Millennium Cities Initiative
EARTH INSTITUTE | COLUMBIA UNIVERSITY

MCI SOCIAL SECTOR WORKING PAPER SERIES

N° 12/2010

A WATER AND SANITATION NEEDS ASSESSMENT FOR KISUMU CITY, KENYA

Prepared by:

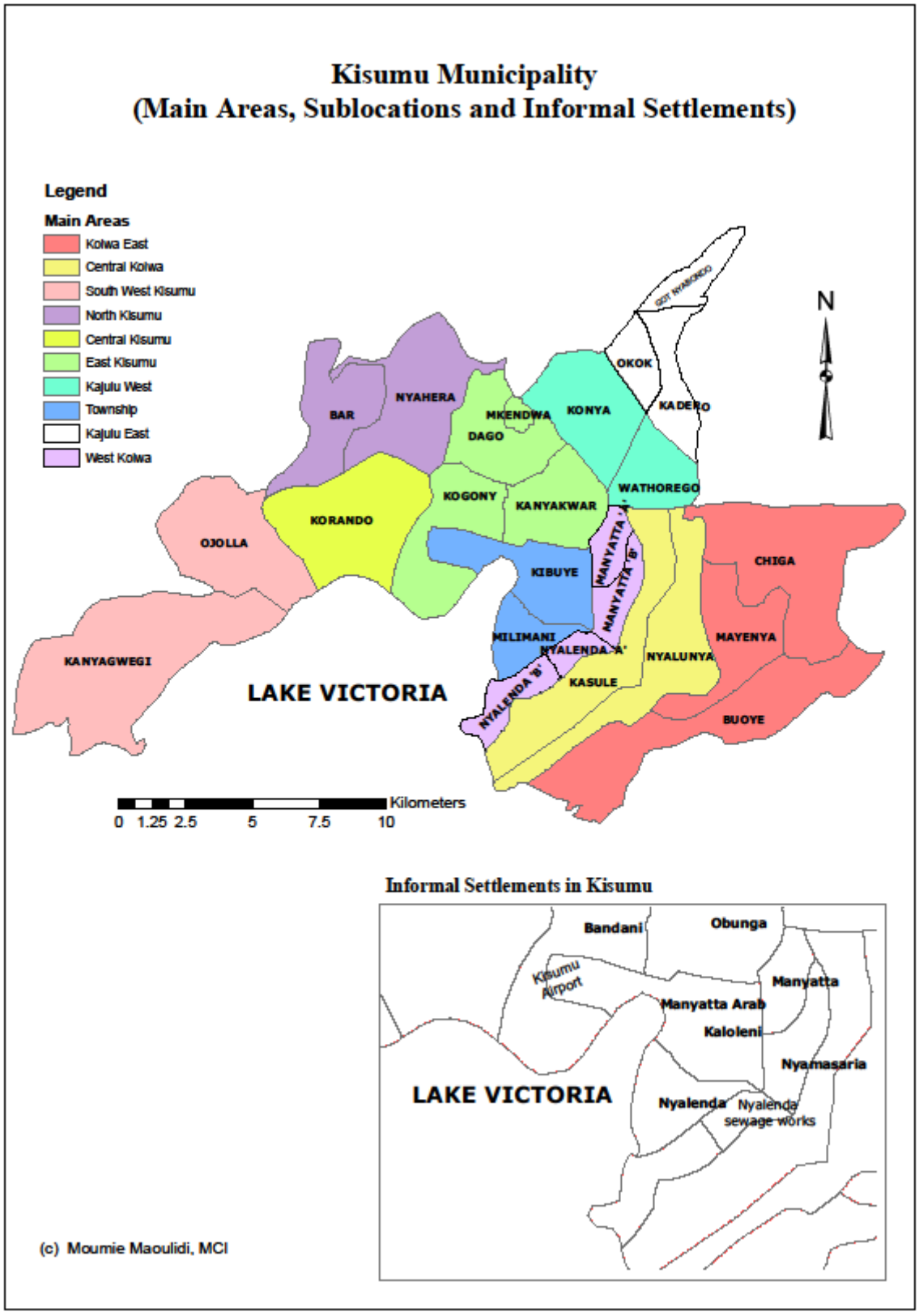
Moumié Maoulidi, Ph.D.

May 2010

475 Riverside Drive, Suite 253, New York, NY, 10115, United States
Phone: +1-212-870-2767; Fax: +1-212-870-2777
Website: http://mci.ei.columbia.edu

NB: This needs assessment was compiled by MCI Social Sector Research Manager Dr. Moumié Maoulidi and relied on field research by MCI Researcher Andrea Castro and MCI Social Sector Specialist Ben Obera. It was edited by MCI Co-Director Dr. Susan Blaustein, with editorial support from MCI interns Sarah Jaffe and Shulie Eisen.

Figure 1. Map of Kisumu



ACKNOWLEDGEMENTS

The Millennium Cities Initiative would like to thank the following institutions for their assistance:

- Municipal Council of Kisumu (MCK)
- Kisumu Water and Sewerage Company (KIWASCO)
- Lake Victoria South Water Services Board (LVSWSB)
- Sustainable Aid in Africa International (SANA)
- Nyanza Provincial Public Health and Sanitation Department
- Rabuor Water Supply Project
- Wandiege Water and Sanitation Project
- Africa Now
- CARE Kenya
- World Vision Kenya

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AFD	French Agency for Development *(Agence Française de Développement*)
CBO	Community-Based Organization
CBS	Central Bureau of Statistics
DMM	Delegated Master Operator Model
JMP	Joint Monitoring Programme
GLUK	Great Lakes University of Kisumu
GTZ	*Deutsche Gesellschaft für Technische Zusammenarbeit*, German Agency for Technical Cooperation
KENSUP	Kenya Slum Upgrading Program
KISWAMP	Kisumu Integrated Solid Waste Management Project
KIWASCO	Kisumu Water and Sanitation Company
KUP	Kisumu Urban Project
LTAP	Long Term Action Plan
LVSWSB	Lake Victoria South Water Services Board
MCK	Municipal Council of Kisumu
MCI	Millennium Cities Initiative
MDGs	Millennium Development Goals
MOs	Master Operators
MoF	Ministry of Finance
NGO	Non-governmental Organization
SANA	Sustainable Aid in Africa
STAP	Short Term Action Plan
SWM	Solid Waste Management
UDDT	Urine Diversion Dehydration Toilet
UFW	Unaccounted-for Water
UN-HABITAT	United Nations Human Settlements Programme
UNICEF	United Nations Children's Fund
VIP	Ventilated Improved Pit Latrine
WATSAN	Water and Sanitation
WHO	World Health Organization
WSP	Water and Sanitation Program

EXECUTIVE SUMMARY

The city of Kisumu is located in Western Kenya, on the shores of Lake Victoria, the second largest fresh water lake in the world; yet the city is characterized by chronic water shortages. Research on the water sector in Kisumu City also shows that water and sanitation services are not keeping pace with the rapid population growth. Many residents living in low-income areas (informal settlements and peri-urban areas) lack access both to clean water and to safe and environmentally sound sanitation facilities. The city desperately needs an efficient water supply system and improved sanitation services. Hygiene education also needs to be accorded priority, mainly because water-borne diseases such as cholera, dysentery and typhoid contribute to numerous deaths every year.

Target 7C of the Millennium Development Goal on Water and Sanitation mandates that the number of people without sustainable access to water and sanitation be reduced by half by 2015. Kisumu City is making good progress towards this target: access to improved water sources increased from 62.5 percent in 2001/02 to 65 percent in 2007, and projections indicate that by 2015, about 83 percent of the population will have sustainable access to an improved water source. Access to improved sanitation has also increased, from 75 percent in 2001/02 to 91 percent in 2007.

Nonetheless, several challenges persist. A key obstacle is addressing unique water and sanitation problems facing populations living in informal settlements and peri-urban areas. These include unreliable water supply, high water prices, and poor quality of water from sources such as shallow wells. Water vendors who supply piped water to informal settlements typically charge rates that are 50 percent higher than rates provided by the water utility. As a result, many informal settlements residents rely on shallow well water, which is often contaminated because of a high density of pit latrines in the vicinity of the wells. Expanding the number of septic tanks could mitigate the negative impacts of pit latrines in informal settlements and composting toilets should be promoted in peri-urban areas. Challenges that face the entire city include increasing water production to meet the demands of a growing population, improving revenue collection, reducing water loss, expanding solid waste collection, developing recycling activities and rehabilitating sewers.

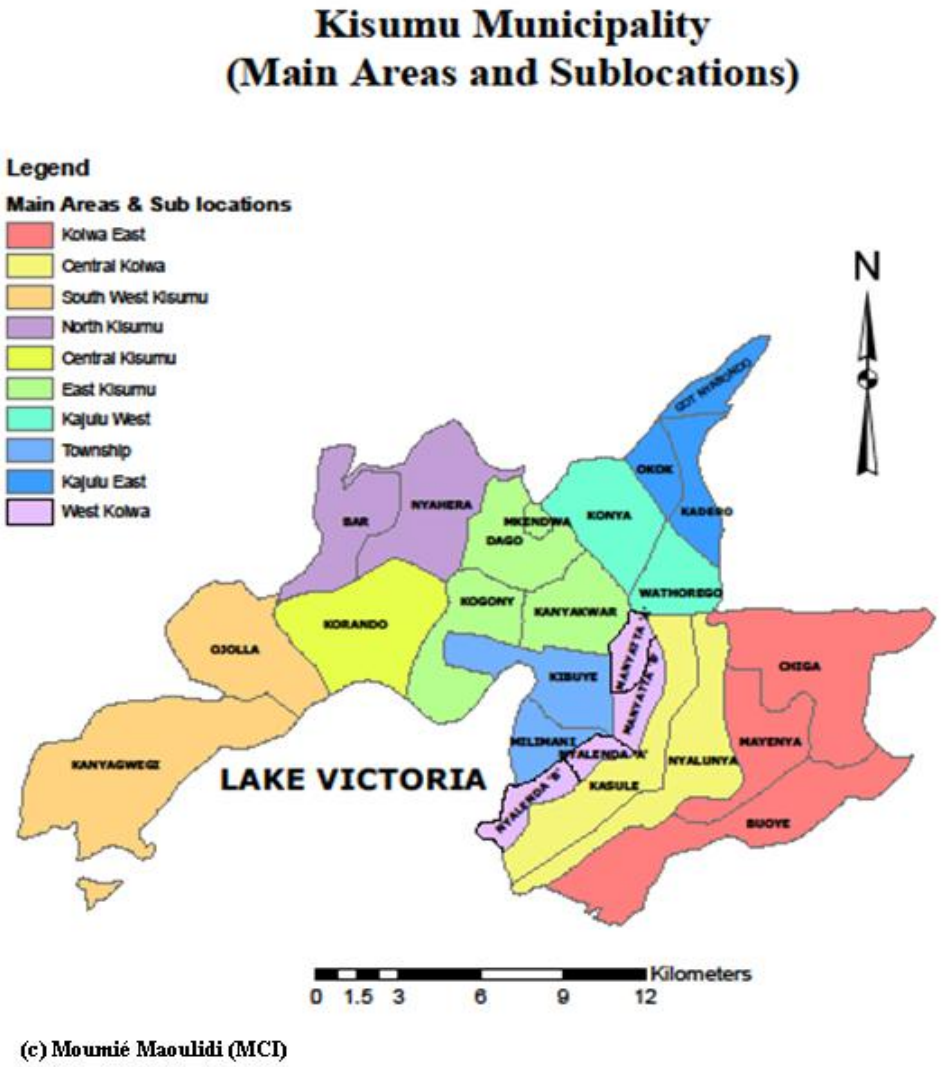
The findings of this needs assessment indicate that with an average annual investment of US $17 per capita, Kisumu has the opportunity to attain the MDG targets related to water and sanitation.

