007b) that there are fixed costs associated with the implementation of the piped water schemes regardless of the size.

The Oyibi WSS had highest investment cost than any other scheme. The probable reason could be the special provision for two separate generator sets and generator houses for the two borehole sites (water sources). These items contributed 10.5% (from the BOQs) to the total investment cost compared to the other seven schemes without such contributions. The generator sets had to be provided because it was not possible to connect the pumping stations to national electricity grid unlike the other water schemes.

However, for the three schemes Abokobi, Pantang and New Kweiman, the first reason for cost disparities could be the cost optimization associated with the populations. Pantang scheme had the least cost among the schemes and has almost the same proportion of the key cost contributors (pipe works; pump installation and control; and reservoir) as that of Abokobi. Figure 7 below shows that Pantang had slight pipe dominance over Abokobi but could not be translated into cost. The reason could be seen in Figures 9 and 10, which for the purposes of this study measures the dispersion of the various schemes' population through the extent of their pipe networks. The figures suggested that Abokobi WSS had its population more dispersed than Pantang and for that matter the per capita cost associated with pipe works became more expensive for Abokobi. Cost contributions from the general items and standpipes costs as shown in Figure 5 could be other reasons for the cost disparity. The general items cost of Abokobi WSS contributions to the total cost were significant because the construction work was divided and awarded to two contractors each presenting general items in their BoQ.

Also, New Kweiman scheme had a higher cost than Pantang and it could be suggested from the scatter plot that the primary reason cost disparity could be the population differences. In fact, it was expected based on the Figure 7 that Pantang would be higher in cost over New Kweiman because of the major pipes dominance. However, a quick look at Figures 9 and 10 suggested that the N/Kweiman populations were more dispersed and for that matter the costs associated with the pipe works became more expensive compared to Pantang scheme. Another reason that could be suggested from the disaggregated cost data was a special provision in the pumps installation and control panel (PICP) item. The provision which was captured as "supply, install and test electric supply including electricity poles over a distance of 2000 m" accounted for 45.5% of the main PICP costs and also represented 5.3% of the total cost of the scheme.

Meanwhile, the cost of Abokobi WSS is more than New Kweiman WSS. The reason for the disparity could be attributed to the cost of pipie works. Pipe works were found to be a prime contributor to total costs as shown in Figure 5. The Abokobi WSS pipe works were dominated by the 150 mm diameter PVC pipes unlike the dominance by the 100 mm ones associated with N/Kweiman WSS as shown in the Figure 7 below. The cost of pipe works was therefore expected to be higher for Abokobi than N/Kweiman since the costs of 150 mm diameter pipes have consistently been about twice that of the 100 mm (Appendix 5, Table 5A.4). In addition, the Abokobi WSS dominated in the 75/50 mm pipes than N/Kweiman contributing to the cost difference.

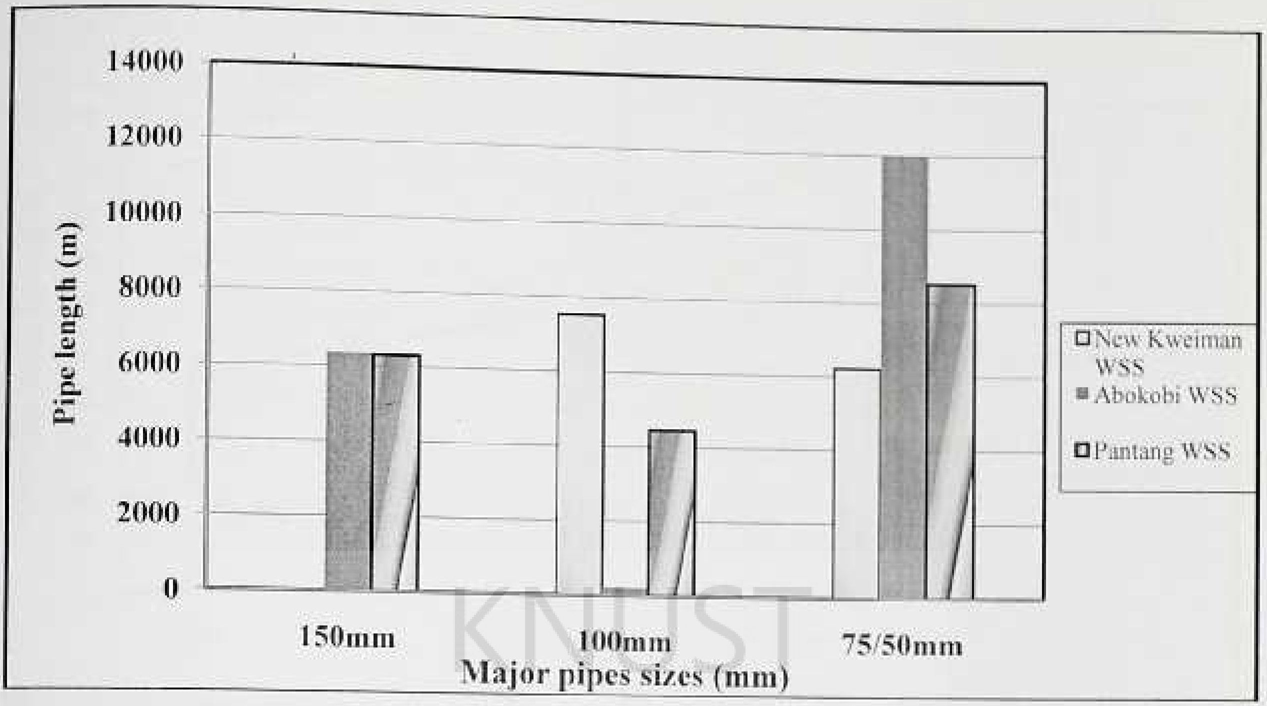


Figure 7: Major pipes and their lengths of three schemes

5.2 The investment cost trend over time

The investment costs trend over the years gives the picture of how the costs of water supply infrastructure provisions have been behaving given the prevailing conditions in the construction environment, which is a function of prices of cement, petroleum (oil), steel, pipes, labour, exchange rates etc. The unit cost of the New Kweiman WSS without the fluctuations was adjusted using the inflation estimator in the construction industry, the Prime Building Cost Index (PBCI) prepared by the Ghana Statistical Service; and the general inflation rate.

The investment cost after the adjustment with the PBCI ranged between 45.63 and 92.04 GH¢ and the adjustment with the general inflation gave the range GH¢ 45.63 – 75.15 for the New Kweiman WSS used for illustration as shown in Figure 8 below.