The structure of the report is as follows: Section I presents an overview of the city, as well as the objectives, methodology and limitations of the study. Section II provides background information on the water and sanitation situation in Kisumu City and discusses key problems faced by residents, namely the availability, affordability and suitability of water and sanitation services. Section III focuses on the financing for water and sanitation in Kisumu City and outlines the results of the costing model. Section IV summarizes the needs assessment's findings and provides some recommendations.

I. INTRODUCTION

Kisumu is the third largest city in Kenya and is located in the western part of the country on the shores of Lake Victoria. The city covers a total area of 417 sq. km, of which 297 km is land, and 120 sq. km is water mass. It was founded in 1901 and currently serves as the capital of Nyanza Province and Kisumu District.[1]

Figure 2. Map of Kisumu Municipality Showing Main Areas and Sublocations



As Figure 2 shows, Kisumu City consists of 25 sub-locations that can be grouped into 10 main locations.[2] Residents of Kisumu can also be broadly divided into the following three

[1] Administratively, Kenya is divided into eight provinces which are further subdivided into 71 districts. Kisumu District is one of 12 Districts in Nyanza Province.

[2] Township, East Kolwa, Central Kolwa, SouthWest Kisumu, North Kisumu, Central Kisumu, East Kisumu, West Kajulu, East Kajulu, and West Kolwa.

categories: urban (town center), informal settlements (slums surrounding the town center), and peri-urban areas located on the outskirts of the Township. Existing settlement areas include Bandani, Kamenya lower, Kibos, Lumumba, Makasembo, Mamboleo, Milimani, Migosi, Manyatta, Nyalenda, Nyamasaria, Nyawita, Obunga, Ondiek and Tobert Ouko.

1.1. Objectives

This paper aims to identify the main water and sanitation challenges facing Kisumu City in its efforts to achieve Target 7C (formerly Target 10) of Millennium Development Goal #7— to cut in half, by 2015, the proportion of people without access to safe drinking water and basic sanitation. In addition, it will suggest interventions with the potential to improve access to safe water and sanitation and will identify the costs needed to implement the proposed interventions.

1.2. Methodology

The research methodology used in this needs assessment includes field research, analysis of data and documents collected from municipal offices as well as a review of the literature. In September-October 2008, a MCI researcher travelled to Kisumu to gather preliminary information, and this work was continued in 2009 by MCI's Social Sector Specialist in Kisumu. In 2010, MCI's Social Sector Research Manager conducted further research by consulting secondary sources to obtain data necessary for water supply and sanitation analysis.

1.3. Limitations

A key challenge in conducting this assessment was the lack of up-to-date coverage data. For instance, 1990 coverage data were not available. This data would have been useful to identify ongoing progress toward meeting MDG targets. In addition, local water and sanitation providers did not have some cost data. To overcome these challenges, the needs assessment relies on the most recent data from secondary sources.

1.4. Demographics

Table 1 presents the city's population in 1999 and the projected populations in 2010, 2011 and 2015, which are based on the 1999 census and the Central Bureau of Statistics' (CBS) recommended growth rate. It is projected that, if the growth rate remains at 2.8 percent, the city's population will be more than a half-million by 2015.[3] The projected 2010 population is 438,807. The city has an overall population density of about 1,052 people per square kilometer. However, the population density is much higher in the informal settlements, where over 60 percent of Kisumu's population lives (MCK and UN-HABITAT, 2004). The population in the informal settlements is expanding rapidly as people from the surrounding Lake Basin area move into the city. Table 1 shows Kisumu City's population by location.

[3] These figures differ from those in such publications as LVSWSB (2008) and Nodalis Conseil (2009) because different growth rates are used.

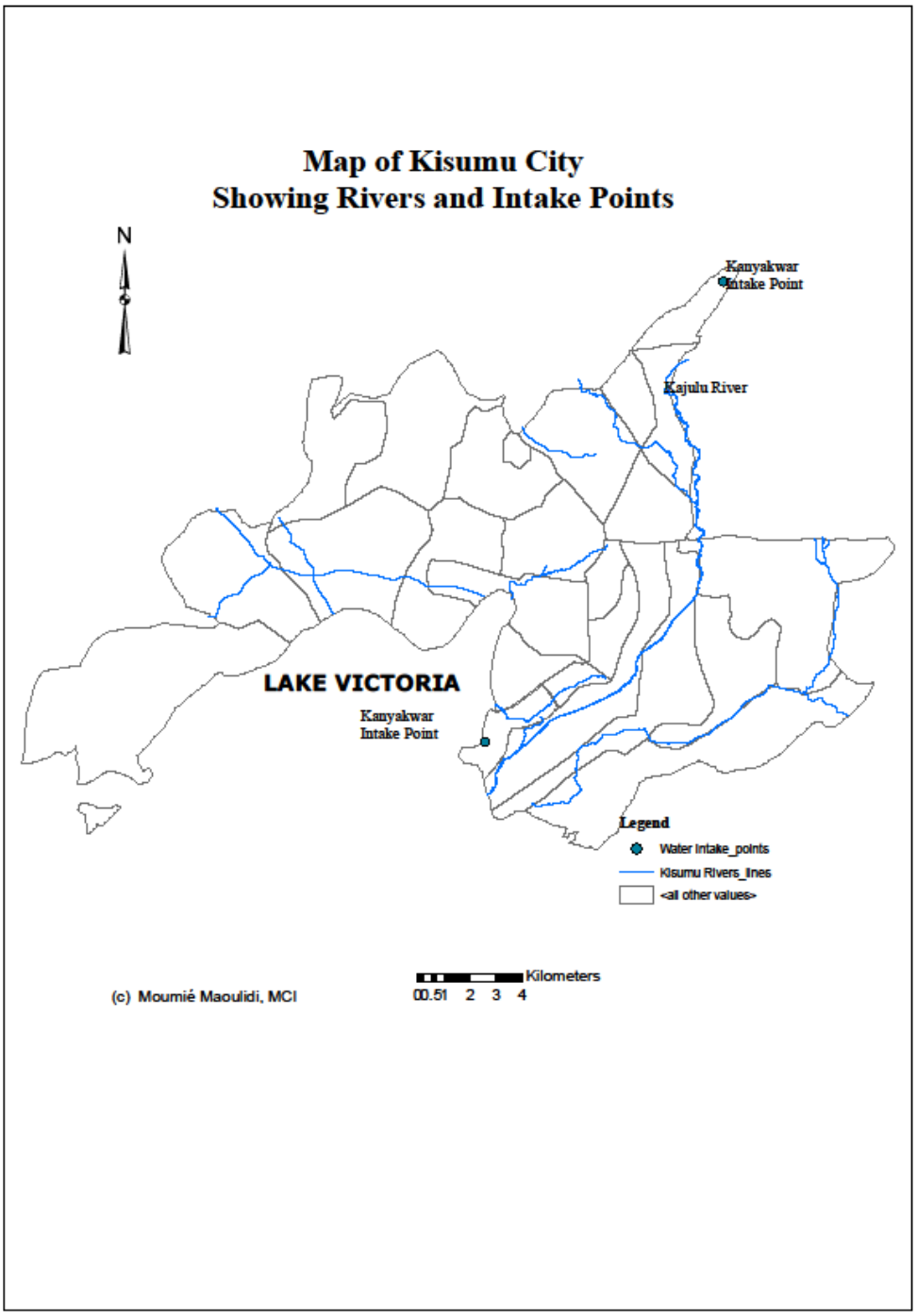
Table 1. Kisumu City Population (1999, 2010, 2011, 2015), by Area

Location	1999 Census	2010	2011	2015	Area (Sq Km)
Central Kisumu	**14,950**	**20,327**	**20,920**	**23,399**	**17.2**
Korando "A"	9,538	12,968	13,347	14,929	9.5
Korando "B"	5,412	7,358	7,573	8,471	7.7
Central Kolwa	**19,387**	**26,360**	**27,129**	**30,344**	**36**
Kasule	10,701	14,550	14,974	16,749	20.4
Nyalunya	8,686	11,810	12,155	13,595	15.3
East Kajulu	**12,064**	**16,403**	**16,882**	**18,882**	**15.3**
Got Nyabondo	3,483	4,736	4,874	5,452	5.1
Kadero	5,304	7,212	7,422	8,302	6.6
Okok	3,277	4,456	4,586	5,129	3.6
East Kisumu	**27,626**	**37,562**	**38,658**	**43,240**	**32.6**
Dago	4,422	6,012	6,188	6,921	10.2
Kanyakwar (Obunga)	8,576	11,660	12,001	13,423	8.5
Kogony (Bandani)	13,961	18,982	19,536	21,851	13.1
Mkendwa	667	906.89108	933	1,044	0.8
East Kolwa	**15,843**	**21,541**	**22,170**	**24,797**	**56**
Buoye	4,586	6,235	6,417	7,178	22.2
Chiga	7,109	9,666	9,948	11,127	22.2
Mayenya	4,148	5,640	5,804	6,492	11.6
Kondele	**69,521**	**94,525**	**97,283**	**108,813**	**4.8**
Manyatta "A"	41,910	56,983	58,646	65,597	2
Migosi	14,771	20,083	20,670	23,119	1.7
Nyawita	12,840	17,458	17,968	20,097	1.1
North Kisumu	**16,337**	**22,213**	**22,861**	**25,570**	**30**
Bar "A"	3,709	5,043	5,190	5,805	6.5
Bar "B"	3,605	4,902	5,045	5,642	7.9
Nyahera	9,023	12,268	12,626	14,123	15.9
S.West Kisumu	**18,831**	**25,604**	**26,351**	**29,474**	**50**
Kanyawegi	5,846	7,949	8,181	9,150	17.1
Ojolla	6,841	9,301	9,573	10,707	17
Osiri	6,144	8,354	8,598	9,616	16
Township	**40,295**	**54,787**	**56,386**	**63,069**	**14.2**
Bandari	7,039	9,571	9,850	11,017	5.7
Kaloleni	13,515	18,376	18,912	21,153	2.1
Northern	10,117	13,756	14,157	15,835	1.3
Southern	9,624	13,085	13,467	15,063	5.1
West Kajulu	**17,478**	**23,764**	**24,458**	**27,356**	**22**
Konya	10,308	14,015	14,424	16,134	11.9
Wathorego	7,170	9,749	10,033	11,222	9.8
West Kolwa	**70,402**	**95,723**	**98,516**	**110,192**	**12.2**
Manyatta "B"	21,027	28,590	29,424	32,911	3.3
Nyalenda "A"	23,731	32,266	33,208	37,143	2.8
Nyalenda "B"	25,644	34,867	35,885	40,137	6.1
TOTAL	**322,734**	**438,807**	**451,614**	**505,136**	**290**