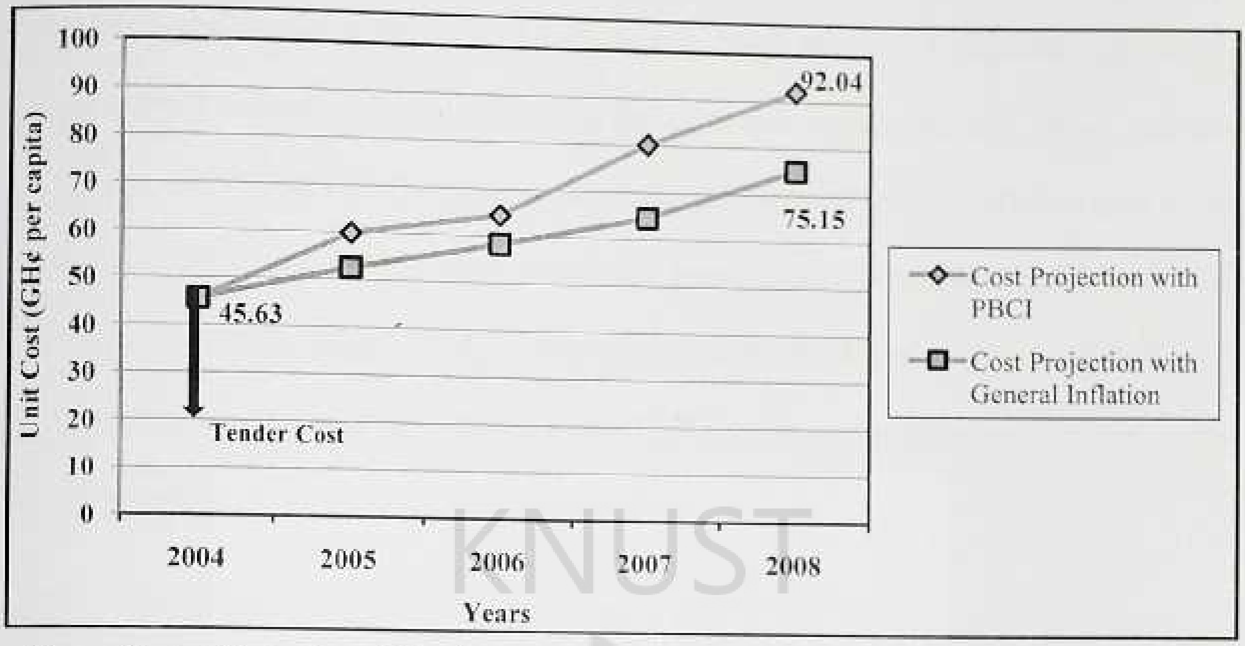


Figure 8: An illustration of the investment cost trend over the last four years.

From Figure 8 above, there has been a general increase in the investment cost. The best relationship that could be suggested to exist between the investment cost and time is linear. It could also be clearly seen that the inflation in the construction industry have been relatively higher than the general inflation in the country. This could be due to the fact that general inflation does not indicate the prices of labour and materials in the construction industry even though it could have effect on the sector. The relatively sharp increase in cost associated with the last three years of the trend could be as results of the soaring fuel prices which generally affect goods and services as indicated by NYBC and NYBF (2008) in their report and even further stated that high oil prices have significant direct and indirect impact on construction operations and materials.

The overview of the cost trend for the four year period (2004 to 2008) indicated that the investment cost doubled (a figure of approximately 102%) with the PBCI while the cost increased by more than half (a value of approximately 65%) with the general inflation. The investment cost trend over the years (which is the PBCI adjusted cost trend) suggested that average yearly increase in cost was approximately 26%. Analysis indicated that the PBCI adjusted cost was more than that of general inflation cost by an average of 18% over the four years. Moreover, because the construction work component (hardware cost) is usually the largest part of total investment cost, it expedient to suggest that the PBCI could be preferred over general inflation in cost projections of water supply programmes to avoid possible huge funds deficits.

5.3 Key factors that influence investment cost

The understanding of key factors that influence investment cost of water supply infrastructure provision could be essential in planning and making informed decisions on costs reduction to make judicious investments with limited funds.

The interviews with key informants suggested some key factors that influence the investment cost of small town water supply schemes. The general impression from the key informants was that these key factors do not pertain to the study area alone but common almost all over the country.

The key factors that influence investment cost of STWSSs based on the interview were pooled together as listed below:

- *The scale or scope of the water scheme*

  The beneficiary communities' population sizes and densities determine this factor. There is an optimum population associated with the STWSSs because of economies of scale.

- *The hydrogeological conditions of the project area*

This determines the cost associated with boreholes as water source for the piped scheme. It influence the investment cost through the number of boreholes required to meet demand, and number of successful and unsuccessful drillings.

- *Unstable and high inflation rates*

This is associated with high year-on-year price increases of labour and materials, and significant cost contributions from fluctuations and variations.

- *Delays associated with water schemes' construction*

Delays from land release problems and procurement processes all coupled with the unstable and high inflation rates influence investment cost by way of significant cost contributions from fluctuations and variations.

The understandings of these key factors and their significance on the various schemes considered for this study are discussed in the rest of the section using the matrix shown in Table 11

Table 11: Matrix of key factors that influence investment costs

Key factors	Criteria used	Schemes						
		Oyibi WSS	**Ashalaadza WSS**	**Sel. Comm. to GWCL System**	**Abokobi WSS**	**Pantang WSS**	**N/Kweiman WSS**	**Asutsuare WSS**
1. The scale or scope of the scheme	Relationship between cost and population.	The scatter graph (Figure 6) suggested a relationship between the cost and population of the schemes. It could be suggested further from the relationship that STWSSs costs in the GAR tend to be cheaper for populations above 7600.						
	Relationship between cost and total pipe-length per capita.	The scatter plot (Figure 9) suggested a relationship between cost and pip-length per capita (i.e. measure of population density in relation to pipe length required to serve beneficiaries). The relationship indicated increase in cost with increase in this variable introduced for the purposes of this study.						
2. The hydrogeologi-cal conditions of the project area	Contribution of water source (borehole or other) to total cost	1.27% borehole cost	3.99% borehole cost	No water source cost i.e. connecting the GWCL main line to the selected communities	3.53% i.e. borehole cost	2.89% i.e. borehole cost	3.07% i.e. borehole cost	1.56% i.e. Intake rehabilitation
3. Unstable and high inflation	The trend of schemes' costs over time	Unstable and high inflation in the construction industry. From the cost trend analysis (Figure 8), the average increase is approximately 26% per year and within four years (2004 to 2008) cost has gone slightly above doubled, i.e. approximately 102%.						

rates	Contribution from [1]fluctuations and [2]variations to total cost	[1](3.83%), [2](1.57%)	[1](3.22%), [2](3.68%)	[1](1.35%), [2](2.26%)	[1](0.0%), [2](0.60%)	[1](12.13%), [2](0.0%)	[1](18.03%), [2](0.0%)	[1](16.36%), [2](25.19%)
4. Delays associated with water schemes' construction	Delays as a result of land release problems	Not applicable	No applicabl e	No applicable	No (but land release problem for Watsan board house which could not be built)	Land release problems for reservoir sites (site had to be changed about 3 times)	Land release problem for pipes routes and reservoir sites	No applicable
	Time gap between tender and start of work (for procurement processes)	4 months	2 months	Not available	1 month	5 months	4 months	13 months
	Stipulated contract duration	4 months	4 months	Not available	3. 5 months	4 months	4 months	9 months
	Actual duration for construction work	5 months	4 months	6 months	5 months	9 months	9 months	10 months

The scale or scope of the water scheme

The scale or scope and extent of the scheme is mostly determined by the beneficiary population sizes and the degree of dispersion of populations among communities of the project area. The smaller the population size and the more dispersed the communities with their populations, the larger the scope assumed by the water scheme and the higher the cost of investment could be as a result of extensive pipe works. There was the general conviction among the key informants that, mostly economies of scale could not have been achieved in STWSSs due to the circumstances of predominant communities with smaller and more dispersed populations resulting in higher per capita cost. The CWSA-GAR was with the view that because of hydrogeological difficulties in the GAR, successful ground water sources are normally mechanized into STWSSs to benefit more communities. There could be that per capita costs may not have been optimized in some instances.