Source: CBS (1999) and MCI . *NB:* 2010, 2011 and 2015 figures are MCI .projections based on Government of Kenya 1999 Census figures. They were derived using an exponential growth function and a 2.8 percent growth rate.

Figure 3 shows Lake Victoria, some of the rivers in Kisumu City and the two water intake points. The map is not authoritative regarding the exact location of rivers, which were traced from Google satellite images that are not constant. Nonetheless, the map provides an idea of the location of water surface sources.

Figure 3. Map of Kisumu Showing Lake Victoria and Rivers and Intake Points



II. WATER AND SANITATION IN KISUMU

2.1. Background

The Municipal Council of Kisumu (MCK) owns all water and sewerage facilities in the city. However, since the enactment of the Kenya Water Act in 2002, which separated the functions of policy formulation and regulation from service provision, the task of efficient and economical provision of water and sewerage services has been devolved to Water Service Boards.[4] Since 2003, the agency responsible for executing and implementing water projects, as well as licensing water service providers in Kisumu, is the Lake Victoria South Water Services Board (LVSWSB). The largest provider of piped water and sewerage services is the Kisumu Water and Sewerage Company (KIWASCO). The Gulf water company is the other water service provider serving peri-urban and rural parts of Kisumu. There are also small-scale community water and sanitation service providers.

2.2. Kisumu's Water System

Most of the water in Kisumu is obtained from Lake Victoria, with a small percentage extracted from the Kibos River (see Figure 3). Other rivers include Nyamasaria, Kisian, Kajulu, Mamboleo, Luanda and Lidango. While the city primarily relies on surface water, ground water is also available. Ong'Or and Long-Cang (2007), for instance, note that "groundwater levels range from 2-5 meters from the soil surface." Efforts to improve water supply have nonetheless focused on surface water, mainly because groundwater is susceptible to contamination by overflowing pit latrines and inadequate drainage.

There are currently two raw water intake points on Lake Victoria and one intake at Kajulu, as shown in Figure 3. There are also two water supply systems: an electrical pump system, supplying about 92 percent of the total water, and a gravity system. The water from Lake Victoria is treated at the Dunga Water treatment plant, located 0.6 km from the intake, and is then pumped to a storage tank in Kibuye, while the water from the Kibos River is treated and then flows by gravity to a reservoir. A 2008 study reports that Kisumu's water supply facilities had a design capacity of 22,700 m^3/day, but were operating at a capacity of only 18,700 m^3/day, with Kajulu supplying 1,700 m^3/day and the Dunga treatment plant producing 17,000 m^3/day (LVSWSB, 2008). The study estimated that water demand in 2007 was 47,700 m^3/day, leaving Kisumu with a supply deficit for that year of over 29,000 m^3/day.[5]

Research on the water sector in Kisumu City shows that water production is not keeping pace with the rapid population growth and that, in any case, the existing infrastructure is operating at between 85 and 93 percent of maximum design capacity.[6] In 2007, KIWASCO met about 40-42 percent of the water demand; but 12 percent of this was lost between the intakes and the

[4] In line with the requirements of the 2002 Water Act, the MCK has taken steps to privatize the water supply and sewerage service provision.

[5] This gap is confirmed by Ong'Or and Long-Cang (2007), who estimate Kisumu's 2007 water demand in 2007 at approximately 45,000 m^3/day and the water supplied by KIWASCO to be 19,000 m^3/day, leaving a deficit of 26,000 m^3/day.

[6] Information provided by Kisumu Water and Sewarage Company (KIWASCO).

treatment works, and significantly more went unaccounted for between the treatment works and the consumption point (Ong'Or and Long-Cang, 2007; LVSWSB, 2008).[7] To reduce water loss and keep pace with increasing water demand, water supply facilities need to be rehabilitated and improved.

Table 2 shows the projected demand for water in different Kisumu sublocations for the next 10 years. To meet current and future water demand, the city clearly must expand its water supply.

Table 2. Water Demand Forecast (m^3/day) for Kisumu Sublocations (2011-2020)

Sub-Location	**Water Demand**	
	2011	**2020**
Kibuye (Migosi, Nyawita)	9,582	12,072
Milimani (N&S)	3,927	4,948
Kanyakwar	1,706	2,149
Nyalenda (A&B)	9,882	12,375
Manyatta (A&B)	12,520	15,774
Wathorego	2,863	3,499
Karondo	2,974	3,747
Kogony	2,777	3,499
Kasule	710	894
Chiga	471	594
Nyalunya	576	726
Kadero	352	443
Okok Got Nyabondo	448	564
Konya	684	861
Total	**49,472**	**62,145**

Source: LVSWSB (2008).

Average water consumption per household varies, depending on the number of people living in a household, income level and where a household is located. For instance, urban households tend to have higher consumption than peri-urban households, even when the peri-urban households are larger (Ong'Or and Long-Cang, 2007). As Table 3 shows, the per capita water consumption for a seven-member peri-urban household connected to a water main is about 60 liters (0.06 m^3) per day, whereas it is twice as much for households in town areas.

Table 3. Per capita Water Consumption

	Urban areas, e.g. Milimani, Migosi	Informal settlements, e.g. Manyatta,
	m^3/day	m^3/day
Individual Connection	0.120	0.060
Communal Tap	0.020	0.020

Source: LVSWSB (2008), Ong'Or and Long-Cang (2007).

[7] Unaccounted-for water (UFW) refers to water loss and can result from leakages from pipes or reservoir walls, burst pipes, metering errors or unauthorized consumption. Water loss = amount of water produced - amount of water billed or consumed.

2.3. Access to Water in Kisumu

According to the definition proposed by WHO / UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation, households in urban areas are considered to have "access to an improved water source" if they are located within half a kilometer of such sources as piped water, public taps, boreholes and protected wells/springs. Since it is difficult to measure distance to such water sources, an alternative working definition is given: "A household is considered to have access to improved water supply if it has sufficient amount of water for family use, at an affordable price, available to household members without being subject to extreme effort, especially to women and children." Table 4 lists the improved and unimproved sources of water as defined by the JMP.

Table 4. Definition of Improved and Unimproved Water Sources

Improved Water Supply Source	Unimproved Water Supply Source
Individual household connection	
Piped water from a yard tap	Tanker truck provided water
Piped water obtained from a neighbor	Vendor provided water
Protected well/spring	Unprotected well/spring
Rain water harvesting	Bottled water
Note: Bottled water is not considered improved because of concern for the quantity of supplied water, not quality.	

Source: http://www.wssinfo.org/definitions/infrastructure.html

Kisumu City residents obtain water from individual connections, yard tap connections, public tap connections, boreholes, springs and water vendors. As of September 2008, KIWASCO had 7,704 domestic water connections and 287 water kiosks (LVSWSB, 2008). [8] About 52 percent of Kisumu residents used piped water delivered to dwellings or compounds, and 13 percent depended on protected shallow wells/springs or roof catchment (LVSWSB, 2008). Hence 65 percent of Kisumu residents had access to an improved water source, while 35 percent relied on unimproved water sources, including water vendors, open wells/springs, streams and ponds (LVSWSB, 2008).

It should be noted, however, that in informal settlements, although some residents have access to piped water, most residents rely on water kiosks, handcart vendors and boreholes for their water supply. The reliance on shallow wells and boreholes in these neighborhoods is problematic because water from these sources is of poor quality. Kisumu City has high water tables; consequently, shallow wells are easily contaminated by overflowing pit latrines, poor wastewater management and inadequate drainage systems. Many residents in peri-urban areas also use water from shallow wells situated in close proximity to the pit latrines, thereby increasing the chances of cross-contamination, especially during the rainy season, when dependency on such readily contaminable water sources contributes to dangerous outbreaks of such diseases as diarrhea, cholera, typhoid, dysentery and malaria.

[8] If commercial and institutional facilities are included, Kisumu had a total of 9,300 connections in 2008.

Efforts to reduce the proportion of Kisumu residents without sustainable access to water have been constrained by several factors:

1. First, existing water supply facilities were constructed over 50 years ago and were designed to cope with a much smaller demand. Given the city's rapidly increasing population, water supply shortages are likely to worsen, unless existing facilities are expanded.
2. Second, facilities such as the Dunga and Kajulu Water Treatment Plants have not been properly maintained and, as a result, have not been operating at full capacity. They have recently been upgraded under the STAP project (see Section 3.2), but the treatment plants need to be continually maintained.

Table 5 shows the projected water supply needs for the next five years.

Table 5. Water Supply Planning

	2010/11	2012/2015
Water supply m^3/day	45,000	50,000

Source: Hydroconseil & B.G. Associates (2003).

Water Quality

Water from sources such as Lake Victoria and the nearby rivers is of acceptable quality, but it requires treatment before it is piped to consumers. As previously mentioned in Section 2.2, water from Lake Victoria is treated at the Dunga Water Treatment Plant, while the water from the Kibos River is treated at Kajulu Water Treatment Plant. Table 6 provides information on the quality of some of Kisumu's surface water sources. It should be noted that a number of car washes have been installed on the Lake Victoria shore, for instance at Kichinjio beach. These businesses pollute the lake with oil spills and chemicals and therefore threaten the quality of the water for Kisumu and its surrounds.

Table 6. Quality of Water from Lake Victoria and Kisumu Rivers

Source	Catchment area of source intake km^2	Water Quality (2006)	Water Quality Future
Lake Victoria	180,950	Acceptable	Acceptable
Kibos River	117	Good	Good
Awach River	108	Good	Good
Sondu Riber	3,287	Acceptable	Acceptable
Nyando River	2,520	Acceptable	Acceptable
Yala River	1,577	Good	Good

Source: LVSWSB (2008).

Most residents in informal settlements only have access to water of poor quality, mainly because their water comes from sources such as shallow wells. In September 2008, a collaborative team from the Kisumu Municipal Department of Public Health, Great Lakes University of Kisumu (GLUK) and Emory University mapped and tested the quality of 72 water sources in the Obunga and Nyawita informal settlements. The field research was conducted a month after a cholera outbreak. Public health officials had provided well owners with clay pots filled with chlorine powder in August 2008, and the research team wanted to examine the contamination levels of sources such as tap water, well water and spring water. The researchers found that 96 percent

of the sampled wells had medium or high levels of contamination, whereas water from KIWASCO taps had little or no contamination, and spring water had medium levels of contamination.[9] A February 2009 household survey involving 1,000 households in Obunga, Kamakowa and Nyawita found that even water from vendors had fecal contamination, confirming the earlier results that populations in informal settlements without access to piped water are ingesting contaminated water.

2.4. Kisumu's Sanitation System

The Municipal Council of Kisumu (MCK) is responsible for environmental sanitation services, as well as pit latrine/septic tank drainage, although it has long been planned for the LVSWSB and KIWASCO to assume responsibility for all drainage services. No date has been set for this transition, and the delay has impeded action and accountability. A legal impediment also needs to be addressed: existing MCK sanitation by-laws, dating from 1954, recognize only sewer, septic tank and conservancy tanks—not pit latrines—as legal structures. Part of the difficulty here is the presence in Kisumu of black cotton soils,[10] which are not conducive to pit latrine construction, as they are loose, and latrines built on them are prone to collapse during the long rains (March-June). Nonetheless, the by-laws need to be amended, because the current laws hinder the proper construction, operation and maintenance of much-needed pit latrines.

The main sanitation facility in Kisumu is the pit latrine. However, in black cotton soil areas, pit latrines are often less than six meters deep and therefore tend to fill up quickly and/or overflow.[11] VIP latrines are a better alternative than unlined single/double pit latrines because they are less odoriferous, but in 2007, only an estimated seven percent of residents used these (LVSWSB, 2008). There are relatively few public toilets in Kisumu City, most of which are concentrated in informal settlements such as Bandani, Nyamasaria and Obunga. In the city centre, there are public toilets in places like the markets, Bus Park and Jomo Kenyatta grounds.

The sewerage system in Kisumu can be classified into three wastewater treatment districts (WTD): the Central WTD, which collects wastewater generated in the northwest; the Eastern WTD, collecting wastewater from the southeast; and the Western WTD, which covers the area below the airport.

There are two types of sewer systems in Kisumu City: a conventional sewer system and a lagoon system (Ong'Or and Long-Cang, 2007). However, the 6,800m^3 sewerage system serves less than 10 percent of the population, and the two sewer systems do not accommodate most of the generated wastewater (UN-HABITAT, 2008). In addition, frequent sewer bursts and blockages are common, resulting in groundwater contamination, environmental pollution and outbreaks of

---

[9] The analysis of water quality focused on the number of E. coli colony forming units (or CFU) in 100 ml of water (about half a cup). For drinking water, WHO recommends that E.coli must be less than 1 cfu/100 ml. In the September 2008 study, water sources with less than 10 cfu were categorized as sources with low levels of contamination, those with 10-1000 cfu were considered to have medium levels of contamination and those with cfus above 1000 had high levels of contamination.

[10] Especially on the lower sides of the city.

[11] Experience in other East African countries shows that large pits (deeper than six meters) last for two decades without major nuisance (Andrew Cotton et al., 1995).

water-related diseases. The low lying areas of Manyatta and Nyalenda have no sewer system as they are lower than the conventional sewer.

Areas with access to the public sewer network include Lumumba, Makasembo, Milimani, Ondiek and Robert Ouko. CRC (2007) reports that some toilets are emptied into storm sewers, soak pits and cess pits, where fecal waste presents an environmental health hazard. The capacity of the sewerage infrastructure is 17,800m^3/day (if operating at full capacity), far less than what is required (LVSWSB, 2008). The sewers were built more than four decades ago, and there has been no rehabilitation or extension of the sewer system, except for the Kibos Trunk sewers, which were built in 1980 (LVSWSB, 2008).[12] Upgrading and expanding the sewerage infrastructure is therefore urgently required.

Given that Kisumu is a budget-constrained city, expanding conventional sewers to peri-urban areas and informal settlements would be an expensive and difficult undertaking. Conventional sewerage is not only costly, it also requires an in-house water supply not typical of low-income peri-urban communities. Kisumu City officials must, therefore, seek alternatives to conventional sewers. The installation of a simplified sewerage system, also known as a condominial system, is an inexpensive and feasible near-term solution, particularly in informal settlements.[13]

Another alternative is the double-vault Urine Diversion Dehydration Toilet (UDDT), which diverts urine into a container and collects faeces in two vaults underneath a toilet seat or squatting pan. Dry soil or wood ash is added into the hole to cover the faeces after every visit. This covers the deposit, reduces odor and the chances of cross termination and helps the composting process. The vaults are used alternately, with only one vault in use at any time until it almost full, whereupon the defecation hole is closed, and the toilet superstructure is transferred to the second vault. These toilets are simple to design, relatively inexpensive and the sludge can be used for fertilizer but UDDTs must be protected from flooding. Section 2.7 provides additional details on UDDTs.

The high population densities in some of Kisumu's informal settlements mean that septic tanks, pit latrines and UDDTs must be emptied regularly. City authorities must therefore develop a sanitation improvement program that specifies clearly the lines of responsibility, once septic tanks, pit latrines and UDDTs are full. MCK must also ensure that there are adequate waste dumping facilities for the safe disposal of waste. Without access to affordable waste dumping sites, septic tank and pit emptying service providers are likely to dump the septic tank/pit sludge illegally.

Solid Waste

In 2001 it was estimated that only 20 percent of the 400 tons of solid waste generated each day in Kisumu City was collected (MCK and UN-HABITAT, 2004). By 2008, the daily generation of household waste was estimated to be 437 tons (Nodalis Conseil, 2009). Fortunately, about 63 percent of the waste generated in Kisumu is organic; hence there is enormous potential for composting (UN-HABITAT, 2008).

[12] Construction of the existing sewerage system in Kisumu began between 1955-65.

[13] This system was originally developed for use in low income peri-urban areas in northeast Brazil in the early 1980s.

The city authority (MCK) only has four trucks (two 2-ton trucks, an old 7-ton compactor truck and an old tractor with a trailer) for collecting waste. These vehicles are in poor condition and often break down. As a result, many households, particularly in the peri-urban areas, have no access to public services and are unable to access private waste collection due to fees levied. They therefore resort to burning or burying their waste (CRC, 2007). Some common dumping grounds have developed on open lands within densely populated neighborhoods. The poor management of solid waste blocks sewers and drainage systems, provides a breeding ground for disease vectors and contributes to the generation of leachates, which pollute the ground water and further contribute to waste related diseases.

The city can significantly reduce the waste taken to the existing dumpsite—located near Moi stadium— by composting and recycling, methods not widely practiced in Kisumu, even though adopting these measures would also alleviate environmental pollution and provide informal employment through the resale of the recyclables. The Municipal Council of Kisumu (MCK) can promote composting by setting up organic waste digesters for manure production as well as for energy, and paper, plastic, metals and other materials can be reused and recycled.

Unfortunately, such waste is still not viewed as a resource in Kisumu. To date, the Municipal Council of Kisumu does not appear to have a plan to incorporate this type of recycling in its solid waste management system.[14] A few enterprises within the city and some residents salvage such materials as plastic bags and bottles, but these are not properly sanitized or disinfected before they are sold in informal settlements, where residents used them for food storage and wrapping. These possibilities indicate that a public awareness campaign promoting a culture of recycling needs to be undertaken.[15]

Liquid Waste

The main sewage treatment plant in Kisumu is the Kisat Conventional Sewage Treatment Plant (STW), built in 1958. In addition, there are three main private industrial wastewater treatment plants, but two of these are pre-treatment facilities only, with just one a full treatment plant.[16] Another plant, serving the eastern part of the city, is the Nyalenda Waste Stabilization Pond (WSP), located adjacent to the Nyalenda low-income area. However, this plant has not been properly maintained and is not fully operational (LVSWSB, 2008).

As the population increases and more septic tanks are installed in Kisumu, and as industrial production increases, wastewater production is likely to increase. The wastewater collected in sewers will required treatment before it can be reused for industrial and domestic use. Usually the most appropriate treatment process is carried out by waste stabilization ponds. Organizations such as the German development agency GTZ are already supporting knowledge-sharing

[14] This does not include what is outlined by AFD in KUP.

[15] MCI is working with the Swedish firm Peepoople to introduce to Kisumu a new, fully biodegradable, single-use "bag toilet" that turns human waste into safe, usable fertilizer over a two-week period. The distribution, collection and fertilizer uses all create valuable livelihood opportunities for urban residents. The product has been successfully piloted in Kibera, Nairobi'ssprawling informal settlement, and will hopefully also be rolled out in Manyatta, Kisumu's downtown slum, sometime within the coming year.

[16] The three private plants are Kisumu Molasses, Kisumu Cotton Mills, and Kenya Breweries. Kisumu Molasses is the full treatment plant.

regarding wastewater recycling, but further engagement is needed. As Table 7 indicates, domestic wastewater generation is projected to outpace collection by 2015.

Table 7. Liquid Sanitation Planning

	2005	2015
Wastewater generation m^3/day (Domestic)	6,105	22,802
Wastewater generation m^3/day	3,595	6,015
Wastewater collection m^3/day	6,342	21,976

Source: Hydroconseil & B.G. Associates (2003).

The Lake Victoria South Water Services Board (LVSWSB) plans to rehabilitate and expand the Nyalenda Waste Stabilization Pond under the LTAP project. In addition, new stabilization ponds will be built at Kobedu/Bandani.