Analysis on the schemes (Figure 6) suggested a strong relationship between cost and the populations. It could be suggested further from the relationship that STWSSs costs in the GAR is optimum at a population of 7600 and the costs tend to be cheaper for populations above 7600. This also meant that the STWSSs with populations less than the 7600 in terms of economies of scale could be suggested to be expensive. Another analysis on the scale was the relationship between cost and pipe-length per capita. The pipe-length per capita for the purposes of this study was used as measure of the population density of the communities involved to have required the length of pipe networks. The graph below (Figure 9) indicated that cost increases with increases in pipe-length per capita (and the higher the pipe-length per capita, the population is suggested to be more dispersed). This could be that as communities and for that matter their populations tend to be more scattered, the more extensive the pipe network required. These relationships and the schemes' characteristic in Figure 10 suggested a reason for the costs differences among those similar schemes (mechanized boreholes) where costs ranged with the highest from Abokobi WSS to the lowest Pantang WSS in an order like the pipe length/cap. Moreover, it has been noted that pipe works was a prime contributor to cost. The exception was the Ashalaadza WSS which could be comparatively described as a smaller system with very limited pipe network.

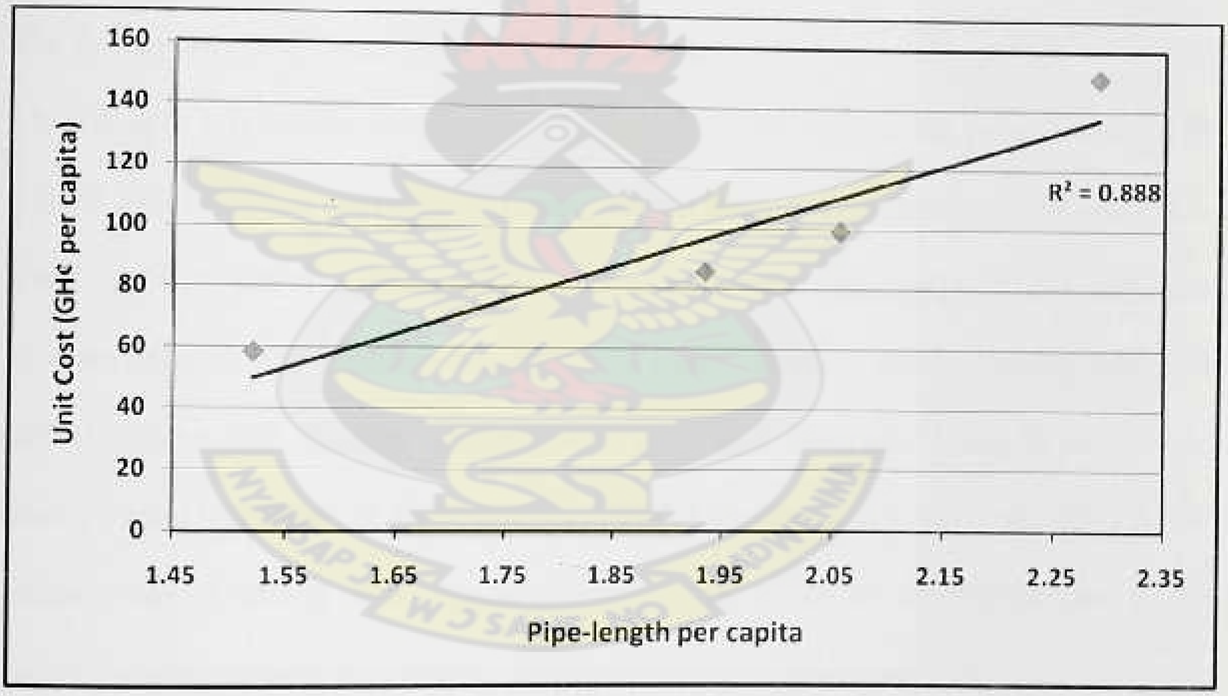


Figure 9: The relationship between cost and pipe length per capita

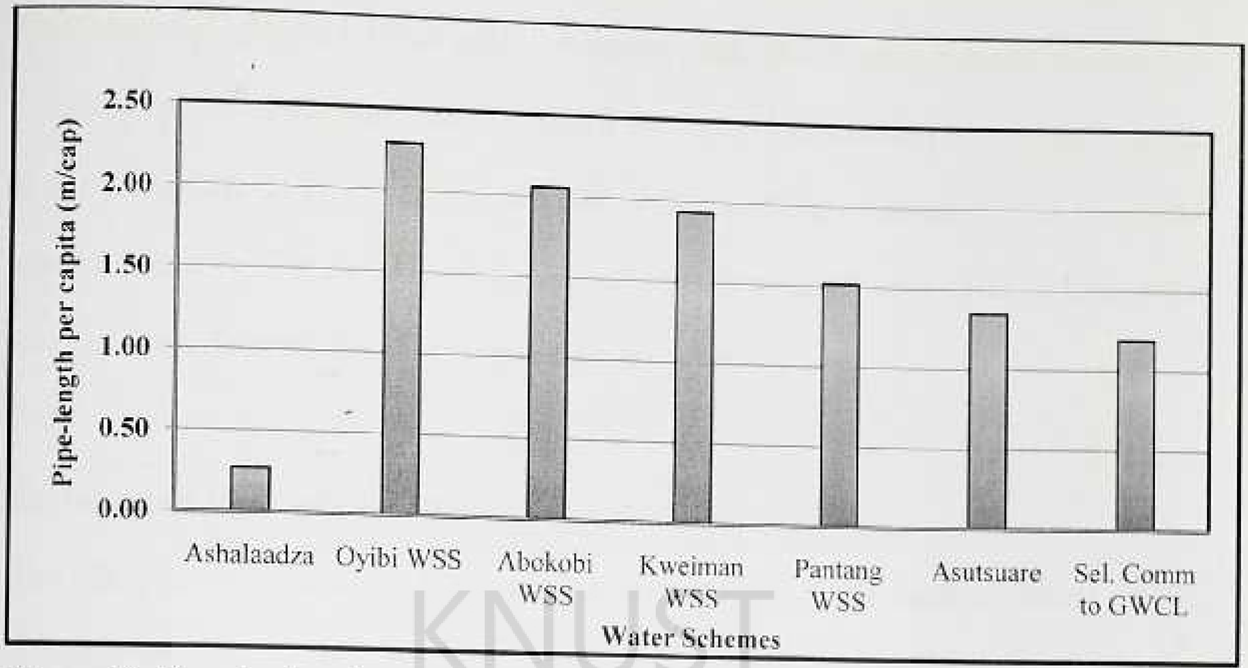


Figure 10: The pipe length per capita of the water schemes

The hydrogeological conditions of the project area

According to CWSA, the first water source option for STWSSs is the ground water. The general assertion from the interviews indicated that ground water source development has lower cost than that of surface water. However, it was also suggested that on a particular scheme, ground water source development cost could contribute significantly to influence the investment cost. Reasons suggested were that: more boreholes could be required to meet demand if aquifers of the project area have characteristic low water yields; and low success rate of drilling could require more drillings, which all come with cost to the particular water scheme of concern.