2.5. Access to Sanitation in Kisumu

According to the JMP definition, a household is considered to have adequate access to sanitation if it has a flush toilet that is connected to a public sewer or septic tank, a ventilated improved pit latrine (VIP) or a pit latrine. Table 8 shows that public and shared toilets and bucket and open pit latrines are considered to be unimproved sanitation, as are so-called flying toilets.

Table 8. Definition of Improved and Unimproved Sanitation Facilities

Improved Sanitation	Unimproved Sanitation
Connection to a public sewer	Bucket latrine
Connection to a septic tank	Public or shared latrine
Pour-flush toilet	Latrines with open pit
Simple pit latrine	Flying toilets
Ventilated improved pit latrine (VIP)	

Source: http://www.wssinfo.org/definitions/infrastructure.html

Recent surveys such as the 2007 Citizen's Report Card show that about 61 percent of households had access to improved sanitation, while 34 percent used shared toilets and five percent relied on open defecation (CRC, 2007).[17] Other surveys, such as the one conducted in 2008 by Mouchel Parkman, for the Kisumu Water and Supply Sanitation Project indicate that 91 percent of the population had access to improved sanitation. However, in areas like Obunga, 40 percent of residents nevertheless lacked access to proper latrines (LVSWSB, 2008).

2.6. Hygiene Education

Hygiene behaviors and habits are mostly formed in childhood. Consequently, school hygiene education programs should be incorporated as a critical component of efforts to improve sanitation.

[17] The 61 percent of those with improved sanitation consists of 24 percent of the population with access to a private flush toilet and 37 percent with access to private pit toilets.

In 2008, the Government of Kenya (GoK), along with the World Bank and UN agencies, launched a national Hand Washing With Soap (HWWS) program in Kisumu, to promote hand washing as an effective method to reduce childhood morbidity and mortality resulting from such diseases as diarrhea, acute respiratory infections (ARI), pneumonia and cholera. Two years earlier, the GoK and CARE launched the SWASH+ (Sustaining and Scaling School Water, Sanitation, and Hygiene Plus Community Impact) program to improve access to safe water, sanitation and hygiene for school children. Funded by the Bill and Melinda Gates Foundation and the Global Water Challenge, this program has mostly been implemented in rural areas of Kisumu District.

The Nyanza Provincial Public Health and Sanitation Department has recommended that hygiene education workshops be conducted for headmasters, who are then expected to return to their respective schools and train a select group of teachers. The teachers will organize a health club at each school to develop a hygiene and sanitation work plan for the school. A total of 114 headmasters will be trained in two groups. Table 9 shows the estimated costs of hosting a hygiene education training for principals to be conducted by four public health officials. The costing model includes the costs of training teachers as well as of the hygiene materials themselves.

Table 9. Unit Costs for a School Hygiene Education Program

Category	Unit Cost (KShs.)	Total Cost (KShs.)	Total Cost (US$)
Transport, per person, per day	200	45,600	608
Stationary, per day	10,000	40,000	533
Lunch, per person	1,000	228,000	3,040
Public Address System, per day	3,000	12,000	160
Venue for 60 people, per day	7,000	28,000	373
Total	21,200	353,600	4,714

Source: MCI Researcher Andrea Castro.

NGOs such as SANA and World Vision have also assisted schools to form School Health Clubs (SHC) for the dissemination of positive hygiene messages. In addition, SANA has trained club members regarding the operation, cleanliness and maintenance of toilets.

2.7. Access to Water and Sanitation in Schools and Hospitals

Students spend a significant part of their day in school, hence it is essential that they have adequate access to water and sanitation facilities. Unfortunately, many students miss school days each year because they are sick with preventable diarrhea disease or because of the dearth of private and hygienic toilet facilities at their school. For instance, lack of hygienic school toilets forces girls to skip school during their menstruation days, ultimately affecting their learning.

A 2005 Kisumu Municipal Education Office schools database shows that only 22 percent of public primary schools had piped water, and 28 percent used other improved sources of water

such as boreholes, rainwater, protected springs and tanks.[18] The provision of clean water to schools could be done by promoting roof catchments.

The typical school toilet in Kisumu is a pit latrine. However, VIPs have recently been introduced in schools located in slum areas such as Manyatta (LVSWSB, 2008). Composting toilets such as UDDTs or ecosan (ecological sanitation) [19] toilets are particularly well suited for urban schools. This is because urban schools often do not have the means either to empty full pits or to dig new ones. Composting toilets are usually designed with two chambers: one side is actively used while the other side is for drying and decomposing waste. Urine is collected separately, making it available as a liquid fertilizer. After about a year, the dried waste can be used as fertilizer to support school gardening projects, thereby reducing costs for food purchases. Sludgy human waste and any wastewater can also be sent to anaerobic methane digesters to produce biogas. Ideally, the digesters should be located in the immediate vicinity of a waste water treatment plant. The biogas that is generated from the digesters can then be used for cooking replacing coal and firewood, thus conserving the environment.

A potential strategy to promote the use of ecosan in schools is to incorporate it into the curriculum or into SWASH+ activities. If ecosan-type sanitation systems are successfully introduced in schools, they can create a ripple effect and promote the use of such toilets in the informal settlements, as well.

Most health facilities in Kisumu have piped water connections but an unreliable water supply, meaning that they often do not have running water. A number of facilities have boreholes with hand pumps, but a number of these are currently non-functional. Equipping these facilities with water storage reservoirs might alleviate the problem. Rainwater harvesting is a potential remedy, but some facilities, such as Ober Health Center, have asbestos roofs, making the water unsafe for human use. In the event that it is not possible to replace the asbestos roofs, the rainwater could be used for flushing toilets. Records from the Provincial Public Health and Sanitation Department call for the construction/rehabilitation of boreholes at Kisumu District Hospital and Chiga Dispensary; this is not a sustainable solution, however, because water from this source tends to be contaminated.

Solid and liquid waste management at Kisumu health facilities also need to improve. For instance, medical waste is often disposed of in open pits, mainly because the incinerators are regularly out of order. In addition, some facilities that are connected to the sewer tend to have corroded or clogged pipes, while others use cesspools to dispose of wastewater. Hospitals could set up bio digester systems, which would enable them to manage waste, generate energy and obtain fertilizer for their gardens.

[18] A 2008 questionnaire given to 67 schools by MCI researcher Andrea Castro found that only 16 percent of schools had piped water.

[19] An ”EcoSan toilet” is a toilet that safely processes human waste in a manner that keeps harmful pathogens out of the water supply.

III. FINANCING WATER AND SANITATION IN KISUMU

3.1. Financing Water and Sanitation

The main sources of local revenue for the Municipal Council of Kisumu include property taxes, single business permits and market fees (Nodalis Conseil, 2009). The city also collects vehicle parking fees, slaughter fees, public health fees and Contributions in Lieu of Rates (CILOR) funds. In February 2009, AFD conducted a financial assessment of Kisumu and found that the MCK's total revenues per capita in fiscal year 2007-2008 were KShs. 1,353 ($18), well below the revenues collected by other cities in Kenya (Nodalis Conseil, 2009).[20]

A needs assessment of the impact of the 2007/2008 post-election violence on the operations of the water sector reports that it negatively affected water and sanitation finances.[21] For instance, KIWASCO had a target to collect KShs. 2 million ($26,666) in January and February 2008 but only collected KShs. 463,222 ($6,176). The total cost of damages to the Kisumu water supply system, including vandalism of pipes and water meters, was KShs. 3 million ($40,000).[22]

In addition to local revenue sources, the national government provides funding to the municipal government for infrastructure projects in Kisumu via the Constituency Development Fund (CDF) and the Local Authority Transfer Fund (LATF).[23] The problem is that the Ministry of Local Government disburses half the annual budget to the Nairobi City Council, with the rest divided among the remaining four city councils.[24] In addition, CDF projects are developed without reference to local area planning, budgeting or participation. Table 10 shows some of the projects funded by the LATF and CDF in Kisumu between 2005 and 2009.

Table 10. Select LATF- and CDF-Funded Water and Sanitation Projects in Kisumu City

Funding Source	Project Name	Location	Duration	Cost
LATF	Construction of Flush Toilets	Manyatta & Kosawo	2 years	1,000,000
LATF	Flush Toilets and Septic Tank	Milimani Ward Office	1 year	300,000
LATF	Borehole at Olando	Kogony	1 year	1,050,000
LATF	Construction of Borehole	Kisumu East	1 year	1,050,000
LATF	Flush Toilet - Taifa Park	Town	1 year	650,000
LATF	Renovation of Toilet- Taifa Park	Town	1 year	350,000
LATF	Installation of Refuse Skips	Town	1 year	1,050,000
CDF	Nyagrongo Water Project	Kajulu East	Ongoing	2,316,442
CDF	Gita Public Toilets	Kajulu East	Competed	250,000
CDF	Wandienge/Sana Water Project	Manyatta	Competed	500,000
CDF	Kangadi Water Project	Kolwa East	Competed	50,000

Source: Nodalis Conseil (2009).

[20] In 2007, the other cities collected the following revenuews per capita: Nairobi-KShs. 2,825 ($37); Mombasa-KShs. 2,247 ($30); Nakuru-KShs. 2,033 ($27); and Eldoret- KShs. 1,707 ($23)

[21] http://www.hackenya.org/index.php?option=com_docman&task=doc_download&Itemid=99999999&gid=297

[22] Ibid.

[23] The CDF was established by the CDF Act of 2003 and is an important source of district financing. The fund is intended for constituency-level development projects and constitutes 17-20 percent of total government funds sent to districts. The LATF was established in 1999 through the LATF Act No. 8 of 1998, with the objective of improving service delivery, improving financial management and reducing the outstanding debt of local authorities.

[24] Kisumu receives less because Nairobi, Mombassa, Eldoret and Nakuru have higher populations.

Local revenue collection and supplemental funds from sources such as LATF and CDF are insufficient to cover water and sanitation expenditures in Kisumu City. According to a 2009 article, MCK had an accrued debt of about KShs 1.2 billion in 2009, 10 percent of which was for Kisumu Water and Sewerage Company related debts (Jakorandoh, 2009).

KIWASCO's water billing and revenue collection system has been ineffective and needs to be replaced by an up-to-date customer database (LVSWSB, 2008).[25] Many water connections in the informal settlements are illegal, resulting in big financial losses for KIWASCO. To save on water losses in the informal settlements due to illegal connections, vandalism and lack of meters, the LVSWSB and KIWASCO have introduced a concept named the Delegated Management Model (DMM).[26]

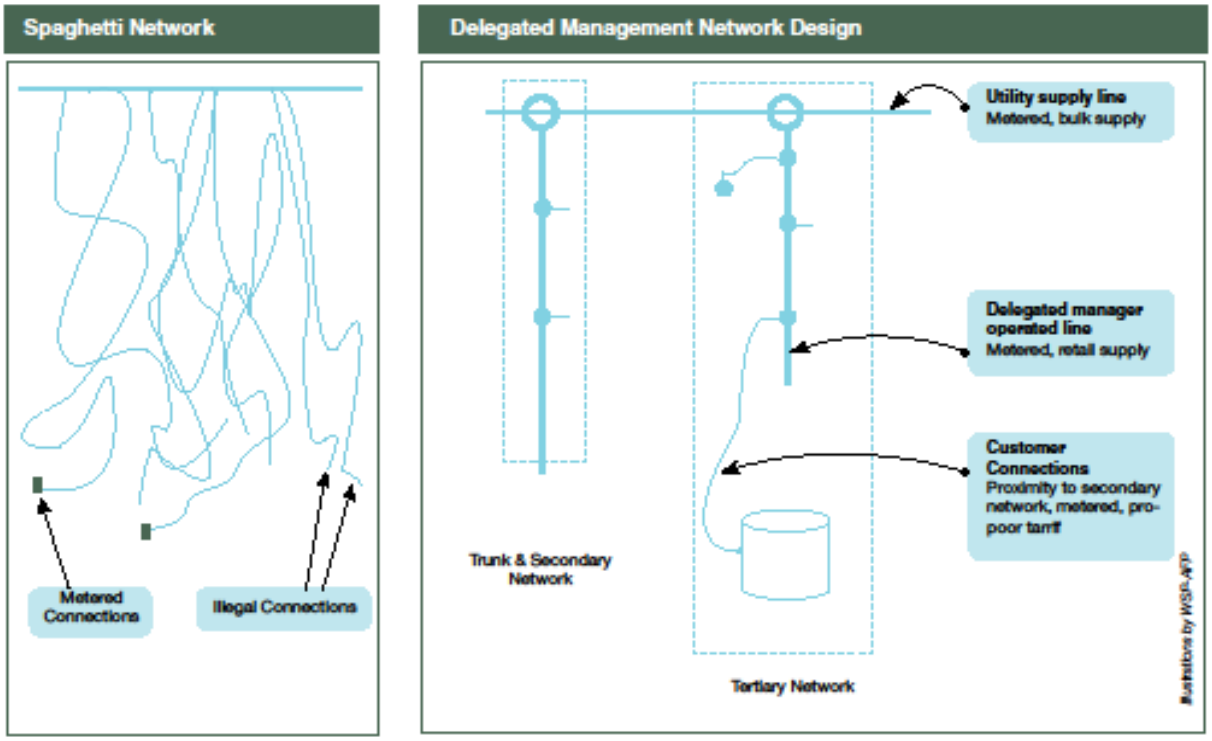
Under the DMM, KIWASCO selects contractors, called 'master operators' (MOs), through a publicly-advertised and competitive process, and offers them a bulk supply tariff. In turn, the MOs bill customers, collect revenue and are responsible for minor maintenance, such as the repair of small leaks. By delegating in this way, KIWASCO reduces administrative costs and brings services closer to the customer. DMM has created jobs, limited unaccounted-for water (UFW) and reduced the overhead costs for KIWASCO. To date, the results from the Nyalenda DMM pilot program have been promising and indicate that the DMM should be scaled up in other informal settlements in Kisumu.

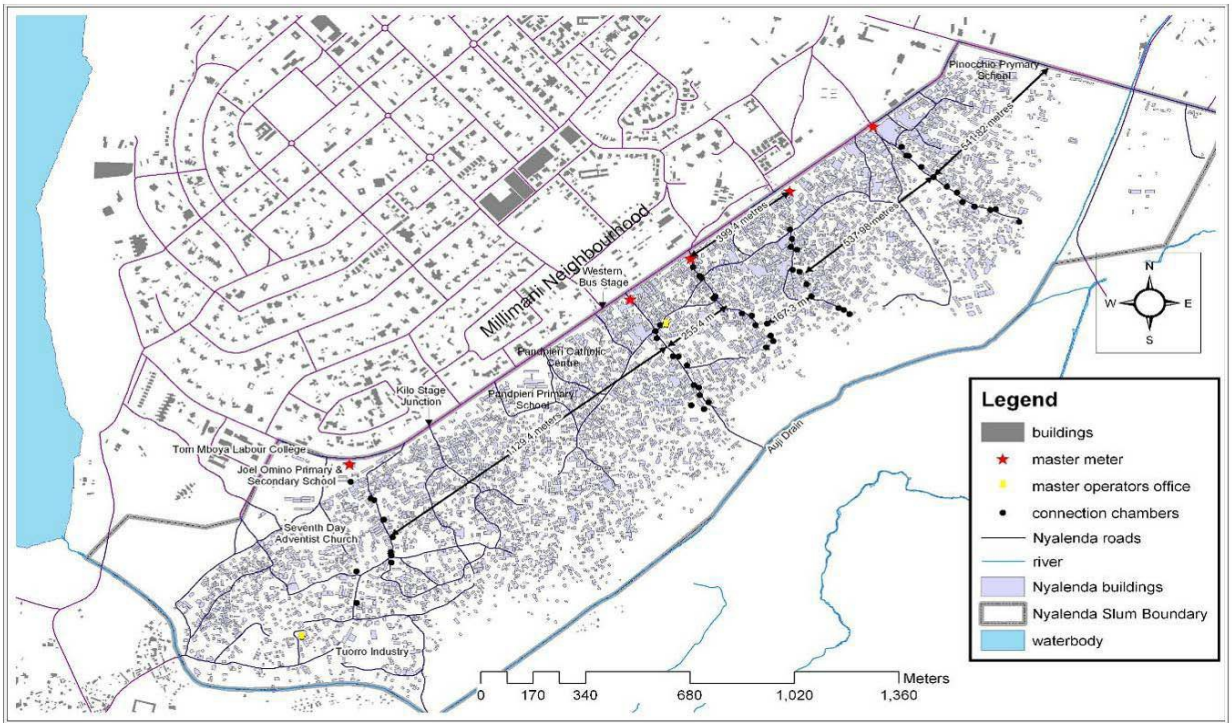
Figure 4 shows how the DMM works. The graphic on the left depicts a network of uncoordinated plastic water pipe connections (so-called spaghetti networks) in an informal settlement. In this system meters are often stolen/removed by consumers, causing problems in billing, and illegal connections contribute as well to leakages and UFW. The graphic on the right shows a Delegated Management Network design. It can be seen that under DMM, master lines are brought into informal settlements with a master meter at each off-take. The graphic at the bottom of Figure 4 shows how this was done in Nyalenda.

[25] GoK/LVSWSB (2005) notes that KIWASCO has a computerized billing system, but the system requires further development.

[26] KIWASCO developed the DMM with the Water and Sanitation Program-Africa (WSP-Africa) and the French Embassy in Kenya in 2004. It was piloted in Nyalenda, a Kisumu slum.

Figure 4. A Spaghetti Network and a Delegated Management Model Network





Source: KIWASCO and WSP (2009).

Tariffs[27]

Water tariffs in Kisumu depend on whether a connection is for domestic or commercial use and the amount of water consumed. Commercial tariffs are flat, meaning that they do not increase with rising consumption. Domestic users are charged by volume of water consumed, based on meter readings. The rates are as follows.

Table 11. Domestic Water Tariffs

Consumption in (m^3)	Monthly charge rate (US$/$m^3$) KIWASCO Domestic	Monthly charge rate (US$/$m^3$) Master Operator
Minimum (6)	2.78	2.40
Above 6 (7-20)	0.56	0.47
Above 20 (21-40)	0.69	0.67
Above 40 (41-60)	0.76	0.67
Over 60	0.83	0.67
Other Costs		
Connection fee	53	20
Deposit	24	13-16

Note: Modified from original table expressed in Kenyan Shillings (KShs). Exchange rate: $1 = 72 KShs.
Source: Adapted from KIWASCO (2006).

Hence, a household consuming between 7 - 20 m^3 per month would pay a monthly meter rent of $2.08, a $2.78 charge for the first for 6 m^3, and $0.56 for every cubic meter between 7 and 20 m^3 that is consumed (LVSWSB, 2008). As a result, a household consuming approximately 10 m^3 per month pays about $7.10.

Water vendors and kiosks in informal settlements charge fees that are far higher than the cost of receiving water directly through the supply meter. According to the 2004 Kisumu City Development Strategy (2004/09) published by UN-HABITAT, the rates charged by water vendors were 50 percent higher than the cost of receiving piped water. A more recent report notes that Kisumu residents accessing water through local kiosks spend an average of KShs. 55 ($0.76) per cubic meter of water (CRC, 2007). It is evident that the cost of vendor-provided water is unreasonably high. This has led many low-income residents to rely on unimproved water sources, such as shallow wells, boreholes, springs, rivers and streams.

It can be seen in Table 11 that the rates offered by Master Operator are slightly cheaper than the KIWASCO rates. The scheme works as follows: the MO pays a deposit of KShs. 15,000 ($200) to KIWASCO; domestic consumers then pay a KShs. 1,000 ($13) deposit to the MO; and kiosks pay a KShs. 5,000 ($67) to the MO. KIWASCO and the MO have a right to withhold the deposits, in case the domestic consumer or kiosk defaults. All the water supplied to informal settlements via MO lines is billed. As a result, this out-sourcing scheme is not only viable for KIWASCO and MOs, but poor residents in informal settlements end up paying less for water than high- and middle-income households.

[27] There is wide variation in the tariffs charged in Kisumu, Nairobi and Mombasa. CRC notes that the Water Services Regulatory Board is working on Guidelines for Setting Tarrifs that will help systematize tariff setting across Kenya.

Table 12 makes clear that the sewerage rates are similar to the water rates.

Table 12. Sewerage Charges

Consumption in (m^3)	Monthly charge rate (US$) -2003 to date
Minimum (6)	2.78
Above 6 (7-20)	0.56
Above 20 (21-40)	0.69
Above 40 (41-60)	0.76
Over 60	0.83

Note: Modified from original table expressed in Kenyan Shillings (KShs). Exchange rate: $1 = 72 KShs.
Source: Adapted from KIWASCO (2006).