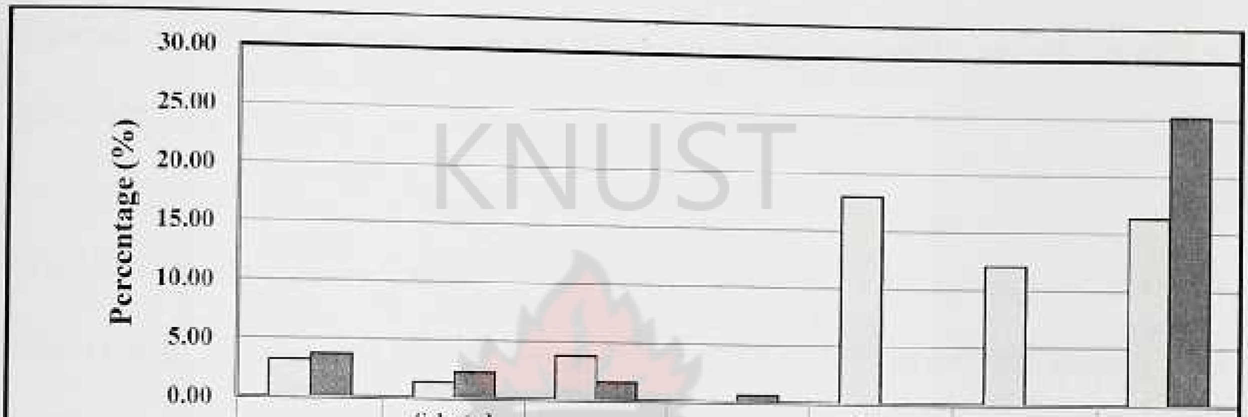
The matrix generated for the schemes in Table 11 suggested that generally the costs associated with boreholes as water source were not significant compared to other key components of the schemes. The costs contributions to the schemes ranged between approximately 1.3% and 4% of total investment costs. This could be due to the fact that not more than 1 – 2 boreholes were involved and that the boreholes yields could meet the demand. For the surface water source, the work involved rehabilitation of the intake structures not new built. Obviously, no cost was associated with GWCL bulk water source for the Selected Communities to GWCL system.

Unstable and high inflation rates

According to the Inflation Outlook and Analysis Report of the Bank of Ghana (2004), inflation reflects the rate at which the general price level increases. This therefore suggests that high rates could reflect high labour and materials prices for higher investment costs of the water schemes as suggested by NYBC and NYBF (2008). Key informants interviewed were generally convinced to comment that high and unstable inflation in the country has also contributed to high costs of STWSSs over the years. Another understanding gathered was that apart from the year-on-year high costs for water supply schemes, high and unstable inflation during schemes construction periods has necessitated contract provisions (as shown in Appendix 3) for payments of fluctuations which mostly become significant additional costs. According to the CWSA-GAR, fluctuations are not normally paid in projects which are less than a year but under special circumstance where price increases become very significant.

Moreover, the investment cost trend analysis in the previous section of this chapter indicated that the inflation over the years has been high. The result was that investment cost had doubled over the four years with an average annual increase of 26%.

Table 4A.2 (Appendix 4) and Figure 11 below indicate that generally there have been some significant fluctuations and variations as part of the schemes' costs. Those that were less significant ranged between 0 and 4% for both fluctuations and variations; and the more significant range was 12 – 18% for fluctuations alone while 25% was for Asutsuare scheme's variations.



	Ashalaadza WSS	Selected Comm to GWCL	Oyibi WSS	Abokobi WSS	New Kweiman WSS	Pantang WSS	Asutsuare WSS
□ Fluctuations (%)	3.22	1.35	3.83	0.00	18.03	12.13	16.36
■ Variations (%)	3.68	2.26	1.57	0.60	0.00	0.00	25.19

Figure 11: Fluctuations and variations contributions to total investment costs

Delays associated with the water schemes construction

Delays in the water supply schemes construction according to the key informants tend to be expensive especially in the environment where inflation is unstable and high. The consensus from the interviews was that the delays of concern are those associated with land release problems; procurement processes; and changes in work. The CWSA-GAR indicated that the agency do not look for land for projects but it is the sole responsibility of the beneficiary communities to provide land as sites for reservoirs, offices, pumping stations, certain pipe routes etc. Particularly, the views were that GAR because of rapid urbanization of the small towns has land release problems for water schemes as a result of land disputes over ownership.

CWSA-GAR requires that within a month, contracts are awarded after tender and then work starts following approval from the political executives (ministers) through procurement processes which are mostly delayed. According the CWSA-GAR, it has an internal policy that construction phases of schemes do not exceed 12 months duration to minimize fluctuations.

The key factors matrix (Table 11) indicated that only Abokobi scheme did not have delays with procurement process based on the CWSA-GAR one-month priority. The other schemes with the figures available indicated durations between 2 and 13 months. Apart from Ashalaadza scheme, the rest could not be completed within the contract duration. Reasons had been attributed to extra work (changes) except the Pantang and New Kweiman water schemes which according to the CWSA-GAR had been predominantly due to land release problems as indicated in the Table 11.

Generally, it could be suggested from the trend in Figure 12 below that cost contributions from fluctuations become more significant with increase in scheme's duration (from tender to completion). From the matrix (Table 11) schemes which took more than 12 months to complete from the time of tender showed significant fluctuations than the others though the fluctuations also depended on the inflation trend at the time.

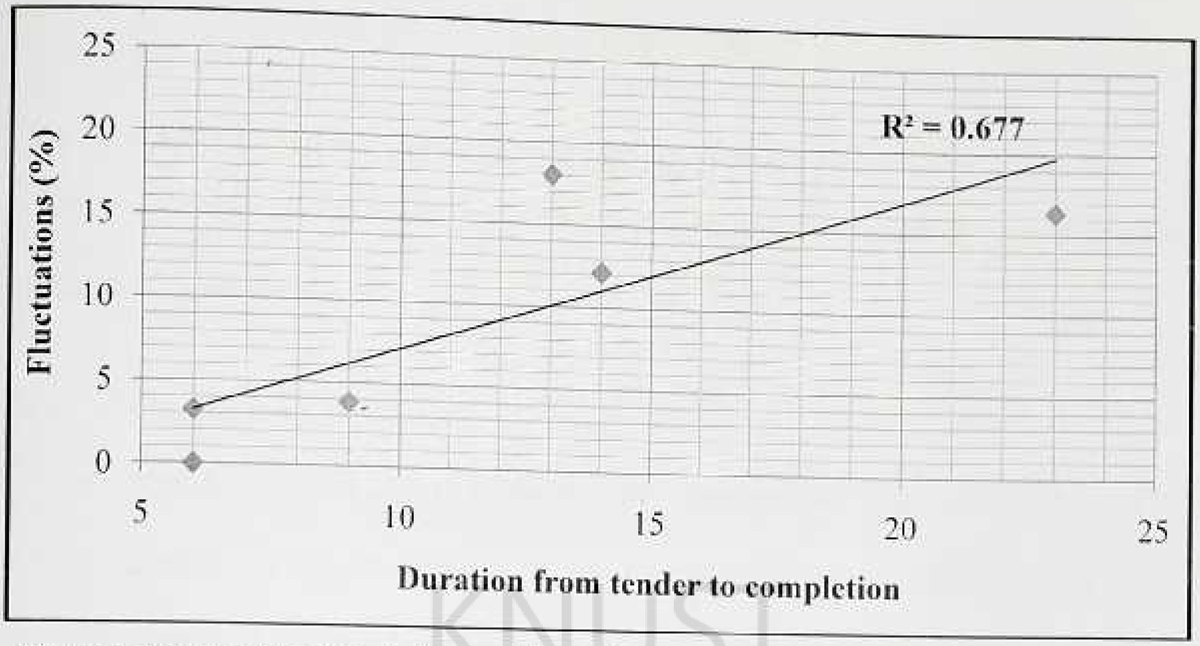


Figure 12: Relationship between fluctuations and duration (from time of tender to completion

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

This last chapter of the thesis presents the conclusion drawn and the recommendations suggested from the study.

6.1 Conclusion

- The investment costs excluding the programme cost of all the STWSSs considered ranged between 58 and 151 GH¢ per capita for 2008 base year and cost trend depicted linear increase doubling over the four years (102%).
- The scale or scope of the schemes determined by the population size and extent of dispersion influences cost because of economies of scale. The investment cost of the water schemes tend to decrease for populations above 7600 because of economies of scale.
- Unstable and high inflation rates translate into high investment costs over time through year-on-year price increases; and fluctuations and variations. Over a four year period, the investment cost doubled (approximately 102% increase) because of unstable and high inflation rates.
- Delays associated with water schemes' construction (through land release problems, and procurement processes delays) coupled with unstable and high inflation contributes to fluctuations and variations.
- Although the hydrogeological conditions of a project area could be a key factor as indicated from the interviews, but did not show to influence significantly the investment cost of the water schemes in the Greater Accra region.

6.2 Recommendations

1. Although water needs have to be satisfied, piped water schemes as water supply interventions to communities could be guided by economies of scale using the population sizes and dispersion for judicious sector investments with the limited funds available. Based on the analysis with the cost data available, it could be suggested that STWSSs in the Greater Accra region could be provided to communities with populations of 7600 and above.
2. Investment cost projections of water supply projects especially STWSSs could be made using the PBCI other than the general inflation to minimize possible funds deficits since inflation in the construction industry is higher than the general inflation measured by the CPI.
3. The key factors identified to influence investment cost like delays associated with land release problems, and procurement processes delays which stakeholders could have control over could be looked at critically to help reduce high additional costs.
4. Further work could be carried out on the identified key factors influencing investment cost with more schemes in the study area when they become available.
5. Similar studies should be carried out in other regions to show the significance of these identified key factors on investment costs in the country.
6. The effect of packing of the project should be studied further.

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APPENDICES

Appendix 1: Open ended questions to key informants

This part of the study was to help identify and provide some understanding on the key factors that influence investment costs of the water supply schemes based on the experiences of the key informants.

Generally, a number of factors could influence the investment cost of STWSSs:

- Population
- Settlement pattern (nucleated or dispersed)
- Inflation and exchange rates
- Complexity of design
- Energy source (generators or national electricity grid)
- Proximity of water source
- Contract terms, etc.

1. What key factors do influence the investment costs of water supply schemes especially the small town water supply schemes?
2. How does each of the identified key factors influence the costs of the schemes?

Appendix 2: Key informants that were contacted for the interviews

Table 2A.1: Key informants contacted

No.	Organization	Contacted Person(s)
1	CWSA-HQ	Water and Sanitation Systems Coordinator
2	CWSA-GAR	Water Supply and Sanitation Engineer; and Zonal Hydrogeologist
3	WaterAid-Ghana	Head of Programmes
4	Kaddacon Limited	Civil Engineer
5	Holix Consult Limited	Managing Director/Civil Engineer
6	Appropriate Development Promotion Limited	Managing Director/Civil Engineer
7	Water Electro-Mechanical Ventures (Appointed Grundfos Pumps and Accessories Distributor)	Managing Director
8	Afrowood Consulting Limited	Technical Director/Project Engineer 3-DWSP

Appendix 3: Contract conditions on fluctuations

Condition of Contract

Clause 56: Fluctuations in prices

The contract sum shall be deemed to have been calculated on the basis of the following considerations.

The rates of wages including overtime and allowances as defined in clause 14 of these conditions and employer's contribution to social welfare or any enactment prevailing 28 days prior to the last date of submission of tenders.

The current market prices prevailing 28 days prior to the last date of submission of tenders.

The amounts payable to the contractor shall be adjusted in respect of the rise and fall in the cost by applying to each payment the formular in this clause. The adjustment to the interim payment certificates in respect of changes in cost and legislation shall be determined from the following formular:

$P_n = 0.1 + 0.9 \times \frac{C_n}{C_o}$.

where P_n is the price adjustment factor to be applied to the amount of payment of work carried out in the subject month; C_o is the cost index defined in the present contract as the combined PBCI (from the Ghana Statistical Service) prevailing 28 days prior to the deadline of submission of tenders; and C_n is the combined PBCI index prevailing 28 days prior to the date of submission of the payment certificate. If any certificate covers more than one month, average factors will be computed as basis for price adjustment.

Source: Excerpt from CWSA-GAR schemes contract documents.

Appendix 4: Investment cost data of the water schemes

Table 4A.1: Investment costs disaggregated as Hardware and Software with fluctuations and variations.

Projects		Oyibi Area WSS	Abokobi WSS	Ashalaja Area WSS	Selected Comms. to GWCL	N/ Kweiman Area WSS	Pantang	Asutuare Area WSS
Year		**2003**	**2003**	**2003**	**2003**	**2005**	**2005**	**2006**
Population		6,651	9,032	2,968	9,634	7,138	12,758	9,564
Software Component (¢)	total	**513,382,005**	**478,271,380**	**151,022,930**	**300,828,333**	**538,211,390**	**490,025,300**	**322,222,924**
	fluctuations	7,580,888	0	3,382,962	0	129,745,532	78,480,500	0
Hardware Component (¢)	total	**3,509,634,144**	**3,967,722,502**	**679,745,930**	**2,191,340,272**	**3,435,601,850**	**4,346,042,956**	**8,002,847,747**
	variations	63,272,600	26,845,000	30,580,000	56,262,398	0	0	2,096,857,114
	fluctuations	146,594,819	0	23,353,465	33,762,194	586,856,350	508,085,178	1,362,350,133
Total Investment Cost (¢)		**4,023,016,149**	**4,445,993,882**	**830,768,860**	**2,492,168,605**	**3,973,813,240**	**4,836,068,256**	**8,325,070,671**

Table 4A.2: The investment costs matrix of the water schemes.