3.2. Water and Sanitation Projects in Kisumu

In recent years, several projects have been initiated to improve the water supply and sanitation in Kisumu City. These include projects funded by the French Agency for Development (AFD or *Agence Française de Development*) and the World Bank, as well as by such non-governmental organizations as World Vision, Sustainable Aid in Africa (SANA) and Undugu Society.

The *Agence Française de Development* (AFD) has pledged a KShs. 1.7 Billion (€20 million)[28] soft loan to improve water supply and sanitation services in Kisumu City. The AFD support is being implemented in two phases, of which the first phase, the Short Term Action Plan (STAP), has been completed. About 30 percent of the total AFD loan, KShs. 510 million (€6 million), was allocated to STAP for the rehabilitation of water intakes, water treatment plants, water storage facilities, sewers and sewerage treatment plants. Under STAP, a new 600mm pipe was built to bring water from the Dunga treatment plant to Kibuye reservoir, and improvements in waste stabilization ponds were also undertaken. The main achievements of STAP have been 1) the extension of the water network to informal settlements; 2) the construction of more water kiosks; and 3) the rehabilitation of water treatment plants to meet their original design capacity, as previously, the plants had been operating well below capacity, due to poor management.

The second phase of the AFD project, known as the Long Term Action Plan (LTAP), seeks to increase water and sanitation coverage by building new intakes, new treatment plants and a new sewerage system. The remaining 70 percent of the AFD loan—KShs. 1.19 Billion (€14 million)—has been allocated to LTAP. However, due to financial constraints, the LTAP works will focus on select areas in Kisumu.[29]

AFD has also sponsored other projects to improve water and sanitation services in the informal settlements of Manyatta and Nyalenda. A pilot, funded by AFD with the participation of the Water and Sanitation Program (WSP), has pioneered public-private partnerships between small private operators and KIWASCO, the local water utility, to extend and improve the water supply.

[28] € = Euros. The exchange rate was 1 €=85 KShs.

[29] The areas to be covered include Kibuye, Milimani, Kanyakwar, Nyalenda, Manyatta, Wathorego, Korando, Kogony, Kasule, Chiga (Kibos area only), Nyalunya, Kadero, Okok, Got Nyabondo, Konya and Manyema. Areas not covered include Kanyagwegi, Ojolla, Bar, Nyahera, Dago, Mkendwa and Buoye.

Under this model, the utility sells bulk water to private agents contracted to operate and manage the network in poor communities. Each private operator manages billing, collection and minor maintenance and provides services such as private connections, shared standpipes and water kiosks. This successful model has the potential for scaling up and is being applied in other low-income areas.

KISWAMP

In response to the increasingly large volume of solid waste generated, the Kisumu Integrated Solid Waste Management Project (KISWAMP) was initiated as a collaborative project between Municipal Council of Kisumu (MCK), UN-HABITAT, SIDA and ILO, with the aim of reducing solid waste, promoting recycling, involving community-based groups and civil society organizations and strengthening public private partnerships. The total cost of this 2007-2010 UN-HABITAT project, financed by SIDA through the UN-HABITAT and ILO, is KShs. 65,587,500 ($874,500). One of the challenges the project has faced is the limited financial management capacity of the MCK. Another challenge is the MCK's limited capacity to manage waste and provide the regulatory environment for other actors. The project is yet to procure waste skips and a skips loader for waste collection and transport.

Kisumu Urban Project (KUP)

Another relevant project is the Kisumu Urban Project (KUP) a four-year AFD development project (2010-2014) to improve living conditions in Kisumu by improving solid waste management and rehabilitating public facilities and infrastructure, among other things.[30] Key water and sanitation initiatives proposed under the KUP include the construction of a new 50-acre sanitary landfill site, 15 kilometers to the northeast of Kisumu City. Two proposed projects are: (1) Development of a ten year Waste Management strategy; (2) Development of a city waste landfill complete with recycling unit; (3) Development of small and medium waste recycling units.

The funding mechanism for projects such as KUP is as follows: AFD provides a concessional loan to the Government of Kenya's Ministry of Finance, and an agreement is signed by AFD and the Ministry of Finance; the Ministry of Finance then retrocedes the loan to MCK as a grant. The total cost for KUP is €40 million or KShs. 4 billion ($53.3 million). However, not all KUP funds are for solid waste management, and KUP does not include financing to clean and collect such equipment as compactors, skips and skip loaders. Table 13 shows the costs of sanitation projects to be implemented under KUP.

Table 13. KUP Investment Costs for Solid Waste Management

[30] The other components are: 1) capacity-building management and planning; 2) slum upgrading; 3) commercial services and markets; 4) public facilities, infrastructure and service delivery.

Description	KShs.	US $
Development of comprehensive solid waste strategy	35,000,000	466,667
Construction of new sanitary landfill site	560,000,000	7,466,667
Rehabilitation and closing of the existing dump site	14,000,000	186,667
Solid waste recycling and recovery activities	20,000,000	266,667
Total	**629,000,000**	**8,386,667**

Source: Nodalis Conseil (2009).

NGO Projects

World Vision operates child-focused programs in Obunga and Bandani, while SANA's focus has been hygiene education and community-based water and sanitation provision in peri-urban and low-income settlements of Kisumu City. For the last six years, SANA has supported community-based WATSAN projects in Kisumu City. Examples of projects initiated by SANA International include the Wandiege community water (borehole) project, implemented with the financial support of AFD and CORDAID.[31] The project has been supplying clean water to residents of Manyatta (B) and has benefitted from financial and in-kind support from the community. The Undugu Society came to Kisumu in 2003, initially as a youth and street children education program. Since 2005, the society has developed a water and sanitation component and has built at least six public latrines in Manyatta (LVSWSB, 2008).

3.3. Costing Model

Data on water and sanitation coverage are derived from a 2008 sample survey conducted by J. Patchett (MP) and Otieno, Odongo and Partners. The 2007 "Citizen's Report Card on Urban Water, Sanitation and Solid Waste Services in Kenya", which was administered in Kenya's three main cities—Nairobi, Mombasa and Kisumu—also provided supplementary information.

Improved water sources or technologies identified by MCI as appropriate for Kisumu include:[32]

1. Individual household connection
2. Piped water from a yard tap
3. Piped water obtained from a neighbor
4. Protected well/spring
5. Rainwater harvesting

Table 14. Water Coverage

[31] CORDAID is a government-funded Dutch NGO supporting numerous Dutch firms and organizations working with Kisumu NGOs to upgrade the downtown slum of Manyatta, as part of CORDAID's Urban Matters project, for which MCI serves as the secretariat and facilitator.

[32] This list of interventions is presented as a reference and should not be viewed as an exhaustive set of options.

Improved Water Source	% Population	Unimproved Water Source	% Population
Individual connection	21	Lake (or dam)	2
Yard tap	28	Water vendors	26
Piped neighbor's connection	3		
Protected shallow well/spring	8	Unprotected shallow well/spring	7
Roof catchment	5		
Total	65		35

Source: LVSWSB (2008).

Technologies included in this needs assessment as representing "improved" sanitation facilities include:

1. Lined pit latrine
2. Ventilated improved pit latrine (VIP)
3. Flush toilet connected to the public sewerage
4. Flush toilet connected to septic tanks
5. Simple pit toilet

Table 15. Sanitation Coverage

Improved Sanitation Source	% Population	Unimproved Sanitation Source	% Population
Flush toilets (connected to sewer)	16	Neighbor's toilet	4
Flush toilet (connected to septic tank)	14	Public toilet	1
Ventilated improved pit latrine (VIP)	7	None	1
Pit latrines	54	Unknown	3
Total	91		9

Source: LVSWSB (2008).

Unit Costs

Water and sanitation unit costs used in the costing model are shown in Tables 16 and 17. The water unit costs are derived from the Bills of Quantities (BoQ) of various organizations working on water issues in Kisumu.

Table 16. Water Unit Costs

	Unit Cost (KShs)	Unit cost (USD)	Source
Household tap connection	11,200	156	Kisumu Millennium Water Alliance/COKE Project, 2005
Yard tap connection	8,700	121	
Public standpipes construction	37,500	521	Kisumu Urban & Peri-urban Project - Obunga Water Supply, 2008
Protected spring construction (retention wall, collection chamber, reticulation to the community and labour charges)	501,144	6,960	BoQ for constructing borehole under the Kano Plains Water and Sanitation Project , Kawere Water Project
Borehole construction (drilling, well head, equipping with foot pump and disinfection)	1,238,820	17,206	BoQ for constructing borehole under the Kano Plains Water and Sanitation Project , Kawere Water Project

Table 17 shows the sanitation unit costs used in the model, obtained from publications by Mara (2006) and Satterthwaite and McGranahan (2006). Appendix 3 shows local unit costs from MCK and SANA and explains why these were not used in this study.

Table 17. Sanitation Unit Costs

	Low Cost	High Cost	Average Cost (USD)
Simple pit latrine	40	50	45
Single-pit VIP latrine	52	261	157
Pour-flush toilet	174	305	239
EcoSan toilet without urine diversion	261	348	305
Urine Diversion Dehydration toilet (UDDT)	744	800	772
A Flush toilet connected to a septic tank	400	1500	950
A Flush toilet connected to sewer			1500

Source: Mara (2006); Satterthwaite and McGranahan (2006); GTZ (2009) for UDDT costs.

3.4. Results of the Costing Model

To identify the financial resources required to meet water and sanitation targets, two models are presented: a Baseline scenario and an Alternative scenario.

Baseline scenario

Interventions under this scenario will be rolled out at an even pace between 2010 and 2015, hence a linear scale-up path has been chosen. The underlying assumptions, with regard to water supply, are as follows:

- Annual operation and maintenance (O&M) costs for water supply are calculated as 7.5 percent of the capital cost of a technology, while it is assumed that rehabilitation costs amount to 15 percent of the capital cost.

- The extension and rehabilitation of the water network and sewer lines is not included as a supplementary intervention in the costing model, as it will be funded by LTAP.
- Rainwater collection is an alternative water source, but it depends on climatic conditions and weather patterns and requires filtering and treatment, which has further cost implications not taken into account in this costing model.

With regard to sanitation, the assumptions are:

- Annual O&M and rehabilitation costs for pit latrines and VIP amount to two percent of the capital cost, but the O&M costs for flush toilets are 7.5 percent, and rehabilitation costs are 15 percent.
- Poor households are more likely to rely on and to share pit latrines, but in the costing model, the percentage of poor households using shared latrines is not considered.