Schemes		Oyibi Area WSS	Ashalaadza Area WSS	Selected Comm to GWCL System	Abokobi Area WSS	N/Kweiman Area WSS	Pantang Area WSS	Asutuare Area WSS
Year		2003	2003	2003	2004	2005	2005	2006
Population		6,551	2,968	9,634	9,032	7,138	12,758	9,564
Software Cost (¢)	subtotal	513,382,005.01	151,022,929.99	300,828,333.33	478,271,380.00	538,211,390	490,025,300.00	322,222,924.00
	per capita (GH¢)	7.84	5.09	3.12	5.30	7.54	3.84	3.37
	% of total investment	12.76	18.18	12.07	10.76	13.54	10.13	3.87
Hardware Cost (¢)	subtotal	3,509,634,144	679,745,930.08	2,191,340,272.00	3,967,722,502.0	3,435,601,850	4,346,042,956.0	8,002,847,747.0
	per capita (GH¢)	53.57	22.90	22.75	43.93	48.13	34.07	83.68
	% of total	87.24	81.82	87.93	89.24	86.46	89.87	96.13
Total Investment Cost	Total	4,023,016,149.0	830,768,860.07	2,492,168,605.33	4,445,993,882.0	3,973,813,240.	4,836,068,256	8,325,070,671.0
	per capita (GH¢)	61.41	27.99	25.87	49.22	55.67	37.91	87.05
Variations	subtotal	63,272,600.00	30,580,000.00	56,262,398.00	26,845,000.00	0.00	0.00	2,096,857,114.00
	per capita (GH¢)	0.97	1.03	0.58	0.30	0.00	0.00	21.92
	% of total investment	1.57	3.68	2.26	0.60	0.00	0.00	25.19
Fluctuations	subtotal	154,175,707.95	26,736,426.41	33,762,194.00	0.00	716,601,881.90	586,565,878.34	1,362,350,132.68
	per capita (GH¢)	2.35	0.90	0.35	0.00	10.04	4.60	14.24
	% of total	3.83	3.22	1.35	0.00	18.03	12.13	16.36

Table 4A.3: Calculations used for the costs adjustments to illustrate trends.

The considerations for the costs trend computation as follows:

- The investment cost (unit cost) of the New Kweiman Water Scheme without the fluctuations and variations is adjusted/projected over the four years from 2004 to 2008 using the PBCI.
- The average of combined PBCI (for both labour and materials) indices are used to compute the cost adjustment factors over the years as shown in the formulars below after CDC (Centre for Disease Control and Prevention – www.cdc.gov/owcd/EET/Cost/Fixed/4/.html).

$$pF_{ad} = \frac{cPBCI_{F/P}}{cPBCI_{Pr}} \quad \ldots\ldots (1)$$

Where

a. pF_{ad} is the investment cost adjustment factor using the PBCI as measure of inflation in the construction industry.
b. $cPBCI_{Pr}$ is the present average combined PBCI which cost figure is to be adjusted to the future or past value depending on the circumstance of interest.
c. $cPBCI_{F/P}$ is the future or past average combined PBCI which cost's figure is to be determined.

- Either the future or past investment (${}_{f/p}\boldsymbol{I}_c$) cost is determine by multiplying the adjustment factor (pF_{ad}) by the present investment cost (${}_{pr}\boldsymbol{I}_c$) as shown below.

$${}_{f/p}\boldsymbol{I}_c = pF_{ad} \times {}_{pr}\boldsymbol{I}_c \quad \ldots\ldots (2)$$

NB: Projection of present year investment cost (${}_{pr}\boldsymbol{I}_c$) to next year (future) (${}_{f}\boldsymbol{I}_c$) using the general inflation rate (r) as the inflation adjustment factor ($iFad = (1 + r\%)^1$) is shown below.

$${}_{f}\boldsymbol{I}_c = {}_{pr}\boldsymbol{I}_c \times (1 + r\%)^1$$

Table 4A.4: As Built Costs and PBCI Adjusted Costs.

Schemes	**2003**	**2004**	**2005**	**2006**	**2008**
	As Built Cost (GH¢ per capita)				Common Base Year Cost (GH¢ per capita)
Oyibi WSS	61.41				150.55
Ashalaadza WSS	27.99				65.27
Selected Comm. to GWCL System	25.87				60.33
Abokobi WSS		49.22			99.28
Pantang WSS			37.91		58.33
New Kweiman WSS			55.67		85.66
Asutuare WSS				87.05	124.43

Table 4A.5: The PBCI and general inflation adjusted investment costs

		Per Capita Investment cost (GH¢)						
	Investment cost without fluctuations and variations (GH¢ per capita)	Year	2003	2004	2005	2006	2007	2008
New Kweiman WSS		Average cPBCI	430.30 †	523.00	685.60	738.00	919.20	1,054.90
		pFad		1.2154	1.3109	1.0764	1.2455	1.1476
		Average inflation			15.08	10.96	10.72	16.49
		iFad			1.1508	1.1096	1.1072	1.1649
	45.63	Using pFad		45.63	59.82	64.39	80.20	92.04
	45.63	Using iFad		45.63	52.51	58.27	64.51	75.15

[1] cPBCI = combined indices of the Prime Building Cost Index
[2] pFad = cost adjustment factor using the PBCI as a measure of inflation in the construction industry
[3] iFad = cost adjustment factor using the general inflation
[4] † = Estimated index

Table 4A.6: The schemes' duration from tender to actual construction work.

No.	Water Schemes	Date of Tendering	Construction Work	
			Start Date	Practical Completion
1	Oyibi Area Water Scheme	June 2003	6/10/2003	26/01/2004
2	Ashalaja Area Water Scheme	May 2003	22/07/2003	21/11/2003
3	Abokobi Area Water Scheme	September 2003	2/10/2003	23/03/2004
4	Asutuare Area Water Scheme	November 2004	4/01/2006	11/2006
5	Selected Comm. to GWCL Sys.	Not available	18/07/2003	10/01/2004
6	Pantang Area Water Scheme	October 2004	31/03/2005	12/2005
7	New Kweiman Water Scheme	November 2004	03/2005	12/2005

Source: CWSA-GAR

Table 4A.7: The water schemes and their beneficiary communities

Water Supply Schemes	Districts	Beneficiary Communities
Ashalaja Water Scheme	Ga West	Ashalajah, Kwame Anum, Alafia, Krokohwe.
Sel. Comm to GWCL	Dangme East	Wassakuse Ngwa and Wayo, Dogwam, Dogo, Bedeku Kponya, Korleykpe, Ghatana, Adonokorpe, Mamayikpo, Totimekorpe, Angorsekorpe
Oyibi Water Scheme	Tema Municipal Assembly	Old and New Saasabi, Kpone Seduase, Oyibi, Malejor, Mensah Bar, Oyibi Estates, Good News Theological College and Seminary, Valley View University.
Abokobi Water Scheme	Ga East	Abokobi, Teiman, Oyarifa.
New Kweiman Water Scheme	Ga East	Ayi Mensah, Habitat (A, B and C), Old and New Kweiman, Danfa, Danfa Hospital, Adoteiman, Otinibi.
Pantang Water Scheme	Ga East	Dravagah, Pantang Hospital, Boi, Akpormang, Abladzei, Pantang Village, Sempeni, Onyamekrom, Aborman, Zion City, Ashongman village, Adjako.
Asutuare Water Scheme	Dangme West	Asutuare township, Kpong irrigation project estate, Osuwen Lanor, Osuwen Gbese.