Costs for water supply and sanitation at health facilities are not included in the baseline model because of incomplete data. The results from the Baseline scenario show that an average annual investment of $17 per capita is necessary to meet the water and sanitation-related MDG targets**.**

Table 18. Baseline Model

Baseline Scenario Costs (USD)							
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**Average**
Water	948,871	1,018,722	1,092,909	1,171,718	1,255,308	1,343,950	1,138,580
Sanitation	5,860,821	6,209,062	6,574,536	6,958,442	7,361,095	7,783,511	6,791,244
Wastewater	24,730	27,232	29,802	32,447	35,164	37,956	31,222
Hygiene and Education	68,903	75,801	84,887	95,329	104,766	113,085	90,462
Total	6,903,325	7,330,817	7,782,133	8,257,936	8,756,333	9,278,503	8,051,508
Per capita	16	16	17	17	18	18	17

Alternate scenario

In the Alternative model, UDDTs are introduced to replace half the pit latrines, and two biogas digesters[33] are built (one in 2010 and one in 2011). Plug-flow digesters are recommended because they are low-cost, require minimal maintenance and produce a good quantity of gas. Each biogas digester will cost approximately $13,300. Given that the provision of commercially managed public latrines is not seen as an 'improved' solution under the MDGs, the proposed biogas production facilities will not be commercial facilities. In the Alternative scenario, costs for providing health facilities with water reservoir tanks and incinerators are also included and

[33] A biogas digester typically mixes water and human waste in anaerobic conditions to make biogas. About 10 percent of the profits from the biogas production should be invested into a community sanitation fund to support the construction of latrines.

have been frontloaded to 2010 and 2011. The average annual per capita costs in the Alternative model for the 2010-2015 period is $22 per capita, as shown in Table 19.

Table 19. Alternative Model

Alternative Scenario Costs (USD)							
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**Average**
Water	948,871	1,018,722	1,092,909	1,171,718	1,255,308	1,343,950	1,138,580
Sanitation	7,758,518	8,210,291	8,683,583	9,179,822	9,699,406	10,243,548	8,962,528
Wastewater	24,730	27,232	29,802	32,447	35,164	37,956	31,222
Hygiene and Education	68,903	75,801	84,887	95,329	104,766	113,085	90,462
Hospitals	35,400	35,400	-	-	-	-	35,400
Total	8,836,423	9,367,447	9,891,180	10,479,316	11,094,644	11,738,539	10,234,591
Per capita	20	21	21	22	23	23	22

IV. CONCLUSION AND RECOMMENDATIONS

For Kisumu City to achieve Target 7C (formerly Target 10) of Millennium Development Goal #7—to cut in half, by 2015, the proportion of people without access to safe drinking water and basic sanitation—the water supply and sanitation infrastructure must be rehabilitated and expanded. In addition, particular attention needs to be paid to improving water and sanitation in low-income areas and reducing disparities between wealthy and poor households in terms of access to clean water and environmentally sound sanitation facilities. With five years remaining to meet the MDGs, sound policies and strategies must be adopted, and additional domestic resources and financial support from the international community needs to be galvanized. With an average annual investment of $17 per capita, MCI estimates that Kisumu will be able to meet the MDG targets related to water and sanitation.

Policies and strategies the city can pursue to improve water and sanitation services include:

- Focusing on providing water and sanitation services to populations living in peri-urban areas and informal settlements. The Delegated Management Model is a good example of how to improve the water supply to informal settlement residents, it should be widely replicated .
- Rehabilitating water and sanitation infrastructure and establishing a good monitoring system to quickly identify infrastructure needing repair.
- Improving revenue collection by reducing the number of illegal connections, enforcing penalties and updating the computer database.
- Setting up waste digesters especially in the slum areas. This will reduce the cost of waste collection, provide biogas for cooking and create jobs.
- Developing solid waste collection, particularly in peri-urban areas, and promoting recycling.
- Advocating for the construction of UDDTs and latrines connected to septic tanks in informal settlements, discouraging the construction of pit latrines that do not conform to city planning codes.

- Promoting the development of boreholes and other community water projects in the peri urban areas where it is expensive to promote piped water from the Utility company.

Regrettably, there is no simple sanitation equivalent of small-scale water providers such as the Master Operators. However, the construction of composting toilets should be promoted as a viable solution for residents of peri-urban areas, as they do not require sewer connections and do not contaminate ground water, unlike pit latrines. They also provide opportunities for environmentally friendly fuel generation. In informal settlements, a simplified sewerage (or condominial) system presents an opportunity for possible replication of the DMM. For instance, entrepreneurs could install a digester connected to toilets in different parts of an informal settlement.

Garbage collection and recycling must also be given due consideration. In addition to improving hygiene, they create potential employment opportunities, particularly among Kisumu's youth. Moreover, given that most of Kisumu's solid waste is organic, a comprehensive recycling program, including a public awareness campaign, is necessary in order to capitalize on these opportunities.

In addition to expanding access to improved water sources and improving sanitation services, hygiene education must also be accorded priority. School children are often eager to learn and willing to absorb new ideas, and hygiene behavior learned in school can lead to lifelong positive health and hygiene habits. Moreover, school children can influence the behavior of family members - both adults and younger siblings - and thereby positively influence the community as a whole. School-based hygiene education programs are therefore an essential part of water and sanitation initiatives.

The designation of Kisumu as a Millennium City by UN Special Envoy on the MDGs Dr. Jeffrey D. Sachs has raised hopes among poor Kisumu residents that they will soon be able to access piped water and better sanitation services (Falkenmark, 2004). By scaling such initiatives as the Delegated Management Model, KIWASCO can guarantee access for the urban poor to affordable and reliable piped water. By promoting both the installation of septic tanks in informal settlements and the construction of Urine Diversion Dehydration Toilets, the MCK can ensure that poor residents will no longer have to rely on unsafe pit latrines and undignified coping mechanisms such as relying on neighbor's toilets. With its national and international partners, multilateral agency and private sector support, the City of Kisumu should soon be equipped to provide the safe drinking water, waste collection and sanitation that its residents dearly aspire to and rightly deserve.

REFERENCES

Awange, J. L, Sharifi, M. A., Ogonda, G., Wickert, J., Grafrent, E., and Omulo, M. A. (2007). *The Falling Lake Victoria Water Level: GRACE, TRIMM and CHAMP Satellite Analysis of the Lake Basin.*

Castro, V. and Morel, A. (2008). "Can delegated management help water utilities improve services to informal settlements?," *Waterlines*, 27(4), pp. 289-306.

Duncan, M. (1996). *Low-Cost Sewerage* (Chichester, UK: John Wiley and Sons).

Emory University and Great Lakes University of Kenya (2008). "Obunga water source mapping and analysis."

Falkenmark, M (2004). "Overarching conclusions and comments from the 2004 Stockholm Water Symposium, 20 August," http://www.siwi.org/press/presrel_04_SWS%20Conclusions.htm (Accessed 3/5/2010).

Government of Kenya / WSP/ World Bank (2007). *Citizen's Report Card (CRC) on Urban Water, Sanitation, and Solid Waste Services in Kenya: Summary of Results from Nairobi, Kisumu and Mombasa* (Nairobi, Kenya: World Bank).

Government of Kenya and ORC Macro (2004). *Kenya Demographic and Health Survey 2003* (Nairobi, Kenya: Central Bureau of Statistics and Ministry of Health, Kenya).

Government of Kenya Ministry of Water and Irrigation/Lake Victoria South Water Services Board [GoK/LVSWSB] (2005). *Kisumu Water Supply and Sanitation Project: LTAP Feasibility Report* (Kisumu: Lake Victoria South Water Services Board).

Hydroconseil and B.G. Associates (2003). *Improving Water Supply and Sanitation Services in Kisumu City (Kenya)*, Feasibility Study, Final Report.

Jakorandoh, A. (2009). "Lakeside city of Kisumu council budget revealed," http://majimbokenya.com/home/2009/06/26/lakeside-city-of-kisumu-council-budget-revealed/ (Accessed 2/15/2010).

Kayombo, S., and Jorgensen, S. E. (2006). "Lake Victoria: Experiences and lessons learned brief," www.ilec.or.jp/lbmi2/reports/27_Lake_Victoria_27 February2006.pdf (Accessed 12/5/2009).

Kiwango, A., and Wolanski, E. (2008), "Papyrus wetlands, nutrients balance, fisheries collapse, food security, and Lake Victoria level decline 2000-2006," *Wetlands Ecology and Management,*16, pp. 89-96.

Kisumu Water Supply and Sanitation Company [KIWASCO] (2006). *Approved Water and Sewerage Charges* (Kisumu: KIWASCO).

Lake Victoria South Water Services Board [LVSWSB] (2008). *Kisumu Water Supply and Sanitation Project. Long Term Action Plan: Water Design Report*. Prepared by Mouchel Parkman, J Patchett (MP), Otieno Odongo and Partners.

Lake Victoria South Water Services Board [LVSWSB] (2005). *Hygiene Promotion Strategy*. *Identification of Implementation and Management Arrangements for Improved Water and Sanitation Services to Informal Settlements in Kisumu*. Prepared by Losai Management Limited.

Municipal Council of Kisumu and UN-HABITAT (2004). *Kisumu City Development Strategies [2004-2009]* (Nairobi: UN-HABITAT/SIDA).

Nordalis Conseil (2009). *Pre-feasibility Study of the Kisumu Urban Project*, *Draft Report* (Paris: Nordalis Conseil).

Ogari, J. (2001). "Impact of exotic fish species and invasive water weeds such as the water hyacinth on Lake Victoria fisheries." Paper presented at LVEMP conference, Kisumu, Kenya.

Ong'Or, B. T. I., and Long-Cang, S. (2007) "Water supply crisis and mitigation options in Kisumu City, Kenya" *Water Resources Development*, 23 (3), pp.485-500.

Osumo, Wilfred M (2001). *Effects of Water Hyacinth on Water Quality of Winam Gulf, Lake Victoria* (Tokyo: The United Nations University).

Satterthwaite, D., and McGranahan, G. (2006). *Overview of the Global Sanitation Problem, Human: Occasional Paper of the 2006 UNDP Human Development Report* (New York: UNDP).

UN-HABITAT (2008). *Kisumu Integrated Solid Waste Management Baseline Survey*. Prepared by Dr. George M. Onyango and Dr. Jacob K. Kibwage (Nairobi, Kenya: UN-HABITAT).

UN-HABITAT (2005*). Situation Analysis of Informal Settlements in Kisumu. Cities Without Slums Sub-Regional Programmes for Eastern and Southern Africa. Kenya Slum Upgrading Programme* (Nairobi, Kenya: UN-HABITAT).