Source: CWSA-GAR

Table 4A.8: Disaggregated hardware costs (from BOQs) as percentage of total as built costs.

Level of Disaggregation		Oyibi WSS	Abokobi WSS	Ashalaadza WSS	Sel. Comm. to GWCL	New Kweiman WSS	Pantang WSS	Asutuare WSS
Level 1	Level 2							
Hardware cost	Items	Percentage of total Investment Cost						
	General items	6.81	7.96	16.15	8.00	3.38	3.46	2.30
	Pumps, installation and control panel	18.70	6.82	12.34	0.00	24.23	7.20	6.98
	Pipelines (Trans. & Dist.) works	37.24	46.08	9.93	58.19	27.57	45.59	23.69
	Treatment plant(s)	0.00	0.00	0.00	0.00	0.00	0.00	17.70
	Reservoir (s)	11.56	7.75	17.36	0.00	3.42	9.01	0.00
	Public Standpipes	2.71	5.24	7.14	7.31	2.62	2.39	1.53
	Borehole(s) or alternative water source works	1.27	3.53	3.99	0.00	3.07	2.89	1.56
	Watsan Board House	3.42	0.00	0.00	0.00	1.47	2.97	0.80

Appendix 5: Other relevant data

Table 5A.1: The combined PBCI from 2004 to 2008

Year/Month Index	January	February	March	April	May	June	July	August	September	October	November	December	Average
PBCI 2004	505.6	506.50	515.3	523.4	523.40	523.40	525.70	525.7	528.3	530.7	531.6	536.3	**523.0**
PBCI 2005	637.1	664.60	683.7	683.9	687.00	689.8	692.4	687.1	699.1	700.6	701.1	701.1	**685.6**
PBCI 2006	731.3	733.10	733.1	733.1	735.00	734.4	739.5	741.4	743	743.8	743.7	744	**738.0**
PBCI 2007	880.4	901.70	911.2	913.4	917.40	915.7	920.4	931.5	934.3	933.6	935.5	935.5	**919.2**
PBCI 2008	983.6	999.00	1028.6	1061	1,061.10	1061.1	1065.4	1070.1	1072.4	1076.9	1078.5	1101.4	**1054.9**

Source: Ghana Statistical Service, Accra

Table 5A.2: Estimation of the combined PBCI for the year 2003.

According to McConnel, C. R. and Brue, S. L. (1999), "Rule of 70 in economics provides a quantitative grasp of inflation's effect. If we divided the number 70 by the annual rate of inflation, the quotient is the number of years it takes for inflation to double the price level".

$$Thus, approximate\ number\ of\ years\ required\ to\ double = \frac{70}{annual\ rate\ of\ inflation}$$

Meanwhile, the PBCI shows that inflation has doubled from the 2004 index to the 2008 index.

$$This\ means, 4\ years = \frac{70}{inflation\ rate\ in\ 2004}$$

$$2004\ inflation\ rate = \frac{70}{4}$$

$$= 17.5\%$$

$$Current\ year\ inflation\ rate = \frac{Current\ Year\ Index - Past\ Year\ Index}{Past\ Year\ Index} \times 100\ (Adapted\ from\ McConnel\ and\ Brue\ (1999))$$

$$Therefore, \quad 2004\ rate = \frac{2004\ index - 2003\ index}{2003\ index} \times 100$$

$$hence\ 2003\ index = 430.30$$

Table 5A.3: The inflation and exchange rates in the country from 2003 to 2008

Month/ Year	2003		2004		2005		2006		2007		2008	
	Inflation (%)	Exchange (¢ per US$)	Inflation (%)	Exchange (¢ per US$)	Inflation (%)	Exchange (¢ per US$)	Inflation (%)	Exchange (¢ per US$)	Inflation (%)	Exchange (¢ per US$)	Inflation (%)	Exchange (GH¢ per US$)
January	16.30	8,536.50	22.4	8,880.24	11.60	9,049.59	14.60	9,128.57	10.9	9,235.50	12.81	0.98
Febuary	29.40	8,559.86	11.3	8,915.16	14.00	9,057.95	12.10	9,119.13	10.4	9,256.40	13.21	0.98
March	29.90	8,600.29	10.5	9,018.30	16.70	9,075.45	9.90	9,138.81	10.2	9,269.40	13.79	0.98
April	30.00	8,690.16	11.2	9,048.98	16.60	9,080.90	9.50	9,141.02	10.5	9,274.50	15.3	0.99
May	29.80	8,684.25	11.2	9,029.45	16.30	9,066.10	10.20	9,145.01	11.0	9,273.90	16.88	1.00
June	29.60	8,700.36	11.9	9,046.54	15.70	9,074.90	10.50	9,191.02	10.7	9,285.30	18.41	1.03
July	29.00	8,721.89	12.4	9,041.80	14.90	9,077.28	11.40	9,198.20	10.1	9,300.00	18.31	1.07
August	27.70	8,735.59	12.9	9,045.70	14.70	9,086.42	11.20	9,197.60	10.4	9,400.00	18.1	
September	26.80	8,732.28	12.6	9,051.76	15.00	9,086.47	10.80	9,209.50	10.2	9,400.00	17.89	
October	24.60	8,805.37	12.4	9,049.36	15.40	9,083.60	10.50	9,224.40	10.1	9,500.00	17.3	
November	23.80	8,852.32	12.3	9,054.73	15.30	9,099.40	10.30	9,229.50	11.4	9,700.00	17.44	
December	23.60	8,880.24	11.8	9,051.26	14.80	9,130.82	10.50	9,235.30	12.75	9,700.00	18.44*	
Average	**26.71%**	**0.8708 GH¢/ US$**	**12.74%**	**0.9019 GH¢/ US$**	**15.08 %**	**0.9081 GH¢/ US$**	**10.96 %**	**0.9180 GH¢/ US$**	**10.72%**	**0.9383 GH¢/ US$**	**16.49%**	**1.0043 GH¢/ US$**

***Projected figure for the month.**

Source: Compiled from the Bank of Ghana (http://www.bog.gov.ghresultspage.php)

Table 5A.4: Example of prices of PVC pipes

PVC pipes (class C) *Diameter by pipe length*	**2004**	**2005**	**2006**	**2007**	**2008**
200mm or 8"X 6m	104.81	120.50	132.58	144.70	173.65
150mm or 6" X 6m	68.74	79.00	83.10	87.00	104.40
100mm or 4" X 6m	32.08	35.89	38.76	40.60	48.71
NB: Prices are the Ex-factory prices including VAT+NHIL in GH¢					

Source: Interplast Ltd, Accra.

Appendix 6: Scatter graphs of schemes

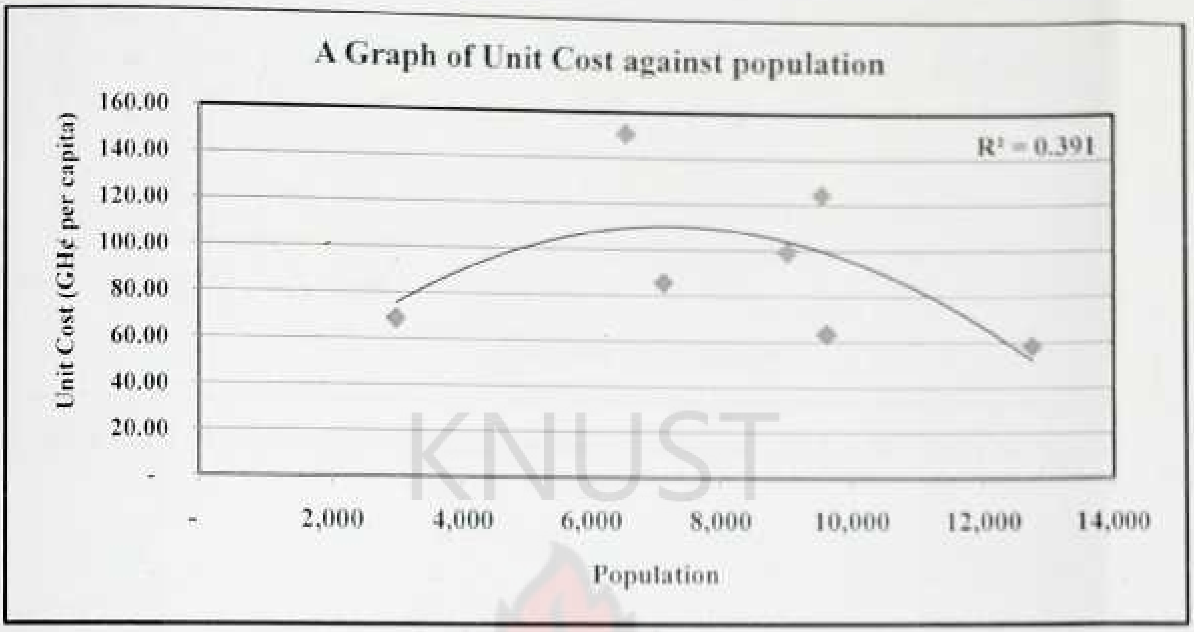

Figure 6A.1: Relationship between cost and population (using all 7 schemes)

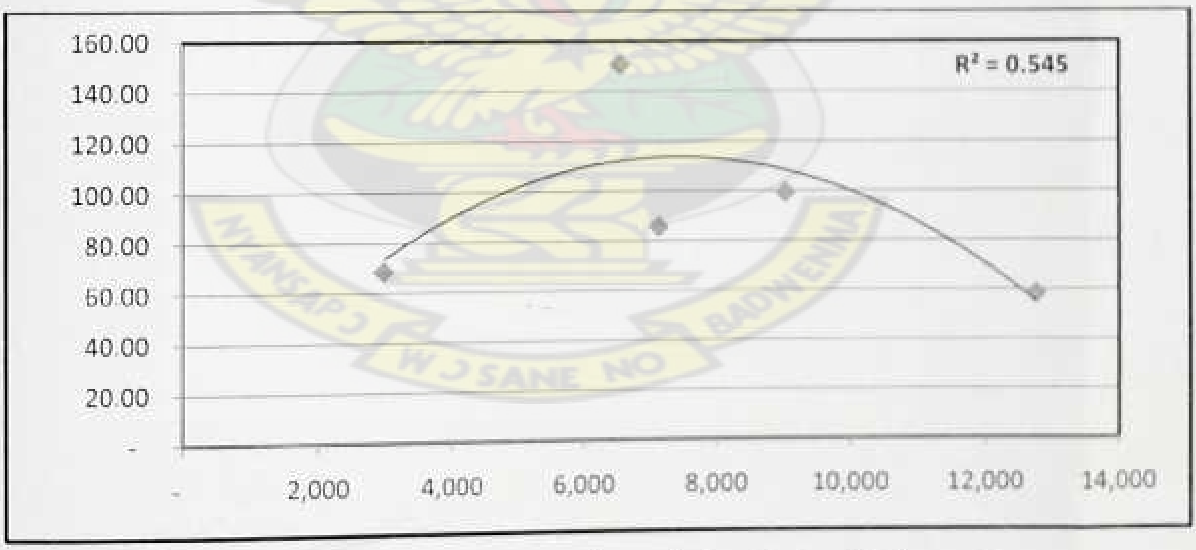

Figure 6A.2: Relationship between cost and population (using 5 schemes)

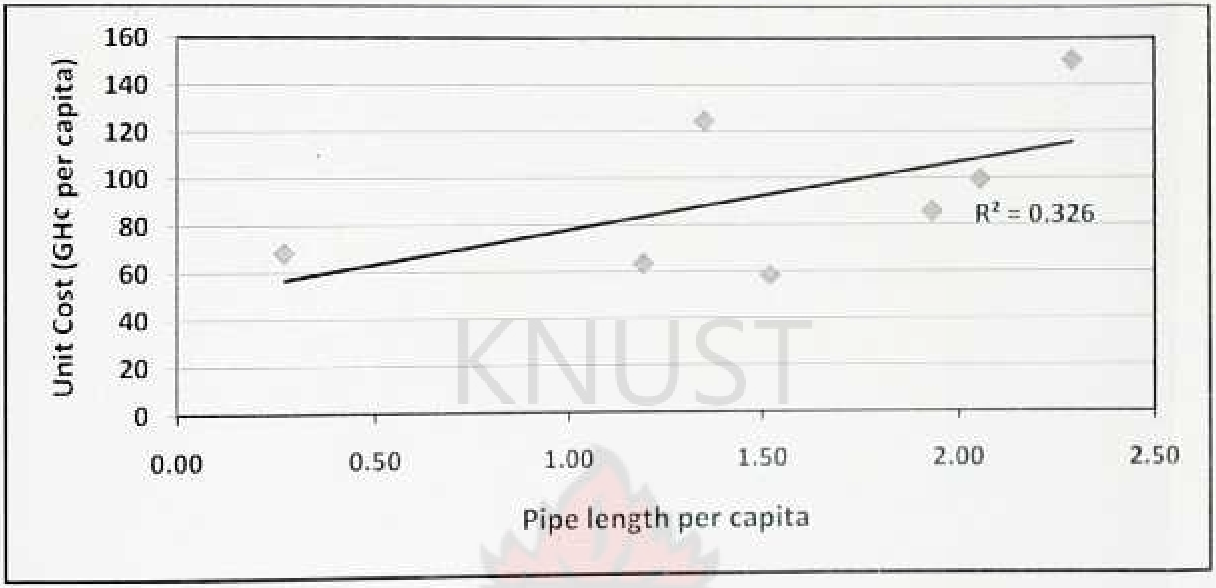

Figure 6A.3: Relationship between cost and pipe length per capita (using all schemes)